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Literature Review **Digital Skills**



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01

Introduction



| WHY WE ARE CARRYING OUT THIS RESEARCH

The purpose of this literature review is to critically evaluate and synthesise the existing research on Digital Skills in the European Union. This involves:

1. **Identifying Key Skills in the field** of Digitalization in Agriculture: The review aims to identify how digitalization in agriculture is transforming how farming and food production systems operate and categorize which skills are most crucial in Agriculture 4.0.
2. **Analysing State of the Art of Farmers' Knowledge and Digital Skills**: This analysis's goal is to look into how levels of technical skills and digital literacy differ and how much they depend on variables like area, farm size, financial resources, and the kinds of crops or livestock being handled.
3. **Mapping Trends and Gaps**: Digitalization is significantly changing the agriculture industry, with a growing emphasis on integrating new technology and digital solutions. Despite a number of encouraging developments, farmers' and stakeholders' lack of digital skills continues to be a significant obstacle.

By outlining what is currently known about the state of the art when it comes of farmers' digital skills in the EU and where there is potential for additional study and development in the Smart Skills project, this review provides a crucial basis for our research.

02

What are Digital Skills?



| WHAT ARE DIGITAL SKILLS?

Definitions:

Digital Skills are defined by UNESCO as “a range of abilities to use digital devices, communication applications, and networks to access and manage information. They enable people to create and share digital content, communicate and collaborate, and solve problems for effective and creative self-fulfillment in life, learning, work, and social activities at large.” [UNESCO, 2023]

Fundamental digital skills, meaning the basic functional skills required for basic use of digital devices and online applications, are widely considered a key component of the new digital age literacy set, along with traditional literacy and numeracy skills.

The advanced spectrum of digital skills includes higher-level skills that allow users to use digital technologies in an empowering and transformative way, such as ICT professions. Major digital transformations, such as artificial intelligence (AI), machine learning, and big data analytics, are changing skill requirements, and thus influencing capacity building and skill development for the 21st century digital economy.

The broader term of **Digital Literacy** is according to UNESCO’s definition a “confident and critical use of a full range of digital technologies for information, communication and basic problem-solving in all aspects of life. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.” [UNESCO]

It is especially important to develop skills in the field of digital transformation, which is not a term of the distant future, but is happening in front of us today.

| WHAT IS DIGITALIZATION?

Digitalisation of Agriculture in the EU

Let's focus also on how digitalisation is transforming the agricultural sector. According to the European Commission, digital technologies can have a lot of impact on agriculture by enhancing productivity and supporting the fight against climate change by introducing sustainable and climate resilient technologies. The European Commission has implemented a variety of projects and has supported many initiatives in research and innovation and deployment actions. An example of the latter is the Common European Agricultural Data Space. Various workshops and calls have been announced and implemented in order to discuss topics including standards, data sovereignty, interoperability, business case creation, cross-sector data exchange, and sustainability.

Digital Agriculture

Digitalisation has been embraced in agriculture, as in many other industries in the modern era. The introduction of digital technologies and solutions is inextricably linked to the growing need to transform agriculture into a more environmentally friendly and sustainable approach. By taking a regulated approach, digitalisation reduces food waste while increasing sustainability, productivity and efficiency. [Choruma et al.]

Precision farming

By providing farmers with real-time information on weather conditions and animal health, digital technologies such as precision management systems and data monitoring via the Internet of Things significantly improve decision-making. This helps to plan for future generations and address climate change. [Choruma et al.]

Sustainable Agriculture

The implementation of sustainable solutions in Agriculture is regulated by the Common Agricultural Policies (CAP) which focuses mainly on three aspects:

- economic sustainability,
- environmental sustainability
- social sustainability of farms

EU countries use a variety of targeted initiatives to achieve these three main objectives, which are designed to fit the unique requirements of each country and include CAP strategic plans. Through these initiatives, EU countries are helping farmers make the transition to sustainable production, maintain their income and meet the objectives of the EU Green Deal.

Apart from the CAP being implemented by all EU countries on a national level, the United Nations are introducing the Sustainable Development Goals (SDG's) – a call to action to tackle climate change and working to preserve our forests and oceans. [EC, Agriculture and rural development]

Agriculture 4.0

Climate change, food waste, resource scarcity, and rapid population increase are just a few of the issues that farming and agriculture have had to confront and address with innovative methods. The inefficiency of previous methods necessitated a fundamental shift in strategy. Modern farming methods have altered significantly since the first agricultural technology revolution in 1961. It becomes increasingly inventive and prolific. As a result, Agriculture 4.0, the upcoming agricultural revolution, must be as green and technologically advanced as feasible.

| IDENTIFYING CHALLENGES AND SOLUTIONS OF DIGITAL AGRICULTURE:

To identify and categorise the various educational approaches currently employed in Vocational Education and Training (VET) across the EU, we can break them down into traditional, modern, and emerging practices:

Challenges encountered by smallholder farmers

- **Low digital literacy among smallholder farmers:**

The term 'digital literacy' is defined as the ability to use digital platforms and technologies to find, evaluate and communicate information. Low digital literacy is often a barrier for many farmers, who are used to traditional approaches on their farm and are afraid to introduce digital solutions because it's a completely new field where they have no experience in.

- **Inadequate digital infrastructure:**

Poor internet connectivity and the lack of digital devices are often a hindrance for smallholder farmers to access the opportunities of digital farming, marketing and financial services.

- **Financial costs associated with digital technologies:**

The high price of both software and hardware have been a challenge for small farmers for many years, not allowing them to grow into a more digital and sustainable farming business. Especially maintenance and training expenses or the use of automated analytic systems, such as sensors or AI, are still not affordable. Simpler devices are more likely to be acquired by farmers with the disadvantage of not having the possibility to adjust and customise them to the specific needs of the given farmer. [Choruma et al.]

Possible solutions of the analysed challenges

- **Audiovisual content:**

Apps, E-Learning platforms and explanatory content on how to use digital technologies often include videos, images, audio files and other audiovisual elements to make digital technologies more accessible for farmeres with low digital skills.

- **Renewable energy sources:**

Solars coupled with data-less devices and other renewable energy sources can be a solution to inadequate digital infrastructure and improve mobile networks of smallholder farmers.

- **Strategies to reduce expenses:**

The challenge of high costs in digital agriculture is being managed by each country individually and it should be addressed by national and European policy makers and development practitioners in order to reduce upfront costs of acquiring devices and software. There is a strong need of innovative financing models and low-cost and user-friendly digital tools which are affordable also for small scale farmers. [Choruma et al.]

| KEY ASPECTS OF DIGITAL SKILLS AND DIGITALIZATION IN AGRICULTURE:

To identify and categorise the various digital approaches currently implemented in Agriculture across the EU, we can break them down into three crucial aspects which are the use of digital technologies, digital marketing and digital farm management:

Use of Digital Technologies

- **Satellite imagery and remote sensing:**

Farmers, agronomists, food producers, and agricultural officials that want to increase output and profitability at the same time can benefit from space-based technology. Key information for tracking soil, snow cover, drought, and agricultural development is provided by remote sensing satellites. Satellite measurements of rainfall, for instance, assist farmers in determining when and how much irrigation their crops will require.

- **Robotics and automated monotonous farm operations:**

The UN estimates that two-thirds of the world's population will reside in cities by 2050, which will reduce the number of workers in rural areas. To reduce the workload for farmers, new technologies will be required for remote operations, process automation, risk identification, and problem solving. A farmer's talents in the future will be less purely agricultural and more a combination of biology and technology.

- **Drones and other aerial imagery:**

Drones allow farmers to precisely quantify crop biomass, plant height, weed presence, and water saturation on particular field locations. They offer better, more precise, and higher-resolution data than satellites.

- **Internet of Things (IoT):**

The agricultural industry is being disrupted by digital revolution. Food production insights can be obtained through the linkage of structured and unstructured data made possible by IoT technologies. Management systems are becoming true artificial intelligence (AI) systems thanks to IoT platforms like IBM's Watson, which use machine learning to sensor or drone data.

- **Artificial Intelligence (AI) and Machine Learning (ML):**

Chatbots (virtual assistants) driven by AI are being employed in the media, insurance, retail, and tourism industries. However, agriculture might potentially make use of this technology by offering farmers advice and solutions for particular issues. Machine learning and Artificial Intelligence are related technologies that fall within the field of computer science. These two technologies are thought to be the most popular ones being used right now to create intelligent systems.

- **GPS systems for agriculture:**

In order to make well-informed judgments, a Geographic Information System (GIS) is a tool that performs geographical analysis and produces visual representations of data. This technology integrates data, software, and hardware. As long as the data has a geographic component, it can represent nearly anything. A desktop or laptop computer, satellites, drones, and portable GPS units are all examples of hardware. But the real power of GIS lies in its ability to analyze several data layers or variables.

Digital Marketing

- **PPC Advertisements:**

Agricultural firms can utilize Pay-Per-Click (PPC) advertising, a powerful digital marketing tactic, to raise their profile, draw in new clients, and increase revenue. PPC is a cost-effective method of targeting particular audiences because advertisers only pay when a user clicks on their advertisement. PPC can be very useful in the agricultural sector for businesses that range from local farms, food producers, and agricultural consultants to seed firms, agri-tech start-ups, and suppliers of agricultural equipment.

- **Creating a Website:**

Websites are crucial for farmers to reach a wider audience, facilitate collaboration, and tap into online markets. They can also create an e-shop for social farming, enabling farmers to tap into online markets and generate sustainable income. This digital bridge between traditional farming practices and modern technology allows farmers to thrive and expand.

- **Creating Social Media Pages:**

In the modern era, social media is an unavoidable promotional tool. It's not just a feature for today's youth. Social media channels are used by people of all ages and from all walks of life to stay in touch with friends, look for information, and check the news on a local, global, and personal basis.

- **Initiate Email Newsletters:**

Nowadays, email marketing is a really effective technique. Offering customers the opportunity to sign up to newsletters is a smart idea. The number of people who are happy to hear about your news and activities may surprise you. Offering something engaging, such as a discount for emailing goods from the farm shop, is a good way to convince people to subscribe to emails.

- **Use Google Analytics to track KPI Data:**

One of the most important and effective tools for monitoring and evaluating key performance indicators (KPIs) is Google Analytics (GA). These KPIs help you evaluate the success of marketing initiatives such as email campaigns, social media promotions, Pay-Per-Click (PPC) advertising and other digital marketing initiatives in the agricultural industry. You can increase ROI, optimise your strategy and learn more about customer behaviour by using the right KPIs.

Digital Farm Management

- **Cloud computing**

Through the Internet, users can access shared pools of reconfigurable system resources through an information technology paradigm known as cloud computing. Consistency and economies of scale are possible through such resource sharing, which serves as a public utility that service providers can quickly deliver to consumers with minimal managerial effort.

- **Big Data:**

When used in agricultural applications, big data analytics enhances weather forecasting, productivity, and cost-effectiveness in relation to fertilizers, pesticides, and harvesting. Moreover, big data analytics tools for agriculture optimize the outcomes rather than the operational expenses. Finding the appropriate inputs at the appropriate time is crucial. Since agriculture is the primary source of income for most nations in the world, it is imperative that applications that support agricultural profit be implemented.

- **Blockchain:**

Although it is still relatively new, blockchain technology is already having a significant impact on the agriculture sector. When combined with agriculture, blockchain technology offers the following benefits: transparency and traceability, increased food safety and quality control, Sustainability of the environment, efficiency, and just compensation for farmers. [UNDP]

03

Research Analysis



| ANALYSIS OF THE STATE OF THE ART OF DIGITAL SKILLS IN AGRICULTURE ACROSS THE EU

Types of ICT-related skills

- **ICT generic skills:** Concerning the application of digital technologies in the workplace.
- **ICT specialist skills:** Required for the manufacturing of goods, services, and information technology.
- **ICT complementary skills:** Skills for carrying out ICT-related responsibilities.
- **Foundation skills:** The ability to use digital technologies through digital literacy, emotional intelligence, and social skills.

The European Commission recommends to improve digital skills to support a digital transformation. The recommendations include raising awareness of the need for digital skills and using loans and grants to support access to digital technologies. Other ways to improve digital skills is to expand the access through education and training systems and promoting employers' training through sectoral organizations and associations. That way digital skills can be integrated into a broader skills strategy that includes other relevant skills for employers. These recommendations aim to support labour market transformation by bridging the digital divide, promoting digital skills, and ensuring access to digital technologies.

The European higher education system faces a significant challenge in improving digital skills. Universities and VET institutions must focus on computer hardware, operating systems, and software. Students must adapt their communication style and work collaboratively in virtual teams. To develop digital skills in the labor market, curriculum reviews, ITC infrastructure adaptations, and promoting ICT skills in disadvantaged groups are needed. The Fast Track for Information Technology (FIT) program for long-term unemployed in Ireland serves as an example. [Zeidmane et al.]

Gaps in the EU related to Digital Skills

The results of the Case Study conducted by Zeidmane et al. published in CELDA 2021 reveals that over a third of civil engineering students lack essential digital skills, while 44.44% of agricultural engineers and 25% of forest science and forestry engineering students lack information assessment and use and management skills. These skills are high for IT or computer majors. However, 36.36% of economics students have developed highly developed skills in accessing and managing information, indicating a need for further development in these areas.

The same study states that higher education is increasingly influenced by digital technologies, making it crucial to develop the necessary competencies for the labour market. A questionnaire was conducted to identify digital skills students need to improve for the future workforce. Results showed that 30.77% of respondents need to improve information coding and programming skills, with 18.77% feeling a great need for this skill. Although evaluation and information management were ranked high by almost a third of respondents, 15.78% still wanted to improve this skill due to its importance in the labour market. The least number of students believe it is necessary to improve skills of using ICT for specific purposes (12.50%) and using ICT legally and ethically (9.38%), although these skills were missing most often.

The number of ICT graduates in EU countries increased from 2014 to 2016, largely due to younger generations' interest in information and communication technologies. However, some countries still lack the full benefits of their ICT training, resulting in a global ICT/digital technology gap. [Folea et al.]

As the digital transformation of jobs intensifies, lower-skilled individuals are increasingly excluded from the workforce. Upskilling and reskilling are crucial for economic growth. Despite governments incorporating digitalization into their policies, there is limited support for addressing the digital skills gap, especially in low-income countries. Education systems are also responsible for equipping young people with the necessary digital skills, but national curriculums, even in high-income countries, often do not reflect these skills. [Charles et al.]

Opportunities to develop Digital Skills

Self-study is the most common opportunity for developing digital skills, accounting for 88.6% of cases in Zaidmane's study. This self-study skills are crucial for the labour market. Students with good communication and collaboration skills were more likely to use peer help (57.1%) to demonstrate how to use specific applications or technology. Additionally, 25.7% of students sought advice from older people using the area. The study highlights the importance of self-study skills in promoting digital skills and determining their employability. Overall, students' digital skills development is influenced by various factors.

Table 5. High need to improve digital skills by specialty, answers in % (n =216)

Specialty	Access to information	Evaluation of information	Use and manage of information
Economics	18.18	27.27	36.36
Civil engineering	20.00	30.00	20.00
Forest science and forestry engineering	40.00	11.11	11.11
Agricultural engineering	50.00	33.33	50.00
Computer control and computer science	14.29	16.67	16.67
Information technologies for sustainable development	11.11	11.11	11.11

Fig. 1: Table 5 of a case study of students' views on the digital skills needed for the labour market [Zeidmane et al.]

The importance of Digital Skills in the EU

A British research revealed that the UK, along with France and Germany, has secured 432 foreign direct investment projects in 2019, making it 30% of Europe's total. Digital skills are crucial for the future of the digital sector, with over 500 international investors recognizing digital as a high growth potential. To support the continued growth of the digital tech sector, the supply of advanced digital skills in the EU needs to be increased. UKCES estimates that an estimated 1.2 million new technical and digitally skilled people will be needed between 2015 and 2022 to meet employer skills needs. Digital skills are essential across all sectors of the economy, including business growth, productivity improvement, and innovation. Therefore, boosting digital skills is crucial for the future of the EU economy.

Digital skills are essential for the modern world of work, with 92% of businesses stating that having a basic level of digital skills is important for employees and 82% of job vacancies asking for digital skills. Advanced digital skills demand has increased in recent years, with 60% of employers expecting their reliance on advanced skills to increase in the next five years.

Despite the high demand for basic digital skills in sectors like IT and communications, there is a near universal demand for basic digital skills and significant demand for advanced digital skills in every sector. Many employers face significant digital skills gaps, with 23% of their current workforce lacking basic digital skills and 37% lacking advanced digital skills.

There are concerns about whether the provision of digital skills is kept up to date with the rapidly changing demands of employers. While many employers are hopeful that digital skills gaps will improve in the future, evidence casts doubt on this confidence. The pipeline of digital skills through the education and skills system is not providing the skills at the scale needed, and the number of people taking ICT courses has declined in recent years. [Bentley-Gockmann]

EU Initiatives to support the Development of Digital Skills

The European Commission has implemented and supported and issued a series of programmes, documents and actions to improve digital skills in various professional sectors [Folea et al]. Here are some of them:

- **New Skills for New Jobs (2008):**
The European Commission acknowledges in this text the growing significance of digital literacy and both basic and advanced digital skills.
- **Digital Agenda for Europe (2010)**
"Improving Digital Skills, Competences and Inclusion" is one of the activities that the EU must perform, according to the Digital Agenda for Europe.
- **Grand Coalition for Digital Jobs (2013)**
A platform that includes businesses, education providers, and private and public entities with the goal of developing digital competencies in Europe and filling information and communication technology job openings.
- **Digital Single Market in Europe (2015)**
This strategy emphasizes the importance of fostering an inclusive digital society, where individuals possess the necessary digital skills to fully utilize online opportunities and enhance their job prospects.
- **The Digital Competence Framework 2.0 (2015)**
This framework identifies five key components of digital competence for citizens: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving, which are essential for personal internet use and increasingly required in the workplace.
- **Digital Skills and Jobs Coalition (2016)**
The coalition consists of Member States, companies, social partners, NGO's, and education providers to address the European lack of digital skills.
- **New Skills Agenda for Europe (2016)**
The Competence Agenda emphasizes the importance of developing human capital through digital competences, starting in primary education. It calls for lifelong learning to prevent lagging behind in skills, particularly digital ones. The "Competency Guarantee" aims to help low-skilled adults acquire numeracy and digital literacy.
- **Digitising European Industry (2016)**
This document discusses digital skills and human capital preparation for workforce transformation, highlighting the profound impact of digitalization on employment, income levels, and income distribution.

04

Conclusion



| CONCLUSION:

This literature review on Digital Skills in the EU highlights the situation and state of the art of skills and competences in various sectors within EU countries. It emphasizes various EU initiatives to develop and support the improvement of digital skills and gives an insight on relevant gaps and trends. Here is a short summary of conclusions of this literature review:

- **Limited Training Resources for the Next Generation of Farmers**
 - a) When it comes to integrating modern technologies and digital skills into their courses, agricultural education institutions frequently fall behind.
 - b) More training courses and materials on Agri-Tech, digital farm management, sustainability, and other contemporary farming methods are required, particularly in rural areas and developing nations.
- **Skills Gap in Data Science and Analytics**
 - a) There is a lack of people with advanced skills in data analytics, machine learning, and artificial intelligence (AI) as farming becomes increasingly data-driven. Many farmers lack the knowledge necessary to use AI-based advice or decipher complicated statistics.
 - b) To close the gap and allow farmers to fully utilize technology like automated systems, crop forecasting, and predictive analytics, training in these areas is crucial.
- **Digital Literacy Among Smallholder Farmers**
 - a) Smallholder farmers in developing nations frequently lack the digital literacy necessary to take advantage of the digital technologies that major farms and agribusinesses are adopting at an accelerating rate.
 - b) Programs for basic digital literacy are needed so that farmers can learn how to use smartphones, apps, and internet platforms to increase their output and access to markets.
- **Lack of Access to High-Tech Equipment and Tools**
 - a) Due to expensive expenses and inadequate infrastructure, many farmers lack access to sophisticated digital tools like drones, sensors, or satellite imaging, particularly in low-income or rural locations.
 - b) Although the advantages of precision farming are becoming more widely acknowledged, smaller enterprises frequently lack access to these equipment, which restricts staff skill development and digital adoption.

The EU Digital Skills and Jobs Coalition, the European Skills Agenda and the Erasmus+ Program are very much focused on Digitalization which is the basis of fulfilling gaps regarding digital skills in the EU, especially in the agricultural sector for a smarter and more sustainable future of farming.

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Essential Skills for SMART Agro-tech: A Review of Educational and Technological Competencies

As the agricultural sector increasingly adopts SMART technologies, the demand for specific skills that integrate digital literacy, data management, and sustainability practices is rising. Essential skills for SMART Agro-tech focus on the use of digital tools such as IoT devices, AI-based data analytics, and precision agriculture techniques, all aimed at optimizing productivity while reducing environmental impact. Key competencies include digital literacy, which allows farmers to manage and interpret data from farm sensors, weather forecasting, and market analytics. Another crucial skill is the ability to operate and maintain advanced machinery, such as drones and automated tractors, which are vital in modern farming practices. In addition to technical proficiency, problem-solving skills and an understanding of sustainability principles are increasingly critical, as SMART technologies are designed to address climate change and resource management challenges. Integrating these skills into vocational education and training (VET) programs is essential to ensure the agricultural workforce is prepared to leverage SMART technology effectively ().

Furthermore, educational approaches to developing these skills, such as blended learning, competence-based training, and e-learning platforms, provide flexible, accessible methods for acquiring knowledge in SMART Agro-tech. These methods allow learners to combine practical, hands-on experience with theoretical understanding, a model well-suited to the agricultural sector. The use of virtual and augmented reality (VR/AR) for simulating farming operations and AI-based adaptive learning platforms further enhances learning by providing personalized and scalable education. Thus, aligning educational curricula with the rapid advancements in agricultural technology is critical for both improving farm productivity and addressing global sustainability goals ().

Individual Paper Analysis

#	Paper	Key Insight	Citations
1	<u>The Role of Digital Skills in Precision Agriculture (Belaya, 2018)</u>	Emphasizes the importance of digital literacy and precision agriculture technologies to optimize resource use and improve productivity in farming.	1
2	<u>Educational Competencies for SMART Farming (OECD, 2023)</u>	Highlights the need for competence-based training programs that focus on integrating digital tools and sustainability in modern farming.	1
3	<u>Vocational Education in Agro-Tech (Tchibozo, 2022)</u>	Discusses the importance of flexible, technology-integrated vocational training programs to meet the evolving needs of the agricultural sector.	1



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