AgriSkills Guidebook on Digitalization in Agriculture

Good Practices • Use Cases • Support Programs

Authors:

Wolfgang Kniejski, Angela Ivanova, (INI-Novation, Germany)

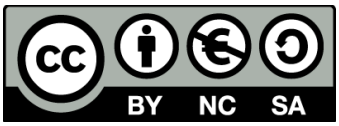
Contributors:

Dimitar Smiljanovski (MEDF, North Macedonia), Effi Tsili (CONNEXIONS, Greece), Pantelis Balaouras (CONNEXIONS, Greece), Drejc Kokošar (Zavod Id20, Slovenia), Wolfgang Eisenreich (WIN, Austria), Irene Facchin (INI-Novation, Germany), Mihail Stanev (INI-Novation, Germany)

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them. Project number: 2021-1-DE02-KA220-VET-000034651

Declaration on copyright:



Content

1. Introduction

According to the United Nations, the world population will increase to around nine billion people by 2036 [1]. There are already supply bottlenecks and hunger in many places. At the same time, agriculture is facing enormous tasks: persistent droughts, shrinking agricultural areas, new diseases and pests. Thus, a constantly growing global population require intelligent solutions quickly. In addition, agriculture should be adapted to modern strategies against climate change.

These challenges can only be met by increasing efficiency in the sector through its transformation. An enabling factor for such necessary efficiency gains is the digitization of agriculture, which has positive impacts on crop, plant and animal health, food processing, post-farming supply chains and environmental control. These significant technological advancements will provide the wider agriculture sector an enormous potential: transformation in agriculture is producing positive effects - on people and society. However, we also have to recognise that with these opportunities come new responsibilities, and new challenges will appear.

Resources are shifting. Technologies are complementing human labour and at the same time new business and new job opportunities are being created. This catalogue “AgriSkills Guidebook on Digitalisation in Agriculture” informs about the impact and addresses a wide range of innovative technologies and applications as well as skillsets required to make the transformation successful. Stakeholders should understand that digitalisation of agriculture is only the starting point in the development towards smart farming and precision farming:

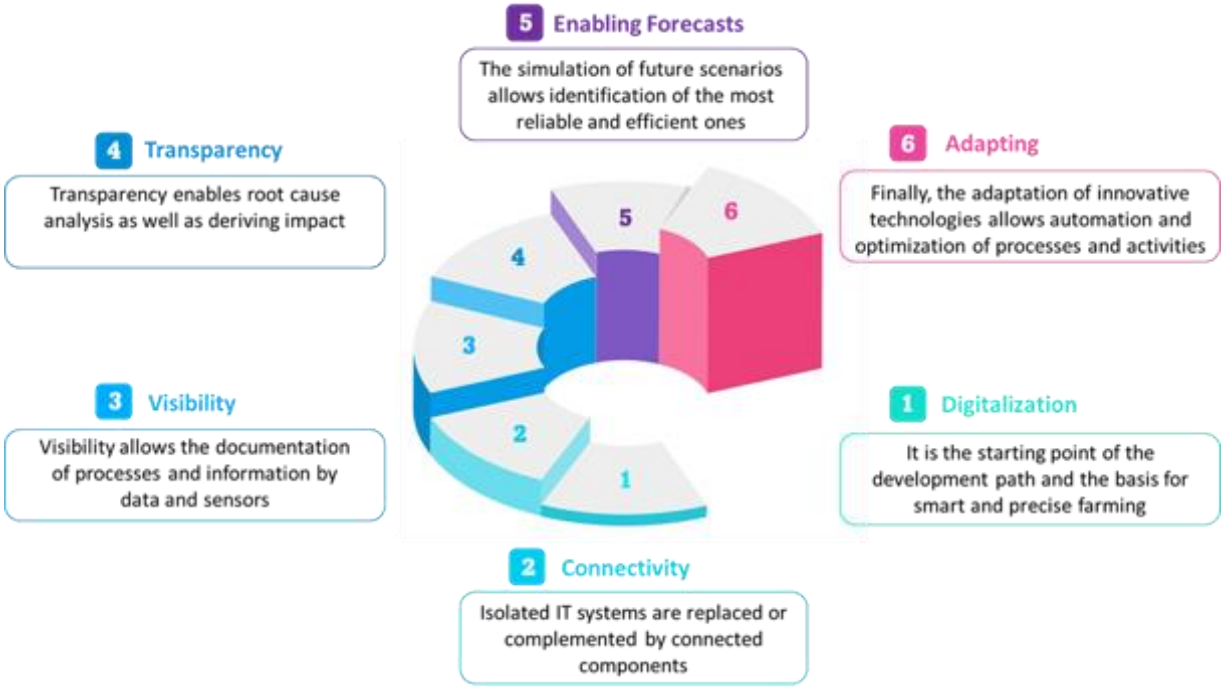


Figure 1. Elements of the digitalisation processes in agriculture, Source: INI-Novation GmbH

The shift towards digital agriculture requires different processes, technologies and organisational changes, especially considering the need of reskilling and upskilling of humans

involved in the digitalisation processes, being it as decision maker how to start the digitalisation, how to apply innovative technologies, applications and solutions and how to use and maintain them. It is about understanding that stakeholders should not only know what technology to seek, but also how to use it. In the digitalisation process of agriculture isolated systems will be replaced or complemented by connected components. Data being gained out of modern systems need to be understood. Visibility is required to support decision processes and operations. Only transparently analysed data will enable analysis tasks and documenting impact. This will lead to understanding scenarios and identifying the most proper ones.

Let's use one example: field robots will be able to identify and remove infected plants or weeds with high precision, take care of the harvest or carry out targeted irrigation and fertilization. One approach to being able to carry out these diverse tasks is to use sensors, software and actuators with the help of artificial intelligence. This creates a modular system that offers tailor-made solutions for every request.

We can foresee that in the near future there will be a shift in how agriculture organizations and stakeholders look at the entire elements in the process of upgrading to smart farming and precision farming. Furthermore, they should also look at business metrics such as Key Performance Indicators (KPI)—a term widely used in business goal setting and human resources. Our future KPIs may no longer be built merely on counting and qualifying our professional achievements based on quantifiable facts and data such as unit sales, customer contacts, or satisfaction ratings. Instead, we will see the rise of what we call indicators, which will reflect an approach to ecological, economic and social sustainability.

Therefore, this guidebook not only showcases technology-based applications enabling the transformation in agriculture. It showcases also elements of the economic framework to make the transformation happen, such as agriculture incubators and accelerator as well as programs to support reskilling and upskilling in the sector. From these points of view, many good practices and expert opinions are presented from Germany, Austria, Slovenia, North Macedonia, and other European countries.

1.1. Main Chapters and Structure

In this first chapter a brief general introduction to Digital Agriculture and especially its trends, impacts and benefits is provided. And the methodology and selection criteria for good pactices and showcases are described. The second chapter addresses innovative approaches in modern agriculture concepts. The chapter suggests a structure for categorising enabling technologies and links them to different application areas. It also addresses the changes in requirements of skills as well as of learning cultures in order to promote a better understanding of and adaptation to changing demands on work forces.

Following this general introduction into a diverse set of Digital Agriculture aspects, this guidebook provides a good practice overview in the two then following chapters: (1) an overview of relevant practices in different application areas in terms of learning practices, accompanied by (2) an overview of already applied technology showcases enabling the transformation in elements of the agriculture value chain processes.

In the then following fifth chapter, some examples are illustrating program elements to support digitalisation of agriculture, i.e. re-skilling and up-skilling examples as well as descriptions of incubators and accelerators focussing on the agriculture sector. The collected good practices and technology use cases are also being published in Social Media channels, in order to facilitate the exchange between interested stakeholder group and users from various countries.

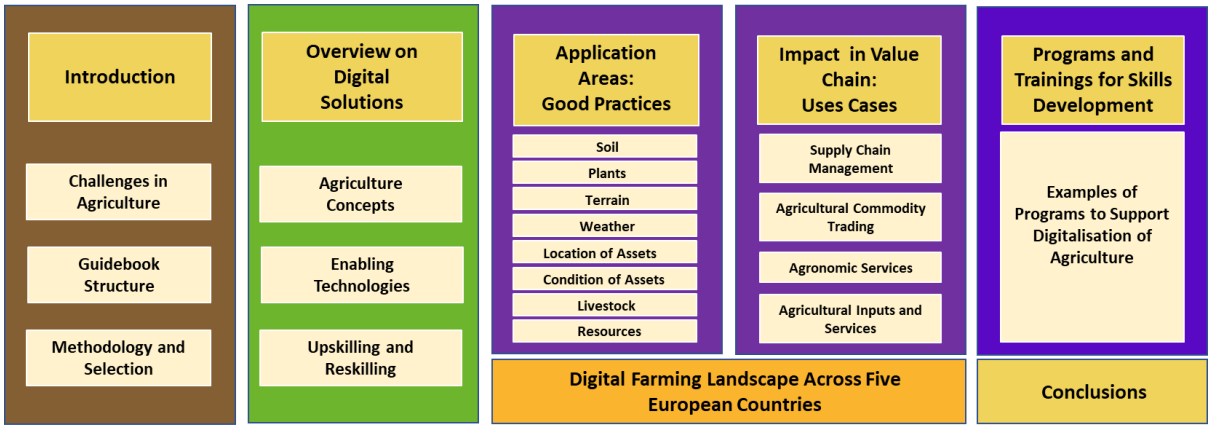


Figure 2. The structure of this good practices catalogue, Source: © INI-Novation GmbH

In the sixth chapter the main takeaways from different European regions will be described, until in the final seventh chapter the »AgriSkills« project is briefly described.

1.2. Methodology and Selection Criteria

The main objective of this guidebook is to collect good practices that can serve as a main input for improving the awareness, knowledge and infomation across Europe in a way that can allow the agriculture stakeholders to reskill and/or upskill themselves to meet the demands of the transition to digitalisation of services and process in the sector. Another main goal of the guidebook is to identify and illustrate good practices that can facilitate the development and deployment of European policies, aimed at supporting both the agriculture sector and its workforce in taking digitalisation benefits.

Apart from the high-level objectives, the authors also defined three main project priorities, that are supposed to ensure that the collected good practices and references are going to contribute towards achieving the high-level objectives and will be able to serve a variety of stakeholders along the process. More precisely, all collected good practices had to be chosen in a way that can:

- Support individuals in acquiring and developing basic skills and key competencies to be able to meet the new demands, resulting from the adoption of digitalisation technologies and concepts.

- Support educators, youth workers, educational leaders, and support staff in acquiring new methods and best practices for upskilling and reskilling enabling the implementation and the use of digital farming and smart farming applications.
- Ensure the transparency and recognition of skills and qualifications in a way that benefit the workforce and the agriculture sector.

In order to achieve the above-stated objectives of identifying good practices for the catalogue, a number of different methods were used. The primary way of identifying good practices was an extensive literature and desk research, covering the most recent digital agriculture focused innovations in technology and education. For that purposes, various sources were used, such as databases, media, websites of companies, chambers, governmental agencies etc.

Another way of identifying novel and relevant best practices was through interviews with technology experts, established companies as well as innovative start-ups. This approach seems to be particularly suitable for novel concepts because the experts could often provide much more insights than media or the academia. Apart from the good practices that were documented as part of the interviews, they also provided us with a broader overview of the technology landscape, which in turn allowed us to look for good practices in areas that we had previously missed. Having said that, the decision to supplement our research activities with interviews seemed well justified and allowed us to create a report that is aligned with the most recent technology innovations.

The main criteria for the selection of good practices were defined by the project consortium at the very beginning. The criteria are related to vocational education and training (VET) objectives can be summarised as follows:

- Innovation – innovative nature activities and a set of necessary competencies that future employees and managers must possess in order to adopt a different approach from conventional approaches in order to be successful. After an in-depth study of the relevant needs and gaps, different types of competences and skills were defined, such as transversal competences, technical skills, creative skills, social skills, contextual skills. All good practices, related with vocational education and training, are related to the defined needed skills.
- Efficiency - good practices should present different initiatives, programs, methods, training materials or other activity, which can produce one or more positive, tangible and/or intangible impact(s) in practical use.
- Reproducibility - Local development projects, methods, actions and policies must be at least partially reproducible or transferable as knowledge and applicable by our main target audience: trainers in VET and adult education trainers, labour market policy makers and human resource managers.
- Sustainability - good practices should show how sustainable economic and human resource development can be achieved through implemented initiatives, methods, policies or other activities to increase the competences and skills provided in our first criteria. In addition, many good practices in the field of the latest and innovative technologies are described in order to increase the knowledge of the rapidly growing technological possibilities and to give clarity to the future perspective of economic and technological development.

2. Overview on Digitalization and Digital Solutions

PIcture 1. Modern Smart Farming Agriculture Technology at Farm © Andrey Popov | Dreamstime.com

Agriculture is a fundamental and crucial activity for all people in the world. It is indispensable to human survival, economic prosperity, and cultural heritage. Its importance extends far beyond the mere act of farming; it shapes societies, economies, and the well-being of individuals around the world.

Nowadays, agriculture is going through a significant transformation and with the development of innovative technologies, digitization is seriously entering all sectors of agriculture. The world is becoming more and more globalised, and there are various challenges that the agricultural sector faces. Here are some of the challenges and reasons why digitalization is crucial:

- *Food Security and Growing Population:* With the global population steadily increasing, there is a growing need to produce more food to meet the demand.
- *Resource Scarcity:* Depleting natural resources, including water and arable land, pose significant challenges for sustainable agriculture.
- *Climate Change and Weather Variability:* Unpredictable weather patterns, extreme events, and shifting climate conditions affect crop yields and livestock management.
- *Rising Input Costs:* The costs associated with inputs like fertilizers, pesticides, and fuel are increasing, impacting the profitability of farming.
- *Labor Shortages:* Many regions face a shortage of skilled labor in agriculture, which can lead to inefficient operations.
- *Market Access and Fair Pricing:* Farmers often face challenges in accessing markets and ensuring fair prices for their products is a concern.
- *Pest and Disease Management:* Controlling pests and diseases is critical for maintaining healthy crops and livestock.
- *Information Asymmetry:* Not all farmers have access to the latest information, best practices, and technologies, leading to disparities in productivity.

The integration of digital technology and solutions is revolutionizing agriculture in various ways, presenting opportunities to enhance efficiency, productivity, and sustainability across the entire agricultural value chain. This generates significant societal, economic, and ecological impacts.

For more infomation, read Read Module 3 “Managing the Agricultural Business in the Digital Economy” and Module 4 ”Building Economic Value Chain in Agriculture Using Digital Technologies” and from AgriSkills Training Course. Follow the link to the AgriSkills 4.0 e-learning platform: https://training.agriskills40.com/modules/.

2.1. Agriculture Concepts

Digitization is increasingly shaping the world of work. While computerisation has until recently been confined to routine tasks involving explicit rule-based activities, algorithms for digitalisation are now rapidly entering domains reliant upon smart data handling and can readily substitute for labour in a wide range of non-routine cognitive tasks. This process significantly changes the nature of work in different industries and professions.

In the field of agriculture digitization, digital transformation is gaining momentum. Research [2]. indicates that farmers are receptive to innovation - 43% of surveyed farmers express a focus on experimenting with new products to enhance yields. In Europe in 2022, 62% of farmers plan to implement farm-management software and remote sensing within the next two years. This trend aligns with a broader transition toward more sustainable and resource-efficient food systems, where precision agriculture plays a pivotal role as a key enabler. In Europe, 21% of farmers utilize precision-agriculture hardware, emphasizing its significance in promoting sustainable and low-emission farming practices. According to McKinsey, business models in agriculture are evolving toward integrated solutions to further enhance efficiency and effectiveness in the sector [2].

Adapting innovative processes to a digital framework has the potential to revolutionize agriculture, making it more efficient and environmentally friendly. The rapid advancements in technologies like the Internet of Things (IoT), cloud computing, robotics, and Artificial Intelligence (AI) are driving the shift towards smart farming [3]. The expectation is that smart farming approaches will ultimately improve knowledge on enterprise and human resource level via efficient sharing and learning from data from multiple enterprises [4].

Technological innovations are reshaping the way farming is done. The modernization of agriculture and the use of digital technology has caused new concepts to emerge such as precision farming, digital farming, and smart farming [5].

Precision farming

The European Parliament’s report on precision agriculture and the future of farming in Europe defines precision agriculture as: *“a modern farming management concept using digital advanced technologies to monitor and optimize agricultural production processes”.* Examples

include GPS and **sensors** - they **collect and analyse data** on factors like soil conditions, weather patterns, and crop health [6].This information is used to make **precise decisions** about planting, irrigation, fertilization, harvesting and raising livestock [7].

According to McKinsey, “precision agriculture is a technology-enabled approach to farming management that observes, measures, and analyzes the needs of individual fields and crops. Precision agriculture is a technology-enabled approach to farming management that observes, measures, and analyzes the needs of individual fields and crops“[8]. The development of precision agriculture is shaped by two technological trends: “big-data and advanced-analytics capabilities on the one hand, and robotics—aerial imagery, sensors, sophisticated local weather forecasts—on the other”[8].

In conclusion, the key point of precision farming is **optimization -** instead of applying an equal amount of fertilizers over an entire field, precision agriculture involves measuring the within-field soil variations and adapting the fertilizer strategy accordingly. This leads to optimized fertilizer usage, saving costs, and reducing environmental impact [5].

Smart farming

Smart farming involves not just individual machines but **all farm operations**. Farmers can use mobile devices such as smartphones and tablets to access real-time data about the condition of soil and plants, terrain, climate, weather, resource usage, manpower, funding, etc. [4]

The focus of smart farming is not on precise measurement but on **capturing data and interpreting them using computing technologies to make farm operations more predictable and efficient** [9]. As a result, farmers can use the collected infomation in a smart way and to make informed decisions based.

Digital farming

Digital farming is **integrating both concepts – precision farming and smart farming**. The essence of digital farming lies in **creating value from data** [5]. “By taking advantage of big data and advanced analytics at every link in the value chain from field to fork, food companies can harness digital’s enormous potential for sustainable value creation. Digital can help them use resources in a more environmentally responsible manner, improve their sourcing decisions, and implement circular-economy solutions in the food chain“ [8]. Farmers can increase their production, save costs in the long-term, and eliminate risks.

These digital farming concepts collectively aim to increase the efficiency, sustainability, and profitability of agricultural practices by applying enabling technologies, while also addressing environmental concerns and ensuring food security for growing populations.

For more infomation, read read Module 1 “Introduction to Digitalization in Agriculture” from AgriSkills Training Course. Follow the link to the AgriSkills 4.0 e-learning platform: https://training.agriskills40.com/modules/.

2.2. Enabling Technologies in Agriculture

Enabling technologies for the digitalization of agriculture, often referred to as "AgTech" (Agricultural Technology), have been instrumental in modernizing and improving the efficiency and sustainability of farming practices. These technologies leverage data, sensors, connectivity, and automation to optimize various aspects of agriculture. Here's an overview of some key enabling technologies for the digitalization of agriculture:

Internet of Things (IoT)

The Internet of Things (IoT) refers to infrastructure, devices located in the field equipped with sensors as well as networking and processing capabilities, data networks, servers, and software, which allow for data exchange, processing / analysis over communication networks and / or the Internet.

Agricultural Internet of Things (IoT) refers to a network in which physical components, such as animals and plants, environmental elements, production tools, and various virtual “objects” in the agricultural system, relate to the internet through agricultural information perception equipment under certain protocols to perform information exchange and communication.

IoT in agriculture can help creating and capturing value in the agricultural value chain by:

- Improved data collection driving farming efficiency;
- Resource optimization;
- End-to-end production control;
- Reduced wastage and cost management.

Big data

While IoT devices collect a large amount of complex data and information, big data refers to the massive data set that no conventional data management tool can handle. Big data has become one of the leading technologies in various sectors.

In agriculture big data is viewed as a combination of technology and analytics that can collect, compile and process novel data in a more useful and timely way to assist decision making. The usage of big data can be beneficial for any specific segment or area, improving forecasting and operational efficiency or it can be used to provide information for the agricultural industry.

Sensor Technology

Sensors are devices that detect particular inputs, such as light, motion, pressure, heat and react by converting them into a signal or other required representations of information output. A very efficient tool in agriculture, precision sensors do not only transmit data that helps farmers monitor but also improve their products and keep abreast of changes in the field and ecosystems.

Sensors may collect data on: yields, rainfall and irrigation; atmospheric conditions such as temperature, humidity, and light levels; soil properties such as moisture, pH, nutrient levels,

and temperature; vegetation cover (as an indication of crop health). Sensor technology plays a crucial role in resolving various challenges in the agricultural value chain.

Drones

A drone is an unmanned aerial vehicle (UAV). Like sensor technology, drones represent hardware tools that can be used to gain a competitive advantage over competitors.

Drones can create and capture value in the input supply & production stage of the agricultural chain through:

- Obtaining field information data (when used with various sensor technology),
- Field mapping and imagery required for precision farming,
- Conducting primary activities such as production through planting / seeding, spraying, and monitoring (health) quality,
- Conducting supporting activities such as security ensuring.

Robotic and Automation

Agricultural robots are specialized technologies that are assisting or replacing farmers' workload with a wide range of operations. They are capable to analyze, contemplate, and carry out a multitude of functions, and they can be programmed to grow and evolve to match the needs of various tasks. The most common usages of robots in agriculture are:

- Harvesting and picking,
- Weed control,
- Autonomous mowing, pruning, seeding, spraying and thinning,
- Phenotyping,
- Sorting and packing,
- Utility platforms.

Artificial Inteligence (AI)

Artificial Intelligence (AI) consists of systems or machines that mimic human intelligence to perform tasks and can iteratively improve themselves based on the information they collect. AI can help in the process of creating and capturing value in such as:

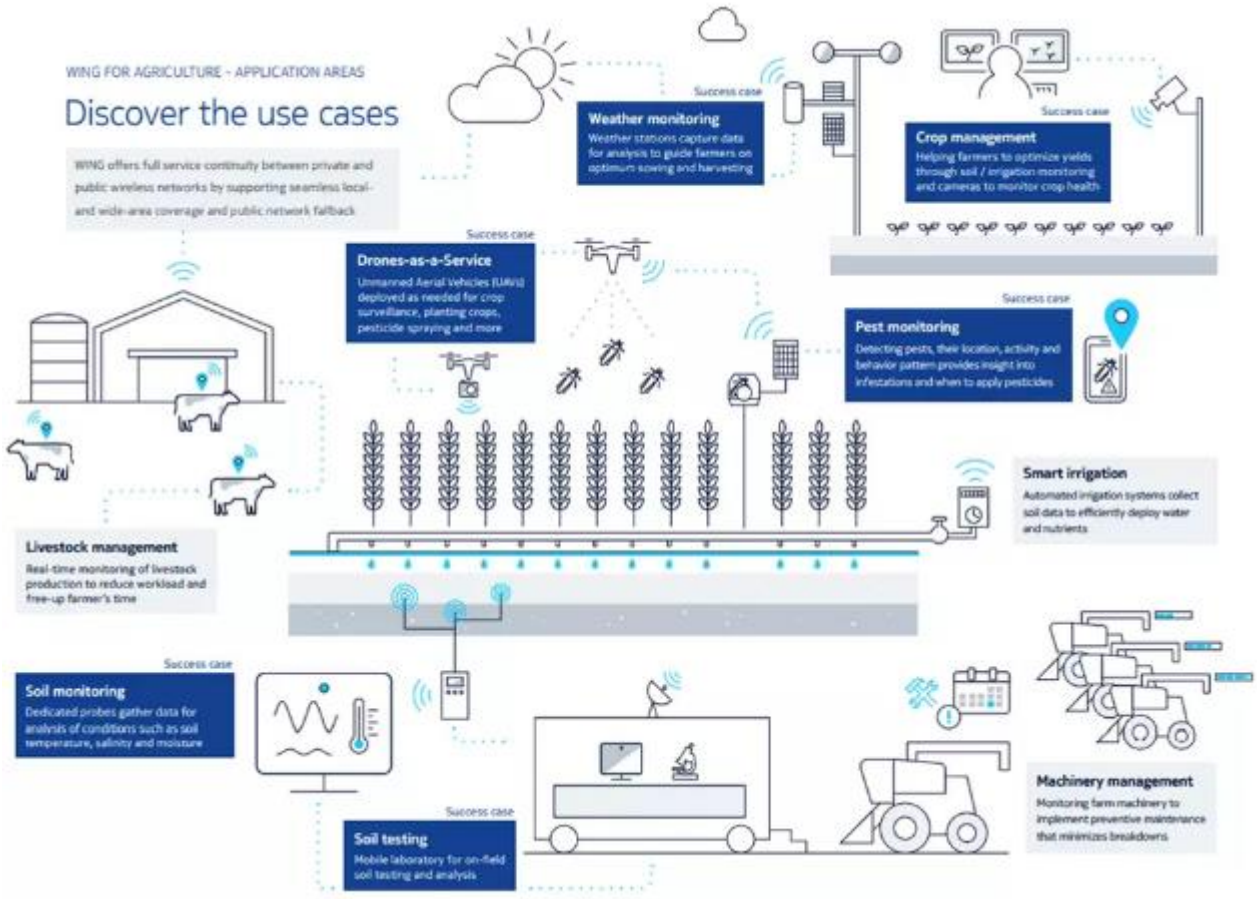
- Monitoring soil health: AI systems can conduct chemical soil analyses and provide accurate estimates of missing nutrients.
- Protecting crops: AI can monitor the state of plants to spot and even predict diseases, identify and remove weeds, and recommend effective treatment of pests.
- Feeding crops: AI is useful for identifying optimal irrigation patterns and nutrient application times and predicting the optimal mix of agronomic products.
- Harvesting: With the help of AI, it’s possible to automate harvesting and even predict the best time for it.

Vertical farming

Vertical farming takes the controlled environment of a modern commercial greenhouse to the next level. By stacking plants vertically on shelves or tall pillars, vertical farming allows up to ten times the yield for a given land area.

Plants are cultivated within entirely enclosed environments, where LED lights serve as substitutes for natural sunlight, and a closed-loop water recycling system is employed. There is no need for pesticides since the indoor space is already free of bugs, and plants can be grown in such clean conditions that there is no need to wash them before eating.

Digitalization in agriculture is revolutionizing the industry by increasing productivity, reducing waste, and promoting sustainability. As technology continues to advance, agriculture is likely to become even more connected and data-driven, enabling farmers to adapt to changing environmental conditions and market demands more effectively (See the piture below).



Picture 2. Illustration - Agriculture IoT Interconnecting Farming Elements. Source: Nokia, *WING IoT network grid*, *https://www.nokia.com/thought-leadership/articles/fight-to-feed-10-billion/*

However, although this “fourth agricultural revolution” brings the promise of multiple gains, it also brings technical, social, economic, ethical, and practical questions, with significant implications for how commercial agriculture is structured, practiced and governed. It also becomes evident that employers, employees, and other relevant stakeholders in the agricultural sector will have to put more emphasis on up-skilling and re-skilling in order to achieve successfully the transition in the sector.

2.3. Upskilling and Reskilling Requirements in the Sector

The agricultural sector is undergoing a rapid shift towards digitalization and technological advancement. It's imperative to ensure that farmers are well-equipped with the knowledge and skills to fully utilize these advancements.

This is where upskilling and reskilling come into play. These processes are essential for providing farmers and agricultural stakeholders with the necessary expertise to effectively harness the benefits of the modern tools and technologies for tasks such as precision farming, data analysis, and IoT applications.

Here are some of the upskilling and reskilling requirements in the agricultural sector for building skills for digital agriculture:

Digital Literacy and Basic Computer Skills	Familiarity with using computers, smartphones, and basic software applications is the basis for accessing and utilizing digital tools in agriculture.
Knowledge of Digital Tools and Technologies	Familiarity with a range of digital tools, including farm management software, precision agriculture technologies, IoT devices, and data analytics platforms.
Data Management and Analysis Skills	The ability to collect, manage, and analyze agricultural data is crucial for making informed decisions and optimizing farm operations.
Precision Farming Techniques	Knowledge of GPS-guided equipment, drone technology, and other precision agriculture techniques for optimizing resource use and maximizing yields.
IoT Device Installation and Management	Proficiency in setting up and maintaining IoT devices and sensors for monitoring soil conditions, weather, and livestock health.
Smart Irrigation and Water Management	Skills in using IoT sensors and automated irrigation systems to efficiently manage water resources and ensure crops receive the right amount of moisture.
Cybersecurity Awareness	Understanding cybersecurity best practices is important for protecting sensitive information and preventing cyber threats in a digitally connected agricultural environment.
Farm Management Software Proficiency	Competency in using farm management software for tasks such as planning, record-keeping, financial management, and decision-making.

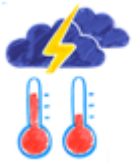
Digital Marketing and E-Commerce Skills	Knowledge of online marketing strategies, social media management, and e-commerce platforms for promoting agricultural products and accessing online markets.
Regulatory Compliance and Data Privacy	Knowledge of legal and regulatory requirements related to data privacy, ownership, and sharing in digital agriculture.
Environmental and Sustainability Considerations	Understanding how digital technologies can be used to promote sustainable and environmentally-friendly farming practices.
Collaboration and Communication Skills	Effective communication and collaboration with peers, experts, and technology providers are important for successful implementation of digital solutions.
Risk Management and Decision-Making Skills	The ability to assess risks associated with digital technologies and make informed decisions about their adoption and use.
Ethical Considerations in Digital Agriculture	Understanding the ethical implications of using digital technologies, including issues related to data privacy, transparency, and fairness.

By addressing these upskilling and reskilling requirements, individuals in the agricultural sector can build the necessary skills to thrive in an increasingly digital agricultural landscape. Training programs and educational initiatives play a critical role in providing the knowledge and support needed for this transition.

For more information, you can explore the AgriSkills Training Course on the AgriSkills 4.0 e-Learning Platform: https://training.agriskills40.com/training/.

Benefits from Upskilling and Reskilling in Agriculture

	By learning how to use digital tools, farmers can *make their work more efficient and cost-effective.* This means they can grow more crops or raise more animals without spending as much money. This helps them making more profit overall.
	Upskilling and reskilling empower farmers by instilling confidence in modern agricultural practices and providing them with greater control over their work. This can lead to increased job satisfaction and a heightened sense of pride in their profession.
	Digital tools give farmers important information that helps them make *smart decisions.* For example, they can decide when to plant, how much water to use, and how to deal with pests. Skilled farmers who understand these technologies can make better choices based on this data.

	Farmers who are proficient in using digital technologies have an *advantage in the market.* They can use new and smart ways of farming that make them stand out from others who have not embraced modern agricultural techniques.
	Skills in digital marketing and e-commerce helps farmers reach *more customers.* They can sell their products in new places, which can bring in more money and help their business grow.
	Farmers with digital skills can handle problems like sudden changes in prices, unpredictable weather, or outbreaks of pests better. They can use technology to monitor, to make *smart decisions* and and *respond on time to potential threats.*
	Digital tools help farmers to work in a way that is good for the environment. For example, with precision farming, they can use the right amount of water for their plants or find eco-friendly ways to deal with pests. Learning these skills helps farmers ensure that farming can continue in a sustainable way for a long time.
	Banks and investors often look for evidence of technological adoption when providing funding or support to agricultural enterprises. Thus, digital proficiency can help farmers get the money they need to run their farms or start new projects. See Module 5 " Financing the Digital Transformation of the Agricultural Business" (https://training.agriskills40.com/modules/)
	Digital tools can help farmers dealing with changes in weather and other environmental challenges. For example, they can use weather data and special sensors to adjust how they farm at just the right times. This helps them keep their farms going even when things get tough due to climate changes or other issues.
	Digital tools can help farmers follow the rules set by the government. For example, they can use them to keep important records that show where their products come from.

As technology continues to evolve, ongoing learning and skills development ensure that farmers remain adaptable and can continue to thrive in an ever-changing agricultural landscape.

3. Agriculture 4.0: Areas of Application

PIcture 3. Automation robotic for harvesting © Chiradech Chotchuang | Dreamstime.com

The digitalization of agriculture has ushered in a new era of innovation and efficiency in the farming industry [11]. By harnessing cutting-edge technologies, agriculture is transitioning into a data-driven, interconnected domain that optimizes various aspects of farming.

These advancements extend across a multitude of areas of applications, including soil management, plant health, terrain analysis, weather monitoring, asset tracking, livestock management, and resource utilization.

Figure 3. Application areas for digitalization of agriculture

By incorporating digital solutions in these areas, farmers and agricultural stakeholders can make informed decisions, enhance productivity, and ensure sustainable practices. This introduction sets the stage in the following sub-chapters for a comprehensive exploration of how technology is transforming agriculture in these key areas.

3.1. Soil

Digital agriculture has brought significant advancements to soil management, revolutionizing the way farmers care for and optimize their land. Soil management includes precision farming, soil mapping, fertility analysis, predictive modelling, soil health monitoring, reduced erosions, data integration and sustainability.

Digital agriculture transforms soil management by providing farmers with the tools and insights needed to maximize productivity while minimizing the negative environmental impacts associated with traditional farming practices. It promotes sustainable and efficient use of land, contributing to the long-term health and viability of agriculture.

By leveraging these technologies, modern agriculture can enhance soil health, increase productivity, reduce environmental impacts, and contribute to sustainable food production for a growing global population.

The following good practices are showcasing **soil** applications:

No.	Good Practice Related to "Soil"	Country
1	SoilOptix: Top Soil Field Mapping for Precision Agriculture	International
2	Transforming Agriculture: Ag Futura's Journey in Revolutionizing Farming Precision	North Macedonia

Top Soil Field Mapping for Precision Agriculture

Name of the Organisations Involved

- SoilOptix®. United States / International

Challenges Identified

Agricultural growers encounter various challenges with traditional soil sampling methods. These challenges include:

- **Inaccuracy and Variability:** Traditional sampling methods often result in soil samples that may not accurately represent the variability present in the entire field. This can lead to imprecise nutrient assessments and recommendations.
- **Labor-Intensive Process:** Collecting soil samples manually is a labour-intensive process, requiring significant time and effort. This can be impractical, especially for large fields or farms with limited manpower.
- **Limited Spatial Resolution:** Traditional sampling may not provide a high spatial resolution, meaning that variations in soil composition within small areas may go undetected. This lack of detail can hinder precision agriculture practices.
- **Frequency and Timing:** Traditional methods are often limited in terms of how frequently and at what times soil samples can be collected. This limitation may result in incomplete or outdated information for decision-making.
- **Accessibility of Remote Areas:** In some cases, reaching remote or difficult-to-access areas for soil sampling may be challenging using traditional methods. This can leave certain parts of the field underrepresented in soil analysis.
- **Subjectivity in Sample Collection:** Human subjectivity in sample collection, such as the depth and location of samples, can introduce variability and inconsistency in the results obtained through traditional methods.

Goals and Solution

The solution is SoilOptix®, a unique, high-end top soil analysis technology that establishes the benchmark for precision and accuracy in agriculture; it's a value-added layer that integrates into the regular management choices farmers make for their fields. *"Now, we can define where the specific issues are in a field, being a nutrient or soil property and can now create a plan to address those issues. And it's the only system that gives us a full texture profile across a field. We know sand, silt and clay are different. However, we could not measure them to this detail before. Now, we can use this in our Variable Rate program to fine tune where we put our fertilizer applications with more precision. Why sample the average when we can sample the variability?"(Trevor Thornton, CCA, P.Ag. Crop Care Consulting Ltd.- SoilOptix® Service Provider Since 2016)*

The **SoilOptix® process** from in field collection to a final data layer involves a standard four step process in which the gamma radiation-based sensor data is combined with strategically located physical soil samples as calibration, providing with soil mapping results in high resolution top soil property layers. The survey data and subsequent lab analysis results of the soil samples are submitted to SoilOptix® data analysis team for processing to be completed. SoilOptix® results are accessible for providers and growers through the

SoilOptix® customer data portal, where fields can be visually assessed or download spatial files such as a shapefile or csv which can be loaded into GIS specific programs/platforms. The resulting data from SoilOptix® can be used for multiple purposes including variable rate application of fertilizer or seed, precise management of water, or more informed practices around field scouting.
The figure below illustrates this four-step process where each is important to the resulting SoilOptix® high resolution soil data information.

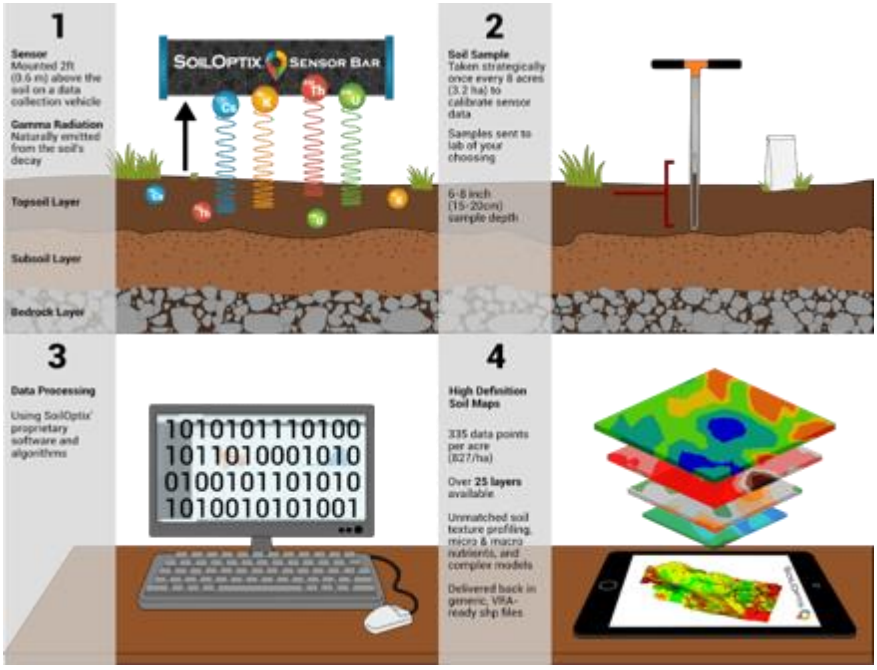


Figure: SoilOptix® Step-By-Step Infographic (Source: SoilOptix.com, link: here)

Actions Taken

The use of gamma radiation in agriculture, previously limited to the geological mining sector, became the subject of research initiated in Europe in 2003.

In 2010, the technological opportunity presented by SoilOptix® was introduced, prompting Practical Precision Inc., founded in 2009, to explore its implementation in North America.

By 2013, Practical Precision brought the SoilOptix® technology to market, offering it as a service to growers in Ontario, Canada, after three years of dedicated research and development.

As of 2021, the company celebrates eight years of operation and provides services in over twelve countries, including Morocco. SoilOptix® continues to uphold its mission by expanding research and development efforts to address spatial measuring challenges in field soils.

For the European market, Syngenta Europe was established through an exclusive contract with Hutchinsons Crop Production Specialists, a UK partner. It is now the authorized supplier of SoilOptix® services for all 51 European nations. The operations, initially launched under the Interra Scan brand, are set to expand, beginning in Hungary, Poland, France, and Ukraine.

Benefits and Impact

- SoilOptix® provides growers with soil analysis results that allow them to make the most informed on-farm decisions.
- In the past few decades, data from remote sensing (RS) has become a promising secondary source for enhancing digital soil mapping at all scales. Remotely sensed data sources produce consistent

and comprehensive data in both time and space; have a sizable spatial coverage that allows mapping of inaccessible areas; contain extractable information, such as spectral reflectance; and present opportunities to augment or replace traditional soil sampling in soil surveys.

- Remote sensing can be used to monitor and track crops, and to detect pests, weather, and other environmental factors that can affect the health of crops.
- Soil layer observation is crucial for precision agriculture. Soil organic matter, soil texture, pH level, moisture content, and other factors can be monitored via remote sensing technologies.

Contact Information

Website: https://soiloptix.com

Email: info@soiloptix.com

Facebook: https://www.facebook.com/SoilOptixInc/

LinkedIn: https://www.linkedin.com/company/soiloptix-inc/

Youtube: https://www.youtube.com/@soiloptix

Instagram: https://www.instagram.com/soiloptix/

Twitter: https://twitter.com/i/flow/login?redirect_after_login=%2FSoilOptix%2F

Prepared by

Irene Facchin (INI-Novation GmbH)

Application Area

☒ Soil

Digital Technology in the Value Chain

☒ Agronomic Services

Digital Technologies

☒ Sensor Technology

Transforming Agriculture: Ag Futura's Journey in Revolutionizing Farming Precision

Name of the Organisations Involved

- Ag Futura Technologies (AGFT), North Macedonia

Challenges Identified

Established in 2016, AgFutura Technologies is guided by a clear vision of a modern agricultural economy tailored to the specific conditions of the agricultural sector in Macedonia and the surrounding region. The company's foundation was driven by the goal of transforming the outdated agricultural practices dominant in North Macedonia, recognizing the necessity for contemporary methods. This realization underscored the urgent need for modernization, leading to the formation of AgFutura Technologies.

Goals and Solution

Over the course of a seven-year journey marked by expansion and innovation, AgFutura has emerged as a pioneering force in the country. The company is uniquely positioned to offer expert advisory services that connect agricultural expertise with digital innovation, thereby revolutionizing the approach to farming in the region.

In the world of agriculture, AgFutura Technologies presents a leading organization that offers consulting services and digital agriculture equipment across four pivotal domains. Within the realm of Digital Agriculture, their expertise unfolds through remote sensing and advisory services, encompassing a wide array of crops. Using digital technologies, they revolutionize decision-making processes for seamless farm management. The narrative extends into Agri-business development, where AgFutura's services span from conceptualization to implementation. Here, a thorough exploration of economic and technological factors forms the foundation for crafting personalized strategic frameworks and implementation plans, complemented by tailored training programs to foster optimal proficiency.

Meanwhile, in the sphere of Project development, AgFutura takes on the role of a Business Support Organization (BSO), extending specialized services for both national and international agricultural projects. Simultaneously, the journey unfolds at the Centre for Digital Agriculture, where a comprehensive curriculum, comprising standard and specialized courses, address the educational and training needs in agronomy, agricultural economics, and digital technologies. Each program is adjusted to meet the specific requirements of a diverse clientele, marking AgFutura Technologies as a transformative force in the dynamic landscape of agricultural innovation.

Actions Taken

Through the Centre for Digital Agriculture, Ag Futura launched a comprehensive outreach program aimed at educating farmers, agricultural experts, and stakeholders on the advantages of integrating digital technologies into daily agricultural practices. With their diverse and extensive project portfolio, they actively collaborate with local agricultural communities, public bodies, and universities. This collaborative effort

involves hosting a range of workshops and conferences, alongside providing hands-on demonstrations to highlight the transformative potential of their technology.

Simultaneously, Ag Futura extends its reach on the global stage by forming strategic partnerships with international funding bodies. This proactive approach serves to secure essential support for the widespread implementation of digital agriculture practices, emphasizing the organization's commitment to advancing technology and innovation in the agricultural landscape.

Source: Ag Futura web-site, Link: https://agfutura.com/

Benefits and Impact

AgFutura stands as a pioneer, introducing comprehensive monitoring and consultancy services in agriculture through digital and precise technologies. Their innovative programs offer numerous benefits, including increased yield, reduced seed usage, and optimized resource consumption. These solutions contribute to crop homogenization, enhance plant health, and improve resilience to stress. They also play a crucial role in sustainability, accurately determining damage from diseases or pests, optimizing fertilizer application, and minimizing environmental impact. AgFutura's story is one of efficiency, resilience, and sustainability, aiming for maximum yield and crop quality while reducing harvest losses and environmental damage.

Contact Information

Ag Futura Technologies

E-mail: info@agfutura.com

Web-site: https://agfutura.com/

Prepared by

Macedonian Enterprise Development Foundation (MEDF)

Application Area

☒ Soil ☒ Plants ☒ Terrain

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services ☒ Agronomic Services

Digital Technologies

☒ Robotic and Automation, Precision Agriculture Services

3.2. Plants

Digital agriculture offers numerous benefits and opportunities for plant-related aspects of farming applications. It enables more efficient and precise plant management, leading to increased crop yields, improved sustainability, and reduced resource usage. Digital agriculture for plants impacts precision farming, crop health monitoring, automated irrigation, fertilization management, crop rotation and diversification, pest and disease management, harvest timing, yield forecasting, crop trait analysis, remote crop monitoring and sustainability.

It is transforming plant-related aspects of farming by leveraging technology to optimize the entire crop lifecycle. This leads to improved crop health, higher yields, and more sustainable, growing global population while conserving natural resources.

By leveraging these technologies, agriculture can become more efficient, productive, and resilient in managing plants and planting, ultimately contributing to sustainable and successful crop production.

The following good practices are showcasing **plant** applications:

No.	Good Practices Related to "Plants"	Country
1	Automatic Dock Detection and Control in Grassland	Austria
2	Conventional Arable Farming Systems vs. Controlled Row Farming (CRF)	Austria
3	Greenland Monitoring	Germany
4	Indoor Vertical and Greenhouse Farming Controlled by Artificial Intelligence	Germany
5	Pflanzentheke – Revolutionizing Agriculture Through Sustainable Urban Vertical Cultivation	Germany
6	"Sensosafe": Use of Sensor-Based Wildlife Detection	Austria
7	Sustainable Revolution in Vineyard Management: MAIWY	Germany
8	Veve: Transforming Home Gardening with Vertical Hydroponic Technology	Italy

Automatic Dock Detection and Control in Grassland

Name of the Organisations Involved

- Allgäu Automation – a start-up company, Germany
- Supported by Innovation Farm in Wieselburg, Austria

Challenges Identified

Blunt-leaved dock (Rumex obtusifolius) stands out as one of the most persistent weed challenges in grasslands. Its robust growth displaces valuable grasses and herbs, and the longevity of dock seeds—persisting in the soil for up to 50 years—poses an enduring issue in grassland management. In conventional farming, dock control typically involves manual-selective methods or widespread herbicide application. In organic farming, mechanical or thermal treatments are employed. The extensive use of herbicides, in particular, demands considerable labour from farmers and may inadvertently harm desirable weeds and legumes.

Goals and Solution

To address these challenges, the German startup company Allgäu Automation developed and introduced an innovative camera-based system for the automatic selective control of dock weeds using image processing, named RumboJet. Production commenced in 2021, with one of the latest models being the RumboJet 880. The software of the RumboJet 880 distinguishes this machine from conventional field sprayers. It relies on six multispectral cameras that generate substantial data at a frame rate of 90 images per second. The computing unit processes these images to determine whether a dock is present under the spray bar. These components dictate the opening of the solenoid valve for nozzle activation and spraying. The software employs a conventional image processing program, detecting docks based on their outline and leaf structure. Additionally, the system considers the size of the dock, activating multiple nozzles if necessary. To prevent wind drift and ensure consistent lighting conditions, each of the three sections is enclosed with a tarpaulin. This guarantees that the spray liquid reaches its intended target.

Actions Taken

In 2022, the “Innovation Farm” assessed the feasibility, potential cost savings, and efficiency of automated selective dock control in various grassland environments. The RumboJet 880, serving as an innovative system for selective dock control, has undergone testing for multiple parameters. The evaluation includes an assessment of the system's user-friendliness, a comparison of user protection against drift compared to conventional methods, and a focus on detecting and controlling dock. The trial analysed factors such as growth, stage, and hit rate, with a determination of the resulting impact on the quantity of plant protection products and labour required.

Benefits and Impact

The pictures show two dock plants 10 days after treatment with the RumboJet 880. By using selective herbicides, only the dock is controlled, and the grasses in the immediate vicinity of the dock remain undamaged.

Picture: RumboJet 880 and the results, Source: Innovation Farm and Allgäu Automation website: https://allgaeuautomation.de/index.php

The RumboJet 880 from Allgäu Automation provides significant savings through individual plant control. This not only reduces costs for plant protection products but also saves valuable working time, especially during the often-stressful peaks of agricultural tasks. In Bavaria, the State Institute for Agriculture (LfL) has recommended the use of RumboJet 880 for 'non-area-wide application' in grasslands. The Innovation Farm also supports this assessment with regard to the test results from 2022. However, it should be noted that, especially in machine communities, it is recommended that the control only be carried out by knowledgeable and trained personnel.

With regard to the Green Deal, which requires farmers to save around 50% of the number of chemical-synthetic pesticides used by 2050, the RumboJet 880 can also make a significant contribution with its selective sorrel control. With its RumboJet, the company Allgäu Automation demonstrates how digitalization can help achieve these goals and generate a double advantage for the farmer, both economically and ecologically. (Report of Innovation Farm from 07.12.2022)

Contact Information

Fabian Butzenlechner

Email: f.butzenlechner@josephinum.at

Allgäu Automation Website: https://allgaeuautomation.de/

Innovation Farm Website: https://www.innovationfarm.at/projekte/automatische-ampferdetektion-und-bekaempfung-im-gruenland/

Prepared by

Wolfgang Eisenreich (WIN)

Application Area

☒ Plants

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services

Digital Technologies

☒ Big data

Conventional Arable Farming Systems vs. Controlled Row Farming (CRF)

Name of the Organisations Involved

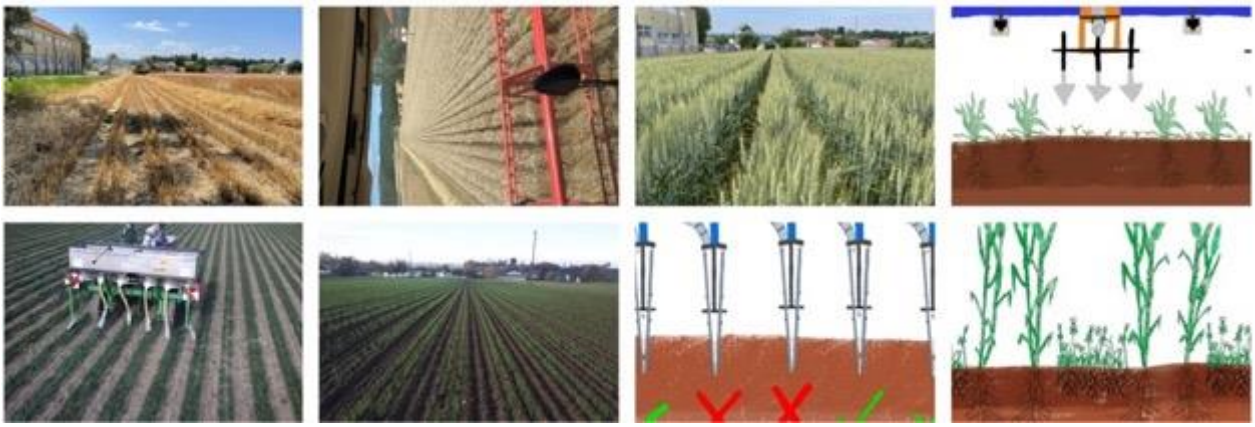
- Innovation Farm in Mold, Austria

Challenges Identified

- Traditional farming methods often lead to inefficient use of plant protection products, resulting in higher costs and potential environmental impact.
- Also, conventional farming practices often lack precision in crop management, resulting in suboptimal resource use and potential yield loss. Ensuring that agricultural practices are applied uniformly throughout the farm at all times can often be a challenge with traditional methods.
- Farmers face barriers to adopting new technologies, including the cost of upgrading machinery and the need for training.

Goals and Solution

The aim is to implement the new arable farming system Controlled Row Farming (CRF) using tried and tested technology and Real-Time Kinematic (RTK) positioning guidance systems, making it applicable to all of the farm's main crops. CRF aims to use band spraying to achieve savings in plant protection products while maintaining the same yield. Additionally, it seeks to enhance the preceding crop effect by sowing clover between the rows.



Pictures Innovation Farm, Source: Innovation Farm, link: https://www.innovationfarm.at/projekte/vergleich-von-herkoemmlichen-ackerbausystem-zu-controlled-row-farming/

Actions Taken

The measured field is divided into two plots. One plot is cultivated using the conventional arable farming system, and the second plot is sown in double rows with a row spacing of 50 cm. The area between the rows is then cultivated using hoeing technology, and the rows are treated using band spraying. In spring, a clover mixture is sown between the rows.

Benefits and Impact

The project addresses the following questions:

- How can double rows of cereals be best planted using conventional technology?
- How can the conventional crop protection sprayer be converted to band spraying?
- How can the clover mixture be sown into the existing crop?
- How can lane planning or row planning be organized efficiently?
- How much labour is involved for the farmer compared to the conventional method?

All benefits and results will be reported in 2025.

Contact Information

Robert Zinner, BSc,

Fachreferent für Digitalisierung, Standortleiter Innovation Farm Mold

Email: robert.zinner@lk-noe.at

Innovation Farm in Mold, Rottenhauser Straße 1, Wieselburg, Austria

Website: https://www.innovationfarm.at/

Facebook: https://www.facebook.com/p/Innovation-Farm-100057301786106/

Youtube: https://www.youtube.com/watch?v=ZyfeAFm0yE4

Prepared by

Wolfgang Eisenreich (WIN)

Application Area

☒ Plants

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services ☒ Agronomic Services

Digital Technologies

☒ Robotic and Automation

Greenland Monitoring

Name of the Organisations Involved

- Fraunhofer Institute for Computer Graphics Smart Farming, Germany

Challenges Identified

Around 40% of the earth's land mass is covered by grassland, on which the prosperity of around 2 billion people worldwide is directly dependent. Grassland serves as pasture, provides important ecosystem functions such as carbon storage and ensures food security for a growing global population.

Through digitized and automated recognition of plant species and analysis of biomass growth, both grassland management and funding opportunities for ecological measures should be made easier. This is where UAS (drone) technology shows great potential: various camera and sensor technologies collect spatially and temporally high-resolution information in the visible and infrared spectrum. With the help of machine learning and artificial intelligence, the species composition as well as the quantity and quality of growth in the grassland can be derived from the 2D images and the 3D models.

This information is a prerequisite for precision farming and can therefore help to reduce the number of fertilizers and pesticides and optimize pasture management.

Goals and Solution

Machine learning and AI algorithms are used to detect and locate plant species from the composite drone images and sensor data. Certain individuals or groups of individual plant species can be identified and located with centimetre precision, so that maps of the flown and scanned field with the distribution of the plant species can then be created.

This detection is relevant in practice, on the one hand, for agriculturally relevant species such as the distribution of nutritious fodder plants, which are indicators of high-quality grassland, and, on the other hand, the quantity and distribution of harmful and even poisonous plants, which reduce the quality of the forage or are even dangerous can be for the health of the animals.

Actions taken

Ecologically, species recognition is particularly important for biodiversity monitoring of grassland areas from intensively to extensively cultivated areas. Specifically, extensively managed grassland, i.e. the low use of fertilizers and mowing or grazing a grassland area once or twice, promotes plant biodiversity on these areas, which also has a positive effect on the insect and bird population. The new eco-regulations of the EU's Common Agricultural Policy (CAP) have been in effect since the beginning of 2023, which means farmers can have extensive pasture supported in order to maintain or even expand it. The Smart Farming department at Fraunhofer IGD trains specific species recognition models using AI algorithms that not only recognize the so-called identifiers for species-rich grassland, but can also localize their distribution and, in some cases, individual plants with centimetre precision. This application will also be certified as proof of government funding in the near future.

Benefits and Impact

Certain individuals or groups of individual plant species can be identified and located with centimeter precision, so that maps of the flown and scanned field with the distribution of the plant species can then be created.

This detection is relevant in practice, on the one hand, for agriculturally relevant species such as the distribution of nutritious fodder plants, which are indicators of high-quality grassland, and, on the other hand, the quantity and distribution of harmful and even poisonous plants, which reduce the quality of the forage or are even dangerous can be for the health of the animals.

Other applications served by the Smart Farming department in the area of drone-based visual computing include biomass assessment and feed quality monitoring in grassland, disease detection and wild or storm damage assessment in arable land and grassland, as well as monitoring carbon sequestration when rewetting moors.

Copyright (c) Fraunhofer IGD, Rostock, Germany

Contact Information

Email: philipp.wree@igd.fraunhofer.de
Website: www.fraunhofer.de
Address: Fraunhofer Institute for Computer Graphics Smart Farming
Joachim-Jungius-Straße 11, 18059 Rostock, Germany

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Application Area
☒ Plants ☒ Terrain

Digital Technology in the Value Chain
☒ Agronomic Services ☒ Agricultural Inputs and Services

Digital Technologies
☒ Sensor Technology ☒ Drones and AGVs ☒ Artificial Intelligence (AI)

Indoor Vertical and Greenhouse Farming Controlled by Artificial Intelligence

Name of the Organisations Involved

- VertiYard UG, Germany
  Urban Farming Company

Challenges Identified

- **High demand for fresh and locally grown produce**

This trend has gained momentum in recent years due to a growing consumer preference for food that is both nutritious and sustainably sourced. Fresh produce retains more nutrients compared to produce that has been transported long distances or stored for extended periods. Locally grown produce often tastes better and has superior quality, as it is harvested at peak ripeness and doesn't need to withstand long transportation.

- **High production cost of current indoor vertical farming technology**

This challenge revolves around the substantial initial investment and operational expenses associated with implementing and maintaining indoor vertical farming systems. Factors contributing to high costs may include the need for specialized equipment, advanced climate control systems, energy-intensive lighting, and technology for automated processes. Addressing this challenge requires innovations in technology, resource optimization, and exploring cost-effective solutions to make indoor vertical farming financially sustainable.

- **Low crop diversity in the Indoor vertical farming**

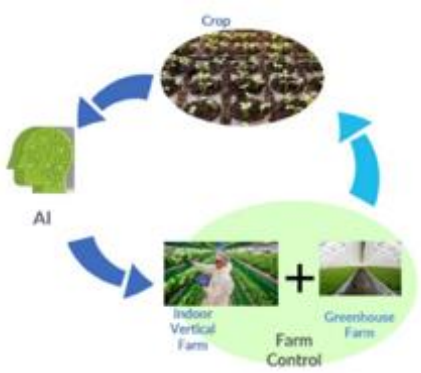
This challenge involves a limitation in the variety of crops that can be effectively grown in indoor vertical farming environments. Certain crops may not adapt well to the controlled conditions of vertical farms, leading to a restricted range of produce. To overcome this challenge, efforts must be directed towards developing and optimizing cultivation techniques that accommodate a broader diversity of crops.

Goals and Solution

As the demand for fresh and sustainable food continues to grow, a hybrid vertical farming technology **VertiYard** has been developed that supports locally grown vegetables, leafy greens, and herbs. This is achieved through cutting-edge farming methods, controlled by AI. This allows people to produce fresh vegetables at competitive price around the year. Employing artificial intelligence (AI) to oversee crops in a Hybrid farm (a blend of Indoor Vertical Farm and Greenhouse Farm) lowers production costs.

Purchasing locally grown produce supports local farmers and the regional economy, which can have positive effects on job creation and community development. Consumers are increasingly concerned about the carbon footprint associated with food transportation. Buying locally grown produce reduces the emissions related to shipping and distribution. This aligns with our broader goal of fostering a greener, healthier, and more sustainable future for both our planet and its inhabitants.

Actions Taken



- Concept of the Hybrid Farm has been identified.
- Sensors and cameras needed to monitor the crop has been identified.
- Potential small-scale farm for developing and testing AI has been identified.

The technology is still under development is yet to be tested and implemented.

Benefits and Impact

- The technology reduces the production cost of the Indoor vertical farming technology.
- Increase the yield compared to the conventional greenhouse farming.
- Increase the diversity of crops grown in Indoor vertical farming.
- After applying VertiYard, the revenue is increased by reducing the operation cost.
- Urban consumers benefitted by everyday fresh produce and our AI crop monitoring technology can also help local farmers to optimize their crop production and increase yield.
- Having a profitable Urban farming technology in Europe.

Image: Young plants growing very large plant commercial Greenhouse. Source: wayhomestudio on Freepik

Image: Leafy greens. Source: iFarm

Contact Information

Richard Chandradoss
Email: richard@vertiyard.com
Website: www.vertiyard.com
Social media: www.linkedin.com/company/vertiyard-ug/

Prepared by

Richard Chandradoss (VertiYard), Wolfgang Kniejski (INI-Novation GmbH)

Application Area
☒ Plants ☒ Terrain

Digital Technology in the Value Chain
☒ Agronomic Services

Digital Technologies
☒ Sensor Technology ☒ Artificial Intelligence (AI) ☒ Vertical Farming

PFLANZENTHEKE - Revolutionizing Agriculture Through Sustainable Urban Vertical Cultivation

Name of the Organisations Involved

- Pflanzentheke GmbH, Startup Company

Challenges Identified

Agricultural land is degrading, population growth is increasing, local cultivation is becoming more and more attractive not only for reasons of environmental protection, but also because of unstable supply chains. Climate change is making food production for vegetable growing more difficult due to a lack of rainfall and extreme weather events.

As a horticultural business, costs must be minimized while still producing high-quality products. With vertical cultivation in an urban environment, PFLANZENTHEKE contributes to all of these things at the same time. It makes it possible to revolutionize agriculture.

Goals and solution

By developing hydroponic plants and systems for the efficient, sustainable, decentralized, independent and local production of food for end consumers, organizations, and horticulturists, you save 90% of water and 85% of fertilizer compared to cultivation in soil. This not only makes the agriculture business climate-resilient, but also sets new standards in sustainable vegetable production and enables farming in urban environments.

Actions taken

FLANZENTHEKE offers specially developed, tailor-made, soilless horizontal or vertical cultivation systems for herbs and leafy vegetables. They respond individually to wishes and concerns of vegetable grower. They also accompany them as a sparring partner through the ups and downs of vegetable production. With their data sets and our know-how, PFLANZENTHEKE can develop – for instance - cultivation planning and enable new unique selling points for horticultural business.

They also offer advice and hydroponic system construction in the urban farming/vertical farming sector. Thus, customers benefit from their data sets and modern measurement and control technology. Lack of precipitation in the summer months or mudding of the soil due to heavy rain shall be no longer a problem.

Benefits and Impact

- The hydroponic plants and systems not only produce vegetables in a resource-saving manner, but also cost-effectively. A high level of automation and ergonomically advantageous working not only reduce costs, but also make work easier for cutomers' employees. Users benefit from a clean harvest product and forgo weed control and increase the internal and external quality of products through complete fertilizer control. Customer values are:
- Transformation of horticultural/agricultural businesses
- Individual offers and services

- Scientific data-based cultivation
- Vertical and horizontal culture systems with measurement and control technology.

Source: Pflanzentheke GmbH

Contact information

Email: info@pflanzentheke.de

Website: www.pflanzentheke.de

Linked-in: https://www.linkedin.com/in/leon-welker-6a612b204/

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Application Area
☒ Plants

Digital Technology in the Value Chain
☒ Agricultural Inputs and Services

Digital Technologies
☒ Vertical Farming

"Sensosafe": Use of Sensor-Based Wildlife Detection

Name of the Organisations Involved

- PÖTTINGER Landtechnik GmbH, Germany
- Supported by Innovation Farm in Mold, Austria

Challenges Identified

The mowing of the first green fodder cut often overlaps with the placement of fawns. Fawns are difficult to recognise during the work process and can be injured or killed by the mower.

Goals and solution

To design a reliable system which detects wild animals while driving and automatically raises the mowing unit without delay or send a signal to the driver. This should lead to a reduction in the number of fawns injured or killed during mowing and an improvement in animal health.

To prevent carcass parts, which cause problems for ruminants, from getting into the forage.

Actions taken

The SENSOSAFE assistance system is designed to detect wild animals while driving and automatically raise the mowing unit without delay or send a signal to the driver. This should lead to a reduction in the number of fawns injured or killed during mowing and an improvement in animal health.

Source: Pöttinger

Benefits and Impact

SENSOSAFE has delivered a convincing performance during use on the pilot farms, with an average trigger probability of 92% measured across all test variants. Converted to the number of fawns currently killed or

injured, this would mean that PÖTTINGER SENSOSAFE could save around 23,000 fawns in Austria and 92,000 - 184,000 fawns.

in Germany (depending on the source). In addition, just as many sources of highly toxic feed contamination could be avoided.

Contact information

Georg Ramharter, Email: georg.ramharter@josephinum.at, Tel. +436648960030

Josef Penzinger, Email: josef@penzinger.info, Tel. +43676737471

PÖTTINGER Website: https://www.poettinger.at/de_de#

Prepared by

Wolfgang Eisenreich (WIN)

Application Area

☒ Plants ☒ Terrain

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services

Digital Technologies

☒ Sensor Technology

Sustainable Revolution in Vineyard Management: MAIWY's Potential for Pests Detection and Disease Significant Pesticide Reduction

BADENCAMPUS

Name of the Organisations Involved

- *MAIWY, Germany*

Challenges Identified

Due to climate change and global warming, new variants of vine leaf diseases caused by bacteria, fungi, and insects have steadily been increasing in the last few years. This has led to a large-scale prophylactic usage of pesticides in vineyards and to pest control in case of infestation. 60% of all fungicides are applied in vineyards, despite the fact that vineyards cover only 3% of Europe's agricultural land. "Today, grapes are among the fruits most heavily contaminated with toxic pesticides," says chemical expert Manfred Krautter of Greenpeace. Or in other words: With a 750 ml bottle of wine, we consume one teaspoon of pesticide residues. Not only the wine but also grape juice, other grape products, and grapes themselves contain pesticide residues.

But why is the pesticide usage in the vineyard so immense?

Until a grapevine yields grapes, it needs to grow for at least 3 years, but protection against pest infestation starts with planting. Since grapevines are planted in short distances, pests can spread easily to neighboring plants.

Winegrowers want to minimize the risk and therefore regularly apply large quantities of pesticides in the vineyards as a prophylactic measure. However, in recent years, awareness of the need for more sustainability and the protection of our habitat has grown significantly and the pressure on agriculture is increasing: In June 2022, the EU Commission suggested that pesticide use would be reduced by 50% in 2030. Why? There are some scientists who have studied the distribution, quantitative detection, and effects of pesticides on various organisms and biodiversity in detail. Pesticide residues are related to the incidence of various human diseases. Scientific studies show a link between pesticides and Parkinson's disease, childhood leukemia, and an increased risk of liver and breast cancer, asthma, allergies, and damage to the nervous system.

What is the current analysis of a vine disease?

This is currently a complex, multi-stage process: After an infested leaf has been detected and the winegrower needs expert help for the pest analysis, they often have to send the leaf to specialized institutes to conduct an exact pest analysis. While the winegrower waits for the result of the institute, the infestation can spread, which results in additional use/need of pesticides to combat the pest. To facilitate, speed up, and optimize vine leaf infestation and vine leaf deficiencies detection, we developed MAIWY.

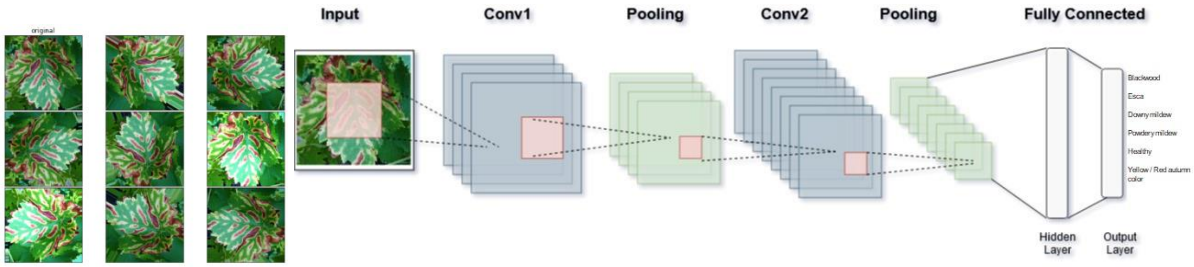
Goals and solution

Our goal is to enable a significant reduction in the enormous use of pesticides in vineyards and preserve our environment. The vision of the app/AI is to detect leaf diseases and nutrient deficiency symptoms before they are visible to the human eye. The MAIWY team has developed a high-quality digital technology for reliable detection of vine leaf diseases, aiming to reduce pesticide usage by differentiating between vine leaf diseases using machine learning and analyzing the regional degree of leaf infestation spread. Building trust in new technologies and possibilities is an important aspect of their work.

Short description of the technology and the beneficiaries

MAIWY detects vine-leaf diseases using an AI algorithm on images taken with a smartphone.

It's easy to use and doesn't require extensive knowledge of vine-plant infections. If a sick plant is identified, MAIWY automatically offers treatment options. For preventative farming, MAIWY also provides a live map of detected diseases at or near the user's location.



Picture 4. Image Augmentation, © MAIWY

MAIWY is available as a smartphone application, free to download from the Google Play Store or the App Store. It is designed to support winegrowers throughout the growth phase of vine-plants, starting at BBCH 11.

Picture 5. MAIWY app, © MAIWY

Here's how it works: First, the winegrower or their employee takes a picture with a smartphone of a potentially infected vine-leaf. MAIWY supports offline usage directly in the vine fields. Then, MAIWY's algorithm predicts the disease and offers the user one or more treatment options without an internet connection. Additionally, the app creates a current local spread map, which is provided to the users, allowing for appropriate measures. The live map is available when the device MAIWY is installed on is connected to the internet. When connected, the user can upload the taken pictures to supply more data points to the live map.

Creation of value:

- The custom dataset created by MAIWY for their machine learning model is a unique and valuable asset, providing a significant competitive advantage for the app. The annotation was done by different vine disease experts.
- MAIWY has developed a machine learning model using TensorFlow and MobileNet for transfer learning based on an RGB image dataset created by their own team. The AI model achieves an accuracy of 96% in classifying 7 different grape leaf diseases.
- The number of active users continuously expands MAIWY's GPS and disease database.
- The model has been deployed to the Google Play Store and Apple App Store, with over 2.5 thousand scans and 760 free app downloads to date.

Actions taken

First, the MAIWY team created an annotated dataset containing over 7,000 images capturing various vine leaf diseases using different mobile phones. However, to achieve high accuracy with the app, it became evident that the team needed to expand their data resources. To address this, they applied data augmentation algorithms to enrich their training dataset. With this database, the MAIWY team was able to construct, train, and validate a machine learning model that runs directly on the device and achieves a 96% accuracy rate. The decision to use edge computing is preliminary due to the limited mobile cellular coverage within vineyard areas.

Integrating the model seamlessly into an app interface facilitates real-time communication with their server. This integration allows them to collect location data and image data from scans. The MAIWY team provided this version of the MAIWY app to winegrowers, giving them the opportunity to test its functionality and enabling the team to gain valuable insights and identify potential challenges. In the meantime, the MAIWY team has also created an improved UI and diversified their dataset.

Benefits and Impact

MAIWY was created with all winegrowers in mind, also non-commercial and part-time winegrowers since no prior pest infestation knowledge is required to use MAIWY. Additionally, even without an internet connection, winegrowers can stay informed and can intervene promptly without losing time for analysis.

With the MAIWY app, winegrowers can take early and appropriate measures to prevent the large-scale spread of diseases or deficiencies by utilizing the provided MAIWY live map of infected plants, thereby safeguarding their yield.

Full-time farmers could potentially save money on plant treatment measures. By identifying infested plants, pesticides can be applied more precisely. Overall, this saves both, money and time, for farmers. Reduction of pesticide usage is beneficial for our whole environment since the residues spread via land, water and air and the grape products are healthier for their consumers.

The MAIWY app is used internationally, as seen on the local spread map.

MAIWY was developed and will be continuously trained in future for a very early detection of pest infestation – a detection method before the pests are perceptible to the human eye. Additionally, the MAIWY developer team plans to explore other disease tracking possibilities - such as via satellites.

User Feedback and Interviews: https://www.maiwy.com/english/feedback

Contact information

MAIWY Team:
Maria-Theresa Licka, Katharina Volkenand and Mario Schweikert
Email: informaticteens@gmail.com
Website: www.maiwy.com
LinkedIn: MAIWY
YouTube: INFOrmAtIc Teens

Prepared by

MAIWY Team and INI-Novation GmbH

Application area
☒ Plants

Digital Technology in the Value Chain
☒ Supply Chain Management

Digital Technologies
☒ Artificial Intelligence ☒ Big Data

Veve: Transforming Home Gardening with Vertical Hydroponic Technology

Name of the Organisations Involved

- RaisingPlus Innovations s.r.l., Italy

Challenges Identified

What was your motivation to implement digital technologies? What challenges or difficulties or other factors have you had that influenced your decision to implement digital technology in your farming?

The NASA hydroponic technology developed for space station chosen presented some difficulties in the integration in the chosen system.

One challenge experienced was the overlapping of the atomizer jets: this created an undercurrent in which the water particles collided and was not able to reach the vegetables in the optimum way. The jets had to be calibrated in the correct way so as to work as planned.

Additionally, they had to find the water pump that could lift the water at the requested height and within the chosen tube diameter.

However, challenges significantly stimulate creativity.

Goals and solution

The initial idea was: “with all the technology available, is there a way to bring a vegetable garden into the house to give vegetables according to everyone's tastes and without producing waste?” (cit. Matteo Sansoni)

The important concept was to reduce space, given that the focus was to cultivate at home. Therefore, the idea developed into “going vertical”.

After long research, the solution chosen was NASA hydroponic technology that was developed for the space station to cultivate in less space and without the use of soil. This technology has been studied and applied first to a prototype and then to the actual product development.

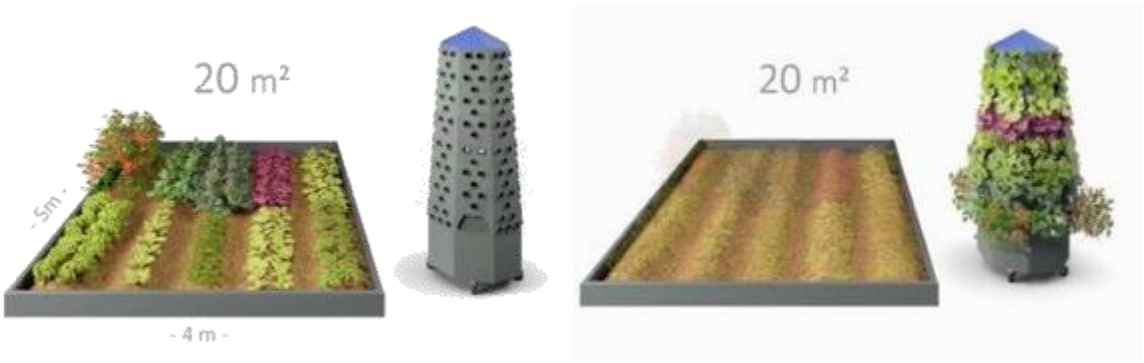
Actions taken

Veve is a vertical garden that only occupies 1 m2 instead of 20 m2. No soil is needed to make it work, just water enriched with nutrients that is sprayed on the roots. In this way roots absorb biological (no chemical) nutrients and oxygen more easily. Plants develop better and easier and faster: the company confirmed that plants grow at double the pace (given the same time, a plant on soil grows 5cm, one on Veve grows 10cm. This reduces development times and Increases production.

The vertical garden is structured as such:

- Water level control,
- Nutrients in proportion to the water (with probes that verify the concentration) = liquid or powder to add to the water, fermented vegetable macerates which all contain macro- and micro-nutrients suitable for the plant,

- Expanded polypropylene panels (polystyrene type) – suitable for food, they support the vegetables with special alveoli + basin for water + pump pushes water every 15 minutes onto sprayers.
- It functions with electric energy.



Skills and Training:

"We growth through mistakes, in the typical learning by doing process". Therefore, the company studied and researched until they reached the final product.

The only part of the process that they admit was more lacking was the economic-financial one. They received support on this from the Progetto Manifattura incubator, which supported their idea and helped them for the economic part and in particular in the definition of the business plan, therefore helping them moving from idea to the practice.

The subsequent steps foreseen are a 60x60x220 internal system in the form of a kitchen appliance. Or the adding of a LED system and a cover for external structure to make it usable even in winter time.

Benefits and Impact

- Greater yield,
- Fewer work difficulties: it is suitable for everyone, elderly or children – for rest homes and schools,
- Self-production of vegetables allows people to cultivate according to their tastes and in a healthy way,
- Home garden: no need to move around and this reduces processing time.

Contact information

Matteo Sansoni
Email: matteosansoni@hotmail.com
Website: https://veve-vertical-veggies.jimdosite.com/
Facebook: https://www.facebook.com/veveverticalveggies/
Instagram: @veve_vertical_veggies

Prepared by

Irene Facchin (INI-Novation GmbH)

Application Area
☒ Plants ☒ Terrain

Digital Technology in the Value Chain
☒ Agricultural Inputs and Services ☒ Agronomic Services

Digital Technologies
☒ Vertical Farming

3.3. Terrain

Digital agriculture is revolutionizing terrain management in farming by providing tools and data-driven insights to optimize land use, enhance sustainability, and improve overall efficiency. Key applications for terrain management are terrain mapping and analysis, erosion control, drainage management, land grading, delineation of fields, variable rate application, terrace and conservation planning, land reclamation, irrigation management, remote monitoring, environmental stewardship, and optimized land use.

Digital agriculture's impact on terrain management is not only about precision but also about sustainable land stewardship. By leveraging technology and data, farmers can make informed decisions to preserve the long-term health of their land while optimizing its use for productive and sustainable agriculture.

By applying these technologies, agriculture can effectively address the challenges posed by diverse terrains, optimizing resource use and promoting sustainable practices across a range of landscapes.

The following good practices are showcasing **terrain** applications:

No.	Good Practices related to "Terrain"	Country
1	Empowering Macedonian Agriculture Through Precision Farming: Geo Innovus Leading the Way	North Macedonia
2	Project "Wildretter F-C" – Wildlife Rescuer Research	Germany
3	Revolutionizing Arable Farming: Lithos' Innovative Approach to Sustainable Pest Control	Austria

Empowering Macedonian Agriculture Through Precision Farming: Geo Innovus Leading the Way

Name of the Organisations Involved

- Geo Innovus, North Macedonia

Challenges Identified

Macedonian agriculture has faced numerous challenges in recent years. The challenges in Macedonian agriculture are multifaceted and daunting. These includes:

- Climate Change: Irregular weather patterns, attributed to climate change, disrupted traditional farming practices, and called for more adaptable approaches.
- Price Volatility: Volatile crop prices hindered farmers' ability to plan and invest confidently.
- Labor Force: There is less labour in the field of agriculture in the country and number of young farmers is decreasing. Furthermore, the labour costs are in continuous growth.
- Cost Fluctuations: Unpredictable fluctuations in raw material costs added financial uncertainties to farming.

Traditional farming practices often proved insufficient to adapt to these changes.

In response to these challenges, the Geo-Innovus company, in collaboration with precision technology leaders, embarked on a mission to modernize agriculture in North Macedonia through precision farming. In light of these challenges, the primary goal was to revolutionize the agriculture landscape in North Macedonia by introducing precision agriculture technology and services, through adapted solutions for relatively small farmers compared with the European counterparts.

Goals and solution

The overarching goal was to revolutionize the agriculture landscape in North Macedonia by introducing precision agriculture, a methodology renowned for its profitability, efficiency, and sustainability. Precision agriculture integrates advanced technologies, data analytics, and modern farming practices to ensure optimal resource utilization while minimizing the environmental impact. The implementation of precision agriculture was the beacon of hope for Macedonian farmers.

The specific goal of the company was to make the initial step towards precision farming in North Macedonia by introducing a new concept usage of navigation systems in the agricultural practices, implementation of GNNS navigator, usage of android operative system and ISOBUS technology for improving productivity and yield, lowering production costs, ensuring sustainability.

Short description of the technology and the beneficiaries

Geo Innovus, in collaboration with other technology providers, introduced cutting-edge precision agriculture systems customized to meet the unique needs of Macedonian agriculture. These systems include:

1. GNSS Systems: Advanced Global Navigation Satellite Systems provided accurate location data for precise field operations.

2. Data Collection and Analysis Software: Specialized software collected and analyzed data from various farm operations, enabling farmers to make informed decisions regarding crop selection, precise application of fertilizers, chemicals, and more.
3. ISOBUS-Compatible Technology: This technology simplified data organization and ensured seamless communication between tractors and implements, irrespective of brand or model.
4. Advanced Precision Planting Solutions: These solutions helped optimize planting operations, ensuring consistent and even spacing of seeds for maximum yield.
5. Expert support services for implementation of the technology and training of farmers on its usage.

The technology can be applied for management of work machines, sowing, planting, spraying, fertilization, navigation, data management, drainage, levelling, harvesting, mapping, and VRA (Variable Rate Application) fertilization.

The true beneficiaries of this technology are the Macedonian farmers. Precision agriculture empowers them to streamline their operations, reduce costs, increase productivity, and make data-driven decisions. It also allows farmers to adapt to the changing climate and environmental conditions more effectively. In a global market characterized by competitiveness and sustainability concerns, Macedonian farmers, with the support of Geo Innovus, have gained a significant advantage.

Geo Innovus demonstrated unwavering dedication to supporting farmers with limited financial resources. They enabled the installation of precision farming equipment in older tractors, making it more accessible for such farmers. The process involved replacing the steering wheel, installing GNSS systems, and sensors, effectively converting old tractors into modern precision farming machines. This approach ensured that even those with budget constraints could benefit from the advantages of precision agriculture.

Possible installation on all self-propelled vehicles from all brands (tractor, combine, sprayer). The Condition: Functional hydraulic and control system.

Source: Geo Innnovus web-site https://geoinnovus.com/

Actions taken

Geo Innovus recognized that the introduction of technology alone was not enough. Farmers needed to be educated and informed about the benefits and applications of precision agriculture. To achieve this, they organized "Precision Agriculture" seminars, which became a cornerstone of the transformation. During these seminars, farmers were introduced to the technology, its potential applications, and the ways it could enhance their farming practices. Geo Innovus also offered comprehensive support, education, and training, ensuring that farmers could confidently embrace this technology.

Benefits and Impact

The impact of precision agriculture equipment has been profound and multifaceted:

- Efficiency Elevated: Precision systems took over late-night planning sessions, allowing farmers to spend more quality time with their families and engage in personal activities. The burden of meticulous planning was lifted, and the joy of efficient farming took its place.
- Counting Savings, Not Stress: Overlaps and skips in field operations, which had long been a source of stress and inefficiency, became a thing of the past. Precision technology ushered in an era of calm and consistency on farms, leading to a significant reduction in fuel and labor costs.
    - Direct savings of 10-20% on all input factors: fertilizers, pesticides, fuel, time, machine depreciation, rational use of labor.
    - Indirect benefits include adherence to agrotechnical deadlines, reduced operator errors, high precision, and minimal need for repairs.
- ISOBUS Technology Magic: The cumbersome task of juggling different equipment displays vanished with the introduction of ISOBUS technology. Farmers could now seamlessly integrate various equipment, regardless of brand or model, simplifying operations and increasing overall efficiency.
- Necessity, Not an Option: Precision agriculture transformed from being an option to a necessity for Macedonian farmers aiming to stay competitive in the global market. This modern approach not only simplified farming tasks but also enhanced data-driven analysis, productivity, profitability, and overall sustainability.

Contact information

Geo Innovus

Email: geoinnovus@gmail.com

Website: www.geoinnovus.com

Prepared by

Macedonian Enterprise Development Foundation

Application Area

☒ Terrain ☒ Location of assets

Digital Technology in the Value Chain

☒ Supply-Chain management

Digital Technologies

☒ IoT ☒ Big data ☒ Sensor Technology

Project “Wildretter F-C” – Wildlife Rescuer Research

Name of the Organisations Involved

- Farmer Christoph Böhm (Hof Schleiersbach) in Fränkisch-Crumbch, Germany;
- The German Aerospace Center (DLR), the agricultural technology company CLAAS and the Technical University of Munich work together under the leadership of i_s_a_ Industrieelektronik GmbH;
- The joint project is supported by the Bavarian State Hunting Association, and project management is carried out by ZENTEC GmbH, Germany.

Challenges Identified

Depending on the vegetation and weather, farmers usually only have a small window of opportunity to mow their meadows and bring in the fodder that is so important for their operations. They use modern mowing devices that work ever faster and more efficiently.

At the same time, fawns released in the meadows in this mowing period are difficult to find, even for experienced hunters. This is because during the first two weeks of life, fawns have a so-called “squeezing instinct” and almost no smell of their own. This means they are excellently camouflaged in the tall grass. During this phase of life, the fawns remain in their place continuously and “press” themselves motionless on the ground when there is danger. This means they are not only protected from predators, but also from being discovered by humans. Without aids it is very difficult to track down and save the fawns from the mowers.

Every year, farmers and hunters have to deal with the same problem: fawns cannot escape the mowers and are killed by the machines. And this is very sad and unacceptable! At the same time, as a consequence, there is not only a risk of contamination of the silage (= green fodder stored in the silo) and damage to the hunting tenant, but also an extremely unpleasant situation for the operators of the mowers who are involved directly confront this locally quite common problem of fawn breeding.

Goals and solution

It is currently very time-consuming to effectively find and rescue fawns using the previously known methods, so that around 100,000 young animals are fatally injured during mowing every year in Germany alone. Against the background of this problem, the WILDRETTER project was launched, which is funded by the Federal Ministry of Agriculture and Food. The aim was to develop a reliable application system for fawn rescue when mowing agricultural areas.

Actions taken

It is the connection of the components and the separation of the search process and rescue that makes the wildlife rescuer “Wildretter” unique (see also image "How it works" below). A central coordination and communication platform (www.wildretter.de) is necessary for planning and implementation within a very limited period of action. The process is most effective when the search operation (in the period before mowing) and the rescue operation (immediately before or during mowing) are decoupled from each other.

Image: How it works: technical components. Source: Wildretter F-C

The standardized control for various carrier systems is the heart of the development. Together with the infrared and digital camera, the GPS route programming and the recognition software, the search areas should be able to be processed very efficiently.

Remote-controlled multicopters (miniature helicopters with 4, 6 or 8 rotors), which can fly for around 15 minutes with a payload of 500-800 grams, are particularly suitable as carrier systems. The research focuses on the most efficient and light technical unit possible. The finding is carried out using GPS-controlled planning (the corresponding meadows are optimally flown overusing this program and recorded with the cameras) and an automated evaluation of the image materials. As a result, you get precise GPS data on which there is a high probability of a fawn lying. The units can be controlled by experienced copter pilots.

Benefits and Impact

- The deer fawns found in this way are marked with an active transponder, which means the animals can be easily found again even after a long time and saved from being mowed at short notice, so that animals and farmers benefit from this process during mowing.
- This will hopefully enable large-scale rescue operations in the near future, which could be done in both portable and machine-based ways.
- The fawns found are carried out of the area immediately before mowing and secured there to prevent them from being brought back to the supposedly safe meadow by the mother animal. After the mowing process they are released and after a short time the deer track them down and lead them away.
- All data, actions and experiences are collected, analysed and evaluated on the platform www.wildretter.de under strict data protection guidelines. This means the project can develop into other regions and improve sustainably.

Image 1: Starting the drone for search, Source: Wildretter F-C

Image 2: Tagging a rescued dear fawn, Source: Wildretter F-C

- The risk of silage contamination is minimised, as well as the emotional and occupational risk to mower operators.

Contact information

Thorsten Stürmer

Email: stuermer@zentec.de

c/o ZENTEC Zentrum für Technologie, Existenzgründung und Cooperation GmbH

Website: https://www.wildretter.de/home.html

Agricultural technology company CLAAS

Website: https://www.claas.com

Prepared by

Wolfgang Kniejski (INI-Novation GmbH),

based on an interview and presonal contacts with Mr. Thorsten Stürmer

Application Area

☒ Plants ☒ Terrain

Digital Technology in the Value Chain

☒ Agronomic Services ☒ Agricultural Inputs and Services

Digital Technologies

☒ Sensor Technology

Revolutionizing Arable Farming: Lithos' Innovative Approach to Sustainable Pest Control

Name of the Organisations Involved

- Lithos Crop Protect GmbH, Austria

Challenges Identified

In modern agriculture, the application of volatile substances, such as pheromones, presents a set of interconnected challenges that demand careful consideration. Firstly, ensuring the effective coverage of these substances requires meticulous control, as factors like wind drift and atmospheric conditions can lead to dispersion beyond the intended target area, thereby diminishing their efficacy.

Secondly, the environmental impact of spraying volatile substances cannot be overlooked. The potential harm to non-target organisms, including beneficial insects and other wildlife, raises concerns. Moreover, there is a risk of environmental contamination if these substances drift into water bodies or sensitive ecosystems.

Thirdly, the stability and persistence of volatile substances pose significant challenges. These substances may degrade rapidly, diminishing their effectiveness over time. Stability issues can arise due to temperature variations, humidity, or exposure to sunlight, impacting the longevity of these substances and their ability to serve as reliable tools in agricultural practices.

In addressing these challenges, a holistic approach is necessary, encompassing advancements in application technology, stringent regulatory frameworks, and ongoing research into the environmental impact and persistence of volatile substances. Achieving a balance between precision application, environmental stewardship, and substance stability is crucial for maximizing the benefits of using volatile substances in agriculture while minimizing potential drawbacks.

Goals and Solution

To address this challenge, Lithos aims is to revolutionize pest control in arable farming by leveraging their patented *lithos micro dispenser® technology*, which utilizes volcanic mineral *lithos natural zeolite* as a substrate. This technology enables the cost-effective and scalable spray application of pheromones, specifically from the *pherolit* series, to create a sustained cloud of scent. The aim is to implement efficient and economical mating disruption in large arable fields, providing a natural solution to pest control challenges in agriculture.

Short description of the technology and the beneficiaries

Lithos' patented *lithos micro dispenser® technology* enables volatile substances such as pheromones to be sprayed. This technology makes mating disruption possible in arable farming while also making the process scalable and affordable. Biological pest control using pheromones has already become indispensable in many orchards and vineyards. In arable farming, the practical implementation of mating disruption has so far failed due to the high cost of deploying and collecting the various dispensers. However, following several years of research, the team of Lithos has found a method of implementing effective mating disruption efficiently and economically on large arable fields in the future – and in a natural way.

Thanks to spray application, the future-driven idea of pheromone-based pest control is now viable in arable farming. The core technology is provided by the volcanic mineral *lithos natural zeolite,* which is special

suited as a substrate to bind specific liquid substances and release them continuously over a longer period of time. As a result, any pheromone in the pherolit series can now be sprayed onto fields of crops easily and quickly to form a long-lasting cloud of scent that effectively confuses the specific insect and prevent them from spreading.

Source: www.lithosprotect.at

Actions Taken

Lithos' patented *lithos micro dispenser® technology* offers a groundbreaking solution for pest control in arable farming, particularly through the efficient and economical implementation of mating disruption. Benefiting farmers, the arable farming industry, and orchard/vineyard owners, the technology leverages volcanic mineral lithos natural zeolite to spray pheromones onto crops. This method provides a cost-effective, scalable, and environmentally friendly approach, promoting sustainable agriculture. Consumers benefit indirectly through potentially safer food products, and the breakthrough contributes to advancements in agricultural technology, inspiring the research and development community. Overall, the technology represents a transformative step toward more efficient and eco-conscious pest control in large arable fields.

Benefits and Impact

- **Farmers and Agricultural Practitioners:**
  - Lithos' technology offers farmers and agricultural practitioners an effective and economically viable method for pest control in arable farming.
  - The scalability and affordability of the lithos micro dispenser technology make it accessible to a broader range of farmers, enabling the implementation of mating disruption in large arable fields.

- **Arable Farming Industry:**
  - The arable farming industry as a whole benefits from the technology by addressing the challenges of implementing mating disruption in a practical and cost-effective manner.
  - The technology contributes to more sustainable and natural pest control methods, aligning with the growing demand for environmentally friendly agricultural practices.

- **Orchard and Vineyard Owners:**
  - While biological pest control using pheromones is already common in orchards and vineyards, Lithos' technology may offer improvements in efficiency and cost-effectiveness.
  - Orchard and vineyard owners may find the lithos micro dispenser® technology beneficial for enhancing their pest control strategies.

Contact Information
Website: www.lithosprotect.at Email: office@lithosprotect.at
Prepared by
Mihail Stanev (INI-Novation GmbH)
Application Area ☒ Soil ☒ Plant ☒ Terrain
Digital Technology in the Value Chain ☒ Agromonic Services ☒ Agricultural Input and Services
Digital Technologies ☒ Drones ☒ Others

3.4. Weather

Digital agriculture refers to the use of modern technology and data-driven approaches to optimize various aspects of agricultural practices. Weather management is a crucial component of digital agriculture because it involves using weather data and technology to make informed decisions in farming. Digital agriculture impacts weather management in the areas of weather data collection, weather forecasting, irrigation management, risk mitigation, data analytics, climate change adaptation and remote monitoring.

In summary, digital agriculture integrates weather data and technology to enhance weather-oriented management in farming. By utilizing weather forecasts, precision agriculture techniques, data analytics, and other tools, farmers can optimize their practices and increase productivity while reducing environmental impact and risks associated with weather-related challenges.

By leveraging these technologies, agriculture can effectively respond to weather-related challenges, optimize resource use, and enhance overall farm resilience in the face of changing weather patterns and extreme events.

The following good practices are showcasing **weather** applications:

No.	Good Practices Related to "Weather"	Country
1	Smart Agriculture Revolution: Topraq's IoT Solutions for Precision Farming	Turkey
2	Weather API: From Challenges to Informed Action	Switzerland/ International

Smart Agriculture Revolution: Topraq's IoT Solutions for Precision Farming

Name of the Organisations Involved

- *Topraq, Turkey*

Challenges Identified

- Climate change and mismanagement of existing water resources cause water depletion and a decrease in precipitation.
- Limited access to agricultural data: Old habits about agriculture cause inefficent usage of technology and production based upon only observation.
- High technological investment cost: Farmers can't invest as much as they need because of high investment cost of agricultural technology.
- Water resources are no longer sufficient for old-style irrigation activities: Farmers need to see the impact of their irrigation activities on the ground to plan their next irrigations with right amount at the right time.
- Limited qualified human resources in agriculture: In addition to the difficulty of finding human resources capable of using technology in farms, operations performed in traditional ways also create situations open to human error.

Short description of the technology

Sensors:

- **Soil Moisture & Temperature**
  Sensors applied to different depths provide data need for the right amount of irrigation at the right time by measuring humidity and temperature.
    - Data and science-based irrigation decisions
    - Subsoil effects of irrigation activities
    - Optimization of water consumption
    - Saving on your electricity bills
    - Crop quality increase

- **Soil Moisture & Temperature & EC**
  It measures the salt level of the soil in addition to humidity and temperature for fertilizing sufficiently. High soil salinity causes slowdown in plant growth, decrease in yield and crop failure. High water level brings the loss of nutritions and low level of water may harm crop quality.
    - Right fertilization decisions
    - Saving on fertilization cost
- **Weather**
  The weather sensor provides data of air temperature, humidity and barometric pressure in order to be able to interfere quickly and accurately.
    - The system monitors the temperature on a daily basis and monitors the cooldown & warm-up times. It feeds the system for the calculations of chilling hours.
    - Provides data for detecting potential frost hazard. It helps to prevent the risk of frost by working with wind fans.
    - Air temperature data has an important role in determining the amount of irrigation requirement of the garden.

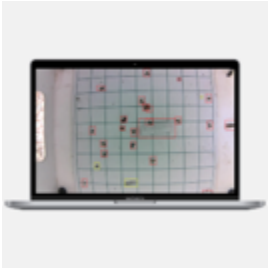
- **Rainfall**
  Local weather forecasts may not provide accurate and reliable data for the location of your garden or field. Rainfall data is vital for determining irrigation and harvest time. Our sensor precisely measures the amount of rainfall in the applied field. It measures and collects the most accurate data for our services in order to make smartest decisions.
- **Wind Speed & Direction**
  The sensor provides important data for the decision process of critical field applications such as pesticide applications and determination of planting direction.
- **Pyranometer**
  It measures the intensity of sunlight effective in each period to predict and plan water needs from planting to harvest. The data obtained from this sensor is used in the calculations of ET0 – evapotranspiration rate.
- **Leaf Wetness & Canopy Temperature**
  Leaf Leaf Wetness & Canopy Temperature is placed on the leaves and acts like a leaf to measure leaf surface wetness generated by dew, rain, or spray irrigation. In addition, it measures the canopy temperature of the tree its positioned on. These measurements are essential when it comes to the imminent prediction of diseases and the calculation of diagnostic models.
- **Flowmeter**
  It provides information about the flow rate of the water passing through the irrigation line and the irrigation start & stop times.

Products:

- **Agro Station**
  T-Weather is a smart meteorological station where you can remotely access your local weather data in real-time.
    - Weather
    - Rainfall
    - Leaf Wetness & Canopy Temperature
    - Pyranometer
    - Wind Speed & Direction
- **Irrigation Optimization Station**
  T-Irrigate is an AI based irrigation optimization solution that enables farmers to manage their irrigation with the right amount at the right time.
    - Soil Moisture & Temperature
    - Soil Moisture & Temperature & EC
    - Water Pressure
    - Flowmeter
    - Rainfall
    - Weather
    - Wind Speed & Direction
    - Leaf Wetness & Canopy Temperature
    - Pyranometer
- **Digital Pheromone Trap**
  T-Trap is an automated AI based pest detection technology that enables real time pest control.

T-Brain: T-Brain is an intelligent engine that provides bidirectional communication between the field and AI Platform. It works with GSM or Lora technology depending on implementation.

AI Platform:
We obtain the Big Data from our stations in your fields and then we present it as reports, graphics and services using AI to enable farmers to take your daily decisions easily.



- **T-Weather User Screens:** We collect all meteorological data needed for harvesting from the sensors at frequent intervals and present them to our users as a summary. Air Temperature, Rainfall, Wind Speed, Humidity, Air Pressure, Leaf Wetness & Canopy Temperature and Solar Radiation data in your fields are presented to our T-Weather: Agro Station users.
- **T-Irrigate User Screens:** It is so easy to have detailed information about your irrigation with user screens! Our farmers have opportunity to control and monitor irrigation information such as Irrigation Start Level, Irrigation Stop Level, Humidity Index, Soil Temperature, Soil Moisture, Flow Rate, Irrigation Time etc. which are specifically determined for their fields and crops by AI.
- **T-Trap User Screens:** Real time images from the AI camera and the Digital Pheromone Trap are securely processed, stored in the Cloud and analyzed. Our users can access the images via the AI Platform, follow the change in the pest population and plan their pest control operations.

Smart Assistant: TOPRAQ Smart Assistant is an AI based BOT software built within Telegram to help users communicate with their systems on a real-time basis. You can set alarms, monitor all irrigation activities, and get real-time data and reports by simply messaging with the system.

Goals and Solution

Topraq was planted in 2019 with the vision of building smart digital agro services and improve farmers' lives. Topraq's dream is to provide clear visibility to farmers in regards to what's going in their fields along with giving them the capability to take science-based decisions.

Topraq's desire is not to sell pure hardware but to bundle IoT products with digital smart services and focus on Sensor as a Service concept. This is why they introduced a unique sales strategy which is Agricultural Technology as a Service, i.e., an annual subscription based model to make farming technology accessible and affordable.

Actions Taken

- Design & manufacture own IoT products. They develop purpose-built mobile software enabling farmers to manage their farms to collect further farming data.
- Use Statistical Machine Learning & Artificial Intelligence within own AI platform to process, store, analyze and correlate.
- Convert big data into algorithms and make it relevant.
- Transform these algorithms into simple, user-friendly services for farmers.

Benefits and Impact

- Better measurements - better management
- Minimized technology investment with annual subscription model
- Saving from electricity bills with optimisation in water consumption
- Improving the quality and efficiency of crops
- Controlling input costs & increasing profitability
- Identifying the needs for each field & harvest
- Creating and tracking ideal growing conditions for products

- Disease prediction with data analysis

Contact Information

Dudullu OSB Mahallesi Des-115. Sokak

C 15 Blok No:15 Ümraniye, İstambul Turkey

Website: https://www.topraq.ai/en/

LinkedIn: https://www.linkedin.com/company/topraq

Instagram: https://www.instagram.com/topraqtarimteknolojileri/

Youtube: https://www.youtube.com/channel/UCXvuWYy0v8CVbfMWglL3BOg

Prepared by

Irene Facchin (INI-Novation GmbH)

Application Area

☒ Soil ☒ Weather

Digital Technology in the Value Chain

☒ Supply Chain Management ☒ Agronomic Services

Digital Technologies

☒ IoT ☒ Sensor Technology ☒ Artificial Intelligence (AI)

Weather API: From Challenges to Informed Action

Name of the Organisations Involved

- Meteomatics GmbH, Germany
- Meteomatics AG, Switzerland
- Utopicus Glòries - Sala Glòries, Spain

Challenges Identified

Agriculture faces numerous challenges related to weather conditions, significantly impacting crop yield, livestock farming, indoor growing, and the broader industry due to climate change. Unpredictable weather events such as heat waves, severe winters, and extreme precipitation can lead to crop failure and livestock losses. Accurate weather data plays a crucial role in optimizing planning for irrigation, fertilization, and pesticide application, contributing to increased crop quality and financial savings. Livestock welfare is affected by weather conditions, influencing animal health and milk production. Adequate sheltering and provision of water and food become critical with the help of precise weather forecasts. Greenhouse cultivation, although controlled, is still influenced by external weather conditions, necessitating efficient management of light, temperature, and humidity. Climate change further intensifies challenges, with rising temperatures, altered precipitation patterns, and extreme events disrupting global supply chains.

Goals and Solution

Incorporating climate projection data into agricultural practices becomes essential for stakeholders to navigate the evolving landscape effectively. Farmers can use weather data to make informed decisions about planting, harvesting, and irrigation.

Meteomatics is an international company, which specializes in high-resolution commercial weather forecasting, power output forecasting for wind, solar and hydro, weather data gathering from the lower atmosphere using Meteodrones, and weather data delivery via the Weather API.

Weather API (Application Programming Interface) acts as an intermediary, enabling software applications to access real-time, forecasted, and historical weather information. These APIs pull data from numerous meteorological stations, satellites, radars, and other weather data sources, providing comprehensive weather details in a structured and easily accessible format. A Weather API typically works over the web, using HTTP requests to communicate with the API server. When a request is made, the API fetches the requested data from its sources and returns it in a user-friendly format, often JSON or XML. This process allows for the easy integration of weather data into websites, mobile apps, and other software applications.

Actions taken

The Weather API serves as a valuable tool for farmers, offering a wealth of data on crucial parameters that directly impact agricultural activities. Here's a breakdown of key variables and the actionable insights they provide:

Soil:

- Frost Depth: Monitor frost depth to determine the potential impact on sensitive crops. Consider protective measures for frost-prone plants.
- Soil Frost: Stay informed about soil frost occurrences, especially during critical growth stages. Adjust planting schedules accordingly.
- Soil Moisture Index: Manage irrigation practices based on the soil moisture index to ensure optimal water conditions for crops.
- Soil Moisture Deficit: Address soil moisture deficits promptly by adjusting irrigation schedules or implementing water conservation measures.
- Soil Water Content: Gauge soil water content to fine-tune irrigation, promoting efficient water use in agriculture.
- Ground Temperature: Track ground temperatures to optimize planting times and enhance seed germination.

Precipitation:

- Accumulated Precipitation: Plan irrigation and harvesting activities based on accumulated precipitation data for better water management.
- Precipitation Probability: Anticipate potential rain events and schedule farming activities accordingly.
- Fresh Snow: Prepare for the challenges of fresh snow, especially in regions susceptible to heavy snowfall.
- Snowfall Probability: Stay alert to the likelihood of snowfall and its potential impact on crops and farm infrastructure.
- Snow Cover Probability: Monitor snow cover probability for insights into ground conditions and potential delays in fieldwork.
- Snow Depth: Consider snow depth in planning operations, particularly if snow removal is necessary.
- Hail: Implement protective measures for crops in the event of anticipated hailstorms.

Global Radiation:

- Direct Radiation: Leverage direct radiation data for optimal crop positioning and sunlight exposure.
- Diffuse Radiation: Understand diffuse radiation patterns for improved crop canopy management.
- Sunshine Duration: Plan farming activities based on sunshine duration to maximize photosynthesis and crop growth.
- Sunrise and Sunset: Align daily farming schedules with sunrise and sunset times for efficient use of daylight.

Wind:

- Wind Speed and Wind Gusts: Prepare for windy conditions by securing crops and structures. Adjust planting and harvesting schedules accordingly.

Weather Warnings:

- Act promptly on weather warnings to mitigate risks associated with frost, snow, wind, thunderstorms, heavy rain, and incessant rain.

Source: https://www.meteomatics.com/en/weather-api/

By incorporating these insights into the farming practices, farmers and agricultural organizations can enhance operational efficiency, optimize resource utilization, and proactively manage weather-related risks on your farm.

In addition, stakeholders can receive detailed information on specific weather parameters, enabling a comprehensive understanding of environmental conditions. These parameters include:

- Evapotranspiration - the sum of water evaporation and transpiration from the surface area to the atmosphere. Application: Crucial for assessing water loss and optimizing irrigation practices.
- Growing Degree Days (GDD) - measures heat accumulation and is employed to estimate the growth and development of crops and pests during the growing season. Application: A vital tool for predicting key stages in crop development.
- Grassland Temperature Sum - a specialized form of GDD that gauges the accumulation of mean day temperature, aiding in determining the start of field work after winter. Application: Critical for scheduling agricultural activities based on temperature thresholds.
- Leaf Wetness - indicates the amount of dew left on surfaces. Application: Essential for disease prediction and optimizing plant health.
- Phytophthora Negative Prognosis - an index indicating the necessity of safety measures against potato blight; no measures are required if the index is below 150. Application: Offers a proactive approach to disease management in potato cultivation.
- Disease Prevention (Mildew, Oidium)- addresses measures to prevent common diseases such as mildew and oidium. Application: Promotes preemptive strategies for maintaining crop health.
- Most Similar Year - Identifies the year with conditions most similar to those of the queried year. Application: Assists stakeholders in drawing insights from historical data for effective decision-making.

This detailed information empowers stakeholders with the tools needed to make informed decisions, manage risks, and optimize agricultural practices in response to specific weather conditions.

Benefits and Impact

Weather APIs serve as invaluable tools for farmers, enabling them to make well-informed decisions throughout the farming process. From planting and harvesting to irrigation, farmers utilize real-time

weather forecasts to optimize their agricultural activities. This data-driven approach enhances efficiency and productivity, contributing to the overall success of agricultural operations.

Contact Information

Meteomatics AG
Unterstrasse 12, 9000 St.Gallen, Switzerland, Phone +41 71 272 66 50

Meteomatics GmbH
Schiffbauerdamm 40, Büro 5309, 10117 Berlin, Germany, Phone +49 30 200 74 280

Utopicus Glòries - Sala Glòries
Carrer de la Ciutat de Granada, 150 - 3er pis, 08018 Barcelona

Website: https://www.meteomatics.com/en/agriculture-industry/

Prepared by

Angela Ivanova (INI-Novation)

Application Area
☒ Weather

Digital Technology in the Value Chain
☒ Agricultural Inputs and Services ☒ Agronomic Services

Digital Technologies
☒ Big data ☒ Drones and AGVs

3.5. Location of Assets

In agriculture, the term "location of assets" refers to the precise identification and tracking of physical resources, equipment, and infrastructure within a farming operation. These assets can include machinery, tools, vehicles, livestock, storage facilities, and more. Knowing the location of assets is crucial for efficient farm management, as it allows farmers to optimize resource utilization, enhance operational workflows, and ensure the security of valuable items.

Digital agriculture has a significant impact on the management of the location of assets within the farming and agricultural sector. Asset management may be applied through applications such as precision asset tracking, efficient resource allocation, prevent theft and loss, maintenance and health monitoring, optimized logistics, inventory management, crop management, data integration as well as compliance and reporting.

Overall, digital agriculture revolutionizes asset management in agriculture by providing real-time location data, optimizing resource allocation, preventing losses, improving maintenance practices, and enhancing the overall efficiency and productivity of farming operations.

By leveraging these technologies, agriculture can enhance efficiency, reduce losses, and improve overall operational management by effectively locating and managing assets in the agricultural ecosystem.

The following good practices are showcasing **location of assets** applications:

No.	Good Practices Related to "Location of Assets"	Country
1	Cultivating Efficiency: Agricon's Digital Solutions for Precision Farming	Germany
2	Inpixon's Intelligent Livestock Management with Real-Time Location Technology	US, Germany, UK, India

Cultivating Efficiency: Agricon's Digital Solutions for Precision Farming

Name of the Organisations Involved

- Agricon GmbH, Germany

Challenges Identified

Agricon is one of the leading providers of digital plant cultivation systems in Central and Eastern Europe. Since 1997, they have helped farmers make more efficient use of their manpower, operating resources, and equipment. As a result, assessments about the cultivation of plants are significantly improved in quality. Agricon's knowledgeable agricultural engineers and service technicians not only bring digital plant cultivation technologies to the agricultural industry, but they also counsel and help companies implement modern plant cultivation techniques. In addition, they research new ways of solving problems and work with practitioners to improve on established methods.

However, the conventional systems for making decisions and carrying out operations are altered and disrupted by digitalization. This means that the manager needs to be adaptable and eager to try out new methods for cultivating plants. It is also essential that the employees of the company take part in the process. To handle the production process more wisely, more openness is unavoidable.

Goals and Solution

Source: https://www.agricon.de/en/fleet

Agricon specializes in information-guided, knowledge-based, automated crop production through precision farming. The application of digital technologies in agriculture is referred to sub-plot management, digital farming, smart farming, precision farming, and precision landscaping. Field agriculture has three main application areas:

- Automation of office processes,
- Digitalization of tractors and other equipment, and
- Precision farming.

The company's primary goal was to find the best way to help the growth process of crops. For every question, such as **"**What is the ideal **number** of seed, fertilizer, or insecticide for a particular field area?**"**, integrated agriculture production offers a definite answer.

Actions Taken

Two solutions are developed:

- agriDOC: a daily created reflection of the farm's work economy; automated and permanent backup of all generated data; an electronic field diary, essentially a permanent up-to-date

overview of the farm with live display of all employees, machines, and devices; and a deeper comprehension of the behavior patterns of employees.

- agriPORT: a cloud-based software that allows to organize operational procedures quickly, safely, and independently; activities are suggested through the use of agronomic guidelines; possibility to share data with authorized third parties. In practice, agriPORT allows to view the enterprise's entire field and crop rotation schedule, exporting lists of fields, and organizing crop rotation.

Benefits and Impact

The benefits for a farmer are multiple: how to plan and use machines, labour and operating resources are more exact. This means there is work time saving, a decrease of management costs, a more efficient use of machine and operational resources, an improvement in cost and yield growth. Indeed, the use of smart technologies can prevent overfertilization, thus preserving the quality of the soil and water, minimizing the negative impact on the environment, and avoiding fertilization errors.

In particular:

AGRIDOC helps to better organise work by reducing needless phone calls and manages visits to save time, an automatic recording of all activities and digital access to all recorded information. Additionally, the farm will get more competitive thanks to the disclosure of downtime and loss periods, enhanced employee motivation, greater transparency, and the possibility to find opportunities for improvement and savings.

With **AGRIPORT,** farmers can quickly, safely, and independently organize their operational procedures without relying on specific suppliers of operating resources and any additional agricultural gear.

Contact Information

Email: info@agricon.de

Website: https://www.agricon.de/en/

Youtube: https://www.youtube.com/user/Agricon2010

Prepared by

Irene Facchin (INI-Novation GmbH)

Application Area

☒ Plants ☒ Location of Assets

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services

Digital Technologies

☒ IoT ☒ Big data

Inpixon's Intelligent Livestock Management with Real-Time Location Technology

Name of the Organisations Involved

- Inprixon, US, Germany, UK, India

Challenges Identified

The agricultural industry faces strains from a volatile market, accelerating demand to feed a growing global population and evolving health, safety, and environmental concerns. This has made keeping livestock healthy and productive a key to business continuation, success, and a sustainable future.

Goals and Solution

To address these challenges and meet emerging regulatory requirements, farmers are increasingly seeking RFID technologies capable of delivering timely insights for each and every member of their herd.

Inpixon is a company, dedicated to leveraging indoor data for positive impact. Specializing in capturing, interpreting, and visualizing indoor data, the company makes indoor spaces smarter, safer, and more secure. Industries across the spectrum, including agriculture, benefit from their solutions, enabling users to boost revenue, reduce costs, and enhance safety. With capabilities such as mapping, positioning, analytics, sensor fusion, and IoT integration, Inpixon enables customers to unveil the untold stories within indoor environments.

Inpixon's livestock tracking technology enables farmers to correlate animal location and movement with health status. Create real-time visibility to enable 24/7 health and behaviour monitoring for cattle, sheep, and other animals on your farm.

Actions taken

To attain real-time visibility in Intelligent Livestock Management, farmers must equip their farms with tools capable of capturing, interpreting, and contextualizing location data. The foundational components of this tracking system include:

- RTLS for Industrial IoT:

Deploy precise, accurate, and industry-leading real-time location systems (RTLS) that extend beyond animal tracking to cover the entire inventory and warehousing environment. This comprehensive solution ensures seamless tracking for optimal farm management.

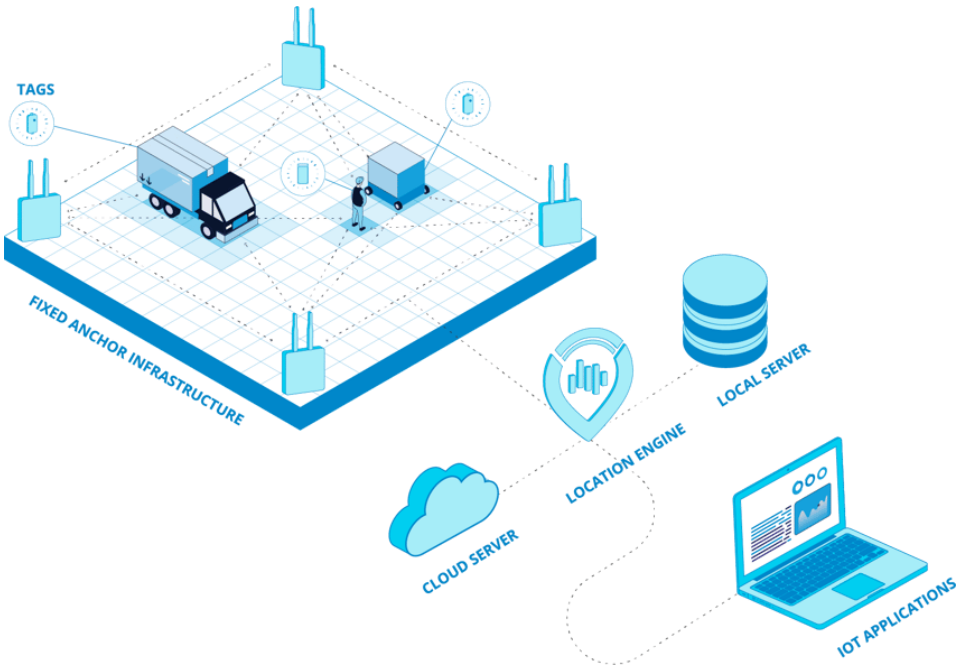
- Indoor Positioning:

Leverage existing technology ecosystems or utilize Inpixon's award-winning sensor technology for effective indoor positioning. This capability enables farmers and producers to discover indoor spaces, enhancing overall location awareness.

- Wireless Device Detection:

Integrate precise indoor positioning with wireless device detection capabilities to establish real-time, 24/7 situational awareness. This integrated approach empowers farmers and producers to make informed decisions regarding security, risk mitigation, and public safety.

Together, these components serve as the essential building blocks of digital location intelligence, providing farmers with the necessary tools to navigate the complexities of modern farm management successfully. (More information: https://www.inpixon.com/industries/livestock-tracking)



Picture: Real-time location system. Source: Inpixton website (link: https://www.inpixon.com/technology/rtls)

Benefits and Impact

Implementing advanced livestock tracking technology brings a multitude of benefits and transformative impacts to agricultural operations:

- Precise monitoring for every animal:

Track the location of each individual animal and monitor the overall herd with unparalleled precision.

- Real-time health insights:

Utilize location data to analyse activity, health, heat, and rumination in real time. Power instant health warnings, inactivity alerts, and more for timely intervention.

- Early detection of potential illness:

Harness real-time location data coupled with behavioural algorithms to automate the detection of potential health issues. Proactively identify unusual activity, stress, rumination patterns, and early signs of infection, enabling prompt preventive measures.

- Geofencing for enhanced alerts:

Implement geofencing to receive real-time alerts and detect specific events, enhancing overall monitoring capabilities.

- Scalability for large herds:

Enjoy scalability to track thousands of animals both indoors and outdoors seamlessly.

- Improved productivity and profitability:

Save valuable hours by eliminating manual searches and checks for individual animals. Increase profitability, enhance yield, and reduce operational costs. Improve product quality by reducing medication levels, supporting more free-range time, and ensuring a healthier, happier herd. Gain valuable insights into animal behaviour, travel patterns, and dwelling preferences, identifying areas for improvement and efficiency.

- Compliance with Global Standards:

Meet global compliance requirements mandating the use of RFID for cattle tracking. Leverage precision UWB and long-range chirp technologies to ensure accuracy, range, and reliability in diverse livestock tracking needs.

By implementing livestock tracking technology, farmers not only ensure compliance and accuracy but also revolutionize farm management, promoting animal welfare, early disease detection, and overall operational efficiency.

Contact Information

Inprixon Headquarters

2479 E. Bayshore Rd, Suite 195, Palo Alto, CA 94303, United States

Tel. +1 (800) 680-7412

Inprixon GmbH, Germany

Offices in Düsseldorf, Eschborn and Berlin

Website: https://www.inpixon.com/contact-us#locations

Author of the Good Practice

Angela Ivanova (INI-Novation GmbH)

Application Area

☒ Location of Assets ☒ Livestock ☒ Terrain

Digital Technology in the Value Chain

☒ Agronomic Services ☒ Agricultural Inputs and Services

Digital Technologies

☒ IoT ☒ Big data ☒ Sensor Automation

3.6. Condition of Assets

Digital agriculture has a significant impact on the management of the condition of assets in the agricultural sector. It utilizes various technologies and data-driven approaches to monitor and maintain the health and other conditions of assets, such as machinery, equipment, and infrastructure. Digital agriculture impacts the management of asset condition in the following applications: remote monitoring, predictive maintenance, reduced downtime, improved equipment efficiency, safety management, asset lifecycle management, resource allocation, data integration, and historical data analysis.

In summary, digital agriculture enhances the management of asset condition by enabling real-time monitoring, predictive maintenance, improved equipment efficiency, enhanced safety measures, and better decision-making. This results in reduced downtime, optimized asset performance, and increased productivity on the farm.

By leveraging these technologies, agriculture can enhance operational efficiency, extend the lifespan of assets, reduce downtime, and ultimately improve the overall productivity and sustainability of agricultural operations.

The following good practices are showcasing **condition of assets** applications:

No.	Good Practices Related to "Condition of Assets"	Country
1	Intelligent Sensor Networks in Farming Machines	Germany
2	Radar Sensors for Precision Farming	Germany

Intelligent Sensor Networks in Farming Machines

Name of the Organisations Involved

- CLAAS Selbstfahrende Erntemaschinen GmbH, Germany
- Universität Bielefeld, Germany

Challenges Identified

Every harvesting process is a big challenge. The combine harvester must be continually adapted to the conditions of the field and the weather because the plants can vary greatly in their size, their spikes, the number of grains and grain size - due to soil influences, water points, shadow formation or different management of the field. This means there is no ‘standard’ setting for a combine harvester.

How can the harvesting process of a combine harvester be better monitored?
How can the person operating the machine be relieved?

These are valid questions related to the identified challenges and to be answered by the good practice example. Scientists from the Research Institute for Cognition and Robotics (CoR-Lab) at Bielefeld University and the agricultural machinery manufacturer CLAAS in Harsewinkel (Gütersloh district) addressed these questions in the innovation project 'Intelligent sensor network for determining process variables' (InSensEPro).

Goals and Solution

Machine learning and AI algorithms are used to detect and locate plant species from the composite drone. The goal of the InSensEPro project was to develop an intelligent sensor network for combine harvesters. The system is intended to precisely determine and interpret grain loss directly during harvest. This means it can recommend to the person operating the machine how to optimize the harvesting journey.

Actions taken

The first step was to find a sensor system that was actually able to determine the desired grain loss. The harvest throughput is immense – up to 120 tons per hour. Capturing this with sensors is a challenging task. In order to avoid blockages or other negative effects, the volume flow must not be hindered by the measurement. At the same time, there are harsh operating conditions during the harvesting process, which rule out classic optical processes such as the internal use of cameras, especially due to the massive amounts of dust. The mechanical stresses caused by vibrations and the transport of the crop are also an exclusion criterion for most processes. The project team found and implemented a suitable structure-borne sound-based sensor system that is able to reliably measure the grain flow and distinguish it from short straw and other transported material.

However, this method cannot directly measure the complete grain loss, but only the crop flow for a specific position in the combine harvester's installation space. As a second step, in order to capture enough data to estimate grain loss, suitable mounting positions for the more than 100 sensors had to be found. In addition, to reduce the amount of wiring and the associated influence on the flow of goods, various wired and wireless transmission technologies were experimented with.

An energy-saving wireless transmission technology – Bluetooth Low Energy – has proven to be particularly suitable for this particular application. The sensor network records all relevant data and makes it available to a central control unit for further analysis. The number of data sources resulting from this is in the mid-three-digit range.

However, this large number of data streams that are continuous over time is neither manageable nor interpretable for a single person, the person driving the combine harvester. And here comes the third step. By using artificial intelligence methods, it has been possible to compress the large amount of data for the combine driver into one target variable, grain loss, and thus make it usable and easy manageable.

The result: In a total of 60 harvest days and 46 laboratory days, it was possible to develop an intelligent sensor network that monitors the processes in the agricultural machine and interprets its data using artificial intelligence.

Image: Networking sensors and equipment during the testing. Source: InSensEPro

Image: The combine harvestor at work. Source: InSensEPro

Benefits and Impact

- With the sensor network, grain losses can now be determined much more precisely, so that the driver can optimize the machine settings to better target grain losses.
- This makes it possible to increase the efficiency of the harvesting machine while at the same time optimizing the quality of the harvested crop. In addition, the person operating the machine is relieved.

Contact Information

Marvin Barther

Email: marvin.barther@claas.com

CLAAS Selbstfahrende Erntemaschinen GmbH,
Website: https://www.claas.com
Other: https://www.its-owl.de/die-projekte-im-ueberblick/innovationsprojekte/innovationsprojekte-1/back-560/insensepro/

YouTube: https://www.youtube.com/watch?v=02G0r6N4nfs

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Application Area ☒ Condition of Assets
Digital Technology in the Value Chain ☒ Agricultural Inputs and Services
Digital Technologies ☒ IoT ☒ Sensor Technology ☒ Artificial Intelligence (AI)

Radar Sensors for Precision Farming

Name of the Organisations Involved

- OndoSense GmbH, Freiburg, Germany

Challenges Identified

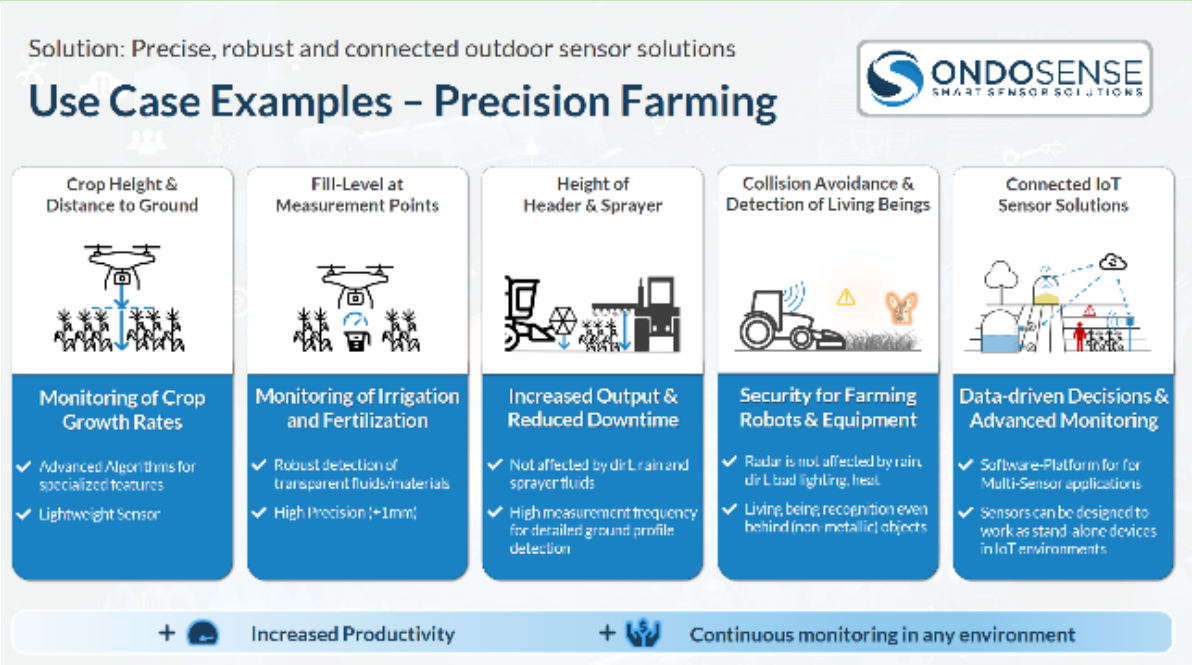
In many industries, there is a need to maintain tolerances in product measurements when those measurements cannot be accurately determined. Excessive height, width or length results in a waste of resources and contributes significantly to the greenhouse gas emissions of the production process. This is particularly true for agriculture, considering the technical requirement of precise measurements for precision farming applications.

Goals and Solution

With smart sensor solutions, OndoSense ensures that customers receive relevant and precise insights for monitoring plant growth, animals, maintenance of agricultural machinery and, for example, distance measurements. This makes a wide variety of applications possible in so-called precision farming.

Actions taken

Customers benefit from the robustness of radar to monitor results and automate processes in harsh environments.



Source: OndoSense

Benefits and Impact

- Reliable collision avoidance: are there living creatures hidden in the field?
- Machine height detection: immune to dust, dirt & spray fluids?
- Accurate irrigation monitoring,
- Completely reliable in harsh weather conditions and dust,
- Use case-specific algorithm functions,
- Ultra lightweight.

Contact Information

Dr. Mathias Klenner

Email: m.klenner@ondosenses.com

OndoSense GmbH,

Website: https://www.ondosense.com

Linked-in: https://www.linkedin.com/in/mathias-klenner-59668912b/

YouTube: https://www.youtube.com/watch?v=vytX41ytGoc

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Application Area

☒ Condition of assets

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services

Digital Technologies

☒ Sensor Technology

3.7. Livestock

Digitalisation has also impact on the management of livestock. It utilizes various technologies and data-driven approaches to monitor and maintain the health and condition of livestock. Examples are: health monitoring, remote tracking, nutritional management, reproduction management, disease management, labor efficiency, environmental monitoring, animal welfare, data integration, historical data analysis, and efficient record keeping.

In summary, digital agriculture enhances the management of livestock condition by enabling real-time monitoring, predictive health management, improved animal welfare, and more efficient labor practices. This results in healthier and more productive livestock, reduced losses, and optimized livestock management on the farm.

By leveraging these technologies, agriculture can enhance animal welfare, improve productivity, and optimize the management of livestock operations, ultimately leading to more efficient and sustainable livestock production.

The following good practices are showcasing **livestock** applications:

No.	Good Practices related to "Livestock"	Country
1	Beenotes™ Apiary Management Solution	Greece
2	Digital Livestock Management	Germany
3	Kmetija Čretnik: Holistic Farm Transformation for Enhanced Animal Welfare and Sustainable Productivity	Slovenia
4	smaXtec - Cow Monitoring Technology	Austria, Germany, UK, Ireland, Switzerland
5	Wuggl – Pig Weighing Technology	Austria

Beenotes™ Apiary Management Solution

Name of the Organisations Involved

- Beenotes Plus

Challenges Identified

Keeping notes in life is a good practice. Taking notes on beekeeping is even better. Some beekeepers apply this practice reverently, maintaining detailed .xls files that document the order of frames, the observed brood, and the type and percentage of pollen. Others use a paper-based system, providing a structured way to record their observations, so that when they visit the apiary, they have a clear idea of what to expect when they open the lid. Some beekeepers mark their hive lids with a marker or simply open the lid to check.
What is certain is that 90% of beekeepers feel the need to document their activities in some way. The younger and fewer bees they have, the more detailed they are. The digitalization of this process and the development of a related tool have been progressing slowly for a few years. Recent developments have caught up, and a new recording app has emerged that is so effective that it cannot be ignored.

Goals and Solution

The Beenotes Apiary Management Software addresses the challenges faced by beekeepers when taking notes, particularly those who prefer using their smartphones for this purpose.

BeeNotes™ software offers beekeepers the ability to take voice notes, collect and analyze hive data, and accurately plan their work, all while maintaining a comprehensive history of their beekeeping actions. Every beekeeper understands the importance of complete and detailed data recording during inspections, but it can be challenging, especially when hands are covered with gloves or occupied with tools. Beenotes solves this problem by automating the recording process, leaving the beekeeper's hands free for work, and eliminating the need for papers, pencils, markers, and other tools.

Essentially, it is a mobile phone application that utilizes voice recognition technology. The application records and converts the voice into digital data, capturing responses to pre-selected questions that the beekeeper customizes based on the season, geographical area, and the pace of hive inspections. Upon completion of the inspection, the data is automatically uploaded to the BeeNotes database.

After each inspection, all the collected data per hive and apiary, including the number of hives, frames, food availability, queen colour, harvest, etc., is displayed directly on the computer or tablet screen, providing a comprehensive overview of the bees' progress. Here, the producer can easily refer back, review, and edit the recordings in greater detail. For instance, if there are recordings from multiple hives, users entering the platform have the option to filter various characteristics, such as identifying the best or worst hives and pinpointing those facing issues, enabling informed decisions about honey production.

Actions Taken

Beenotes is a tool that ensures beekeepers the ability to do their work easier, faster and with better results, i.e. more production. It allows:

- **Voice Guided Inspections**
  Use of the app to easily record what happens on site. Open a dialogue with beehives in 2 ways:
  - With standard questions,
  - With your comments.
- **Group hives according to data**
  Form groups of hives depending on which bee colony needs more space, which queen bee needs replacement, which bees need feeding or treatment, and which beehive is ready for production.
- **Plan actions**
  Plan work on a hive or a group of hives in time and with accuracy. Check the history of your actions and improve your methods and productivity.

Benefits and Impact

A unique and valuable tool for

- Versatile voice inspections,
- Control of bee health and productivity,
- Scheduling made easy leading to efficient apiary management,
- Complete history of actions for as many apiaries and beehives as you want.

Contact Information

Email: info@beenotes.com

Website: www.beenotes.com

LinkedIn: https://www.linkedin.com/company/beenotes-plus/

79A, Thoukididou street, Alimos, 17455 Athens, Greece

Prepared by

Effie Tsili (CONNEXIONS)

Application Area
☒ Livestock

Digital Technology in the Value Chain
☒ Agronomic Services

Digital Technologies
☒ IoT

Digital Livestock Management

Name of the Organisations Involved

- Fraunhofer Institute for Computer Graphics Smart Farming (Public Applied R&D Organisation)

Challenges Identified

In practice, due to the high complexity of multisensory systems, extensive and systematic measurements, and evaluations of animal welfare parameters in herd management are rarely carried out. In many cases, the effort is reduced by using conductivity measurement sensors.
A high level of technical planning and configuration effort is required for the continuous recording of animal welfare parameters in different environments (stable, pasture). Using cow animal welfare as an example, a sensor and data platform is being developed for practice based on the plug & play principle to close the gap between available solutions and practical application.
Together with the FBN Dummerstorf, digital concepts for the stable are to be developed in a practical manner.

Goals and Solution

We use advanced computer vision technologies to address specific problems in the livestock industry. By using image processing algorithms and machine learning, we can extract valuable information from images and videos and use this to optimize livestock management.

Actions Taken

- Animal health: Computer vision allows detecting signs of various disease symptoms or behavioural abnormalities in animals. By analysing images and videos, pet owners can provide early warning of potential health problems and take appropriate measures to limit the spread of disease.
- Behaviour monitoring: Computer vision can monitor animal behaviour and detect abnormal behaviour. By analysing movements and interactions in real time, we can identify changes in behaviour that may indicate stress, pain or other problems. This allows pet owners to intervene in a timely manner and improve the well-being of their animals.
- Nutrition optimization: By monitoring animals' eating behaviour using computer vision, pet owners can monitor and optimize feed intake. By analysing data such as eating times and quantities, they can create individual feeding plans to ensure a balanced diet and minimize feed waste.
- Inventory management: Computer vision can help with automatic counting and identification of animals. By using camera systems and image recognition algorithms, livestock owners can accurately monitor animal populations without having to perform manual counts. This makes inventory management easier and enables efficient planning.
- Animal welfare: By combining computer vision with other technologies such as temperature and humidity sensors, animal owners can monitor and optimize the microclimate in stables. This allows them to ensure that environmental conditions meet the animals' needs and maximize their well-being.

Benefits and Impact

Our solutions give us detailed insights into animal behaviour, health and nutrition. By automating monitoring and analysis processes, we help livestock producers make better management decisions, improve animal health and welfare, and increase the efficiency of their operations.

A high level of technical planning and configuration effort is required for the continuous recording of animal welfare parameters in different environments (stable, pasture). Using cow animal welfare as an example, a sensor and data platform is being developed for practice based on the plug & play principle in order to close the gap between available solutions and practical application.

Copyright (c) Fraunhofer IGD, Rostock, Germany

Contact Information

Philip Wree

Email: philipp.wree@igd.fraunhofer.de

Website: www.fraunhofer.de

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Application Area

☒ Livestock ☒ Conditions of Assets

Digital Technology in the Value Chain

☒ Agronomic Services

Digital Technologies

☒ IoT ☒ Artificial Intelligence (AI)

Kmetija Čretnik: Holistic Farm Transformation for Enhanced Animal Welfare and Sustainable Productivity

Name of the Organisations Involved

- Farm Čretnik, Slovenia
- ID Agro, Netherlands

Challenges Identified

Farm Čretnik in Slovenia encountered several serious challenges, including:

- *Old barn:* As it was over 35 years old, the barn had structural and functional limitations.
- *No pasture capacity*: The farm lacked space for natural grazing.
- *Tied breeding*: Not an optimal practice for milking cows.
- *Outdated Design:* The barn's layout was not suitable for modern farming practices.
- *Inefficient Farming*: The work on the farm demanded high time and effort.
- *Animal Welfare Concerns*: Artificial flooring negatively impacted animal well-being.
- *Changing Customer Preferences*: Customers demand transparency, higher animal welfare, and lower environmental impact.
- *First HWF implementation* – no guarantee

Goals and Solution

In response to those challenges, the farm undertook a full renovation with the goal of boosting overall farm productivity while aligning with environmental objectives and significantly improving the well-being of the animals. Through combined efforts, the farm management integrated the following solutions:

1. *Modernized Barn Design:* The construction involved a new open-floor barn with high ceilings, ample natural light, ventilation, and greenery – aligning with 21st-century farming needs.
2. *High Welfare Floor (HWF) Implementation*: The introduction of HWF, proven to enhance animal welfare, mimics a natural pasture environment with permeable surfaces, like dirt and grass.
3. *Efficient robotic technologies*: The implemented HWF is compatible with the integrated cleaning robots, optimizing workload by constantly managing surface manure. Additionally, a robotic milking machine has been integrated to reduce the time demands on the farmers.

Short description of the technology

- *Innovative Three-Layer Flooring*: Concrete base with permeable layers: plastic honeycomb, comfort layer, and fabric; designed for efficient drainage through pipes to the slurry pit.
- *Emission Reduction and Dry Flooring:* Secretion separation on the surface reduces ammonia emissions by 80%; ensures a consistently dry floor, positively impacting udder and hoof health.

- *Smart Monitoring System:* Ankle bracelets equipped with tracking chips and pedometers collect detailed data on cow behaviour and milking metrics.
- Effortless Robotic Milking: Utilizes a 100% automatic robotic milking machine, eliminating the need for manual labour.
- *Implemented systems* to encourage and support the natural behaviours of the animals.

Picture: Simon Cretnik, the farm owner, won a special award in 2023 for his innovative approach and animal welfare. Source: https://www.facebook.com/kmetijacretnik

Actions Taken

Step 1: Recognizing Renovation and Innovation Needs

- Acknowledging the necessity for renovation and innovation in farming practices.

Step 2: Collaboration with Bio-technical University and Dutch Company

- Reaching out to the Biotechnical Faculty (University of Ljubljana) for solution suggestions.
- Establishing Contact with Dutch Company ID Agro, specializing in developing and marketing innovative housing systems for the livestock sector.

Step 3: Tailored Technology Adoption

- *Identifying and adopting technology that aligns with the specific needs of the farms.*

Step 4: Bold Implementation

- Implementing the chosen technology despite potential risks, such as uncertainties about its longevity and performance.

Benefits and Impact

The farm owner applied a holistic, comprehensive approach with the adoption of tailored technology, resulting in the following benefits:

- The farm achieved **enhanced well-being of the animals** and **increased productivity**. More specifically, this led to higher milk production (now averaging 34 liters per day, compared to 24-27 liters per day previously), extended lifespan, and overall improved animal welfare. Animals now have the freedom to move and lay down anywhere in the barn, contributing to a more natural and comfortable environment. The High Welfare Flooring (HWF), offering a slightly soft surface beneficial for animals with trotters and promoting higher laying times with no restrictive laying boxes.

- With the integration of automation, there is **a lesser demand for manual labor.** The modernized barn design resolves age-related limitations, and robotic milking along with HWF-compatible cleaning reduces workload.
- **Environmental responsiveness -** the emission reduction aligns with changing preferences.

In conclusion, these changes contribute to **higher quality products**, primarily in milk, with potential benefits extending to meat in later stages of production.

Contact Information

Čretnik farm (Kmetija Čretnik)
Tel. +386 51 317 871
Website: https://www.kmetija-cretnik.si/kontakt.html
Facebook: https://facebook.com/kmetijacretnik/

ID Agro
Tel. +31 (0) 572-37 14 04
Website: https://www.idagro.nl/producten/high-welfare-floor

Prepared by

Drejc Kokošar (ID20)

Application Area
☒ Condition of assets, ☒ Livestock

Digital Technology in the Value Chain
☒ Supply Chain Management

Digital Technologies
☒ IoT ☒ Robotic and Automation

smaXtec - Cow Monitoring Technology

Name of the Organisations Involved

- smaXtec animal care GmbH, Austria (Headquarters)

Challenges Identified

Farmers face a myriad of challenges that significantly impact the health, productivity, and overall well-being of their cow herds. One of the primary concerns is the early detection of diseases among cows. Identifying health issues at their inception is crucial for preventing the escalation of diseases and minimizing their impact on farm operations. The conventional approach often falls short in providing timely alerts, resulting in severe courses of diseases and potential economic losses for farmers.

Moreover, the overuse of antibiotics poses a considerable problem in the industry. Excessive antibiotic usage not only raises concerns about the health of the animals but also contributes to escalating treatment costs. Farmers grapple with the need for a more sustainable and proactive approach to managing cow health that minimizes the reliance on antibiotics while maintaining optimal herd performance.

Reproductive success presents another significant challenge in dairy farming. The subtile signs of heat in cows, coupled with variations in behaviour, make it difficult for farmers to pinpoint the ideal time for insemination. Missed heats can incur substantial costs, both in terms of reduced pregnancy rates and increased insemination expenses. This challenge calls for a solution that enhances the accuracy of heat detection and improves overall reproductive efficiency.

In essence, the interconnected challenges in dairy farming revolve around the timely detection of health issues, sustainable disease management as well as optimizing reproductive and calving processes. Addressing these challenges requires innovative technologies, such as smaXtec's, that provide continuous monitoring, early alerts, and comprehensive data sharing to empower farmers in making informed decisions for the well-being of their herds and the sustainability of their operations.

Goals and Solution

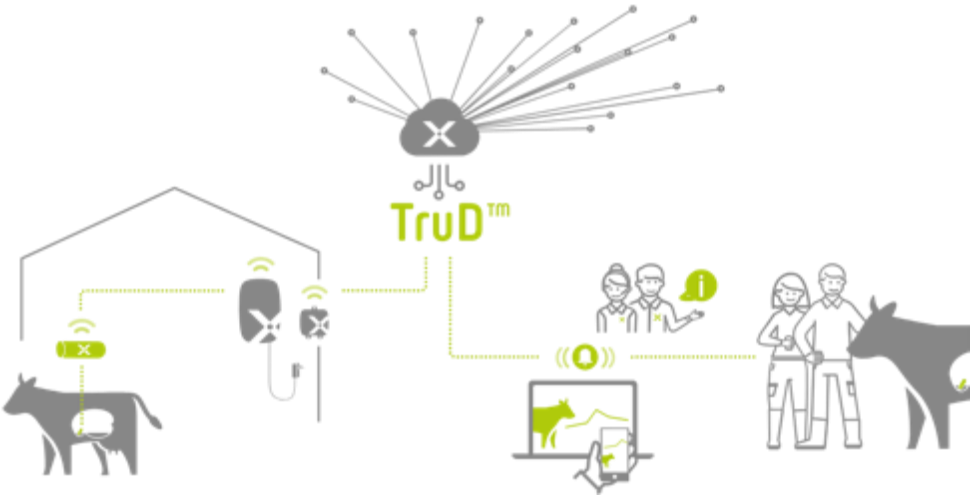
smaXtec's primary goals in dairy farming technology are to proactively manage the health of cow herds. This involves early disease detection, reducing the severity of illnesses and minimizing antibiotic use. The technology aims to optimize reproductive success by precisely identifying the ideal times for insemination, resulting in shorter calving intervals and improved fertility rates. Early calving detection ensures timely support during and after birthing, while comprehensive data sharing with veterinarians provides a holistic view of cow health for effective treatment and monitoring.

Overall, smaXtec seeks to enhance the well-being of dairy herds and promote sustainable practices in cow farming.

Short description of the technology and the beneficiaries

smaXtec's cow health system is a transformative technology for global dairy farmers, offering valuable insights directly from within their herds. At the core of this innovation is the *smaXtec bolus technology*, a small and advanced device that is ingested by the cows. This bolus, equipped with sensors, continuously measures the inner body temperature of the cows. What sets it apart is its connection to the internet,

allowing for real-time data transmission and providing continuous insights into the health and well-being of each individual cow. This connectivity enables farmers to receive instant alerts and updates, ensuring early response to emerging issues and contributing to reduced disease severity. The smaXtec bolus empowers dairy farmers with a reliable and efficient tool for making informed decisions based on scientific data, ultimately elevating the overall health, reproduction, and performance of their herds.



Source: www.smaxtec.com

Actions Taken

By using a smart and connected bolus technology, smaXtec tackles dairy farming challenges by providing real-time, internet-connected insights into cow health. This enables early disease detection, minimizes antibiotic use, optimizes reproductive success, and enhances overall herd well-being, empowering farmers with proactive, data-driven decision-making for sustainable and productive farming.

Benefits and Impact

- 24/7 monitoring of cows' health
- Early detection of health problems
- Recommended actions in case of need via artificial intelligence
- Optimized herd health
- Monitoring of recovery
- Improved cow fertility
- Calving detection & monitoring
- Feeding optimization

Contact Information

Website: www.smaxtec.com

smaXtec animal care GmbH (Headqurter)

Sandgasse 36/2, 8010 Graz, Austria

T +43 316 46 15 88

Email: info@smaXtec.com

smaXtec Limited
4 Michael Street, Limerick, V94 V184, Ireland
T +353 61 410 879

smaXtec GmbH
Salzburger Straße 10, 83404 Ainring, Germany
T +49 6021 43 763 0

smaXtec AG
Kantonsstrasse 35, 8807 Freienbach/SZ, Switzerland
T +41 (0) 55 560 11 00

Prepared by

Mihail Stanev (INI-Novation GmbH)

Application Area
☒ Livestock

Digital Technology in the Value Chain
☒ Agromonic Services ☒ Agricultural Input and Services

Digital Technologies
☒ IoT ☒ Sensors ☒ Artificial Intelligence

Wuggl – Pig Weighing Technology

Name of the Organisations Involved

- WUGGL GmbH, Austria

Challenges Identified

Traditional methods of weighing pigs present several challenges for farmers that have been effectively addressed by a new technology. The conventional process of pig weighing is often time-consuming and labor-intensive, requiring the use of physical scales. This traditional approach can be particularly challenging when attempting to obtain accurate measurements due to the difficulty in handling and restraining the animals. Conventional weighing methods may not always provide the precision required. Moreover, the act of physically weighing pigs can induce stress and discomfort for the animals, potentially affecting their well-being. Stressful weighing processes may lead to inaccurate results as the animals may not remain still or cooperative during the procedure.

Additionally, the need for specific setups and equipment for traditional weighing methods can pose logistical challenges on the farm. The portability and flexibility of weighing equipment are crucial factors, especially in dynamic agricultural environments where pigs may be situated in various locations such as barns or outdoor runs.

Goals and Solution

The goal of WUGGL's innovative pig-weighing solution is to revolutionize traditional pig weighing methods. The key goals include simplifying the weighing process for farmers by introducing a non-contact, instant measurement method. WUGGL strives to enhance efficiency, user-friendliness, and precision in weight measurements while minimizing stress on the animals. The solution is designed to be versatile, catering to various farm environments, and incorporates practical features such as robust construction and a user-friendly interface to meet the specific needs of farmers in pig management.

Short description of the technology and the beneficiaries

Founded in southern Styria (Austria), WUGGL is an agricultural startup that aims to revolutionize the weighing of pigs. WUGGL's innovative pig-weighing technology, represents a significant change to traditional methods, introducing a streamlined and efficient approach to the weighing process. At the heart of this technology is a novel non-contact measurement method that eliminates the need for physical scales. Instead, the farmer takes a picture of the pig's body, and the application displays the accurate weight.

This user-friendly interface ensures that farmers can easily select the specific pig for weighing, regardless of its angle or stance. The instantaneous nature of the measurement not only reduces the labour intensity associated with traditional weighing but also minimizes stress on the animals, as there is no need for physical contact or restraint during the process.

Portability is a key feature of WUGGL's technology, allowing farmers to weigh pigs in diverse locations, whether in barns, runs, or other environments. The WUGGL One's practical design incorporates impact-resistant materials, making it durable even in challenging agricultural conditions. Additionally, its waterproof housing facilitates easy cleaning, addressing the inevitable exposure to dust and dirt in farming settings

In summary, WUGGL's pig-weighing technology stands out for its non-contact, instant measurement method, user-friendly interface, and practical design features. By addressing the challenges of traditional methods, WUGGL One offers farmers a more efficient, accurate, and stress-free solution for managing the weight of their pigs in diverse agricultural settings.

The technology significantly accelerates the process of weighing pigs optically and eliminates the need for each pig to be individual weighted on a scale.

Source: www.wuggl.com

Actions Taken

WUGGL's pig-weighing device utilizes a non-contact measurement method, which allows the device to capture an image of the pig's body with a simple click. This image is then processed in real-time through a combination of hardware and advanced algorithms, and the accurate weight of the pig is displayed on the device's screen.

Farmers interact with the technology through a user-friendly interface, which is especially handy when using it on the field or in different environments. By selecting the specific pig on the display with a click, farmers can initiate the weighing process. This intuitive interaction ensures quick and efficient measurements without the need for physical contact or complex setup. The technology's portability and adaptability further enhance its usability, enabling farmers to weigh pigs wherever necessary, whether in barns, runs, or other locations. The combination of technological innovation and user-friendly design positions the WUGGL One as a modern and effective solution for simplifying the pig-weighing process in agriculture.

Benefits and Impact

- Body image of the animal and weight can be read immediately and with a greater accuracy than traditional methods.
- Weight measuring accuracy is at 98%.
- Determining the animal's weight is possible from many angles, which also eliminates the need for a physical contact with the animal.
- The technology is an inexpensive alternative to conventional animal scales.

- Weight control option for each animal and group of animals.

Contact Information

Website: www.wuggl.com

WUGGL GmbH

Göttling 6, 8403 Lebring, Austria

Email: info@wuggl.com

Prepared by

Mihail Stanev (INI-Novation GmbH)

Application Area

☒ Livestock

Digital Technology in the Value Chain

☒ Agromonic Services

Digital Technologies

☒ Sensors ☒ Artificial Intelligence

3.8. Resource Usage

Also the management of resources impacts the agricultural sector. It utilizes various technologies and data-driven approaches to optimize the use of resources, including water, soil, fertilizers, pesticides, and energy in the following applications: irrigation management, Fertilizer Management, Pesticide Management, Energy Efficiency, Resource Optimization, Sustainability Practices, Data Analytics, Inventory Management, Environmental Stewardship, Cost Savings and Compliance and Reporting.

In summary, digital agriculture enhances the management and use of resources by providing real-time data, precision agriculture techniques, efficient allocation of resources, and a focus on sustainability. This results in reduced resource waste, increased productivity, and minimized environmental impact in the agricultural sector.

By leveraging these technologies, agriculture can become more efficient, sustainable, and resilient, ensuring that resources are used in a way that maximizes productivity while reducing negative environmental impact.

The following good practices are showcasing **resource usage** applications:

No.	Good Practices related to "Resource Usage"	Country
1	Precision Agronomy Initiative Related to Cotton Ginning and Trading in Greece	Greece
2	Radicos' TWIN Greenhouse & Livestock Housing Monitoring System	Austria
3	Virtual Tour through the Innovation Farm in Wieselburg	Austria

Precision Agronomy Initiative Related to Cotton Ginning and Trading in Greece

Name of the Organisations Involved

- Thrakika Ekkokistiria S.A., Greece

Challenges Identified

Thracian Ginning S.A. stands as one of Greece's largest and oldest cotton ginning facilities, situated in north-eastern Greece near Komotini. Established in 1972, it was the sole ginning plant in Eastern Macedonia and Thrace for many years.

Unlike countries such as America, Australia, and Brazil, Greece faced challenges due to fragmented land ownership. Even major cotton producers had plots spread across vast distances, hindering the feasibility of essential investments like weather stations and sensors.

Goals and Solution

Smart farming, focusing on precise energy application, became a priority for the company. Thracian Ginnings aimed at input savings, enhanced yields, superior quality, and reduced environmental impact, opting for smart farming. In 2016, the company implemented the Gaiasense system by Neuropublic, emphasizing good agricultural practices for efficient resource use.

Actions Taken

The company emphasizes precision farming, integrating data-driven insights, technological applications, and sustainable agricultural practices into the cotton ginning process. Taking on the role of intermediaries, Thracian Ginnings initiated intelligent agriculture in Rodopi in 2017/18 using the Gaiasense system. The process involves soil analysis, regular satellite imagery, weather stations, humidity sensors, and insect traps.

Data collected, along with agronomists' input and producers' cultivation records, allows personalized advice on irrigation, fertilization, and disease treatment. Cotton producers pay a modest annual fee, receiving detailed reports for each crop year.

Benefits and Impact

- *For the Cotton Producers (Clients of the Company):* With the overall data collected and the diaries filled in by the company's agronomists, documenting the cultivation care of participating producers, advice is provided to each individual producer on when to irrigate, the appropriate quantity for proper fertilization, and disease treatment. Producers pay a small annual fee. For each growing year, each producer receives a report for their plots containing all the crop data (such a report can be viewed here). The data-driven approach has yielded positive outcomes for participating producers, leading to an annual increase in acres involved in the intelligent agriculture program.

- For the Agricultural Sector: The right energy, in the right place, at the right time, and in the right amount. Thus, these practices contribute to the conservation of available natural resources and the optimal use of agricultural inputs. The emphasis on precise energy application contributes to good agricultural practices, promoting resource conservation and optimal use of agricultural inputs.
- For Thracian Ginning Company Itself: Despite economic challenges in Greece, Thracian Ginning has successfully expanded its operations, currently overseeing three ginning plants – two in Rodopi and one in Provatonas Evros. The company's enduring commitment to quality, environmental protection, and innovation remains unwavering.





Contact Information

Thrakika Ekkokistiria S.A. - Cotton Ginning & Trading

Email: info@thrakika.gr

Website: www.thrakika.gr

Prepared by

Effie Tsili (CONNEXIONS)

Application Area

☒ Soil ☒ Plants ☒ Weather ☒ Resource Usage

Digital Technology in the Value Chain

☒ Agronomic Services ☒ Agriculture Inputs and Services

Digital Technologies

☒ IoT ☒ Sensor Technology ☒ Artificial Intelligence (AI)

Radicos' TWIN Greenhouse & Livestock Housing Monitoring System

Name of the Organisations Involved

- RADICOS TECHNOLOGIES GmbH, Austria

Challenges Identified

Monitoring greenhouses and livestock housing involves tackling a multitude of challenges given the intricate nature of these agricultural environments. The dynamics of both greenhouses and livestock housing demand a comprehensive approach to ensure the optimal conditions necessary for plant growth and animal well-being. In navigating these complexities, several interconnected challenges emerge.

One primary challenge lies in the variability of environmental conditions. Greenhouses and livestock housing are subject to constant fluctuations in temperature, humidity, and air quality. The effectiveness of monitoring systems relies on the deployment of adaptable sensor technologies capable of withstanding diverse and often harsh conditions.

Precision agriculture practices, prevalent in greenhouse settings, require accurate and real-time monitoring. Achieving precision involves deploying sophisticated sensors that capture nuanced data on soil moisture, nutrient levels, and crop health. Similarly, precision monitoring in livestock housing is essential for understanding animal behaviour, health, and feeding patterns.

Energy efficiency is another concern, especially in greenhouses with energy-intensive operations for heating, cooling, and lighting. Balancing the need for an optimal environment with energy efficiency is challenging, and monitoring must include tracking energy consumption patterns to identify opportunities for sustainable practices and cost savings.

Addressing these challenges requires a holistic approach that combines technological innovation, data science, and sustainable practices. Continuous advancements in sensor technologies, connectivity solutions, and analytics tools are essential for overcoming these challenges and optimizing the productivity of greenhouse and livestock operations.

Goals and Solution

Radicos aims to tackle these challenges and revolutionize greenhouse and livestock housing monitoring through its TWIN Greenhouse & Livestock Housing Monitoring System. This tailored climate monitoring solution elevates smart farming by deploying an extensive network of hundreds of sensors at an affordable price. The high-level goal of Radicos is to provide a comprehensive and informative system that masters the complex task of establishing and maintaining the perfect climate for plants and livestock.

Short description of the technology and the beneficiaries

Radicos' *TWIN Greenhouse & Livestock Housing Monitoring System* represents an advanced climate monitoring solution tailored for smart farming. Unlike traditional systems with limited sensors, TWIN offers an extensive network of hundreds of sensors at an affordable price, ensuring complete and accurate information crucial for the well-being, health, and quality of plants and livestock. The TWIN system offers complete information on temperature, humidity, CO_2, NH_3, and H_2S, with plans for integrating additional

sensors. Not only does TWIN contribute to the welfare and health of plants and livestock, but it also focuses on cost efficiency, enabling significant savings in energy through informed control measures. The system is designed for easy installation in diverse environments, including dusty atmospheres and high humidity levels, ensuring reliability. The TWIN Dashboard provides visualization with high-resolution heat and humidity maps, configurable graphs, and alarms, empowering users with real-time insights for proactive decision-making. Radicos' overarching mission is to enhance efficiency, sustainability, and the overall well-being of agricultural operations.

Source: www.radicos.com

Actions Taken

The *TWIN Greenhouse & Livestock Housing Monitoring System* creates significant value by revolutionizing climate monitoring in agriculture. Its extensive network of sensors delivers complete and accurate information, empowering farmers, livestock owners, and greenhouse operators to optimize conditions for plant growth and animal health. The system's affordability, energy efficiency, and compatibility with existing technologies result in cost savings, making sustainable farming practices more accessible. TWIN's impact extends to consumers, ensuring the production of safer and higher-quality food products. Overall, the technology enhances efficiency, sustainability, and productivity across the agricultural sector.

Benefits and Impact

- Farmers benefit from the TWIN system by gaining access to comprehensive climate data, allowing for informed decision-making to optimize conditions for plant growth and livestock health.
- Owners and managers of livestock operations benefit from TWIN's ability to monitor parameters like temperature, humidity, and gas levels, ensuring a healthier and more comfortable environment for animals.
- Greenhouse operators benefit from the TWIN system's precise monitoring capabilities, helping create and maintain an ideal climate for crop cultivation, resulting in higher yields and improved crop quality.
- The TWIN system promotes sustainable and environmentally friendly practices by facilitating more efficient resource usage through targeted monitoring, aligning with the goals of environmental conservation.

Contact Information

Website: www.radicos.com

Email: info@radicos.com

Prepared by

Mihail Stanev (INI-Novation GmbH)

Application Area

☒ Plant ☒ Livestock ☒ Resources

Digital Technology in the Value Chain

☒ Agromonic Services

Digital Technologies

☒ Sensors ☒ Artificial Intelligence

Virtual Tour through the Innovation Farm

Name of the Organisations Involved

- Innovation Farm, Austria
- Agromarketing GmbH, Austria

Challenges Identified

Innovation Farm is always on the lookout for innovations to deal with the latest developments in Agriculture 4.0. Their aim is to bring farmers closer to digitalisation in agriculture.

Goals and Solution

With the help of 360° technology, Innovation Farm has created a virtual representation of their three sites in Wieselburg, Mold and Raumberg-Gumpenstein with the arable farming, grassland, and indoor farming projects. All innovations can be experienced as if the visitor were standing in front of them. They can move around the trial fields, take a look inside the stables or climb aboard and take a virtual ride on the trial machines.

Actions Taken

The following highlights await the visitor:

- A bird's eye view of the three sites
- A virtual journey of discovery through our halls, fields, stables and laboratories
- Informative descriptions of the innovations
- Detailed shots of the machines and systems
- 360° videos of the innovations in use
- An immersive experience with a learning and fun factor.

Benefits and Impact

- In the machine halls and on the test field, the visitor can view the tested innovations individually and walk around them virtually,
- Detailed images show the technical highlights of each machine,
- On the information boards one can find short descriptions as well as pictures and videos on the relevant topic.

Pictures Innovation Farm

Link: https://www.innovationfarm.at/virtueller-rundgang-innovation-farm/

Contact Information

Dr. Gerald Grausgruber

E-mail: office@agromarketing.at Tel.: +43 664 / 83 96 120

AgroMarketing GmbH, Dietmarstraße 5, 4910 Ried im Innkreis

Prepared by

Wolfgang Eisenreich (WIN)

Application Area

☒ Resources Usage

Digital Technology in the Value Chain

☒ Agricultural Inputs and Services

Digital Technologies

☒ IoT

4. Impact of the Digital Technology in the Value Chain

PIcture 6. © Ljupco, Dreamstime.com

Agricultural Value Chains encompass the entire process from production to consumption, emphasizing the steps that add value to agricultural products. The Value Chain elements aim to add value to products and service as it progresses through various stages of the supply chain.

In Module 4 ”Building Economic Value Chain in Agriculture Using Digital Technologies” from AgriSkills Training Course (https://training.agriskills40.com/modules/), the value chain is described in detail from an economic perspective. Additionally, you can find there information about the common uses of the most innovative technologies for gaining a competitive advantage of your products.

The integration of digital technologies in agriculture revolutionizes the way farmers and stakeholders operate within the value chain. Here are some key effects related to the significant and transformative impact of digital technologies in agriculture:

- Digital technologies allow for *precise monitoring and management of crops.* This is precision farming. This leads to optimized resource allocation, improved yields, and reduced input costs.
- Advanced sensors, drones, and satellite imagery provide a variety of data. This enables farmers and stakeholders to make *informed decisions* about planting, irrigation, fertilization, and pest control.
- Digital technologies enable *better coordination between various stages* of the agricultural supply chain, from production to processing to distribution. This can lead to reduced waste, increased efficiency, and improved traceability.
- Digital platforms and e-commerce tools connect farmers directly with consumers or intermediaries. This reduces the reliance on traditional middlemen and increases transparency in pricing and transactions. *Farmers receive better market access.*
- Blockchain and other digital tools enable detailed tracking of products from farm to table. This enhances food safety and allows consumers to *verify the origin and quality of agricultural products.*

- Sensors and IoT devices allow for *remote monitoring of crops and livestock*. Automated systems can control irrigation, manage climate conditions, and even harvest crops, increasing efficiency and reducing labor costs.
- Predictive analytics and climate modeling tools help farmers anticipate and mitigate risks related to weather, pests, and market fluctuations. This allows for *better planning and risk management strategies.*
- Digital banking and payment systems provide farmers with *better access to financial services,* allowing them to secure credit, manage transactions, and invest in their operations.
- Digital technologies can help *optimize resource use, reduce chemical inputs, and promote sustainable practices*. This leads to more environmentally friendly and resource-efficient agricultural operations.
- Digital platforms offer access to a wealth of agricultural knowledge, best practices, and training resources. This helps *farmers stay informed* about the latest techniques and technologies.

Effective management of agricultural value chains is essential for ensuring that products reach consumers with high quality, efficiently, safely and sustainably. It also plays a critical role in economic development and poverty reduction, particularly in rural areas where agriculture is a primary source of livelihood.

In the previous Chapter 3, numerous good practices from farms and development companies, are showcasing how innovative technologies are applied across different application areas.

In this Chapter 4 of this document, our focus is on showcaing digital technologies supporting some integral parts of the value chain in agriculture as supply chain management, agronomic services, agricultural inputs and services and agricultural commodity trading. These components collectively form the value chain in agriculture, representing the series of activities and processes involved in bringing agricultural products from the farm to the end consumer. Each element plays a specific role in creating value and ensuring the success and sustainability of agricultural operations.

4.1. Supply Chain Management

Short Information about Supply Chain Management

Supply Chain Management (SCM) in agriculture constitutes the core prccesses in the agricultural value/cahins, orchestrating the coordination of all activities related to the production, processing, distribution, and marketing of agricultural products and ensuring that goods move efficiently from the farm to the end consumer.

Key components include planning, sourcing inputs, planting and cultivation, timing harvests, post-harvest handling, processing, and value addition through branding and packaging. Storage and warehousing, diverse transportation modes, market research, and access strategies are vital. Quality control, information technology tools, regulatory compliance, and sustainability practices round out SCM. Collaboration with stakeholders enables optimized

operations. Efficient supply chain management is paramount for safe, high-quality agricultural product delivery. It minimizes waste, enhances profitability, and aligns with the intricacies of a global market.

Use Cases of Digital Technolgies in the Supply Chain Management

Digital technologies have a significant impact on supply chain management in agriculture. Here are some concrete examples of how it has transformed this industry:

- Digital technology enables farmers to use GPS-guided tractors and drones to optimize planting, irrigation, and harvesting. This precision agriculture allows for more efficient use of resources like water, fertilizers, and pesticides.
- IoT (Internet of Things) devices, such as sensors and monitors, are used to collect data on soil conditions, weather patterns, and equipment performance. This real-time information helps farmers make more informed decisions about planting, irrigation, and pest control.
- Digital tools like RFID (Radio-Frequency Identification) and barcoding systems provide accurate and real-time tracking of inventory levels. This helps in preventing overstocking or shortages, leading to cost savings.
- Online marketplaces and e-commerce platforms connect farmers directly with buyers, eliminating the need for intermediaries. This can lead to better prices for farmers and fresher produce for consumers.
- Advanced analytics and machine learning algorithms are used to analyze historical data and market trends. This enables more accurate demand forecasting, helping farmers plan their production cycles more effectively.
- Automation technologies like autonomous tractors and robotic harvesters are becoming more prevalent. These machines can work around the clock, increasing efficiency and reducing labor costs.
- Digital tools provide end-to-end visibility in the supply chain, allowing stakeholders to track the movement of goods from farm to table. This transparency helps in identifying and resolving any issues or delays.
- Access to real-time weather and climate data allow farmers to make proactive decisions about planting, irrigation, and harvest timing. This reduces risks associated with unpredictable weather patterns.
- Farmers can use mobile applications to communicate with suppliers, buyers, and logistics partners. They can also use these apps to keep digital records of activities like planting dates, pesticide applications, and harvest yields.
- Digital technology enables the implementation of sustainable farming practices. For instance, data analytics can optimize crop rotation and resource allocation, reducing environmental impact.
- Digital tools can help farmers stay compliant with various regulations and certifications related to food safety, organic farming, and sustainability.

The integration of digital technology in agriculture's supply chain management has led to increased efficiency, reduced waste, improved quality, and enhanced sustainability practices. It has also empowered farmers with data-driven insights to make more informed decisions in an evolving agriculture and industry. Bellow, three good practices are presented:

No.	Digital Technologies in Supply Chain Management	Country
1	Innovative Solutions in Organic Farming: The BIOKARPOS Journey	Greece
2	Centaur: Transformative Solutions for Quality Grain Storage	Greece
3	farmAIr: Early Detection of Plant Stress	Greece

Innovative Solutions in Organic Farming: The BIOKARPOS Journey

Name of the Organisations Involved

- BIOKARPOS S.A., Greece

Challenges Identified

Traditional organic farming, while aligned with sustainable and environmentally friendly practices, may encounter challenges in the process of cultivation, harvesting, control, packaging, and distribution of products. Conventional methods of packaging, if they are not protective, can lead to a higher risk of spoilage or damage during transportation. Limited distribution networks can result in delays and difficulties in reaching consumers in a timely manner. Due to challenges in the supply chain and distribution, organic products may have a shorter shelf life by the time they reach consumers. This can affect their freshness and overall quality.

Goals and Solution

BIOKARPOS, a family business founded in 2006, is nestled in Maladreni, Argolis, Northern Peloponnese, within a region celebrated for its rich history, fertile soil, and excellent climate. The company's origins can be traced back to Michael Mavrogiannis, the great-grandfather of the family, who fervently transformed the family farm into an organic unit, spanning over 1000 acres today.
The overarching goal of the family is to provide clean, nutritious products that are accessible to all. Their cultivation, harvesting, control, packaging, and distribution processes are aligned with this philosophy, which has guided the family business throughout the years. In this journey, BIOKARPOS relies on two key allies: their dedicated partners, who form the soul of the company, and modern scientific and technological means, in which they continuously invest.

Actions Taken

During the last years, BIOKARPOS has implemented investments for the creation of a new modern packaging house, the modernisation of production department and the mechanical equipment, regarding the cultivation of the private farm. The company is equipped with the most modern technological means that ensure the maintenance of the original quality and excellent hygiene for the products, during all stages of production. With an unwavering commitment to providing valid and high-quality customer service, the company has invested in complete vertical integration, establishing a fleet of proprietary refrigerated trucks. These trucks facilitate daily deliveries of a comprehensive range of excellent quality organic products to both the mainland and the islands of Greece.

Benefits and Impact

Notably, BIOKARPOS, drawing on its extensive experience, has dynamically entered the market by introducing high-quality private label products under the brands "EuBio" and "Amelxi." The key pillars of the product offering are:

- Product Safety
- Excellent quality

- Fair Prices
- Wide variety
- Consistency in Services

Today, the company stands as one of the most esteemed suppliers of organic products in Greece, boasting a flourishing international presence—a source of immense pride for BIOKARPOS.

Source: BIOKARPOS website

Contact Information

BIOKARPOS S.A.
Website: https://www.biokarpos.gr/en/
Email: info@biokarpos.net

Prepared by

CONNEXIONS

Application Area
☒ Resources Usage

Digital Technology in the Value Chain
☒ Supply Chain Management ☒ Agricultural Inputs and Services

Digital Technologies
☒ Other Technologies

Transformative Solutions for Quality Grain Storage

Name of the Organisations Involved

- Centaur Analytics, Greece

Challenges Identified

High technology is coming to solve another problem in grain production, with an innovative solution from Greek agro-technology company Centaur Analytics that ensures high quality grain during storage and minimises losses.

Using a system of intelligent sensors that record data such as humidity, temperature, etc. and then inform any user device connected to the Internet, Centaur Analytics' solution monitors the condition of stored grain and informs the producer immediately.

Goals and Solution

Centaur Analytics' technological solution aims to simplify the process for producers to ensure the quality of their products and reap the economic benefits of their use. Developed and manufactured in Greece, Centaur's products offer solutions in the digitalization of the food supply chain. The Internet of Crops® platform encompasses products that facilitate continuous monitoring of grain conditions in post-harvest storage, precision fumigation monitoring, and complete traceability of a product's journey "from the field to the consumer's fork."

The solutions are based on two pillars: real-time measurements from smart sensors and other sources, such as weather stations, and models and algorithms to draw conclusions and make predictions. This enables the creation of a 'digital twin' for each warehouse or silo, providing a detailed picture of temperature and humidity, along with insights into quality parameters like dry matter loss, mold growth, germination capacity, etc. Predictions about the product's development can be made up to 6 months in advance.

Source: https://www.centaur.ag

Details about the technology and the beneficiaries:

In a user-friendly manner, the Centaur system empowers users to extend the safe storage period of their products, receive timely notifications of risks or tampering, and make informed decisions on product

management—whether it's an opportune time to sell or consume. Users can access and share traceability data to enhance their product's competitiveness and guarantee its quality. The Internet of Crops® application is accessible from any web-enabled device (mobile phone, tablet, PC), prioritizing usability, especially for mobile devices. The application has been continuously improved over the last 5 years based on daily user interactions in over 25 countries worldwide.

Actions Taken

Centaur maintains constant contact with its strategic customers, providing a continuous flow of information regarding their day-to-day needs and the challenges they face. In this context, alongside the development and improvement of existing Centaur products, the company's team consistently creates various prototypes. These prototypes undergo on-site testing, and depending on the sector's response, they are integrated into the range of product solutions. This approach ensures flexibility and precision in product development and customer service.

Benefits and Impact

The Internet of Crops® is an inclusive IoT (Internet of Things) solution designed to scale, catering to the monitoring needs of assets of any size. This ensures that everyone can enjoy the benefits at a cost aligned with the scale of their production and/or business.

Based on previous studies conducted on behalf of the company by organizations such as Iowa State University in the USA, the minimum benefit to users of advanced grain management solutions is more than 5%. In practice, this means that the Internet of Crops® solution is the most cost-effective 'insurance' stakeholders can buy for their product, with a return on investment achievable within the first period of use.

For more information, follow the link: https://www.agro24.gr/agrotika/kainotomia/tehnologia/centaur-analytics-mia-kainotomos-lysi-poy-exasfalizei-tin-poiotita

Contact Information

Website: www.centaur.ag

Email: sales@centaur.ag

Prepared by

Pantelis Balaouras (CONNEXIONS)

Application Area

☒ Resources Usage ☒ Condition of Assets

Digital Technology in the Value Chain

☒ Supply Chain Management ☒ Agricultural Inputs and Services

Digital Technologies

☒ IoT ☒ Sensor Technology

Early Detection of Plant Stress

Name of the Organisations Involved

- farmAIr, Greece

Challenges Identified

The ever-increasing problems facing humanity, such as population growth and climate change, are exacerbating malnutrition in many parts of the world. If we continue with the current diets and production practices, we will need an area twice the size of India to feed the world's population by 2050, based on expected population growth. Additionally, the agri-food sector, as it operates today, is responsible for a quarter of carbon dioxide emissions.

Changes in climate, including unpredictable weather events, can subject plants to stress. While higher atmospheric CO2 levels can initially stimulate photosynthesis, associated climate changes may introduce stressors.

Plant stress is a significant challenge for agriculture and can have detrimental effects on crop yields and overall productivity. This stress occurs when environmental conditions exceed the optimal range for plant growth and development. It can be caused by both abiotic factors (such as excessive heat, frost, flooding, drought, etc.) and biotic factors (including pathogens, insects, herbivores, etc.). This, in turn, increases production costs while reducing the quantity and quality of the final product.

Goals and Solution

farmAIr is a dynamic, flexible and customer oriented AgriTech company, committed to always bring cutting-edge technology and the best experience to their customers. "*Using thermal and digital cameras, machine learning and artificial intelligence, we identify plant stress at the leaf level and well before any symptoms appear, for some diseases up to 2-3 years earlier, giving the farmer the necessary time to react. This differentiates us from the international "competition" and that is why our technology has been patented, which has an international classification and application in agriculture and the environment*", says Stamatis Diavatidis, co-founder of farmAIr. At the moment, farmAIr technology is available for vineyards, planning to gradually expand to virtually any plant with leaves.

How does the farmAIr project work?

Currently, drones are employed to gather field data, providing farmers with two options:

- Integrated Diagnostic Service (End-2-End): A specialized team conducts aerial photography.
- Simple Diagnostic Service (Bring Your Own Image): Farmers use their own compatible drones equipped with thermal and digital cameras, guided by our instructions for aerial photography.

Agricultural technology and machinery companies collaborate with farmAIr team for custom software development and other related needs, with associated fees.

Farmers can leverage this technology and the farmAIr platform, along with other services (weather data, soil data, vegetation indicators, water content, chlorophyll, etc.), to pinpoint crop issues using their mobile phones or tablets. They can then "download" the comprehensive diagnostic report for each field in PDF format, ready to be shared with their scientific team.

Source: https://www.farmair.io

Actions Taken

“Currently, farmAIr technology and services are utilized on a paid basis (annual subscription per hectare) with significant success in Greek vineyards. Since our inception, we have gained 23 satisfied partners, including the largest wineries in the country, agricultural cooperatives, nurseries, and private individuals. Our immediate goal is to gradually expand to the traditional wine-producing countries of France, Italy, Spain, Portugal, Chile, Argentina, South Africa, Australia, and California. Our next objective for the agricultural market is to extend our services to other crops," says the company's co-founder.

FarmAIr is actively pursuing collaborations with other agri-tech and agri-product companies. The company has recently signed a memorandum of understanding with a greenhouse company looking to expand into open-field crops. Additionally, FarmAIr is in discussions with indoor vertical farming and smart tractor companies to establish partnerships, exchange or co-develop new technologies, and foster mutually beneficial commercial relationships that will establish it as a reliable partner for international operators and companies.

Moreover, in a notable development, farmAIr has recently signed a Memorandum of Understanding with the largest of these satellite-launching companies, and negotiations are underway with two others.
Contacts are being established with insurance companies and international certification bodies to facilitate the use of the technology and its services in the field of agricultural compensation and mapping challenges in significant agricultural areas worldwide. Although farmAIr is currently specialized in vines, expansion to cover more crops is on the horizon.

Benefits and Impact

Using thermal and digital cameras, machine learning and artificial intelligence, farmAIr identify plant stress at the leaf level and well before any symptoms appear, for some diseases up to 2-3 years earlier, giving the farmer the necessary time to react.

Growers can manage plant stress, prevent disease transmission to the healthy part of their field, saving (on average) around 35% of treatment costs, and manage irrigation, fertiliser and pesticide use in a better and more targeted way, ensuring the health of their crops, increasing the efficiency and quality of production, and applying sustainable farming practices in line with the requirements of the Common Agricultural Policy and the United Nations Sustainable Development Goals.

Contact Information

Website: www.farmair.io

Email: sales@farmair.io

Prepared by

Pantelis Balaouras (CONNEXIONS)

Application Area

☒ Soil ☒ Plants

Digital Technology in the Value Chain

☒ Supply Chain Management ☒ Agronomic Services

Digital Technologies

☒ IoT ☒ Drones and AGVs

4.2. Agricultural Commodity Trading

Short Information about Agricultural Commodity Trading

Engaging in agricultural commodity trading entails the profitable exchange of various raw agricultural goods covering livestock products (including dairy), grains, vegetables, fats and oils, wine, fruits and other goods, through buying and selling activities. This market operates through various channels, each with its unique features. Traders rely on market analysis, employing technical, fundamental, and sentiment-based approaches, and regulatory bodies like the CFTC oversee fair and transparent trading practices.

Agricultural commodity trading is a dynamic and complex market that plays a vital role in ensuring the efficient distribution of agricultural products around the world. It plays a crucial role in connecting producers with processors, distributors, and end consumers. Efficient commodity trading helps determine fair prices and ensures a steady flow of products through the value chain. The global trade depends on efficient transportation and logistics networks, while technology, including electronic trading platforms, has transformed commodity trading, enabling algorithmic and automated systems to flourish.

Use Cases of Digital Technologies in Agricultural Commodity Trading

In agricultural commodity trading, digital technologies opened up opportunities for a wider range of participants, from individual farmers to global trading firms, to participate in the agricultural commodity market.

- *Online Trading Platforms:* Digital platforms facilitate the buying and selling of agricultural commodities in real-time. Traders can access markets from anywhere, enabling a broader participation and increased efficiency.
- *Market Information and Analysis:* Advanced software and algorithms provide traders with real-time market data, news, and analysis. This helps them make informed decisions and respond quickly to changing market conditions.
- *Automated Trading Systems:* Algorithmic trading, powered by complex algorithms, allows for automated execution of trades based on pre-defined criteria. This improves speed and accuracy in trading.
- *Marketplace Integration:* Online platforms integrate various aspects of trading, including contract negotiation, payments, and delivery scheduling, streamlining the entire trading process.
- *Data Analytics and AI:* Advanced analytics and artificial intelligence provide insights into market trends, helping traders make more accurate predictions and investment decisions.

We highlighted specific digital technology use case below that increase access to markets impacting liquidity for farmers and businesses:

No.	Digital Technologies in Agricultural Commodity Trading	Country
1	Kern Tec - Upcycling of Raw Materials	Austria
2	Wikifarmer – the Leading B2B Marketplace of Agricultural Products	Greece/ International

Kern Tec - Upcycling of Raw Materials

Name of the Organisations Involved

- Kern Tec, Austria

Challenges Identified

Upcycling agricultural by-products poses several challenges that span environmental, technological, and economic dimensions. One primary obstacle is the heterogeneity of these by-products, which can include crop residues, organic waste, and processing leftovers. The diversity in composition and quality makes it challenging to develop standardized upcycling processes. On the technology side, other challenges arise from the need for advanced and specialized machinery to efficiently convert agricultural by-products into valuable products. Processing methods must be tailored to the specific characteristics of each by-product, requiring continuous innovation and adaptation. Additionally, some by-products may contain contaminants or impurities, demanding sophisticated purification techniques.

Upcycling agricultural by-products is a multifaceted challenge requiring interdisciplinary collaboration and innovative solutions. Overcoming these obstacles is crucial for realizing the environmental and economic benefits associated with transforming agricultural residues into valuable resources.

Goals and Solution

Kern Tec aims to develop and implement technologies that address the challenges associated with upcycling agricultural by-products, focusing on innovative and sustainable solutions that can transform diverse agricultural residues into valuable products.

Through interdisciplinary collaboration and adherence to regulatory standards, Kern Tec strives to lead the way in creating a more efficient and environmentally conscious approach to agricultural by-product utilization.

Short description of the technology and the beneficiaries

Kern Tec is an Austria based upcycling and food tech company. With tech- and supply chain innovation Kern Tec is able to turn industrial by-products into high value ingredients for the food & beverage industry but also for cosmetic and industrial applications. Kern Tec is committed to bring unique plant based ingredients and products to the global food market created from pits from apricots, cherries and plums. These raw materials were previously seen as a side product in the global production, but with Kern Tec's technologies they can be processed into tasty, sustainable, nutritious and safe products like food & cosmetic oils, protein powders, "nut" spreads and even dairy alternatives. The seeds can be called as the most sustainable nuts that ever existed with plenty of applications and opportunities to come. SO far, Kern Tec has been able to successfully upcycle over 1.000.000 kg of fruit pits and is heavily investing in scaling the processes and bringing the technologies to whole Europe and beyond.

Source: www.kern-tec.com

Actions Taken

Kern Tec's upcycling technology generates significant value by transforming industrial by-products, such as fruit pits from apricots, cherries, and plums, into high-value ingredients. The technology creates unique, sustainable, and nutritious offerings for the food & beverage, cosmetic, and industrial sectors. By turning overlooked byproducts into products like oils, protein powders, "nut" spreads, and dairy alternatives, Kern Tec contributes to a more circular economy, reducing waste and offering environmentally friendly alternatives. The technology not only benefits manufacturers and consumers by providing innovative, healthy choices but also contributes to job creation and economic growth. As Kern Tec expands its reach globally, the value extends to diverse industries and consumers seeking sustainable and diverse product options.

Benefits and Impact

- The agricultural sector benefits indirectly, as Kern Tec's technology valorizes previously considered by-products (fruit pits). This incentivizes sustainable agricultural practices and potentially increases the overall efficiency and value of fruit cultivation.
- Manufacturers in the food and beverage industry benefit from Kern Tec's innovative upcycling technology, as it provides high-value ingredients derived from industrial byproducts. This contributes to the creation of unique, sustainable, and nutritious products, including oils, protein powders, "nut" spreads, and dairy alternatives.
- Kern Tec's upcycling technology contributes to environmental conservation by reducing waste and promoting the sustainable use of resources. By transforming fruit pits into valuable ingredients, the company aligns with principles of circular economy and waste reduction.

Contact Information

Website: https://www.kern-tec.com/en/

Email: office@kern-tec.com

Prepared by

Mihail Stanev (INI-Novation GmbH)

Application Area

☒ Plant

Digital Technology in the Value Chain

☒ Agromonic Services ☒ Agricultural Commodity Trading

Digital Technologies

☒ Others

WIKIFARMER - the Leading B2B Marketplace of Agricultural Products

Name of the Organisations Involved

- Wikifarmer

Challenges Identified

- Most farmers in the world still cultivate their fields with techniques learnt by experience or taught by their ancestors, leading to non-optimum practices in terms of yield and environmental impact. As a result, the company decided to publish thousands of articles with agricultural best practices and how-to guides.
- Farmers produce the most valuable part of the food supply chain, but they are the ones getting the least value out of it. Farmers can now increase their potential clientele, sell all their stock, reduce their wastage, and all that at better prices, increasing their profitability by up to 300%.

Goals and Solution

Wikifarmer is a global platform with the mission to empower farmers through educating them and offering them direct access to the commercial markets to sell their products at fair prices.

The company mission is to:

- **Create a /more Transparent and Fairer Ecosystem**

The goal is to create a fair, transparent, and rewarding environment for all people involved in Agriculture, by connecting the Producers directly with the Buyers, avoiding the unnecessary large commissions paid in the food value chain until today, and forcing transparency, accountability, security, and reliability to every transaction.

Farmers and Producers dedicate their lives to their crops but get the lowest value of the total sales cycle; they deserve a fair share.

- **Fight Climate Change**

Helping farmers learn modern and sustainable best practices and at the same time aiding them to get a larger value out of the supply chain is something that can become the main driver towards a more sustainable agricultural world.

Farmers can increase their yields while at the same time they can use practices that can benefit the environment. In addition to that, higher producers' profitability means further investment in technology, new techniques, and equipment which in the longer term will have a very positive income to our world.

- **Enhance Agricultural Trade**

They are here to connect all the dots and facilitate agricultural trade and commerce locally, regionally, and globally. The only way that all the agricultural bottlenecks can be broken and surpassed is through digitization and the creation of a digital ecosystem that connects all the necessary parties together (producers, buyers, logistics, quality assurance partners, financing, and insurance providers**).** The company mission is to enable and enhance the creation of such an ecosystem.

Actions Taken

- Wikifarmer MarketPlace - Access the local and global agricultural markets through Wikifarmer MarketPlace.
  Farmers can now increase their potential clientele, sell all of their stock, reduce their wastage, and all of that at better prices, increasing their profitability by up to 300%.

- Wikifarmer Library - Learn from the biggest, open Library for farmers globally.
  Thousands of articles have been published with agricultural best practices and how-to guides with the contribution of thousands of farmers, agronomists, and experts, making all the material freely accessible to all farmers in the world in more than 15 language versions.

Source: https://wikifarmer.com/market/en/

Benefits and Impact

- All farmers have access to relevant educational material, the latest scientific-technological advances, and practical manuals that can help them upgrade their production and income in a sustainable way. This effort has been recognized by the International Food and Agriculture Organization (F.A.O.) of the United Nations by characterizing Wikifarmer's Library as "The Wikipedia of Farming."
- Higher profitability for farmers means more investments in their production capabilities, higher employment, and more sustainable farming. Wikifarmer Marketplace enables thousands of farmers across several countries to create more distribution channels for their products, gain direct access to thousands of businesses and reduce their dependence on intermediaries with no value.
- For buyers, as an end-to-end stop, the whole ordering process has become simpler, making it easier to find anything related to agriculture and complete orders with security and confidence from the moment needed until it's delivered.
- On a higher level, the platform envisions contributing to a sustainable future, supporting businesses, the economy, the environment, and anyone involved in agriculture, which is needed today more than ever.

Contact Information

Email: info@wikifarmer.com
Website: https://wikifarmer.com/
Website: https://m.me/Wikifarmer.official

Prepared by

Effie Tsili (CONNEXIONS)

Application Area
☒ Resource Usage

Digital Technology in the Value Chain
☒ Comodity Traiding

Digital Technologies
☒ Big Data

4.3. Agronomic Services

Short Information about Agronomic Services

Agronomic services, offered by knowledgeable agronomists, are vital for optimizing crop production and maximizing quality. These services focus on providing specialized knowledge, expertise, and recommendations related to the science of agriculture, encompassing various processes such as harvesting, post-harvesting, soil health care, sustainable agriculture, and educational initiatives.

Agronomic services begin with thorough soil analysis to determine nutrient levels and pH values, tailoring fertilizer and soil amendment recommendations accordingly. Agronomists guide crop selection based on local conditions, disease resistance, and market demand, also emphasizing rotation schedules for optimal yield and pest management. They advise on planting times, seeding rates, and equipment adjustments for uniform stands. Continuous field inspections help agronomists to identify and address pests, diseases, weeds, and nutrient deficiencies. Addditonally, agronomists collaborate with farmers to implement practices that reduce environmental impact and conserve resources. They share their knowledge through workshops, seminars, and informational materials, significantly contributing to the advancement of modern agriculture.

Use Cases of Digital Technologies in Agronomic Services

Through the integration of technology and data analysis, agronomists harness various sources to inform decision-making and refine agronomic practices. Precision agriculture solutions that are integrated with agronomic services, including field mapping, soil and nutrient analysis, enable data-driven recommendations for fertilization and pest management.

Below, there are highlighted specific use cases as technologies and services to demonstrate the effective integration of digital technologies in agronomic services:

No.	Digital Technologies in Agronomic Services	Country
1	Agricolus - the Platform for Precision Farming	Italy
2	Farmdok - Precision Farming Solution	Austria
3	Gaiasense Smart Farming System	Greece
4	Gaia Robotics: Transforming Agriculture with Innovative Technology Solutions	Greece

Agricolus - the Platform for Precision Farming

Name of the Organisations Involved

- Agricolus, Italy

Challenges Identified

The initiative to introduce cutting-edge agricultural technologies throughout Italy stemmed from the industry's challenges, including increased management costs, climate change, and European legislation. Facilitating the adoption of such technologies aims to help agriculture fulfil its obligations to uphold environmental and economic sustainability.

Goals and Solution

Agricolus, based in Perugia, Umbria known as the "green heart" of Italy, is a pioneering company in smart farming, with a mission to "Make AgriTech sustainable." Using its digital tools, Agricolus aims to assist every participant in the agri-food chain and maximize agronomic techniques.

Actions Taken

- Agricolus developed the user-friendly Agricolus platform, accessible directly from the web through a simple registration process. The Agricolus Platform comprises key applications of Smart Farming, including geolocated field mapping, satellite imagery with vegetation indexes, forecast models for phenology, irrigation, pest and diseases, task management, crop scouting with a mobile app, and prescription maps for fertilization. This integrated platform combines data from various sources, providing farmers with a user-friendly Decision Support System (DSS). This empowers farmers to make timely and appropriate decisions based on the actual needs of their crops.

- To support the digitization and sustainability, Agricolus developed AgriTrack, a digital tool for communication and analysis tailored for agricultural organizations such as associations, cooperatives, distributors, and food processors.

- The Agricolus Academy was established. This educational initiative is crucial to empower agronomists, agricultural specialists, and agrotechnicians with the skills to effectively use AgriTech tools and analyze data. The Agricolus Professional Academy offers various certification levels, with credits recognized by the relevant Order.

- Agricolus offers several solutions tailored to farmers' requirements such as Agricolus Easy, Agricolus Observa, and Agricolus Plus

Agricolus Easy

With Agricolus Easy you may map an area up to 50 hectares and view your plots' NDVI vigor index. Sentinel 2 photos with a spatial resolution of 10 meters are accessible every 5 days, allowing to remotely monitor crops and assess their growth to effectively plan the tasks to be done in the field. The Agricolus Farmer mobile app allows to geolocate data, take direct field measurements, and add notes and photographs about diseases, pests, and damage.

Agricolu Observa

Agricolus Observa is the answer for farms in need of reliable assistance with crop monitoring and management. The emphasis is on field data collection and satellite imagery, a method that gives all herbaceous, cereal, and horticultural crops the best possible outcomes.

Agricolus Plus

Agricolus Plus is the answer for farmers seeking cutting-edge technology assistance for a comprehensive 360-degree agronomic approach. The platform can be tailored to meet the unique requirements of any farm, especially those who grow many crops and wish to link weather stations and use forecast models.

Benefits and Impact

Agricolus, an advanced AgriTech platform, simplifies and elevates farmers' work: farmers can efficiently schedule tasks, optimize resource usage and potentially reducing inputs (fertilizer, water, and treatments) by up to 20%. Membership options, including Agricolus Free, cater to diverse needs.

The Agricolus Academy empowers farmers with comprehensive AgriTech knowledge, enabling informed decisions and maximizing farm output. Certification levels validate farmers' expertise, instilling confidence in leveraging digital tools for enhanced agricultural practices.

Contact Information

Website: https://www.agricolus.com/en/

Facebook: https://www.facebook.com/AGRICOLUSsrl/

Twitter: https://twitter.com/i/flow/login?redirect_after_login=%2FAgricolusSuite%2F

Instagram: https://www.instagram.com/agricolus_srl/

Youtube: https://www.youtube.com/channel/UCgPvHu4sllWCtmioOZf2y-Q

LinkedIn: https://www.linkedin.com/company/agricoluss.r.l./

Email: discover@agricolus.com

Prepared by

Irene Facchin (INI-Novation GmbH)

Application Area

☒ Soil ☒ Terrain

Digital Technology in the Value Chain

☒ Agromonic Services

Digital Technologies

☒ IoT ☒ Big Data

Farmdok – Precision Farming Solution

Name of the Organisations Involved

- Farmdok, Austria

Challenges Identified

Farmers encounter various challenges in traditional agricultural practices that can be effectively addressed through digital technology solutions. Field management complexities, including crop rotation and soil samples, can be streamlined with digital tools, providing a centralized overview of fields and facilitating efficient planning. Documentation, often a time-consuming task, can be automated through digital platforms, ensuring accurate and easily accessible records of activities from seeding to harvest. Stock management challenges, such as monitoring stock movements and maintaining comprehensive reports, can be simplified with digital solutions, enabling real-time tracking and optimized resource utilization.

Overall, digital technology offers farmers practical solutions for enhanced field management, streamlined documentation processes, and efficient stock management, contributing to improved productivity and sustainable agricultural practices. However, many service providers offer stand-alone solutions which cannot be integrated with other solutions, thus making it hard for farmers to use digital technology at scale in their work. This particular challenge is being solved by Farmdok.

Goals and Solution

The main goal of Farmdok is to empower farmers with cutting-edge technology, leveraging satellite and weather data, to enhance the efficiency and sustainability of agricultural practices. By providing a comprehensive digital platform, Farmdok aims to optimize field management, automate documentation processes, and improve resource utilization for precision farming from seeding to harvest.

Short description of the technology and the beneficiaries

Farmdok's platform employs various advanced technologies to harness a wealth of data, including satellite and weather data, enabling farmers to plan their operations better, determine yield potential and optimize the distribution of seeds, fertilizers, and other materials. The platform, accessible through commercially available smartphones and tablet PCs, ensures practicality, independence from specific machinery, offline capability, and functionality without a mobile network.

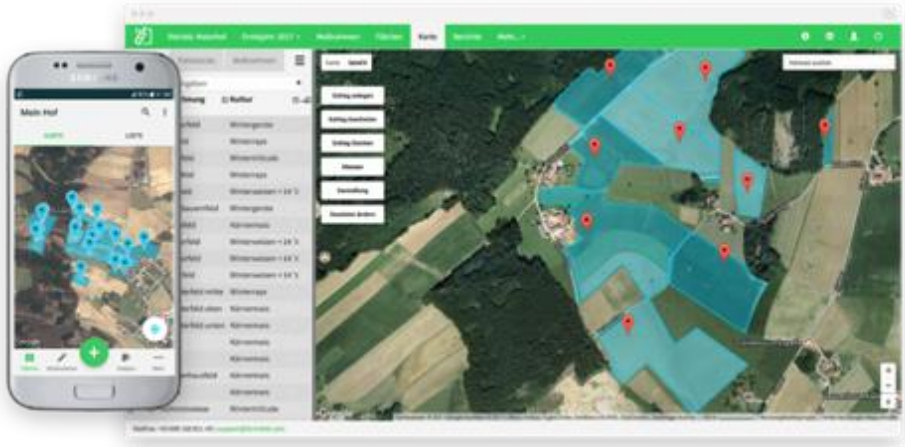
Key features of the technology encompass comprehensive field management tools, including field lists, maps, crop rotation, and soil sample records. It facilitates efficient documentation and order management through the recording of measures, automated order planning, and the inclusion of geolocated photos in field notes. The technology offers robust reporting and export capabilities, allowing farmers to conduct in-depth evaluations and export data in various formats.

Farmdok's platform extends to fertilizer management, enabling farmers to plan nutrient requirements for the entire farm and specific fields. It supports detailed documentation of plant protection measures with registration numbers and live checks. Warehouse management features include tracking stock movements, maintaining inventory levels, and generating comprehensive reports.

On the financial side, various cost accounting capabilities empower farmers to calculate contribution margins at the company, crop, and field levels, aiding in financial decision-making. The technology

facilitates customer management by allowing the creation of customers or sub-companies and the management of associated fields.

Furthermore, the technology offers application cards for sowing and fertilization based on satellite data, enhancing precision in farming practices. Connectivity and interfaces with platforms like NutriGuide, MyJohnDeere, and AMA ensure seamless integration with external systems, enhancing the overall utility of Farmdok's technology.



Source: www.farmdok.com

Actions Taken

Farmdok allows farmers can tap into the unlimited potential of smart technologies for managing their various activities and resources at scale and over time. The technology functions as a mobile app (Android and IOS), which means that it is not tied to a tractor or machine, and it is also capable of working offline without a mobile network. In short, the versatility of Farmdok's platform allows farmers to tackle some of their biggest challenges, and to have a cost-efficient centralised system for managing all of their operations.

Benefits and Impact

Farmers can benefit from satellite images and smart technologies to better plan their resources, activities, stock, and to be more agile in their farming business, thus increasing their competitiveness.

Contact Information

Website: www.farmdok.com

Email: office@farmdok.com

Prepared by

Mihail Stanev (INI-Novation GmbH)

Application Area

☒ Soil ☒ Plant ☒ Terrain ☒ Weather

Digital Technology in the Value Chain

☒ Agromonic Services ☒ Agricultural Input and Services

Digital Technologies

☒ IoT ☒ Sensors ☒ Artificial Intelligence

Gaiasense Smart Farming System

Name of the Organisations Involved

- NEUROPUBLIC, Greece
- GAIA EPICHEIREIN, Greece

Challenges Identified

Until today farmers decided based on experience and perhaps the scientific knowledge of their local agronomist. But many times, to understand what is happening in the field they have to ask specialized scientists who are often not available. They struggle that they are not making the best decisions for their crop, and they see that they are losing in yield and quality of production.

As for agricultural consultants they rely almost exclusively on field observations. The only "tool" is their eyes, while in practice there is data that they do not have access to or cannot easily utilize. And researchers are not able to put their research results into practice.

For the first time in Europe, not only large-scale farmers but also small-holder farmers can have access to the privileges and capabilities of smart farming by using Gaiasense. It can be utilized by farmers, agriculturists, researchers, industries and analysis laboratories.

The Gaiasense system is a Greek innovation that marries IT technologies with agronomic science in a holistic way. In the field of intelligent agriculture, Gaiasense is pioneering at the European level. It enhances and optimizes the decision-making process and precision applications in agricultural crops, however small or large in size.

Goals and Solution

The Gaiasense smart farming system is an innovative tool for developing digital advisory for agriculture.

It is a Greek smart farming system that continuously records and analyses data and measurements from fields and offers all those technological tools that will lead to significant economic and environmental benefit.

It provides with scientific knowledge and reliable information to deal with the dangers and problems of production in the best and most reliable way. It provides advice for thousands of farmers in Greece and abroad and expands at an impressive rate. A farmer using the Gaiasense system enjoys one of the most advanced smart farming services at a European level, paying only an annual subscription corresponding to the length of its use.

Gaiasense collects data from the field, the satellite, the scientist, and the farmer, and gives the tools to the agricultural consultant, the researcher, and the farmer to take advantage of every possibility to get a better, more and more economical agricultural product from the Greek land.

But the European vanguard of Gaiasense is that it concerns everyone.

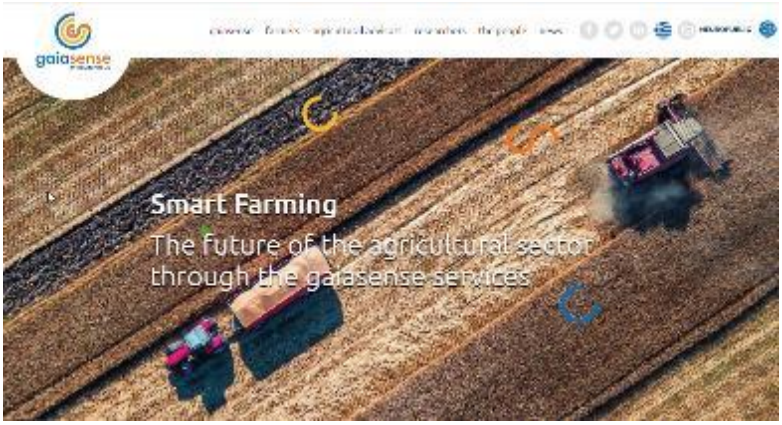
Short description of the technology and the beneficiaries

Gaiasense is an integrated system consisting of a technological infrastructure of thousands of IoT sensors installed on productive agricultural land across Greece and Europe. A digital platform collecting and processing satellite land data, a cloud ecosystem of applications for mobile devices and computers.

The **Gaiasense** system combines a multitude of informatics technologies (Big Data, Cloud Computing, Internet of Things, Machine Learning, Service-oriented Architectures, modern techniques and programming languages, and Semantic Web) with interdisciplinary fields like soil science, agricultural engineering, meteorology, agronomic and biological sciences and environmental sciences.

Actions Taken

It is for the first time in Europe that such an integrated smart farming system is created and operates on the one hand containing a high-scale technological infrastructure, and on the other hand an operational infrastructure with agriculturists, researchers and laboratories supporting it.
Gaiasense was developed entirely in Greece by NEUROPUBLIC A.E. and has been successfully implemented in recent years in the Greek territory.
Today Gaiasense covers more than twenty-five different types of crops and its infrastructure is installed in 70 different areas throughout Greece and abroad covering more than 1.5 million acres.



Source: https://www.gaiasense.gr/en/

Benefits and Impact

- Gaiasense is an advanced, but also simple to use, service for every farmer, irrespective of how familiar the farmer is to new technologies.
- It is an integrated production management system, it is economical, accurate and can be customised in each different region, for each type of soil, for each microclimate, for each variety.
- Farmers can improve their production in many ways, benefit financially and take advantage of new features for their products.
- It offers new advisory services to Agricultural Advisor that they have not been able to do until now, seal their work with scientific documentation and gain access to the professional prospects of the new digital era in agriculture.
- Allows researchers to gain access to important data, test their research under real conditions, develop it, and make profit out of it.
- Gaiasense has proven to offer a series of benefits:
  - Reduction in the use of pesticides, fertilizers, and irrigation water,
  - Effectively addressing the threats that affect production,
  - Qualitative and quantitative improvement of production,

- Added value to agricultural products,
- Reduction of environmental impacts,
- Compliance with the regulatory framework of EU.

Contact Information

Website: https://www.gaiasense.gr/home

Email: info@gaiasense.gr

More Infomation: https://www.gaiasense.gr/wp-content/uploads/2022/06/gaiasense_leaflet_21X27_GS_EN.pdf

Prepared by

Effie Tsili (CONNEXIONS)

Application Area

☒ Soil ☒ Plant ☒ Terrain

Digital Technology in the Value Chain

☒ Agromonic Services

Digital Technologies

☒ IoT ☒ Big Data ☒ Sensor Technology

Gaia Robotics: Transforming Agriculture with Innovative Technology Solutions

Name of the Organisations Involved

- Gaia Robotics, Greece

Challenges Identified

Gaia Robotics is an innovative Greek SME leveraging on the experience and knowledge of its multidisciplinary core members, working in numerous R&D activities. Gaia's main focus is a holistic vision of innovation, generated by efficiency, scientific curiosity and expert knowledge where ideas, techniques, tools and methods from different disciplines are integrated to make innovative, secure and responsible technology.

Gaia's main area of expertise lies in ICT, Green and Environmental Tech, Agritech, Robotics, Artificial Intelligence and Critical Infrastructures.

Goals and Solution

Gaia Robotics particularly works on crossing the gap between booming cutting-edge technology and the real efficiency it brings at a low cost and has managed to become the leading UAV and Precision Agriculture technology solutions Provider in Greece, that has collaborated with a multitude of customers and types of crops successfully addressing their specific needs. Gaia Robotics has already completed complex large-scale projects utilizing the vast experience of its remote sensing and geospatial analysis experts by assisting its customers using advanced scientific sensors and unmanned aerial vehicles (UAV) in acquiring, processing, and analysing remote sensing and computer vision data.

Gaia Robotics is actively engaged in various projects and case studies and its team constantly conducts research and development on emerging technologies. This highly skilled team is responsible for the development of

- **MyGaia Cloud Platform** which is a Decision Support System tailormade to help producers and agronomist optimize their farming management decisions and achieve a sustainable production that can produce more yields with less inputs and a smaller environmental footprint.
- **COLT Weather Station,** which is an innovative low cost, IoT enabled environmental sensor that leverages novel green technologies such as tree energy harvesting and provides crucial data to our clients helping them better monitor their crops or greenhouses;
- MyGaia360 is a state of the art, end to end robotic solution that is poised to revolutionize urban farming and democratize food production.

Short description of the technology and the beneficiaries

MyGaia, is a pioneering Digital Agriculture Platform that is crop agnostic and offers the most complete farm management and problem prediction solution.

The Platform helps farmers analyze crop status by using a broad spectrum of available farming data sources. They create easy to understand plant health maps and crop management zones accompanied by an up to date weather data stream. This enables to offer a complete suite of analytical tools generated by scientifically collected data.

How it works:

- Data Collection

Data collection is achieved through a broad set of technological tools such as multi spectral sensors, satellite imaging as well as a wealth of additional satellite data.

- Data Processing and Analysis

After the data collection is completed, they are automatically uploaded and processed by our proprietary MyGaia platform.

- Data Visualization

The end results are readily accessible to the user, using their personal code, through any device connected to the Internet and can also be downloaded in various formats.

Gaia Robotics succeeds in combining information technologies with agronomic science in a holistic and sustainable way that aims on revolutionizing food systems through the digital transformation of the production process. It enhances and optimizes the decision making and precise applications in agricultural crops no matter how small or large scale they are and collects and fuses actionable data from both the crops, remote sensing solutions like satellites and UAV enabled multispectral sensors and also from the agronomist and the producer. Thus, Gaia Robotics provides the necessary tools to the agricultural advisor, the researcher and the producer in order for them to optimize their yields, while reducing the environmental footprint of their practices. Therefore, the innovation and scalability potential of Gaia Robotics lies exactly in its unique characteristic that it concerns everyone engaged in the food system production cycle**.**

Actions Taken

Gaia Robotics has completed for 3 consecutive years, in close cooperation with KYKNOS SA, the largest UAV enabled precision agriculture survey in Greece. The data collection and analysis campaigns concluded have produced a wealth of novel and extremely useful data regarding the growing process and farming regimens of processing tomato and have enabled related producers and agronomists to expand their knowledge and optimize their production.

Finally, MyGaia360 is an innovative and very promising robotic project, that could offer novel solutions to existing production problems, leading to a new circular economy paradigm.

Benefits and Impact

My Gaia offers

- Plant Development & Growth Monitoring
- Early Detection of Disease and pests
- Detection and diagnostics of stress
- (mechanical damage, nutrient deficiency, water stress, soil compaction)
- Constant Monitoring of the effect of herbicides & fertilizers (optimization of fertilization)
- Prediction of yield
- Crop Management Zones
- Alerts - Users Notifications

Gaia Robotics solutions empowers farmers to achieve significant economic gains including 30% increase in yield, 40% decrease in costs, as well as 70% decrease in disease-related risks, all of which facilitates the production of quality products and reduces negative environmental impact.

Contact Information

Email: info@gaiarobotics.gr

Website: https://www.gaiarobotics.gr

Prepared by

Effie Tsili (CONNEXIONS)

Application Area

☒ Soil ☒ Plants ☒ Terrain

Digital Technology in the Value Chain

☒ Agronomic Services

Digital Technologies

☒ Robotic and Automation ☒ IoT ☒ Sonsor Technology ☒ Drones and AGvs

4.4. Agricultural Inputs and Services

Short Information

Agricultural inputs constitute the fundamental elements essential for the cultivation processes, encompassing a spectrum of tangible goods. These include tangible goods like high-quality seeds, fertilizers formulated for specific crops, pesticides tailored for pest control, cutting-edge machinery designed to enhance efficiency, and an array of materials vital for the farming process. These inputs collectively form the backbone of modern agricultural practices, facilitating the growth and development of crops while optimizing yields.

Additionally, agricultural services play a pivotal role in supporting and augmenting the overall farming ecosystem. These services extend beyond the mere provision of goods, encompassing a broad range of activities crucial for the smooth functioning of agricultural enterprises. For instance, equipment repair services ensure that farming machinery operates at peak efficiency, minimizing downtime and maximizing productivity.

In addition, transportation services, within the agricultural value chain, are vital for the seamless movement of goods from farm to market, ensuring timely delivery and minimizing post-harvest losses. Storage facilities, another integral aspect of agricultural services, provide a secure environment for preserving crops, preventing spoilage, and allowing for strategic inventory management.

In summary, agricultural inputs and services collectively form a comprehensive framework that not only supports the core cultivation process but also contributes significantly to the efficiency, resilience, and sustainability of modern farming practices. These essential components play a crucial role in ensuring the prosperity of the agricultural sector, addressing the diverse needs of farmers and fostering innovation within the broader agricultural Value Chain .

Use Cases of Digital Technologies in Agricultural Inputs and Services

Digital technologies have revolutionized various aspects of agricultural services such as equipment repair, transportation, and storage facilities:

- **Equipment Maintenance and Repair. Examples:**
  - Predictive Maintenance: IoT sensors on machinery can monitor equipment performance in real-time. They detect issues before they lead to breakdowns, enabling timely repairs.
  - Remote Diagnostics: Technicians can diagnose equipment issues remotely using digital tools, reducing downtime and improving repair efficiency.
  - Augmented Reality (AR) for Repairs: Technicians can use AR glasses to receive visual instructions for repairing equipment, improving accuracy and speed.
- **Transportation and Logistics. Examples:**
  - Route Optimization: Digital platforms use GPS and traffic data to find the most efficient routes for transporting goods. This reduces fuel consumption and delivery times.
  - Telematics for Fleet Management: IoT devices in vehicles track location, speed, and fuel consumption. This information is used to optimize vehicle usage and monitor driver behavior.

- Electronic Logging Devices (ELDs): ELDs automate hours-of-service recording for truck drivers, ensuring compliance with regulations.

- **Storage Facilities. Examples:**
  - Climate Control and Monitoring: IoT sensors inside storage facilities monitor temperature, humidity, and other environmental factors. This helps maintain optimal conditions for stored crops.
  - Inventory Management Systems: Digital systems track inventory levels and provide alerts for restocking or managing perishable goods.
  - RFID and Barcode Technology: These technologies are used for efficient tracking and management of stored goods, reducing errors and improving inventory accuracy.
- **Drones for Surveillance and Inspection. Examples:**
  - Drones are used to monitor large storage facilities, providing a bird's-eye view of inventory levels and identifying potential issues.
  - Warehouse Management Systems (WMS): WMS software helps automate and optimize warehouse operations, including order fulfillment, inventory tracking, and space utilization.
- **Fleet Management Software. Examples:**
  - These systems monitor vehicle usage, maintenance schedules, and fuel efficiency, optimizing the performance of transportation fleets.

The integration of digital technologies in agricultural services related to equipment repair, transportation, and storage facilities has led to reduced costs, and improved overall efficiency of the operations. It allows for better resource allocation and ensures that agricultural products are handled and transported in a safe and sustainable manner.

Use cases of technologies impacting the agricultural inputs and services are illustrated below:

No.	Digital Technologies in Agricultural Inputs and Services	Country
1	Agriculture Robots as a Service – Agroverse	Greece
2	SnailX – Snail Management Solution	Austria
3	Sustainability and Winery Success with eVineyard	Slovenia
4	CampusGenius - Enabling Digitization in Farming via Private 5G Connectivity	Germany

Agriculture Robots as a Service

AGROVERSE

Name of the Organisations Involved

- Agroverse, Greece

Challenges Identified

Growers want to find a way to reduce the burden of hard work in the field at a time when they are also facing a significant labour shortage. At the same time, consumers are now demanding higher quality, healthier and more sustainable agricultural products, which can be more easily delivered by using intelligent robots in the field. At a time when the agricultural sector is estimated to consume 50% of Europe's water, studies have shown that the use of robots in spraying operations could reduce water consumption by up to 90%.

The use of robots in agriculture is expected to increase in the coming years as the technology becomes more advanced and cost-effective. However, it is still relatively limited for the following main reasons:

- High cost: Agricultural robots can be expensive to build and maintain. This can put them out of the reach of small-scale farmers or those with low-margin crops.
- Lack of information and complexity: Many farmers may not be aware of the benefits of using robots in agriculture and may have difficulty understanding how they work.
- Limited infrastructure: Agricultural robots often require specialised infrastructure, such as charging stations and other related facilities, which are not readily available in all areas.
- Adaptability: Agricultural robots may be better suited to flat fields with uniform rows of crops than sloping fields of irregular shape. They may also be unable to navigate effectively in fields with dense crops, such as vineyards or orchards. This can limit the types of fields and crops for which robots are practical, reducing their overall flexibility.
- Legal and safety issues: Regulations governing the use of robots in agriculture are still evolving, and there may be uncertainties about legal and safety issues that could affect their adoption. As agricultural robots become more connected to online platforms and collect more data, there are security concerns about privacy, security or even malicious use of a particular robot.

The “Agriculture Robots as a Service” is responding to all those specific needs and challenges.

Goals and Solution

The goal of the Agroverse service is to help farmers produce high-quality food, sustainably and effortlessly and reduce the aforementioned main reasons which limit the use of robots.

Agroverse is introducing “Agriculture Robots as a Service”. The robots are offered as a service, the farmer does not buy them, they just pay only the work they do. They won’t have to pay a large amount of money upfront or even lease them. The robots are autonomous. The farmers don’t have to operate, maintain, or service them. Everything is handled by the operator.

Agroverse provides fully autonomous electric and self-powered robots, capable of collecting data on crops and offered as a service to farmers. By offering agricultural robots as a service, farmers pay for the use of the robots per acre without having to purchase the robots, reducing upfront costs. This makes them more affordable to farmers of all scales, including small-scale farmers.

Short description of the technology and the beneficiaries

Robots are used in agriculture and their use is increasing every day as technology develops. They can perform various agricultural tasks such as mechanical weeding, spraying, planting, harvesting and monitoring the health and other parameters of crops. One of the most common types of agricultural robots is the Automated Guided Vehicle (AGV), which performs agricultural tasks in the field in an automated manner without human intervention.

Agroverse's robots perform daily agricultural tasks such as mechanical weeding, spraying, harvesting and other agricultural tasks that typically require planning, time and execution by the farmer. In addition, through the use of sensors, our solution could enable farmers to gain more information about their crops, including potential disease outbreaks and yield predictions. This information could help farmers make more targeted decisions in a more automated way. Specifically, Agroverse's online application will alert the farmer when such indications are present while the robot is working, allowing the farmer to plan the next session. By showing farmers the positive impact that robots can have on crop yields and resource management, it immediately increases the likelihood that they will adopt such technologies. In addition, our solution is independent of local infrastructure, as nothing is required beyond the Agroverse Hub, which acts as a charging station for the robots. The robots are equipped with peripheral cameras and depth sensors that understand the local topography and can therefore adapt to sloping fields as well as dense crops.

In conclusion, the capabilities of our service make it easy to understand that Agroverse is the solution to the most common challenges facing agricultural robots today, with a vision to make it possible for farmers to "buy the rest" they deserve.

Source: https://www.agroverse.tech

Actions Taken

Agroverse is methodically addressing the safety issues associated with agricultural robots, as we aim to have robots working in the presence of the farmer or our qualified personnel. Our cameras and sensors then feed our AI algorithms with more data, enabling our robots to avoid obstacles, objects, people and animals. In addition, the inbuilt GPS makes the field boundaries clear to our robots so that they can only enter and use pesticides, fertilisers and other resources within the field boundaries, ensuring their safe operation. The Agroverse application is accessible only through a unique username and password per user and is able to maintain information records such as: work area, resource rate, yield rate per hour, etc.

Benefits and Impact

- Agriculture is one of the most critical and challenging industries due to factors such as climate change, limited resources, and increasing demand for production. Drone technology and agricultural robots have the potential to help address some of these challenges by enabling more efficient and sustainable farming practices with the use of Industry 4.0 technologies. We are really excited with Agroverse team building a state-of-the-art Agritech product and at the same time making a positive impact on the world."
- The robot as a service model reduce the impact of the main reasons (high cost, lack of information and complexity, lack of infrastructure, adaptability, legal and safety issues) which limit the use of robots.

Contact Information

Website: https://www.agroverse.tech

Email: sales@agroverse.tech

Prepared by

Effie Tsili (CONNEXIONS)

Application Area

☒ Soil ☒ Plant ☒ Terrain

Digital Technology in the Value Chain

☒ Agromonic Services ☒ Agricultural Input and Services

Digital Technologies

☒ Robotic and Automation ☒ Sensor technology ☒ Artificial Inteligence (AI)

SnailX – Snail Management Solution

Name of the Organisations Involved

- SnailX GmbH, Austria

Challenges Identified

Snails, particularly slugs, pose a significant problem for agriculture due to their voracious appetite that results in extensive damage to crops. Flowers, perennials, and vegetable gardens are all vulnerable to these pests, leading to tangible impacts on harvests. The challenge extends beyond sporadic incidents, as slug infestations are described as a common and substantial issue for gardeners and farmers, presenting an enormous hurdle for those aiming to cultivate thriving gardens.

Moreover, traditional slugs control solutions involve a lot of chemicals, which raises considerable environmental considerations suggesting that such methods may contribute to soil. This adds urgency to the search for sustainable alternatives in addressing the challenges posed by snails in agriculture.

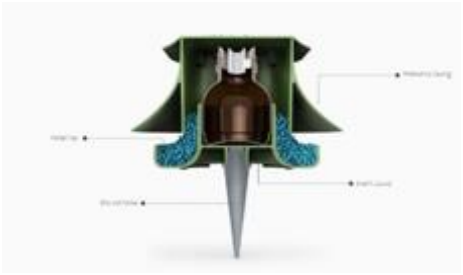
Goals and Solution

SnailX aims to address the pervasive challenges presented by snails, specifically slugs, in agriculture. The high-level goal is to offer an efficient and enduring solution for controlling these pests, ultimately safeguarding gardens and crops from the extensive damage caused by their insatiable appetite. By providing an effective means of slug population control, SnailX seeks to enable gardeners and farmers to nurture flourishing gardens, enhance harvests, and alleviate the persistent issues associated with snail infestations.

Short description of the technology and the beneficiaries

SnailX is a company dedicated to enhancing the joy of gardening through its revolutionary solution to combat the persistent challenge of slugs — the *SnailX Slug Trap*. This weatherproof device seamlessly combines an exceptionally efficient attractant with proven slug pellets, providing a complete and hassle-free gardening experience. As gardening enthusiasts delight in the beauty of their flourishing plants, SnailX Slug Traps quietly stand as garden heroes, putting an end to slug-related woes. With a patented maintenance-free design, users can easily replace the attractant bottle and refill the slug pellets, ensuring a continuous and enjoyable gardening journey free from the disruptions caused by slugs.

What sets SnailX apart is its commitment to simplicity and user-friendly maintenance. The patented design ensures that users can effortlessly replace the attractant bottle and refill slug pellets, marking a paradigm shift in the way gardeners address slug-related challenges. This maintenance-free approach not only adds convenience to gardening routines but also ensures a continuous and undisturbed journey towards a lush and vibrant garden.



Source: www.snailx.co.uk

Actions Taken

Gardeners and farmers can employ the *SnailX Slug Trap* to combat the challenges posed by snails. The technology operates with a patented maintenance-free design, allowing farmers to replace the attractant bottle and refill slug pellets easily. This seamless integration ensures continuous protection against slug infestations, providing farmers with an effective and user-friendly solution to manage and mitigate the impact of snails on their crops.

Benefits and Impact

- Farmers and gardening enthusiasts can use the device to safeguard their gardens against snails.
- The slug control device is more cost and resource efficient than traditional solutions.
- Hygienic & inconspicuous presence in the user's garden
- The device provides optimal weather protection for slug pellets
- Inaccessible to other animals
- No soil pollution
- Easy maintenance & broad impact

Contact Information

Website: www.snailx.co.uk

SnailX GmbH, Hafeldstr. 57, 4652 Fischlham, Austria

T; +43 664 631 76 17

Email: office@snailx.at

Prepared by

Mihail Stanev (INI-Novation GmbH)

Application Area
☒ Plant

Digital Technology in the Value Chain
☒ Agricultural Input and Services

Digital Technologies
☒ Others

Sustainability and Winery Success with eVineyard

Name of the Organisations Involved

- eVineyard, Slovenia
- Grape growers

Challenges Identified

The wine industry frequently encounters challenges in securing an adequate and skilled labour force, especially during critical periods like harvesting. Insufficient labour can result in delays for crucial tasks such as harvesting, pruning, and vineyard maintenance, impacting overall vineyard productivity and grape quality. Vineyard operations also grapple with escalating costs related to labour, equipment, and inputs like fertilizers and pesticides. The rise in operational costs may strain profit margins, posing a challenge to the economic sustainability of vineyards.

On the other hand, changing climate patterns, encompassing temperature shifts and altered precipitation, influence grape ripening, vine health, and overall vineyard conditions. Climate variability can lead to unpredictable grape quality, influencing the flavour profile and characteristics of the produced wine.

Furthermore, vineyards are vulnerable to various pests (insects, nematodes) and diseases (mildews, rot) that can jeopardize grape health and yield. Outbreaks of pests and diseases may result in significant crop losses, heightened production costs, and the necessity for extensive pesticide application.

Goals and Solution

eVineyard is a vineyard management software that helps grape growers manage their vineyards more efficiently and sustainably. The software offers a variety of features, including:

- Vineyard inspection: eVineyard allows growers to record and track observations about their vineyards, such as pest and disease pressure, vine health, and soil conditions. This information can be used to make informed decisions about vineyard management practices.
- Intelligent work planning: eVineyard can help growers plan their work by providing suggestions for tasks that need to be completed, such as pruning, spraying, and harvesting. The software also takes into account factors such as weather conditions and labor availability to generate realistic work schedules.
- Work tracking: eVineyard allows growers to track the progress of their work and see how it is impacting their vineyards. This information can be used to identify areas where improvements can be made.
- Payroll: eVineyard can be used to track employee hours and generate payrolls. This can save growers time and money.
- Harvest tracking: eVineyard can be used to track the harvest and generate reports on yield, quality, and labor costs. This information can be used to make informed decisions about vineyard management practices.
- Mapping: eVineyard can generate maps of vineyards that show the location of vines, pests, diseases, and other relevant information. This information can be used to make informed decisions about vineyard management practices.

Picture: © Crystal Craig

Short Description of the Technology and the Beneficiaries

eVineyard is a cloud-based software accessible to grape growers of all sizes. The software is easy to use and does not require any special training. The beneficiaries of eVineyard include grape growers and consumers.

Actions Taken

Radgonske Gorice winery, a trailblazer in innovative solutions, initially integrated eVineyard's decision support system into their certified ecological vineyard. Adhering to stringent ecological production regulations, the system provides crucial insights and aids in compliance by meticulously tracing all activities for certification audits.

Encouraged by success, the vineyard management extended eVineyard to non-ecological vineyards, placing new weather stations strategically. Automated logging and work norm calculations empower vineyard managers, ensuring precise control over workflow. The four vineyard managers express surprise at the value brought by eVineyard, citing substantial time savings and trouble avoidance.

Radgonske Gorice stands as an example of a winery benefiting from eVineyard's cutting-edge technologies and multi-season testing. This success story underscores eVineyard's commitment to transforming vineyard management with the power of data-driven insights. More about this and other use cases: [The vineyard management system – eVineyard (evineyardapp.com)]

eVineyard has been adopted by over 1,000 grape growers around the world. The software has been shown to improve the quality and yield of grapes, while also reducing the environmental impact of grape growing. It has been recognized by a number of organizations, including the World Economic Forum and the Sustainable Agriculture Network.

Benefits and Impact

eVineyard provides flexible and systematic approach, offering also decision support models, developed over five years. It provides high contribute to sustainable and environmentally friendly agriculture. Benefits:

- Grape growers: eVineyard can help grape growers to improve the quality and yield of their grapes, while also reducing their environmental impact.
- Consumers: eVineyard can help to ensure that consumers have access to high-quality, sustainably produced grapes.
- The environment: eVineyard can help to reduce the environmental impact of grape growing by reducing the use of pesticides and fertilizers.

Matic Šerc, leading eVineyard's development, expresses pride in pushing innovation in data analytics for agriculture. Client validation underscores the mission to make agriculture more sustainable. Unlike competitors, eVineyard applies predictive analytics technology developed through EU Research and Development programs.

Contact Information

Email: info@evineyardapp.com

Website: https://www.evineyardapp.com

Prepared by

Drejc Kokošar (id20)

Application Area

☒ Plants ☒ Resource Usage

Digital Technology in the Value Chain

☒ Supply-Chain Management ☒ Agriculture Inputs and Services

Digital Technologies

☒ IoT ☒ Big Data

Enabling Digitization in Farming via Private 5G Connectivity

Name of the Organisations Involved

- CampusGenius GmbH, Germany

Challenges Identified

Wireless connectivity in rural areas offers in general a low performance not comparable to densely populated areas. In some rural areas, insufficient infrastructure, characterized by a lack of well-developed telecommunications networks, represents a significant obstacle to providing reliable and high-speed Internet access. On the other hand, geographical features such as hills, valleys and remote landscapes further complicate the problem by hindering the propagation of wireless signals. This results in patchy coverage and dead zones, making it a challenge to establish a consistent and reliable connection. These conditions hinder the adoption of digital agricultural practices in rural communities.

Goals and Solution

GeniusNetwork enables the use of digital technologies (sensors, drones, agricultural machinery or other devices) by bringing reliable 5G connectivity to farmers where it is needed - in fields, in buildings and anywhere else in rural areas.

Short description of the technology and the beneficiaries

GeniusNetwork is a customized network solution for small, medium and large farmers, and agribusinesses for 5G wireless communications of all sizes. Application areas are customized according to user requirements.

Pictures: GeniusNetwork

Various technical use cases have been developed that provide true 5G-SA connectivity for any type of applications that require wireless communication. 5G-SA GeniusNetwork is a transportable system and can be ordered at any time for evaluation, testing or special purposes in different use cases.

Actions Taken

GeniusNetwork company builds trailers including a 5G network that can be moved between fields and provides connectivity wherever required. They include a indipendend energy supply, edge computing power and a satellite or LTE backhaul for remote managing or data transmissions.

Benefits and Impact

- **Connection of agricultural machineries for automatic acquisition of a wide variety of data, e.g., images from drones, temperature, humidity or material condition sensors, localization, machine information;**
- **Enabling drones to transmit video streams and analyse them on the edge in real time for harvesting and security control;**
- Mass sensor networks and automated irrigation of crops;
- Perfect wireless control of automated guided vehicles in logistics;
- Enables wireless automation of building services, internal telephony, flexible work controll
- Enables position sensing of devices in the building, localization of vehicles and equipment, autonomous control of transport vehicles or drones, and autonomous transport systems for freight.

Contact Information

Dipl.-Wi.-Ing Thomas Höschele

Email: thomas.hoeschele@campusgenius.com

Website: www.campusgenius.com

LinkedIn: https://www.linkedin.com/company/campusgenius/

Prepared by

Dipl.-Wi.-Ing Thomas Höschele (GeniusNetwork), Wolfgang Kniejsi (INI-Novation GmbH)

Application Area

☒ Plant ☒ Soil ☒ Location of assets ☒ Condition of assets

Digital Technology in the Value Chain

☒ Agricultural Input and Services

Digital Technologies

☒ Others

5. Programs and Trainings for Skills Development

Picture 7. © Smshoot Dreamstime.com

Training programs, which support digitalization in agriculture, are designed to equip farmers, agribusinesses, and agricultural stakeholders with the skills and knowledge needed to effectively utilize digital technologies in their farming operations. There are various types of training programs, including workshops, online courses and webinars, incubators, on-site demonstrations and training for farmers, cooperative programs, and more. These programs play a crucial role in enabling the agricultural sector to leverage the benefits of digitalization for improved productivity, sustainability, and profitability.

Here are some key aspects and components of training programs for digital agriculture:

- *Basic Digital Literacy:* Training programs often start by providing participants with basic digital literacy skills, including how to use computers, smartphones, and other devices. This foundation is essential for effective engagement with digital tools and platforms.
- *Digital Technology Overview:* Participants learn about the integration of cutting-edge digital technologies related to agriculture, including farm management software, precision farming tools, data collection devices, and IoT (Internet of Things) sensors.
- *Precision Agriculture:* Training programs provide knowledge the use of GPS, remote sensing, and other technologies to improve yields and reduce environmental impact.
- *IoT Systems in Agriculture:* Training can cover the deployment of IoT devices and sensors for real-time monitoring of environmental conditions, crop health, and livestock well-being and water management.
- *Data Management and Analysis:* Understanding how to collect, store, and analyse agricultural data is a crucial component of digital agriculture training. This includes using tools for data visualization, interpretation, and decision-making.
- *Digital Marketing and Market Access:* Training programs may include modules on using digital platforms for marketing agricultural products, accessing online marketplaces, and engaging with consumers through social media and e-commerce.

- *Regulatory Compliance and Data Privacy:* Participants are educated about legal and regulatory considerations related to data privacy, ownership, and sharing, as well as compliance with standards and government regulations.
- *Cybersecurity and Digital Safety:* Given the increasing reliance on digital technologies, participants are trained on the essence of cybersecurity and how to protect sensitive information from cyber-attacks.
- *Farm Management Software:* Participants learn how to use farm management software to plan, monitor, and analyse various aspects of their operations, including planting schedules, input application, irrigation management, and harvest planning.
- *Continuous Learning Programs:* Continuous learning opportunities, webinars, and updates on the latest advancements in digital agriculture are essential. The training is adapted to evolving technologies, practices and use cases.

Recognizing participants' achievements through certificates or other forms of acknowledgment can motivate continued engagement with digital agriculture practices.

The following examples illustrate various approaches and initiatives that can be employed to build skills for digital agriculture through effective programs. Each approach caters to different learning styles and needs of adopting knowledge, ensuring that participants gain practical information and confidence in adopting digital technologies in their farming operations.

No.	Programes and Trainings	Country
1	AgDataHub and Innovation Centre	International
2	Demeter Project H2020	International
3	Poliprespa Sustainable Development Program	Greece
4	Smart Farming Initiative	Greece
5	Support Program: AgTech Innovation Centre	Ireland
6	Support Program ”Visionpier”	Germany
7	Weinbau 4.0	Germany

AgDataHub and Innovation Centre

Name of the Organisations Involved

- AgDataHub, France
- Poznam Supercomputing and Networking Center, Poland

Challenges Identified

Today, there is a common understanding that data holds high value. Leveraging this value and trading data creates huge revenues for large data platforms. Rarely do the creators of data benefit adequately; often, only the cost for data creation and management remains with them. Furthermore, many give their data away for free or pay with it for the use of a service. Finally, others keep it for themselves without taking advantage of its value.

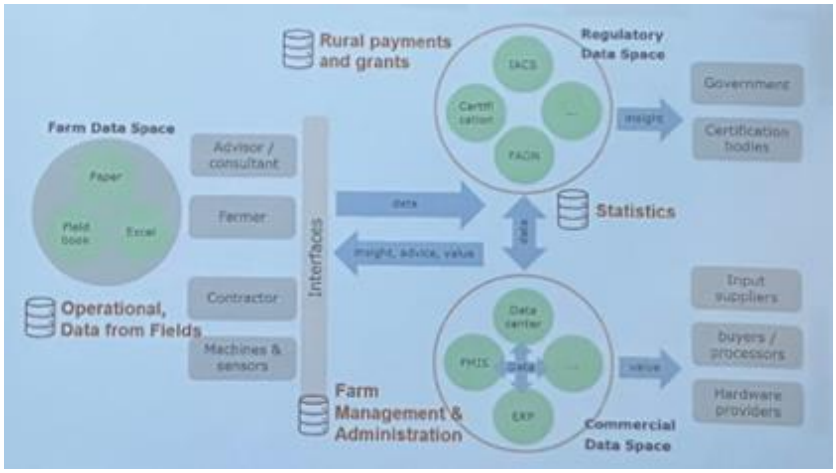
Agriculture faces major challenges: it must meet the world's food needs, provide farmers with an adequate income, and, at the same time, protect the environment. To achieve these goals, careful use of resources and smart agriculture are required. AgriDataSpace will strengthen smart agriculture capacity, competitiveness, and fair income through the multi-technological implementation of an innovative, intelligent, and fully distributed platform. The project takes a multi-dimensional approach that combines Big Data and data space technologies with agricultural knowledge, new business models, and agri-environmental measures. There is a need for vendor-independent data ecosystems and marketplaces, open to all at low cost and with low entry barriers. This need is addressed by AgDataHub in the agriculture domains. The specification of data exchange orchestration forms the basis for a data marketplace based on European values, ensuring data sovereignty for the creator of the data and trust among participants.

Goals and Solution

AgriDataSpace project aims to pave the way for a European data space for agriculture that facilitates data sharing, processing, and analysis in a secured, trusted, transparent and responsible manner to create new opportunities for monitoring and optimising natural resource use stimulating data-driven innovations in the field of agriculture.

Actions Taken

- Map the current landscape of on-going data sharing initiatives and design approaches in agriculture,
- Analyse and assess current governance models and develop a multi-stakeholder governance scheme for the EU data space for agriculture,
- Analyse and assess current business models and explore potential business models for various agriculture stakeholder relations,
- Explore the evolving legislative framework and provide solutions and technical enablers for ethical tensions related to data sovereignty,
- Develop a conceptual reference architecture for a common data space framework in agriculture and a reference technology canvas,
- Engage stakeholders in various activities for evaluation and validation in order to reach broad consensus,
- Develop a roadmap that compiles all requirements into a comprehensive pathway towards implementation of the EU data space for agriculture.



Copyright (C): PSNC, Poland

Benefits and Impact

- Support of agriculture related startups in business development, access-to-finance and access-to-market,
- Reducing the lead time for startup creation and startup growth,
- Mentoring, coaching and training of agriculture-oriented entrepreneurs,
- Data sharing modules are:
  - Virtual farm (with dashboard),
  - Tracing the origin of products,
  - Risk reporting,
  - Sharing meteorological data.

Contact Information

Sebastien Picardat (AgDataHub, France)

Email: sebastien.picardat@agdatahub.eu , Website: www.agdatahub.eu

Raul Palma (Poznam Supercomputing and Networking Center, Poland)

Website: https://agridataspace-csa.eu

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Demeter Project H2020

Name of the Organisations Involved

- DEMETER Project H2020

Challenges Identified

A top goal for the EU is to support sustainable agriculture and food production, protect natural resources and boost food safety. Smart farming via GPS, soil scanning, data management, and IoT technologies could help attain the EU goal of ameliorating the quantity and quality of farming production.

The EU-funded DEMETER is a large-scale project deployed in 18 countries, 15 of which are EU member states. The project analyses data obtained from a wide range of actors (production sectors and systems) to provide an integrated interoperable data model enabling optimal resource management in the European agri-food sector.

Source: https://cordis.europa.eu/project/id/857202/reporting

- The first challenge addressed by DEMETER is to make sure farmers feel secure and in control of the information they get from their data. Right now, farmers often feel like they're drowning in a sea of data. The goal of DEMETER is to change that and farmers to not just handle all that data but actually get useful insights from it.
- The second challenge DEMETER takes on revolves around enabling farmers to seamlessly integrate new technologies with their existing farm machinery. The idea is that farmers shouldn't have to part ways with the reliable equipment they've already invested in. DEMETER is dedicated to safeguarding their previous investments while introducing them to the realm of technological

agriculture and innovative solutions. It's a delicate balancing act between embracing the new and preserving the old.

- The third challenge is aimed at optimizing data analysis. To uncover valuable trends and patterns, it is necessary to work on large data sets obtained across multiple farms. To fully exploit the value of data, trusted collaborative spaces are created where data can be shared, navigating conflicting interests and competition. It is also a chance to empower farmers by giving them full control over their data rights.
- The fourth challenge entails overcoming market barriers, set against a backdrop where large players have strategically positioned themselves early on to secure dominant roles through supplier-operated technological and data platforms.
- The fifth challenge addressed is the interoperability and adoption of technological standards to ensure compatibility to have data exchange and communication standards that link the different systems together in a unified system covering all aspects of the agricultural exploitation.

Goals and Solution

DEMETER aims to put digital tools at the service of farmers:

1. Using a human-in-the-loop model that consistently focuses on blending human knowledge and experience with digital information.
2. Focusing on interoperability as a core digital tool, expanding the scope of interoperability between data, services, platforms, M2M (machine-to-machine) communication and online intelligence, but also human knowledge, and implementing interoperability by connecting farmers, consultants and suppliers of ICT solutions and machinery.
3. Transforming the sector by building a solution on a set of digital technologies: Internet of Things, Earth observation, big data, artificial intelligence, and digital practices: collaboration, mobility, and open innovation.

These choices are made with the help of DEMETER's large user base (approximately 6000 farmers) and extensive pilot coverage in 18 countries.

Actions Taken

- **60 partners in collaboration together**

The DEMETER consortium consists of 60 partners bringing together farmers and farmers' organisations, academic institutions, and small and large public and private organisations representing demand and supply sides. Led by project coordinator Walton Institute, the partners deliver a significant outreach capability globally, to cover a representative sample of the stakeholders needs and demands, thereby answering market potential and innovation

- **20 Use Cases**

The DEMETER pilot projects are used to demonstrate and evaluate how innovations and extended capabilities benefit from the interoperability mechanisms. The pilots, running across 18 European countries (Belgium, Czech Republic, Finland, Georgia, Germany, Greece, Ireland, Italy, Latvia, Montenegro, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Turkey), are also used to monitor the evolution of the maturity in the stakeholders involved.

- **5 clusters**

The pilots are grouped into 5 clusters: arable crops, precision farming in arable crops, fruit and vegetable production, livestock (poultry, dairy, animal welfare) and the supply chain.

	Water and Energy Management related to Arable Crops	Example: Smart energy management in irrigated crops, or optimal rice irrigation
	Precision farming related to Arable Crops	Example: In-service agricultural machinery condition monitoring, or data brokerage / decision support
	Crop health and quality (fruit and veg sector)	Example: Decision support systems for olive growers
	Animal health	Example: Dairy farmers dashboard for the milk and meat production chain
	Cross sectoral	Example: Pollination optimization in apiculture or enabling transparency in the poultry industry supply chain

More infomation: https://h2020-demeter.eu/wp-content/uploads/2020/02/DEMETER_PilotBooklet_ENG.pdf

Benefits and Impact

DEMETER offers several advantages to farmers, whether they are "small" or "large" farmers; dairy, poultry, fruit and vegetable producers or farmer; young or older farmers:

DEMETER is a European-funded project which aims to empower farmers and farmer cooperatives in two main ways. First, by allowing farmers to use their existing machinery and platforms to deliver new, integrated knowledge to help decision-making. Second, by easing farmers' updating or acquisition of machinery, platforms and sensors ensuring technologies speak a common language meaning they can be easily connected, combined, and cooperate with each other.

DEMETER gives farmers control of their data opening up new business models and new possibilities in collaboration and cooperation.

Contact Information

Website: https://h2020-demeter.eu/contact/

Arclabs Research & Innovation Building, WIT, West Campus, Carriganore,

Waterford, X91 P20H, Ireland

Telephone: +353 (0)5130 292

Email: info@h2020-demeter.eu

Prepared by

Angela Ivanova (INI-Novation GmbH)

Polipresρa Sustainable Development Program

Name of the Organisations Involved

- Stavros Niarchos Foundation, Greece (www.snf.org)
- Society for the protection of Prespa, Greece (www.spp.gr)

Challenges Identified

The practice of smart farming came to Prespa through the Polipresρa sustainable development program, which is implemented by the local bodies of the area and with a donation from the Stavros Niarchos Foundation (SNF) and other supporters. The numerous and varied actions of Polipresρa aim to synchronize good environmental practices, economy, and society in a common trajectory for the benefit of the region and its people.

Goals and Solution

The inhabitants of Prespa are basically engaged in the primary sector and in the cultivation of beans. In the context of Polipresρa, the cooperation of the Prespa Protection Society (EPP) with the American Agricultural School (AGS) began with the aim of introducing precision agriculture practices in organic crops. Precision agriculture aims, both to increase production and improve its quality, and to reduce negative impacts on the environment, with tools that enable farmers to adapt farming methods to the real needs of their field. In a protected area, a rare ecosystem, such as Prespa National Park, the implementation of such practices is essential and has multiple benefits.

The pilot program in Prespa has been implemented since the spring of 2020, which also marked the start of this year's growing season, numbering six beneficiary organic bean growers. Experienced scientists from the AGS side with regular visits provided individualized counselling to the six farmers. Soil analyses were carried out on the parcels to determine soil parameters critical for production and special sensors were installed to monitor and record valuable information about the prevailing conditions. From the studies that were carried out, the needs for irrigation, the quantity and the time intervals during which it had to be carried out, were determined exactly, while instructions were also given for fertilizing the crops. In addition, a meteorological station was installed in Prespa, providing the most valid forecasts possible, both in the short term (7 days) and in the medium term (14 days). The intervention of the Polipresρa program is hoped to be a model for implementing smart agriculture pilot actions in protected areas.

Actions Taken

Prespa has now entered the Internet of Things (IoT). The necessary infrastructure has already been created, which gives possibilities to monitor and control the production, which could hardly be found in other regions of Europe now.

One of the most important conclusions was related to water management, in which a particularly increased use was observed in relation to the actual need of the plant. The farmers are not responsible for this use, but the irrigation system in the Prespa plain, which does not give the cultivator much control (irrigation method with open furrows). The good thing is that after systematic work and persistence of all Prespa agencies, one of the biggest irrigation projects in the country, drip irrigation, is going to be implemented in the Prespa plain in the coming years.

Benefits and Impact

- The organic farmers threshed their fields in November, without losses, according to the expected harvest and are ready to release an excellent product with great added value, the famous and protected PGI-certified Prespa bean.
- Farmers do not have to guess what is happening in their field, but they know it for sure. And they can easily find all these valuable information on their mobile phone.
- They can work with expert scientists and see a difference in both the quality and quantity of the beans. When experience is combined with science, there is always a result.
- Producers with great knowledge of the subject manage to produce excellent quality products and assimilate the new knowledge in an effective way.
- The Poliprespa program strengthens the primary sector with the aim of environmentally friendly farming practices, beneficial to the farmer and attractive to the new generation that will take over the fight for the land.
- The wider area of the Prespa plain is currently gathering a great deal of technology, supporting current and future needs of the area in terms of possibilities to receive and transmit measurements from sensors. The increased capabilities resulting from the combination of LoRa, mobile telephony and 3 satellite communications technologies are exploited and give the digital ecosystem the ability to interconnect more than 3000 devices (sensors).
- The smart agriculture program in Prespa can contribute to the operation of the drip irrigation system, which will be installed in the future, help to accurately calculate the requirements and capabilities of the network, to achieve the correct irrigation practice by all producers in the plain of Prespa. The main goal is the economy of water, the most precious of natural resources, but also the strengthening and safeguarding of the produced product.

Contact Information

Zenia Anastasiadou, Prespa Protection Society (EPP)

Email: zenia@spp.gr

Sustainable Development Program ”Poliprespa”

Website: www.poliprespa.com

Email: info@poliprespa.com

Prepared by

Effie Tsili (CONNEXIONS)

Smart Farming Initiative

Name of the Organisations Involved

- AB Vassilopoulos, Greece
- American school, Greece
- American Agricultural School, Greece

Challenges Identified

The innovative Smart Farming programme is the result of the partnership between Bodossaki Foundation, AB Vassilopoulos and the American Farm School, to support Greek primary production. All three organisations share the same love for the best of the Greek land and a common vision for the creation of those conditions so that Greeks Producers to stay and continue to highlight the food culture of our country.

Together they present a new and innovative initiative, the Intelligent Agriculture Program, which introduces high technologies to the primary sector of our country. With technology as an ally, the Program brings innovations, generates value and opens new paths for modern Greek Producers.

Smart agriculture is an integrated approach to managing agricultural activity. The application of high technology in the daily practice of the Greek farmer is perhaps the biggest bet for the success and sustainability of the next generation of farmers.

Goals and Solution

The programme introduces new technologies in Greek's primary production and is an important step for the development of intelligent agriculture in our country.

Using proven practices, 12 state-of-the-art telemetry devices will be installed over a 6-month period, which will accurately and immediately inform producers of parameters affecting their farms:

- Meteorological parameters, such as temperature and relative humidity, precipitation, and solar radiation.
- Soil parameters such as soil moisture and temperature.

This will enable them to make informed decisions based on important meteorological and soil parameters. This equipment was further enhanced with appropriate software, to maximise the benefits to local producers. The areas selected are associated with the production of agricultural products of key significance to the local and national economy.

The program aspires to incentivize the creation of a "community of action" that will unite early adopters and allow them to operate multiplying.

Actions taken

In different regions of the country, telemetric field monitoring devices will be installed that will provide tools, which will essentially contribute to decision-making by producers, e.g., determining the necessity of irrigation and/or the quantity of irrigation water. These devices will be cloud-connected to send real-time information on various soil parameters.

The information is accessible both via computer and via smart mobile devices and is presented in a user-friendly format via maps.

Furthermore, the program includes training and education services for producers with dissemination days as well as educational visits by groups of students from the agri-food sector at the points of application.

As part of the program, a dedicated Facebook page has been created, with the aim of developing communication between the beneficiary groups and disseminating information to third parties.

The 12 stations will be installed in:

- 4 vineyards in Kavala, Kilkis and Peloponnese,
- 2 olive groves in Kalamata and Halkidiki,
- 4 kiwifruit production estates in Central Macedonia,
- 2 grassland sites in Elassona and Xanthi.

Benefits and Impact

In practical terms, the programme is directly benefiting about 155 farmers, while this number will significantly increase with the addition of indirect beneficiaries, who will have access to an open data platform to be developed and made publicly available. Producers will become familiar with the use of new technologies, while being able to manage their farms more precisely.

- They will be informed of the efficient use of production resources, fertilizers and pesticides.
- They will get used to the new technologies and to harmonize with the rest of the European farmers.
- They will join in a "community", which will allow direct communication and exchange of knowledge and ideas.
- They will come in a contact with established and budding industry scientists through demonstration visits to estates with precision agriculture devices installed.
- They will contract in the protection of the environment.

Contact Information

SMART AGRICULTURE PROGRAM

American College of Agriculture

Marinou Antipa 54

T.Th. 60097, 570 01, Thermi Thessaloniki
T: +30 2310492851
Email: info@smartfarminginitiative.gr
Website: https://smartfarminginitiative.gr/

Prepared by

Effie Tsili (CONNEXIONS)

Support Program: AgTech Innovation Centre

Name of the Organisations Involved

- AgTech Innovation Centre of University College Dublin (UCD), Ireland

Challenges Identified

AgTechUCD is University Accelerator to stimulate Agriculture Innovation. It promotes and accelerates early-stage startups and SMEs with disruptive innovations in Ireland and Europe in the AgTech, Agrifood, Veterinary and Equine sectors, as they build their innovative businesses into leading enterprises. AgTechUCD is helping startups to get customer and investor-ready, and to scale globally, delivering a suite of programmes and tailored support for startups, including:

- Innovation Days - generating solutions for the agricultural industry,
- Incubator - helping new startups to build out their business models.

Goals and Solution

Based at the UCD Lyons Farm, AgTechUCD offers the only on farm workspace hub to promote and accelerate agri-businesses and startups. AgTechUCD provides access to on-farm experimental facilities, allowing testing and trialling of products and services in a real-world environment. Startups also have preferred access to UCD food processing facilities, access to Venture Capital & Business Angels networks, mentoring, corporate partners, office and lab spaces, and much more.

Actions taken

AgTechUCD is running a series of Innovation Days. These Innovation Days aim to generate solutions for some of the agricultural industries biggest challenges.

AgTechUCD Agccelerator Programme is a 12-week accelerator programme for early-stage startups in Ireland and Europe, in the AgTech, FoodTech, VetTech and BioAgTech sectors, supporting startups as they build their innovative businesses into leading enterprises.

The programme is delivered online 2 mornings per week (Tuesday & Thursday) and fast tracks the business development and leadership skills. The Agccelerator is tailored to understand the needs and challenges facing your startup, giving you the tools and templates, support and guidance needed to accelerate your startup. Industry experts and mentors will also support you throughout the programme.

Benefits and Impact

- Support of agriculture related startups in business development, access-to-finance and access-to-market,
- Reducing the lead time for startup creation and startup growth,
- Mentoring, coaching and training of agriculture-oriented entrepreneurs.

Copyright (C): AgTech UCD

Contact Information

Email: niamh.collins1@ucd.ie

Website: https://www.ucd.ie/innovation/about-agtechucd/

Linked-in: https://bit.ly/3eIxxfT

Social media: X: @AgTechUCD

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Support Programme ”Visionpier”

Name of the Organisations Involved

- Visionpier @ IDS Imaging Development Systems GmbH, Germany

Challenges Identified

The Visionpier marketplace offers a wide range of fascinating image processing solutions with which nothing stands in the way of process automation. The partners' applications combine powerful hardware with innovative software and integrate them seamlessly into existing processes. This gives agriculture companies low-threshold access to future-oriented technologies and saves valuable development time.

Goals and Solution

The marketplace Visionpier brings together everyone who is looking for or offering a complete solution with image processing. The platform is used to share exciting projects and promote exchange. The range of services extends from quality management and logistics to retail, and smart farming.

Actions taken

Solutions can be individually adapted: You can either browse our offering or use our configurator and request suitable applications with just one click. Our marketplace partners will work with you to develop a proof of concept to adapt the image processing system to your requirements. The integration service into your processes then takes place. If you cannot find a suitable solution, you can also submit a general query. In this case, the Visionpier team will refer you.

Image: The visionpier team, Copyright (C): IDS

Benefits and Impact

- Competitive advantages through rapid access to innovative solutions for smart farming.
- From tools to the entire package of hardware, software, and integration into existing processes.
- All tools and solutions can be customized to individual requirements.

- The solutions and the exchange with the community on Visionpier bring new impulses.
- Thanks to the complete solutions, you save valuable development time and create space for new projects.

All data, actions and experiences are collected, analysed and evaluated on the platform www.wildretter.de under strict data protection guidelines. This means the project can develop into other regions and improve sustainably.

Contact Information

Sigrid Rögner

Email: info@visionpier.de

Website: https://de.visionpier.com/

LinkedIn: https://www.linkedin.com/showcase/visionpier/

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Competence Center “Weinbau 4.0”

Name of the Organisations Involved

- WFG – Wirtschaftsförderungsgesellschaft des Landkreises Emmendingen mbH
- ZG Raiffeisen eG
- ZG Raiffeisen Technik GmbH
- Intech GmbH & Co. KG
- HEG - Heidelberger Energiegenossenschaft eG

Challenges Identified

Regional winemakers face challenges such as structural changes, succession and skilled worker issues, climate change impacts, reduced spray consumption, uneconomical steep slopes, and fallow vineyards. In response, the "Weinbau 4.0" flagship project aims to support small-scale vineyards, addressing these challenges and ensuring the attractiveness of winemaking for the next decades. Led by the Economic Development Agency of the Emmendingen district, the project was recognized by Minister Peter Hauk on April 14, 2021, as a flagship initiative in the RegioWIN 2030 competition. With a total cost of around 5 million euros, the project receives approximately 3 million euros in funding from the state of Baden-Württemberg and the European Regional Development Fund (ERDF).

Goals and Solution

- The goal of the flagship project "Viticulture 4.0" is to increase innovation performance in viticulture, among manufacturers and suppliers, service providers, agricultural machinery mechanics and the trades through the establishment of a competence center and technological measures by the project's completion in 2027.This aims to enhance value creation and build regional expertise.
- The focus is on expansion of research and innovation capacities and the adoption of advanced technologies involving the development and implementation of prototypes, pilot plants, and demonstrators for showcasing bioeconomic technologies in the agricultural products sector.
- As a response to the challenges faced by small-scale wine-growing businesses, including issues like structural change, succession, skilled worker problems, and the consequences of climate change, this initiative aims to address uneconomic steep slopes and fallow vineyards. The objective is not only to enhance the attractiveness of the winemaking profession but also to boost the overall profitability of the industry. This includes measures such as health protection, as well as time and cost savings, among other strategies.
- Focused on advancing specific competencies, the initiative aims to enhance sustainability and promote renewable energy by concurrently utilizing wine-growing and photovoltaic areas (Agri-Photovoltaic demonstration facilities (Agri-PV/Viti-PV) are being developed and tested in viticulture).
- Additionally, the plan involves integrating sensors and automation for digital transformation in winegrowing, utilizing geoinformation and guidance from the districts. It also envisions

strengthening regional cooperation in winegrowing through the establishment of a regional competence center, offering training and further education, public relations efforts, and fostering increased cross-border exchange in viticulture with Alsace.

Actions taken

To address the challenge of high investment costs in innovative technologies for small wine-growing businesses, plans include the development of innovation clusters for automation (tractors, robotics) and drones. Additionally, studies will be conducted on the development and implementation of dual-use photovoltaic systems in the vineyard (Viti-PV).

Images: Supporting drones operated at the wine growing facilities (© Ulrich Spitzmüller, Emmendingen)

Simultaneously, the flagship project is establishing the "Viticulture 4.0" Competence Center in Emmendingen, hosted by the Economic Development Agency (WFG). The primary objectives are to enhance regional collaboration, sustain winemaking traditions, preserve the cultural landscape, and foster knowledge transfer, user-oriented research, development, and innovation.

The Competence Center plays a pivotal role, organizing network meetings for Agri-Photovoltaics, supporting drone and automation innovation clusters, and facilitating technology collaborations. It hosts events that focus on advancements such as the simultaneous use of viticulture and photovoltaic areas (Agri-PV/Viti-PV) and automation/sensor technology.

Furthermore, acting as a regional hub for winemakers, cooperatives, and other wine regions, the Competence Center provides support for education, training, public relations, regional collaboration, and actively encourages cross-border exchange in viticulture with Alsace and other EU projects.

Benefits and Impact

- The preservation of the cultural landscape, facilitated by the Viticulture 4.0 flagship project and its focus on steep slopes, is advantageous for both the wine industry and the region. This, in turn, has the potential to bolster the locally significant tourism industry.
- Through the planned automation of soil and vine care, as well as the utilization of drones in the RegioWIN flagship project Viticulture 4.0, a reduction in spray and spray consumption is anticipated. The EIP-Agri project 'Introduction of spray drones to steep-slope viticulture' demonstrated around 90% less drift for the spray drone compared to the baseline. Agri-PV systems not only contribute to CO2 savings but also generate renewable energy through space-saving dual use. Moreover, these innovative approaches benefit the environment and can contribute to maintaining the health of both winegrowers and citizens.

Contact Information
Martin Linser Email: wfg@landkreis-emmendingen.de Wirtschaftsförderungsgesellschaft des Landkreises Emmendingen mbH Website: www.wfg-landkreis-emmendingen.de
Prepared by
Wolfgang Kniejski (INI-Novation GmbH)

6. Digital Farming Landscape Across Five European Countries

Picture 8. European Map © Chormail, Dreamstime.com

In an era where technology is reshaping industries, agriculture is no exception. The adoption of digital farming practices varies across European countries, each grappling with distinct challenges and opportunities. This chapter dives into the current state of digital farming in five diverse countries – Germany, Austria, North Macedonia, Slovenia, and Greece.

As we navigate through the digital realms of farming in these nations, it is crucial to understand the essential skills required for the adoption of digital technologies. The AgriSkills project conducted a compact survey titled "Survey Findings: Uncovering Essential Skills for Adopting Digital Technologies in Agriculture." This insightful survey provides a comprehensive overview of the skills landscape, shedding light on the key aspects that foster the digital transformation in European agriculture. (Link to the survey: https://agriskills40.com/goals-results/need-analysis-survey-findings/)

Complementing these survey results, the following state of the art summary aims to unravel the unique landscapes that shape the integration of technology into agriculture through a comparative lens.

6.1. Current State of Digital Farming in Germany

Overview

Germany has a rich agricultural tradition dating back centuries, and today it stands as one of Europe's leading agricultural powerhouses. The country was Europe's second-biggest agricultural production nation in 2022, with a production value of EUR 74.4 billion [12]. Germany's agricultural landscape is marked by a rich diversity of crops, including staples like wheat, barley, corn, sugar beets, rye, oats and potatoes, alongside a variety of fruits like apples, cherries, and berries. In recent years, there has been a noticeable shift towards adopting organic farming practices, aligning with the growing consumer demand for sustainably-produced food [47, 48]. Germany is renowned for its strict quality standards, ensuring that agricultural products meet high safety and environmental criteria.

The agricultural sector in the country is characterized by a mix of large-scale commercial farms and smaller family-owned operations, contributing significantly to both domestic consumption and export markets. Every sixth German farm plans to invest in digitalization in the near future and the estimated software spending in the agricultural industry in 2024 is 72 million euros [12]. This industry places a strong emphasis on fostering the so called twin transition in agriculture: digital innovation and sustainability, with a persistent commitment to reducing waste and energy consumption.

In recent decades, high-tech tools like self-driven tractors, milking robots, and advanced harvesters have become standard in agriculture worldwide. Germany is the world’s third-largest producer of agricultural machinery, following the USA and China. In 2022, the domestic market volume for agricultural machinery was approximately EUR 7.5 billion. Data collection, processing, and intelligent automation technologies are important focal points in new machinery development [12].

The future lies in smart farming, driven by AI and resource-efficient techniques. Germany is at the forefront of this shift, utilizing technologies like Artificial Intelligence (AI) for precise plant treatment and fertilization based on leaf coloring, geodata, and soil maps. This not only revolutionizes traditional farming practices but also transforms how agricultural products are stored, processed, and distributed through rapid digitalization. For instance, consumers can establish precisely where the fruit of a particular seed batch was grown and treated [13].

This combination of technological prowess, commitment to quality, and sustainable practices solidifies Germany's standing as a key player in the global food production landscape.

Digital infrastructure

Germany boasts a robust and well-developed digital infrastructure, positioning it as a leading technological force within Europe. The country is renowned for its extensive and high-speed broadband networks, which cover a significant portion of its territory, including urban centers and rural areas. This widespread access to the internet has facilitated the growth of digital services, e-commerce, and various forms of online communication. Germany also places a strong emphasis on data protection and privacy, with strict regulations such as the General Data Protection Regulation (GDPR) in place to safeguard individuals' personal information.

In terms of innovation, Germany stands at the forefront of technological advancement. The country is home to numerous world-class research institutions, fostering breakthroughs in areas like artificial intelligence, blockchain, and cybersecurity.

Additionally, Germany has a vibrant startup ecosystem, in cities and in regions, attracting talent and investment from around the world. The government actively supports digital transformation initiatives, with initiatives such as Industry 4.0 aiming to integrate cutting-edge technologies like IoT (Internet of Things) and automation into traditional industries.

Overall, Germany's digital infrastructure serves as a strong foundation for its thriving tech sector and contributes significantly to its competitive edge in the global digital economy.

Digital Skills and ICT in Agriculture

In Germany, majority of farmers have basic digital skills, allowing them to use computers, access the internet, and utilize basic software applications for farm management [49]. However, a smaller percentage of farmers possess advanced digital skills, which involve the use of specialized agricultural software, precision farming technologies, and data analytics for optimized decision-making.

A number of studies addressing adoption and use of digital technologies in crop production and livestock show that approximately 70% of farms in Germany have some level of ICT integration. This includes the use of farm management software, GPS-guided machinery, and other digital tools for tasks like crop monitoring, yield forecasting, and livestock management. Precision farming technologies, which utilize ICT for precise and efficient resource allocation, are employed on about 40% of farms in Germany. This includes practices like variable rate fertilization, automated irrigation, and GPS-guided seeding.

Another study examines the adoption of precision agriculture (PA) and digital technologies only in a small-scale farms in Germany. The survey, with 2.390 farmer responses, reveals potential adoption rates of 15–20% for technologies like barn robotics, section control, variable-rate applications, and satellite data mapping within the next five years. Established use of entry technologies increases the likelihood of adopting additional ones. The current emphasis is on user-friendly automation solutions to ease farmers' workload. Understanding current tech trends is crucial for effective policy efforts to promote digitalization in agriculture [14].

Farms utilizing advanced ICT technologies tend to experience an average increase in productivity of about 15-20%. This can result from improved resource management, reduced input costs, and enhanced decision-making based on data-driven insights.

The integration of ICT in agriculture in Germany has contributed to advancements in sustainable practices. Around 60-70% of farms employing digital technologies report a reduction in environmental impact through better resource management and precision application of inputs.

Analysis of Digital Farming and Skills

Based on our project survey about digital farming and the essential skills needed in Germany, several key findings emerged:

- One of the challenges in the digitalization of agriculture is the absence of solutions that are specifically designed to meet the individual needs and requirements of small-scale farmers.
- Farmers require more information regarding the benefits and risks of using digital technologies in agriculture, as well as concrete examples of digital agriculture, in order to foster awareness and confidence in the adoption of digital technology in farming.
- Additionally, respondents believe that the utilization of digital devices, communication applications, networks for accessing and managing information, along with precision farming and the implementation of sensor technologies, should be enhanced among agricultural stakeholders.
- The farmers believe that it's crucial to acquire knowledge in developing a business model and managing digital agricultural operations. Most respondents also highlight the importance of strategic thinking for digital transformation and data-based decision-making.
- Respondents from Germany have emphasized the need for more information on creating value in agriculture using digital technologies.
- Furthermore, problem-solving skills, proficiency in co-creation, collaboration, and networking are additional abilities that farmers deem highly important for developing sustainable digital farming practices. Additionally, the capacity to assess alternatives - evaluating how optimal and ethical it is to use one technology over another - is considered significant by most respondents.

Conclusions

Despite progress, there are still challenges in the widespread adoption of ICT in agriculture. These include factors like initial investment costs, access to high-speed internet in remote areas, and ensuring that farmers have the necessary training and support to effectively utilize digital tools. Farmers require computer skills to manage sensor data. They need a blend of traditional farming knowledge and digital system understanding. Learning comes mainly from manufacturers and informal channels. Both younger and older farmers feel their education lacked sufficient digital tech coverage [15]. There is a need for agricultural education to incorporate digital skills, emphasizing the positive effects of digitalization on farming.

6.2. Current State of Digital Farming in North Macedonia

Overview

Agriculture and food production play a crucial role in the Macedonian economy, accounting for approximately 7-8% of the country's GDP and employing more than one-sixth of the national workforce. Nevertheless, this sector faces challenges due to its highly fragmented

farm structure, where small-scale farmers are responsible for a substantial 87% of agricultural production. There is low labor productivity in agriculture, which is attributed to small land holdings, mixed farming practices, and limited adoption of technology. The average size of privately owned agricultural land parcels is approximately 0.22 hectares, which is fragmented and thus limitation for implementation of certain modern technologies due to its costs-benefit ratio.

One of the significant challenges in the country's agricultural sector is the aging workforce. Only 4% of farm owners are under 35 years of age, while 62% are over 55 years old. This age structure is unfavorable for the sector's sustainability and development, as it indicates a shortage of young farmers. There is a low level of formal education in the agricultural sector. Most farmers have only completed primary or secondary education, with very few having formal agricultural education. The lack of formal education, training, and managerial skills among the agricultural workforce hinders modernization, restructuring, and innovation in the sector.

One significant issue is the lack of technology and innovation transfer due to weak connections between key institutions in the system. Some academic and scientific institutions have agricultural land but lack support for substantial applied projects, hindering technology demonstration.

Modern agriculture requires strong support with the rapid flow of information, emphasizing interconnecting systems and providing broader access for producers to use these resources.

Digital Infrastructure

The country's digital infrastructure presents a mixed scenario. While fixed broadband subscriptions are limited, with only 20 subscriptions per 100 inhabitants, mobile services have achieved relatively high penetration rates. Almost the entire population has access to 3G and LTE services, and approximately 79% of the population uses the Internet. However, digital skills among the active population are rated as moderate, leaving room for improvement.

North Macedonia has undertaken several e-agriculture initiatives, including the introduction of the Integrated Administration and Control System in 2007. This system includes the Single Registry of Agricultural Holdings and the Land Parcel Identification System (LPIS) to enhance farming practices. Additionally, the General Agricultural Strategy developed by the Ministry of Agriculture, Forestry, and Water Economy covers various aspects of e-agriculture, and it has resulted in financial support for farmers investing in ICT-related technologies. The General Agricultural Strategy developed by the Ministry of Agriculture, Forestry, and Water Economy covers various aspects of e-agriculture and has resulted in financial support for farmers investing in ICT-related technologies.

Digital Skills and ICT in Agriculture

Macedonian farmers display substantial proficiency with basic digital tools, such as smartphones (55%), computers (70%), and the Internet (60%). These capabilities suggest a solid foundation for introducing digital technologies into agriculture. However, farmers have limited awareness and knowledge of advanced ICT-based technologies like automated

systems, GPS, GIS systems, and precision agriculture tools. To fully leverage digital technologies in agriculture, there may be a need for increased capacity building and awareness initiatives.

Data Management and Soil Information

The implementation of the Land Resources Information Management System (LRIMS) has introduced a comprehensive data management and analysis system, facilitating standardized analysis, monitoring, and forecasting of land conditions. Moreover, North Macedonia launched its Soil Information System (MASIS) in 2015, with support from the FAO and its Global Soil Partnership, providing valuable information on soil characteristics.

Analysis of Digital Farming and Skills

The AgriSkills project recently conducted a compact survey named „Survey Findings: Uncovering Essential Skills for Adopting Digital Technologies in Agriculture", shedding light on the state of digital farming and skills in North Macedonia. The survey revealed several key findings:

- *Challenges in Digitalization:* Respondents identified significant challenges, including a lack of financial resources for investment, a deficiency in "digital" skills among potential users, and a need for customized solutions tailored to small-scale farmers.
- *Awareness and Information Needs:* Participants expressed the need for more real-world examples of digital agriculture and comprehensive information on digital technologies suitable for small-scale farming. These factors are seen as vital to instill confidence and awareness in the use of digital technology in agriculture.
- *Priority Areas for Improvement:* Survey participants emphasized the importance of enhancing knowledge on precision farming, sensor technologies, and the utilization of digital devices, communication applications, and networks for information management.
- *Importance of Financial Knowledge:* The participants stressed the significance of gaining knowledge in financing the digital transformation and developing effective business models, considering these aspects vital for successful digital integration.
- *Creation of Value in Agriculture:* In North Macedonia, participants expressed the need for more information on creating value in agriculture using digital technologies to maximize economic potential.
- *Essential Skills:* The survey highlighted the importance of creative skills, problem-solving abilities, and proficiency in digital marketing. It also underscored the need for assessing alternatives in technology usage in an optimal and ethical manner.

Conclusion

The current state of digital farming in North Macedonia reflects both the challenges and prospects inherent in the agricultural sector. Small-scale farming dominates, accounting for a substantial portion of agricultural production but facing challenges in labor productivity due to

limited technology adoption. The aging workforce and low formal education levels further compound these issues. Moreover, weak connections between key institutions hinder technology transfer, and modern agriculture demands improved information flow and interconnectivity.

The country's digital infrastructure exhibits mixed characteristics, with limited fixed broadband but widespread mobile services and internet usage. Digital skills, while moderate, leave room for improvement.

Farmers in the region exhibit proficiency in basic digital tools, providing a solid foundation for digital technology integration. However, there's a need to bolster awareness and knowledge of advanced ICT-based technologies to fully leverage digital advancements in agriculture. The findings from the AgriSkills project's survey highlight several key areas for improvement, including addressing financial challenges, enhancing digital skills, promoting precision farming, and developing effective business models. Moreover, there is a clear demand for more information on creating economic value through digital technologies in agriculture, emphasizing the importance of fostering essential skills and optimizing technology usage in an ethical and optimal manner.

6.3. Current State of Digital Farming in Greece

Overview

The agri-food sector is crucial for the global and local economy. In Greece, the food, beverage and tobacco industry, maintains the first place in number of companies among the various sectors of processing (16.263 companies in total 57.014) and is the largest employer of domestic processing, at a rate of 39%. At the same time, in 2020, the agricultural sector contributed 4.7% of the total Gross Value Added (GVA), while it employs over 400 thousand people, or more than 10% of the total employed human resources in the country. At the same time, the Agri-food sector, as a whole, contributes significantly to Greek exports, presenting, for the first time in several years, in 2020, a trade balance with a surplus of € 207 million [20].

In Greece, the agricultural sector is characterized by low productivity compared to the European average, which is attributed to several inherent ills, including:

- The level of agricultural education of farmers in the country, which is one of the lowest recorded in the EU, a phenomenon that is also associated with the old age of farmers.
- The small size of the farms and the low level of cooperation.
- The low level of adoption of technological innovation.

Productivity improvements, observed over the last fifty years, are expected to accelerate thanks to developments, mainly in digital technology and genetics. The farm of the future will utilize digital innovation, through a wide range of connected devices, advanced data collection technologies (e.g., drones, robotic field scanners, etc.) and machine learning algorithms.

At the same time, productive innovations will continue to create new opportunities, which will help reduce costs, utilize new resources and reduce the environmental footprint of the Agri-food sector.

Digital Infrastructure

According to Digital Economy and Society Index – DESI Greece ranks 25th of 27 EU Member States in the 2022 edition of the DESI [21]. However, overall Greece progressed well in recent years comparatively with other EU Member States, signalling that Greece is catching up.

In connectivity, Greece has made significant progress, notably in Very High-Capacity Networks (VHCN) and 5G coverage. Although, the country still needs to progress particularly in the take-up of at least 100 Mbps fixed broadband which remains very low (9%) compared to the EU average (41%) and further improve 5G coverage (66%) to ensure access to high-speed connectivity in the entire country.

The 'Digital Transformation Bible' presented by the Ministry of Digital Governance in 2020 became a state law on 5 July 2021. It sets out the strategic roadmap for Greece's digital transformation over the next 5 years. The strategy covers six pillars: (i) connectivity; (ii) digital skills; (iii) digital state; (iv) digital business; (v) digital innovation; and (vi) integration of digital technology in every sector of the economy. Greece went on to publish its Operational Programme for the digital transformation (2021- 2027) under the EU cohesion policy in October 2021, which will help it to implement all pillars of the strategy.

5G Connectivity and households with Internet access

Regarding 5G connectivity in Greece boasts three MNOs: Cosmote, Nova and Vodafone. Cosmote is the largest operator in the country; it claims that it will cover 90% of Greece's population with 5G connectivity by the end of 2023 [22]. In 2022 the share of rural households with internet access in Greece remained at around 75,53% [23] percent while the share of urban households remained at around 89,91% [24].

Bridging the gap in broadband infrastructure in rural areas

In recent years, Greece has been investing in infrastructure that modernises its economy and creates the basis for its transition to the new digital era. The Ministry of Rural Development and Food also participates in this effort, and has included in its programming, projects that develop the technological infrastructure of the Greek countryside among the agricultural infrastructure projects, such as land improvement and irrigation projects, that it implements [25].

High on the list of these projects of the Ministry of Rural Development is the action of "Development of broadband infrastructure in rural areas" (Action 7.3), which is co-financed by funds from the Rural Development Programme and the European Regional Development Fund (ERDF), being a key part of the National Broadband Plan.

An action that includes a number of individual projects that have been designed and are in the implementation phase. These infrastructures are expected to be further upgraded with the sub-project "Ultra High Broadband Infrastructure - ULTRAFAST BROADBAND (UFBB)", a project with a total budget of €75 million of which €25 million is covered.

This project concerns the development of the Rural Broadband Network in the so-called "white" areas of Greece, i.e. mountainous, isolated and border regions that do not have internet access infrastructure. These areas are inhabited by only 6% of the country's total population, and experience the digital divide with other areas, greatly affecting the activity of local services and social well-being.

The development of the rural Broadband network will contribute to the upgrading of the Greek Region, ensuring social inclusion, helping the economic development, sustainability and digital productivity of businesses. It will also act as a deterrent to the relocation of economic activity by encouraging entrepreneurs to run their businesses from their hometown.

The action aims to create infrastructure that will ensure that people living in rural areas, especially those living in island and mountainous areas but also in small settlements, can connect to the internet at speeds of up to a minimum of 100Mbps, which can be upgraded up to 1 (one) gigabit.

This will not only bridge the digital gap between the country's regions but will also create the basic infrastructure for the implementation of "smart agriculture" even in the most remote parts of Greece, helping to make the modernization plan of the Greek rural economy feasible.

The basic approach is the construction of new public passive and active broadband access infrastructure, subject to technological neutrality, which will then be provided in an open and cost-effective model of availability for use/utilisation by third party telecom providers.

At the beginning of the year, the project acquired temporary contractors for the entire country, is currently in the contracting phase and is expected to proceed to finalisation in the coming months.

Digital Skills and ICT in Agriculture

According to Eurostat, Greece is the 4th worst performer in Europe in terms of above-basic overall digital skills among rural residents [26, 27]. Please note that not all rural residents are farmers. In fact, 9 out of 10 people living in rural and remote areas of Greece are - almost - digitally illiterate, with only 10,97% having above-basic overall digital skills. Practically, only 1 in 10 people living in rural areas in Greece currently has the digital skills needed to take advantage of the opportunities offered by the global Internet.

This is the fourth worst performance across Europe, with a wide gap between our country and other European markets on this critical indicator. The Netherlands is Europe's champion in this area, as almost half of residents in rural and remote areas (46%) have advanced digital skills. Iceland and Finland have similarly high rates, where almost 41% of the rural population has advanced digital skills.

On the contrary, Bulgaria, Romania, North Macedonia and Greece are the countries with the lowest percentages of rural residents with advanced digital skills (from 3% to 5% of citizens in

Bulgaria, Romania and North Macedonia have advanced overall digital skills). While Germany has 15,67%, Austria 27,9% and Slovenia 16,04%.

According to another reseach [28] which focuses on the intra-rural digital divide, presenting a typology based on empirical data retrieved from two Greek Regional Units in a sample of 339 farmers, the majority of the responders (82.0% and 82.9% respectively) do have Internet access at home and at least one ICT device (PC/tablet/laptop), while less than the half (41.0%) are Smartphone owners. An amount of 62.8% are ICT users, while 37,1% are quite experienced (ICT usage >8 years). The majority have never been trained (either formal or non-formal) on ICT usage (75,5%).

The digital divide is present both in age and education, as the inductive statistics indicated that the relatively younger farmers and the most educated are more frequently ICT users, they have an ICT device (PC/tablet/laptop) in their household, are smartphone owners, and have been trained on ICT (either formal or non-formal). Moreover, the most experienced ICT users (>8 years) have the highest level of education (>12 years), and have attended some ICT course. The primary occupation seems to influence the intra-rural digital divide shaping, as the full-time farmers are less likely to be ICT users than the part-time farmers (57,2% of the full-time farmers and 72,6% of the part-time farmers are ICT users). Moreover, 72,0% of the less experienced on ICT usage (8 years) are farmers as a secondary occupation. It is worth noting that the farmers with a relatively higher educational level state farming as a secondary occupation significantly more frequently, which indicates that the most educated rural inhabitants invest their qualifications mainly in the non-agricultural sector.

ICT use is also related to household ICT equipment, as the farmers who are ICT users have an ICT device at home (PC/tablet/laptop) and Internet access. Comparing this finding with that of Samathrakis et al. (2006), we can argue that the digital divide in rural areas is decreasing in the last decade.

To study the farmers' ICT technical and cognitive skills, a scale of 23 self-report statements based on international literature and previous qualitative research, was developed. The 23 statements were answered only by the ICT users, and the results are following.The highest acquired skills are the browser running skill, finding information in Greek and opening a new tab in the internet browser. Low acquired skills are the ability to recognize a website that is virus related, connecting and setting up a printer, handling basic formulas in a spreadsheet, and installing new software or updating an old one. The lowest acquired skills are repairing a computer technical issue and creating a Blog. In summary, it is observed that the low and lowest acquired skills appear in advanced ICT skills (hardware skills, advanced software and advanced Internet skills).

The research demonstrates *three types of farmers* regarding ICT familiarization and digital maturity:

- The first type is labelled "*Digitally Matures*" and includes 32,4% of the sample. This type describes the highly skilled farmers in basic browsing, communication and multimedia, medium-high skilled both in the evaluation of online resources and high requirement ICTs and medium-low score in potential difficulties. The "Digitally mature" farmers have attended (at least) 12 years of formal education, have been trained on ICT, aged younger than 35 years old, and their main occupation is off-farming.

- The second type includes 42,9% of the sample and is labelled "*Digitally Ignorant*", as it describes farmers who are either non-ICT users or low ICT skilled. These farmers are primary education graduates (54,9% on six years of formal education) who have never been trained (formal or non-formal) on ICT use, aged 55-64 years old and they are full time farmers (32,3%).
- The third type is labelled "*Digitally Teens*", includes 24,7% of the sample and describes farmers who are highly skilled at basic browsing, medium-low skilled both at evaluating online resources and high requirement ICTs, and medium-low scored in potential difficulties. "Digitally teen" farmers have never been trained on ICT use, aged 45-54 years old, attended nine years on formal education, and they have farming as primary occupation.

The "Digitally Matures" are young and well educated, but they are not engaged in agriculture as primary occupation farmers. Assuming that several agricultural sector innovations require increased ICT skills, this category of farmers is arguably the most innovative. However, they are not primarily farmers, which limits this possibility. Based on those conclusions, policies should focus mainly on "Digitally Teens" as they are farmers as the main occupation and could enhance their knowledge through training.

Data Management and Soil Information

The project "Digital Transformation of the Agricultural Sector" [29] was secured on 16.10.2023 with a budget of 33,7 milion euros.The project is implemented in the framework of the National Recovery and Resilience Plan "Greece 2.0", with funding from the EU - NextGeneration EU [30].

It concerns the creation of a technological platform and infrastructure to support the modernisation of the agricultural sector, which will address the problems of the current situation and allow the provision of personalised environmental data and information on open crop plots using modern information and communication technology. Essentially, this platform will be the central pillar for the implementation of digital transformation policies at Greek and European level.

The main building blocks of the overall system will be the Data Collection Stations, which will constitute the network for the collection of atmospheric and soil parameters, the Unmanned Aircraft Systems, the Remote Sensing and Observation Satellite Data and the Distribution and Support Centres, while the entire software powered by the collected data and integrating the required system business logic, will constitute the Smart Farming Software Platform, through which the Smart Agriculture services will be provided. The Ministry responsible for the project is the Ministry of Rural Development and Food.

Analysis of Digital Farming and Skills

Based on our project survey about digital farming and the essential skills needed in Greece, several key findings emerged:

- Farmers in Greece consider low awareness of the benefits offered by new technologies and digitalization in the field of agriculture in addition to the lack of customized solutions that suit small farmers to be the main challenge for digitalization in agriculture.
- Digital technologies available for small scale farmers followed by examples of digital agriculture and benefits and risks of usage of digital technologies in agriculture are the areas in which the participants need more information in order to develop awareness and confidence in the usage of digital technologie
- Precision agriculture technologies, precision farming and usage of sensor technologies are pointed out as knowledge that needs to be improved among agricultural stakeholders.
- Gaining knowledge in the field of Financing the digital transformation and Strategic Thinking for Digital Transformation is considered to be very important for developing in agricultural business.
- Creation of value in agriculture using digital technologies and Using digital technologies for overcoming value chain challenges are the areas stated in which the participants need more information in order to develop economic value in agriculture.
- Participants in the survey from Greece pointed out that Creative skills-active use of online tools, platforms and solutions and problem solving skills are very important in order to develop sustainable digital farming. Skills in co-creation, collaboration and networking were marked as important by most of the respondents.

Conclusion

The situation in Greece is evolving and actors in the agri-food sector are moving at different "speeds" in terms of technology adoption and integration. One obstacle is the fragmentation of farms, which limits the potential benefits per producer of investing in technology. However, there have been highly successful pilot applications of smart agriculture, for example in viticulture and rice production.

5G connectivity and broadband infrastructure in rural areas is, or will soon be, ubiquitous, so the underlying telecommunications infrastructure will soon no longer be a limiting factor for digital agriculture.

The digital transformation of the agricultural sector has been launched, and in the next few years a nationwide intelligent agriculture software platform will be launched, through which intelligent agriculture services will be available to farmers.

So, the question is how mature will be the farmers to exploit these Intelligent Agriculture services in terms of knowledge and finance capacity. The greek farmers can be classified in three groups:

The question, then, is how mature farmers will be in terms of knowledge and financial capacity to take advantage of these intelligent farming services. Greek farmers can be divided into three groups:

- *Digitally Ignorant:* farmers who are either non-ICT users or have low ICT skills, have a primary education, have never received any training (formal or non-formal) in the use

of ICT, are aged 55-64 years and are full-time farmers. This group includes 42,9% of farmers.

- *Digital teenagers:* farmers with high skills in basic browsing, medium-low skills in both evaluating online resources and high demand ICT, and medium-low skills in potential difficulties. This group has never been trained in the use of ICT, is aged 45-54, has nine years of formal education and has agriculture as their main occupation. This group includes 24,7% of farmers.
- *Digitally mature:* farmers with high skills in basic browsing, communication and multimedia, medium-high skills in both evaluating online resources and high demand ICT, and medium-low skills in potential difficulties. This group has 12 years of formal education, has received ICT training, is younger than 35 years of age and has a main occupation outside agriculture. This group includes 32,4% of farmers.

Awareness-raising actions on the benefits of new technologies and digitalisation in agriculture need to be targeted at all three groups of farmers mentioned above. These actions could be implemented by using e-learning services such as the AgriSkills 4.0 platform.The aim of the awareness-raising actions is to help digitally ignorant farmers to become digitally teen, the digitally teen farmers to find motivations to become digitally mature, and finally the digitally mature farmers to start thinking about rapidly changing their main occupation from off-farm to farming.

The next steps are to provide face-to-face training, both formal and informal, in the field with the aim of using the national smart agriculture services through practical examples and real use. Farmers, especially the digital youth and mature farmers, need advanced IT skills to manage sensor data. They need a mix of traditional agricultural knowledge and understanding of digital systems. There is a need for agricultural education to incorporate digital skills and emphasise the positive impact of digitalisation on agriculture.

6.4. Current State of Digital Farming in Slovenia

Overview

Nestled in the heart of Europe, Slovenia is a small country with a rich agricultural tradition. Despite its modest size, Slovenia is home to a thriving agricultural sector that is increasingly embracing digital technologies to improve productivity, sustainability, and resilience. Slovenia's agricultural roots stretch back centuries, with a strong emphasis on small-scale family farms. This heritage has shaped the country's agricultural landscape, characterized by a diverse range of crops and livestock. From the vineyards of the Vipava Valley to the orchards of the Drava Valley, Slovenia produces a bounty of high-quality agricultural products.

Agriculture is relatively small sector in Slovenia in terms of employment and revenue. In 2021, agriculture accounted for 4,9% of total employment in Slovenia and generated the total revenue of 1,8 billion EUR (compared to 34,5 billion EUR for industry and 14,6 billion EUR for services).

Slovenia has a total area of 20.273 square kilometers, of which 33,9% is agricultural land. Most of the agricultural land is used for permanent meadows and pastures (28,5%), followed by arable land (19,1%) and orchards and vineyards (3,6%).

Slovenia produces a variety of agricultural products, including milk (639.925 tons (2021), wheat and spelt (151.100 tons (2022)), apples (120.000 tons (2022)) and grapes (100.000 tons (2022)) [31]. Slovenia is a net exporter of agricultural products.

Slovenia's farming is based on small-scale family farms – there are 68.331 agriculture businesses in Slovenia. The average size of an agricultural holding is 6,9 hectares (2021) [31].

In recent years, Slovenia has emerged as a leader in the adoption of digital farming technologies. The country's tech-savvy farmers are utilizing a wide range of tools, from precision agriculture and robotics to artificial intelligence and the Internet of Things (IoT).

Digital Infrastructure

Slovenia has made in recent decade a substantial progress in developing a robust digital infrastructure, laying the foundation for a thriving digital economy and society. The country boasts widespread access to high-speed internet connectivity, with 94 % of households and businesses having access to fiber-optic networks [32] and this extensive connectivity has enabled the adoption of a wide range of digital technologies, from e-commerce and online banking to telemedicine and education.

The Slovenian government has played a significant role in promoting digital infrastructure development, implementing initiatives such as the Gigabit infrastructure development plan 2030 [33] and the Digital Slovenia 2030 Strategy [34].

For effective digitization in agriculture, basic digital spatial records are needed, which have been available in Slovenia for many years. There are also many registers available that collect data on individual crops or breeding. For example, the central cattle register [35] registers cattle and their breeders, and at the same time, production parameters and other data are monitored on a large sample. These data supplement other production data and help to optimize it, and the data are also important for breeding programs. The state also has a well-developed network of agrometeorological stations [36] that monitor weather data directly in the production areas. The public plant health service [37] predicts the development of diseases and pests based on their values, models, and direct monitoring, and advises the most appropriate plant protection strategy.

Remote sensing (satellite imaging and aerial imaging with drones) represents one of the central approaches to capturing data on crop status. Slovenia is very active in the field of remote sensing, both in terms of data capture and interpretation. Although the scope of agricultural machinery that can record and/or use data for precision farming (combines, fertilizer spreaders, FFS application, seeders) is gradually increasing, this segment is the biggest gap that prevents faster introduction of digitization of agriculture in Slovenia.

When it comes to digital farming, the government has implemented a number of initiatives to promote the use of digital technologies in agriculture, including:

- *Expanding high-speed internet access to rural areas:* This is crucial for enabling farmers to fully participate in the digital transformation of agriculture, as it allows them to access real-time data and utilize cloud-based platforms for farm management and decision-making.
- *Providing financial incentives and support:* The government offers subsidies and grants to help farmers offset the initial costs of implementing digital technologies, making them more accessible to smaller farms and those with limited financial resources.
- *Promoting digital literacy and skills development:* Education and training programs are being implemented to equip farmers with the necessary skills and knowledge to effectively utilize digital farming tools and platforms. This includes training on data analysis, precision agriculture techniques, and the use of digital sensors and monitoring devices.
- *Encouraging collaboration and knowledge sharing:* The government is fostering a culture of collaboration among farmers, researchers, and industry stakeholders to accelerate the diffusion of digital farming practices and promote the development of innovative solutions tailored to the specific needs of Slovenian agriculture.

Digital Skill and ICT in Agriculture

The adoption of digital technologies in agriculture is still relatively slow, but it is expected to accelerate in the coming years and is subject to the specificities of the Slovenian agriculture sector with several small-scale family-run farms. It indeed proves that digital farming does not only apply to large farms, but also family farms:

- In Slovenia, milking robots are already in use, which increase efficiency in the feeding of cows, as the robots are connected to feeders that dose feed based on the amount of milk milked, and also simplify the milking itself. Sensors for irrigation and monitoring of soil conditions are also in use, which optimize water consumption based on soil information, tractors, robots for cleaning stables and attachments for tillage, plant protection and crop harvesting, which are satellite-guided and partially roboticized, and many experimental technologies (e.g. self-propelled machines with various sensors and tasks).
- Agricultural holdings have access to graphical data on agricultural plots and land use, which they can use to guide agricultural machinery based on the global positioning system GNSS, or in planning planting and crop rotation.
- Some farms also use aerial surveillance - analysis of satellite images or images obtained with smaller drones - for faster detection of plant disease symptoms, for inadequate supply of nutrients, or for lack of water in plants.
- Dairy farms can get all data on production, feeding and health status of animals based on milk analysis - all in electronic form. This gives them precise control over farm management and costs, improves reproduction, and rationalizes animal feed. Based on analysis, farmers are informed about hidden health problems or nutritional errors.
- Some farmers also use *electronic probes to measure the amount of green mass on meadows* - for the purpose of feeding grazing animals. Vegetable and fruit farms use accurate local weather and Phyto data for the purpose of irrigation with the aim of reducing water consumption in agriculture and timely protection against pests and

diseases. With timely action, they can reduce or even eliminate the consequences of drought and various diseases or pests.

Despite significant progress in digital farming adoption, *a digital gap persists in Slovenian agriculture*. This gap is evident in the uneven distribution of digital technologies across different farm sizes, regions, and sectors. Several factors contribute to the digital gap in Slovenian agriculture:

- Access to infrastructure: Although 94 % of households and businesses have high-speed possibility of fibre-speed networks, many rural areas still have limited access to high-speed internet connectivity, which hinders the adoption of digital technologies that rely on real-time data transfer and analysis.
- Digital literacy and skills: Farmers, especially older generations, may lack the necessary digital literacy and skills to effectively utilize digital farming tools and platforms.
- Financial constraints: The upfront costs of implementing digital technologies can pose a financial barrier for smaller farms, particularly those with limited access to capital.
- Adaptability and risk aversion: Some farmers may be hesitant to adopt new technologies due to concerns about compatibility with existing systems, potential risks, and the need for significant changes in farming practices.

The digital gap in Slovenian agriculture has several implications for the sector's competitiveness, sustainability, and resilience:

- Reduced productivity: Farms that lag behind in digital adoption may experience lower yields, higher production costs, and decreased efficiency compared to their more digitally advanced counterparts.
- Limited sustainability: Without access to digital tools for precision agriculture and resource management, farms may struggle to optimize resource use, leading to increased environmental impact and reduced sustainability.
- Reduced resilience to challenges: The inability to leverage digital technologies for data-driven decision-making and risk mitigation can make farms more vulnerable to climate change, pests, and market fluctuations.

Here are some examples of Slovenian companies that are developing digital farming technologies:

- *Termodron*: Termodron is a company that develops precision farming solutions using drones and multispectral images. Webpage: https://termodron.si/.
- *Trace Labs* is a company working on the implementation of blockchain technology in supply chains and other industries. Based on the open source Origin Trail technology, they provide data on the origin, certificates, and other details on the origin of meat or other agricultural products. Webpage: https://tracelabs.io/.
- *Run Chicken* is a company that develops innovative chicken equipment and sells it worldwide. It started with automated chicken doors that open and close by themselves and continued with a feeder and hatchery for hens. Webpage: https://run-chicken.com/.

Analysis of Digital Farming and Skills

The AgriSkills project recently conducted a compact survey named „Survey Findings: Uncovering Essential Skills for Adopting Digital Technologies in Agriculture", shedding light on the state of digital farming and skills in Slovenia. Based on our project survey about digital farming and the essential skills needed in Slovenia, several key findings emerged:

- Challenges in digitalization: Among the main challenges are the lack of appropriate digital skills and lack of digital solutions appropriate for small farms.
- Awareness and Information Needs: More information is needed, especially about examples of digitalization in agriculture and digital technologies, appropriate for small farms.
- Priority Areas for Improvement: Among the priority areas, the use of digital tools, communication applications and networks stand out, followed by precision farming technologies and digital platforms for sales/production/marketing.
- Importance of Knowledge: Responded answered the importance of acquiring knowledge in the following spheres: environmental impacts of digitalization of farming, time management, strategic thinking, data analytics and recognizing needs and priorites.
- Creation of Value in Agriculture: To create more value in agriculture, more information is needed on the use of digital technologies for overcoming the challenges in value chains.
- Essential Skills: Essential skills needed are creative skills (use of web tools, platforms, and solutions), followed by skills for co-creation, connection and networking and problem-solving skills.

Conclusions

Slovenia has made significant progress in developing digital infrastructure and adopting digital technologies in agriculture. The country has implemented a number of initiatives to promote digital farming, including expanding high-speed internet access to rural areas, providing financial incentives, and promoting digital literacy and skills development.

However, a digital gap persists in Slovenian agriculture due to factors such as limited access to infrastructure, digital literacy and skills, financial constraints, and adaptability and risk aversion. This digital gap has implications for the sector's competitiveness, sustainability, and resilience.

To address the gap, a significant investment in the development of skill set and awareness-raising should be made – with the small-scale family-run farms in mind.

6.5. Current State of Digital Farming in Austria

Overview

The trend towards fewer, but larger farms in Austrian agriculture and forestry continues. Overall, the number of farms has decreased by 11 % in the past decade, whereas the average area used for agriculture has increased by 26 %. Families continue to be the backbone of the Austrian agricultural economy, where four out of five workers are family members. The trend towards organic farming continues as well: 22.4 % of farms are managed according to organic standards, compared to 15.1 % in 2010" [38].

Reduction in agricultural and forestry holdings: With 154 953 farms in total, the number of holdings in 2020 decreased by 11 % compared to the previous agricultural census of 2010. Of that total number, 110 781 holdings had land for crop production and/or livestock.

Farms are increasing in size: Austrian agricultural sector still is small-scale compared to other EU countries, but the trend towards larger farms continues steadily: whereas holdings had an average area of 42.6 ha in 2010, it was 44.9 ha in 2020. Similarly, the average utilized agricultural area (consisting of arable land, kitchen gardens, permanent crops and permanent grassland) expanded from 18.8 ha to 23.6 ha.

Animal husbandry showed a similar change: whereas the average Austrian farm had 28 cattle ten years ago, this number had risen to 34 cattle in 2020. For pigs, the average amount increased from 85 in 2010 to 112 in 2020.

Structure of the agricultural and forestry holdings: Out of 154 953 farms, 36 % were run as main activity farms and 57 % as secondary activity farms. Both of these types, or a combined total of 93 %, are family farms – the vast majority of Austrian holdings. The remaining 7 % are holdings owned by joint shareholders or other legal persons.

In 2020, a total of 420 018 people (+2 % compared to 2010) were employed in agriculture and forestry, of which 336 015 (-4 %) were family members and 84 003 (+31 %) were non-family members. The increase in in non-family members was mainly due to temporary labour, i.e. persons who are not employed on the farm all year round.

In 2020, agriculture contributed around 1,1% of Austria's GDP [49]. Despite the very small share of agricultural and forestry activities themselves in Austria's gross value added, upstream and downstream economic sectors make a significant contribution to sales revenues and employment and thus represent important economic sectors for the country [40]. In 2020, an average of 3.9 percent of the workforce in Austria was employed in agriculture [41].

Digital Infrastructure

Digitalisation is an important instrument for bringing economic strength and a good quality of life to every part of Austria. The Federal Ministry of Agriculture, Regions and Tourism (BMLRT) is responsible for ensuring – through the broadband rollout, digital innovation in agriculture and online services for businesses – that digital transformation brings benefits for the whole country [42].

Because non-wage labour costs are high in Austria, it is relatively expensive to hire workers. There is also a lack of well-trained personnel in many cases. For this reason, many companies are trying to automate work steps. Digitization has enormous potential in this regard [43]. Digitalization tools and concepts have been used in Austrian's agriculture for some time [44].

Some key facts about the automatization of Austria's agricultural sector:

- 850 farms milk in Austria with automatic milking systems.
- Over 70% of Austrian agricultural businesses use the Internet for business management.
- 13% of Austria's arable land are cultivated with GPS-controlled technology
- Every 5th farm uses digital farm management systems for recording and documentation programs.
- 6% of farmers use precision farming systems.
- 3% of farms with <50 ha arable land and 21% with >50 ha arable land use precision farming systems.

The attitude of farmers toward Agriculture 4.0 is predominantly positive and, according to a survey, the farmers feel well informed [45].

Digital Skills and ICT in Agriculture

The Digital Action Plan Austria is being developed in a broad and agile process. It involves experts from a wide range of disciplines from different federal ministries and, above all, those who will benefit from the individual projects and measures. Each year, individual chapters of the action plan are developed with scientific support and presented in a federal state. The results of the topic identification are concrete projects or legal measures, which are provided with implementation plans and budgets. Each field of action is supported by experts in the field, who help to shape the projects and provide information on objectives and progress. The final implementation measures and decisions are presented, and the next chapters of the action plan are launched.

The government programme 2020-2024 "Out of responsibility for Austria" provides for the development and implementation of a digitalisation strategy in agriculture in line with the objectives of the CAP strategy.

In order to be optimally positioned for the future, a strategic outlook for digitalisation in Austrian agriculture was developed and the potential for success of digitalisation in agriculture was analysed. In a comprehensive process, almost 100 experts from 51 organisations developed more than 30 proposals for measures in eight fields of action with the aim of promoting digitalisation in agriculture.

Future activities will focus on

- Raising awareness and understanding of digitalisation;
- Development of digital skills;
- Improving access to and use of data;
- Reducing administrative burdens;

- Creating incentives through the targeted promotion of digital technologies and services;
- Promoting research and development to generate innovation.

A competence centre for digital agriculture will be established in Wieselburg to improve networking. All in all, innovations, products, and services are to be created that generate real added value for Austrian farmers and society, ultimately strengthening and securing Austria as a business location sustainably.

The Smart Farming Digital Action Plan focuses on the following eight fields of action:

- Improving the availability and quality of data in the digital infrastructure;
- More innovation through intensified dialogue between stakeholders;
- Intensified research and development in the field of digitalisation in agriculture;
- Setting up advisory and training programmes to provide digital skills as part of a "lifelong learning" approach;
- Expanding and deepening training on digitalisation in agriculture at federal, state and university level and through mutual exchange;
- Strategically coordinated, cross-institutional communication campaigns on digital benefits in the field of public relations;
- Increased funding for technological innovation in agriculture;
- Simplifying and speeding up administrative procedures.

Conclusions

We could observe an increasing speed in developing digital infrastructure and adopting digital technologies in agriculture in Austria. A number of initiatives have been implemented to promote digital farming, including expanding high-speed internet access to rural areas, providing financial incentives, and promoting digital literacy and skills development.

Digitalisation has long since penetrated many areas of agriculture. A significant proportion of administration, accounting and subsidy applications are already digital on most farms. New technologies can make farming more efficient, enable better decision-making, contribute to sustainable production and offer many other opportunities.

Digitalisation opens up a wide range of new possibilities in arable and grassland farming: machines can be connected to the internet and a lot of data can be collected and analysed automatically. This means that land can be farmed more precisely, more efficiently and in a more environmentally friendly way. The Ministry wants to promote these positive developments and help make them accessible to all farms.

To achieve these goals, the Ministry has launched various initiatives, projects and funding programmes:

Applying new technologies, trends and developments in agriculture: The Innovation Farm, located at Wieselburg, Raumberg-Gumpenstein and Mold, focuses on new technologies, trends and developments, making them visible, tangible and, above all, applicable to agriculture. It pools expertise in the field of digitalisation at three locations and with 20 pilot farms to promote the environmentally friendly development of agriculture with the help of new technologies. Its task is to test, optimise and communicate modern technical developments,

products and concepts in both indoor farming (livestock farming) and outdoor farming (arable farming, grassland). The main objective of the Innovation Farm is to identify the benefits of new technical solutions for Austrian agriculture and to facilitate farmers' access to new developments, thus making an important contribution to sustainable agriculture. Through the interaction between manufacturers and research, practical solutions for modern farming operations are to be evaluated and made available. The concept of Agriculture 4.0 must be made tangible and applicable for users. The aim is to identify opportunities and risks, analyse trends and use the available expertise to ensure efficient and sustainable agriculture [46].

Free RTK signal for agriculture: Thanks to an administrative agreement with the Federal Office of Metrology and Surveying, the APOS RTK signal will be provided free of charge to agriculture from 1 February 2021. This is an important basis for the application and further development of precision agriculture in Austria.

Education and training for teachers and advisors: A comprehensive training programme at the University of Agricultural and Environmental Education lays the foundations for the necessary education and training qualifications. The University of Agricultural and Environmental Education has its own institute for e-learning and e-didactics.

Funding research projects related to digitalisation: The Ministry promotes practice-oriented research and conducts and supports research in the field of digitisation. In addition to the activities already underway, the Ministry of Agriculture is currently making two million euros available for applied research projects related to digitisation that seek concrete solutions for practical applications.

Modern training in agricultural and forestry secondary schools: In 2020, the Ministry of Agriculture has invested more than 1.3 million euros in digitisation projects in the school sector. In addition to the creation of an "Information Technology in Agriculture" training programme, the technical equipment in schools has been improved, laying the foundations for new learning.

The DIGITAL Europe programme aims to optimise the development and use of AI with a European strategy for artificial intelligence (AI). The European Commission is therefore funding so-called "Test and Experimentation Facilities" (TEF) in four different sectors: manufacturing, healthcare, smart cities and communities, and agri-food. The "agrifoodTEF" project consortium with Austrian participation was successful in the tender for the agricultural sector. The project has started on 1 January 2023 and will run for five years. It offers a wide range of different services to help companies test and validate their product developments in the field of AI and robotics under real-life conditions. The project partners form a network that meets the needs of the agriculture and food production sector across Europe.

The total budget of the project is €60 million across Europe, of which 50% is provided by the European Commission and 50% by national funding bodies, in Austria by the Austrian Research Promotion Agency (FFG). In Austria, 5 million euros will be provided.

Digitalisation is expected to increase the efficiency of farming operations, reduce the use of pesticides and fertilisers, and address labour shortages. By 2030, all farms will be connected to the fibre-optic network and 5G will be used to control high-tech machinery.

As part of the 2nd Broadband Billion, agricultural businesses are already being subsidised, with 75 per cent of the costs (up to €50,000) for the upgrade being reimbursed.

7. Conclusion

Picture 9. Learning with innovative technology in organic farming © Stevanovicigor | Dreamstime.com

Countries exhibit varying degrees of digital technology adoption in their agricultural sectors. Some countries have embraced these advancements more extensively, while others are still in the nascent stages of integration. These differences are mirrored in the corresponding skill sets required for effective utilization of these technologies in the respective agricultural landscapes. These range from basic digital literacy to specialized knowledge in precision farming, data analytics, and IoT integration:

- **Tailored training programs:** Recognizing the unique needs of each region, it is imperative to implement tailored training programs. These should focus on building foundational digital literacy skills, and subsequently progress towards more advanced competencies as per the local context.
- **Collaborative initiatives:** Encouraging collaborative efforts between educational institutions, governmental bodies, and agriculture stakeholders can facilitate the development of targeted skill-building programs. These initiatives can bridge existing skill gaps and ensure a seamless transition towards digitalized agriculture.
- **Sector-specific workshops/ seminars:** Organizing sector-specific workshops and seminars can provide an interactive platform for farmers and stakeholders to gain hands-on experience with relevant digital tools and technologies. These events can serve as pivotal knowledge-sharing platforms.
- **Promotion of technological innovation:** Fostering an environment conducive to technological innovation is crucial. Local research and development initiatives should be encouraged, aimed at creating solutions that align with the specific needs and resources of the agricultural communities.

Acknowledging the distinct levels of digital technology adoption and corresponding skill requirements across countries is a vital step towards fostering sustainable agricultural development. By prioritizing localized skill enhancement, we can empower farming communities to harness the full potential of digital technologies, ultimately contributing to increased productivity, sustainability, and resilience in agriculture.

References

No	Source
1	United Nations, *Global Issues – Population*. Link: https://www.un.org/en/global-issues/population
2	David Fiocco, Vasanth Ganesan, Maria Garcia de la Serrana Lozano, and Hussain Sharifi, *Agtech: Breaking down the farmer adoption dilemma*, McKinsey&Company, 2023. Link: www.mckinsey.com/industries/agriculture/our-insights/agtech-breaking-down-the-farmer-adoption-dilemma
3	Bioeconomy BW, *Digitalization in agriculture – from precision farming to farming 4.0,* 2018. Link: https://www.biooekonomie-bw.de/en/articles/dossiers/digitisation-in-agriculture-from-precision-farming-to-farming-40
4	Julie Ingram, Damian Maye, *What Are the Implications of Digitalisation for Agricultural Knowledge?* Frontiers. Link: https://www.frontiersin.org/articles/10.3389/fsufs.2020.00066/full
5	AgroCares, *What is the difference between precision, digital and smart farming?,* Blog article. Link: https://agrocares.com/what-is-the-difference-between-precision-digital-and-smart-farming/
6	Scientific Foresight Study, *Precision agriculture and the future of farming in Europe*, 2016. Link: https://www.europarl.europa.eu/RegData/etudes/STUD/2016/581892/EPRS_STU(2016)581892_EN.pdf
7	Sathish Kumar R, *Smart Agriculture: The Future of Agriculture using AI & IoT*, 2023. Link: https://www.linkedin.com/pulse/smart-agriculture-future-using-ai-iot-sathish-kumar-r/
8	Clarisse Magnin, *How big data will revolutionize the global food chain,* McKinsey.com 2016. Link: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/how-big-data-will-revolutionize-the-global-food-chain
9	Prakhyath Hegde, *Precision Agriculture: How is it different from Smart Farming?,* Cropin.com 2021. Link: https://www.cropin.com/blogs/smart-farming-vs-precision-farming-systems
10	DTN Team, *Precision Farming vs. Digital Farming vs. Smart Farming: What's The Difference?* DTN.com, 2021. Link: https://www.dtn.com/precision-farming-vs-digital-farming-vs-smart-farming-whats-the-difference/

11	Alok Nayak, *Precision Agriculture: How Computer Vision is Changing Farming,* 2023. Link: https://www.linkedin.com/pulse/precision-agriculture-how-computer-vision-changing-farming-alok-nayak-lqmaf/
12	GTAI – Germany Traid and Invest, *Digital Farming in Germany*, Issue 2023/2024, Link: https://www.gtai.de/en/invest/service/publications/digital-farming-in-germany-992502
13	Aditya Kumar, *India-Germany Collaboration in Farm Technology*, Diplomatist Magazine, 2020. Link: https://diplomatist.com/2020/12/14/india-germany-collaboration-in-farm-technology/#:~:text=Germany%20with%20technologies%20like%20Artificial,agricultural%20practices%20but%20is%20also
14	Andreas Gabriel, Markus Gandorfer, *Adoption of digital technologies in agriculture - an inventory in a european small-scale farming region*, Springer 2022. Link: https://link.springer.com/article/10.1007/s11119-022-09931-1#Abs1
15	Michael Goller, Carina Caruso, Christian Harteis, *Digitalisation in Agriculture: Knowledge and Learning Requirements of German Dairy Farmers*, URVET, 2021 Link: https://journals.sub.uni-hamburg.de/hup2/ijrvet/article/view/724
16	United Nations, *Republic of North Macedonia Digital Development Country Profile,* (PDF) 2021. Link: https://northmacedonia.un.org/sites/default/files/2021-11/Digital%20Development%20Country%20Profile_North%20Macedonia_%2029.10.21.pdf
17	*Status of Digital Agriculture in 18 countries of Europe and Central Asia*, International Telecommunication Union and Food and Agriculture Organization of the United Nations, 2020. Link: https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2020/Series%20of%20Webinars/20-00244_Status_digital_Agriculture-revFAOV4.0-MASTER-FILE-20-JUNE_REVIEW-FAO_PL_print%20%28002%29.pdf
18	Министерство за земјоделство, шумарство и водостопанство, *Национална Стратегија за Земјоделството и Руралниот Развој за Периодот 2021-2027 Година*. Link: https://ipard.gov.mk/wp-content/uploads/2021/02/Национална-стратегија-за-земјоделство-и-рурален-развој-2021-2027.pdf
19	AgriTech 4.0, *The State of Macedonian Agriculture*, Link: https://www.agriteach.hu/sites/default/files/events/upload-field/agriteach_o1_a2_state_of_art_macedonia_english_version.pdf
20	Οικονομικός Ταχυδρόμος, *Greek agri-food sector: How it can meet the challenges of today and tomorrow*, 2022. Link

21	European Commission, *Greece in the Digital Economy and Society Index*, DESI. Link: https://digital-strategy.ec.europa.eu/en/policies/desi-greece#:~:text=Overall%20Greece%20did%20not%20make,its%20digital%20economy%20and%20society.
22	Will Townsend, *Greece Aims For Olympian Heights With 5G And Beyond*, Forbes, 2023. Link: https://www.forbes.com/sites/moorinsights/2023/04/13/greece-aims-for-olympian-heights-with-5g-and-beyond/?sh=7edd7af777f7
23	*Share of rural households with internet access in Greece from 2011 to 2022,* Statista,com. Link: https://www.statista.com/statistics/1236294/share-towns-rural-households-internet-access-europa-greece/
24	*Share of urban households with internet access in Greece from 2011 to 2022*, Statista.com. Link: https://www.statista.com/statistics/1235515/internet-access-urban-households-greece/
25	Agro24.gr, *Τεχνολογικές υποδομές ευρυζωνικότητας αλλάζουν τον χάρτη της ελληνικής υπαίθρου*, 2022. Link: https://www.agro24.gr/agrotika/agrotiki-epikairotita/elliniki-epikairotita/tehnologikes-ypodomes-eyryzonikotitas-allazoyn
26	Eurostat, *EU digital skills divide: cities outpace rural areas*, 2023. Link: https://ec.europa.eu/eurostat/en/web/products-eurostat-news/w/ddn-20230320-2
27	Νατάσα Φραγκούλη, *Μόνο 1 στους 10 κατοίκους αγροτικών περιοχών έχει digital skills*, ΣΕΠΕ, 2023. Link: https://www.sepe.gr/research-studies/21654689/mono-1-stous-10-katoikous-agrotikon-periohon-ehei-digital-skills/
28	Maria Botsiou, Vassilios Dagdilelis, Stavriani Koutsou, *The Greek farmers' ICT skills and the intra-rural digital divide formation*, Agricultural Economics Review 19(1):52-68, 2018. Link: https://www.researchgate.net/publication/351428774_The_Greek_farmers'_ICT_skills_and_the_intra-rural_digital_divide_formation
29	*Έκλεισε το deal για ψηφιακό μετασχηματισμό ύψους 33,7 εκ. ευρώ, μια από τα ίδια,* AgroTypos.gr, 2023. Link: https://www.agrotypos.gr/chrima/trapezes-alla-chrimatodotika-mesa/ekleise-to-deal-gia-psifiako-metaschimatismo-ypsous-337-ek
30	Διακήρυξη Ηλεκτρονικού Ανοικτού Άνω των Ορίων Διαγωνισμού για το Έργο «Ψηφιακός Μετασχηματισμός του Γεωργικού Τομέα», Ktpae.gr, 2022 Link: https://www.ktpae.gr/diagwnismoi/διακήρυξη-ηλεκτρονικού-ανοικτού-άνω/
31	Republika Slovenija, Statisticni Urad, Kmetijstvo, gozdarstvo, ribištvo, Aktualni Podatki. Link: https://www.stat.si/StatWeb/Field/Index/11

32	Republika Slovenija, Statisticni Urad, Kakovost življenja, Aktualni Podatki. Link: https://www.stat.si/StatWeb/Field/Index/10
33	Republika Slovenija, *Načrt razvoja gigabitne infrastrukture do leta 2030*, Link: https://www.gov.si/assets/ministrstva/MDP/javne-objave/Nacrt-razvoja-gigabitne-infrastrukture-do-leta-2030.pdf
34	Republika Slovenija, *Digitalna Slovenija 2030 - Krovna strategija digitalne preobrazbe Slovenije do leta 2030*, Ljubljana, 2023. Link: https://www.gov.si/assets/ministrstva/MDP/Dokumenti/DSI2030-potrjena-na-Vladi-RS_marec-2023.pdf
35	Republika Slovenija, *Dostop do portala Volos*, Gov.sl. Link: https://www.gov.si/zbirke/storitve/dostop-do-portala-volos/
36	Republika Slovenija, Agrometeorološki portal, *Izpis lokacij s podatki meritev in opazovanj za vse lokacije,* Gov.sl, Link: http://agromet.mkgp.gov.si/APP2/Home/Index
37	Republika Slovenija, *Plant health,* Gov.sl, Link: https://www.gov.si/en/policies/agriculture-forestry-and-food/plant-protection/plant-health/
38	Stefan Peyr, *Farm Structure Survey 2020: Agricultural and forestry holdings increased in size. Rise in organic agriculture*, Statistics Austria Federal Institution under Public Law, 2022. Link: https://www.statistik.at/fileadmin/announcement/2022/07/20220712AS2020EN.pdf
39	Statista, Link: https://bit.ly/3DOAG8K
40	Universität Wien, *Solidarische Landwirtschaft in Österreich - Alternativen für den Agrarsektor,* Genossenschaftswesen, 2021. Link: https://genos.univie.ac.at/fileadmin/user_upload/genossenschaftswesen/Eller_L__2021__Solidarische_Land-wirtschaft_in_%C3%96sterreich_Alternativen_f%C3%BCr_den_Agrarsektor.pdf
41	Statista Research Department, *Verteilung der Erwerbstätigen in Österreich nach Wirtschaftssektoren von 2012 bis 2022*. Link: https://de.statista.com/statistik/daten/studie/217608/umfrage/erwerbstaetige-nach-wirtschaftssektoren-in-oesterreich
42	Digitalization report 2020, *Now for Tomorrow - Digitalisation for growth and futureproofing*, Digital Austria. Link: https://www.digitalaustria.gv.at/digitalisierungsbericht_en.html

43	*Landwirtschaft, Digitalisierung, Tierhaltung*. Bundesministerium Land- und Forstwirtschaft, Regionen und Wasserwirtschaft. Link: https://info.bmlrt.gv.at/themen/landwirtschaft/digitalisierung/praxis/tierhaltung.html
44	Ländliches Fortbildungsinstitut, *Digitalisierung in der Land- und Forstwirtschaft*, Link: https://noe.lfi.at/bildungskampagne-digitalisierung-in-der-land-und-forstwirtschaft+2500+2673107
45	Dipl.-Ing. Martin Hirt, *Digitalisierungs-Studie: Bäuerliche Betriebe offen für Innovationen,* APA-OTS, 2021. Link: https://www.ots.at/presseaussendung/OTS_20210729_OTS0080/digitalisierungs-studie-baeuerliche-betriebe-offen-fuer-innovationen
46	InnovationFarm.at, Link: https://www.innovationfarm.at/
47	Federal Ministry of Food and Agriculture, *Organic Farming in Germany,* Issue 2022, PDF document (EN). Link: https://www.bmel.de/SharedDocs/Downloads/EN/Publications/Organic-Farming-in-Germany.pdf?__blob=publicationFile&v=4
48	Torsten Kurth, Benjamin Subei, Paul Plötner, Felicitas Bünger, Max Havermeier, and Simon Krämer, *The Case for Regenerative Agriculture in Germany - and Beyond,* Issue 2023, NABU (Nature And Biodiversity Conservation Union), PDF document (EN). Link: https://www.nabu.de/imperia/md/content/nabude/landwirtschaft/230323-the_case_for_regenerative_agriculture_longversion-engl.pdf
49	Susanne Stricker, *Situation of Agricultural Information and Communication Technology (ICT) in Germany,* Research Gate, 2023. Link: https://www.researchgate.net/publication/228987253_Situation_of_Agricultural_Information_and_Communication_Technology_ICT_in_Germany

About AgriSkills

AgriSkills – Entrepreneurial Skills for Digitalization of Rural Agriculture is a European project, funded by Erasmus+ Program. Our objective is to raise awareness about the digital transformation in agriculture and to provide a training program for entrepreneurial skills in digital, precision, and smart farming.

The AgriSkills consortium brings extensive experience in business development, vocational training, digital technologies, innovation management, and regional development.

- INI-Novation GmbH, Germany (coordinator) www.ini-novation.com
- MEDF Skopje, North Macedonia www.mrfp.mk
- WIN, Austria www.wissenschaftsinitiative.at/
- CONNEXIONS, Greece www.connexions.gr
- ID20, Slovenia www.id20.si

AgriSkills Results stimulate awareness, knowledge, and skills of learners and trainers in the field on the issues of digitalization and digital farming.

Initial Survey, titled "*Survey Findings: Uncovering Essential Skills for Adopting Digital Technologies in Agriculture*" *(https://agriskills40.com/goals-results/need-analysis-survey-findings/)* is a study of the needs for the development of upskilling knowledge and competences useful for the use and adoption of digital technologies in agricultural production and management. The survey was conducted in five European countries: Germany, North Macedonia, Greece, Slovenia, and Austria.

AgriSkills Training Course (https://training.agriskills40.com/training/), developed as a 'guided tour' through the entire range of digital opportunities in agriculture, introduces the needed skills and competences implemented into a complete training.

AgriSkills reference catalogue, titled *"AgriSkills Guidebook on Digitalization in Agriculture" (https://training.agriskills40.com/catalogue/),* promotes inspiring initiatives, good practices, and use cases with a special focus on fostering business development, thus making innovation happen in agriculture, especially in rural areas.

AgriSkills *4.0 e-Learning Platform (https://training.agriskills40.com)* serves as a virtual environment for interactive online courses, representing a completely new approach to understanding digital agriculture.

AgriSkills 4.0 App

AgriSkills Website

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them. Project number: 2021-1-DE02-KA220-VET-000034651