

# Towards Agriculture 5.0 in the European Union: Training and digital skill trends in the agricultural sector\*

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## Abstract

Sustainability and digital transformation are two processes that significantly impact the agricultural sector. Digital transformation alone requires companies to highly coordinate their available human capital and new technologies. Sustainability makes sure this happens in an environmentally friendly way. These principles brought changes to the sector, and today Agriculture 5.0 has started to replace Agriculture 4.0, which integrates digital technologies alongside with focusing on optimizing resources, improving efficiency and applying sustainable practices in firm operations. Thanks to new digital technologies, human resources can be even more effectively managed as a strategic resource within organizations. In our study, we review the trends of the past 10 years related to agricultural education at BSc/BA and MA/MSc levels. We also examine the current digital skills of those working in agriculture, highlighting competencies related to data analysis. We present the digital technologies characteristic of the sector and those anticipated in the future, along with the associated required digital competencies. Our results are presented from the perspective of digital, data-driven decision support, which helps quantify and collect various indicators of effectiveness and sustainability within a framework, thus achieving the set economic and environmental goals.

## Keywords

Digital skills, Agriculture 5.0, data analysis

## 1. Introduction

Among several barriers, the lack of digital skill and competences (Ndege et al, 2024) or skilled labour (Dimitrijević, 2023) is a persistent issue in the agricultural sector when it comes to digital transformation. Brazilian and American examples show that innovation in the agricultural sector heavily relies on skilled individuals and their high acquisition costs (Dibbern et al., 2024). There can be several reasons why agricultural actors should obtain and maintain their digital skills (Addison et al, 2024). As Agriculture 5.0 transforms the skill requirements for agricultural production, modern agricultural practices started to depend on skilled personnel (Dabbous et al., 2023). This could put an end to the misconception that agricultural jobs are often considered as low-skill occupations.

## 2. Literature review

The authors began the research with discovering all the relevant literatures of the field with a keyword analysis. They have generated a co-occurrence map via WoSViewer which provided intriguing insights (Figure 1). This visual representation notably reveals several concentrated clusters where certain terms intersect significantly with agriculture, suggesting an evolving dialogue

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In recent years, the incorporation of modern technological skills into agricultural activities has become essential for advancing long-term sustainability goals. The growing use of digital technologies in rural regions is reshaping previous sectoral practices, leading to more efficient resource allocation and the development of innovative farming and management techniques.

While this shift toward digital methods is promising, it also underscores the gap between urban and rural areas in terms of technology and knowledge access. Addressing this disparity is crucial to fully harness the benefits of digital advancements in agriculture. By obtaining more advanced digital skills the adoption and implementation of new technologies becomes smoother, paving the way for a more efficient and resilient agricultural performance.

## 2.1. Secondary data analysis

To substantiate our findings, we collected relevant datasets from Eurostat regarding the digital skills of those individuals who are working in agriculture and are aged between 15-74 years. Eurostat collects data regarding a wide range of different soft and computer skill, which need further detailing.

For this study, secondary data was collected from surveys targeting agricultural engineers who completed their university degrees in Hungary. The two primary publicly accessible sources of data were the DiplománTúl (2024) and the FIR (Adult Education Information System) database (FIR, 2024). These surveys spanned from 2014 to 2021 (and still going on) and encompassed graduates from BA/BSc, MA/MSc levels, and vocational training programs as well in adult education. The information gathered focused on students who graduated in agricultural fields and their employment outcomes, with job placements categorized according to the Hungarian Standard Classification of Occupations (FEOR) and NACE Rev.2.

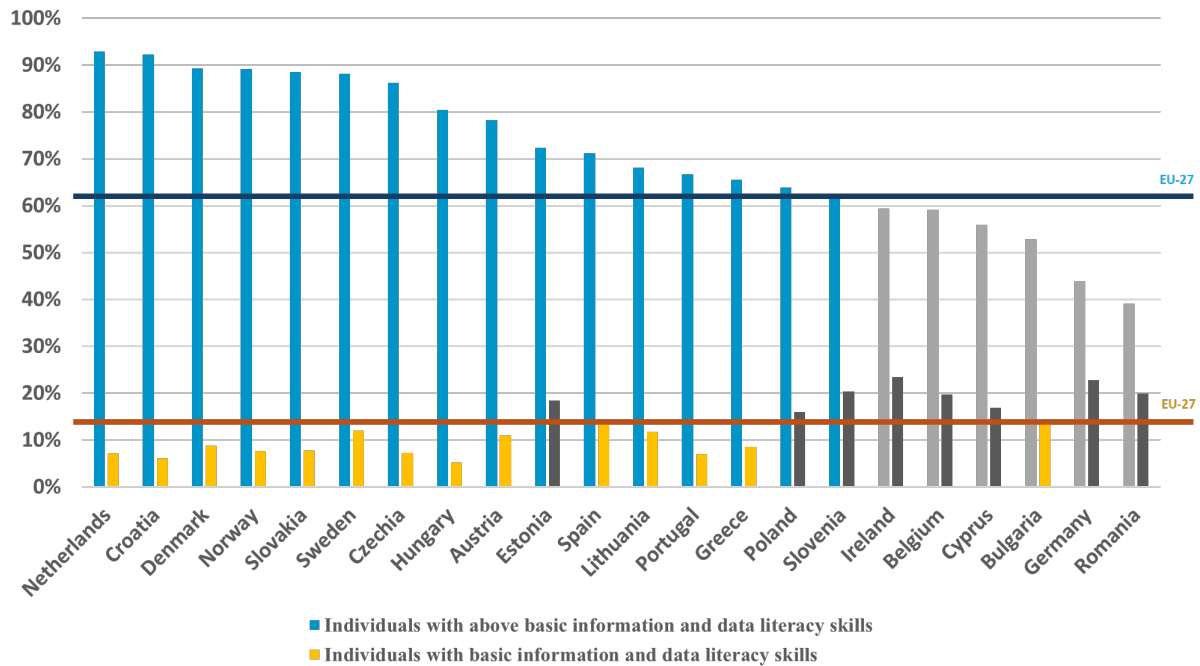
Since the data was initially distributed by majors, we calculated approximate headcounts of graduates who secured employment, either full-time or alongside further studies upon their graduation. After compiling the total number of graduates per occupation, we identified the most common positions, which were predominantly in the management area.

Our research builds on the work of *Zhou et al. (2024)*, who highlighted that individuals with higher education tend to possess more advanced digital skills and have higher digital literacy, making them well-suited to manage and resolve complex challenges in agricultural management issues.

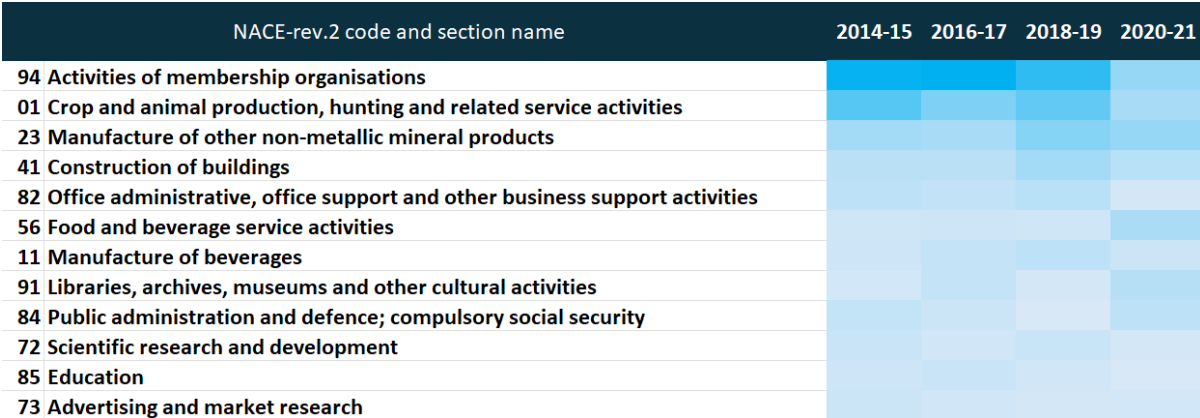
While similar studies have been conducted in in India (Bansal et al., 2022), Romania (Bodescu et al., 2024), Austria (Ramalho et al., 2023) and Vietnam (Kieu, 2024) - where researchers assessed the level of digital skills and competencies of students and lecturers in agricultural engineering programs with primary data collection methods. Currently, there is no comparable research in the literature that relies on representative secondary data sources to support the key findings of the previously mentioned studies.

## 3. Results

There are several indicators that Eurostat measure every two years. Among agricultural workers the level of digital literacy is quite high (*Figure 2*), however if we examine other digital skills, we can conclude that there are fundamental differences among nations. The level of safety, problem-solving, collaboration and online ICT skills of these individuals are very low in some cases. It needs to be highlighted here that in most cases the EU member countries have no available data to analyze, making it harder to compare and define best practices. Based on the analysed results, northern and western European countries can be considered high performers, central and southern member countries are moderate performers, and eastern countries lag behind these countries.



**Figure 2:** % of individuals working in agriculture with basic or above basic information and data literacy skills in 2023 (%). Source: Eurostat (2024)



**Figure 3:** Heat map of other occupations by NACE-rev2. among agricultural engineering graduates per year. Source: DiplománTúl (2024)

After summarizing the filled occupations of the working agricultural engineer graduates, we found that while most of their jobs were closely aligned with their academic trainings, some pursued roles outside their specific field. We believe these positions are attracting more graduates, often leading them to shift into new sectors or industries (Figure 3). Although, these roles may not be directly tied to their academic programs, they often require the digital skills and specialized knowledge gained during their studies, offering graduates new and diverse career paths.

**4. Conclusions**

Our findings reveal a growing number of graduates in the agricultural fields, with the exception of a decline during the pandemic. However a significant portion of these graduates are employed outside the agricultural sector, which presents a challenge. Higher education graduates often possess the digital skills emphasized in the Agriculture 5.0 framework, yet there are notable deficiencies in

these skills among the current agricultural workforce. It would be advantageous to retain digitally skilled graduates in agriculture-related positions after graduation, as this could help mitigate the shortage of skilled labour in the sector. The level of digital skills of agricultural workers is generally acceptable, but if we look at the more specific competencies, there are already shortcomings. At both the agricultural sector and supply chain levels, as well as across the entire agri-food industry, the presence of digital skills will play an increasingly crucial role in achieving the latest sustainability goals. Complex digital knowledge is required to select and use the appropriate technologies in the field, and to apply digital solutions that complement them.

## Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

## References

- [1] Amal Dabbous, Karine Aoun Barakat and Sascha Kraus, 2023. The impact of digitalization on entrepreneurial activity and sustainable competitiveness: A panel data analysis. *Technology in Society*. Vol. 73, article 102224. ISSN 0160-791X. <https://doi.org/10.1016/j.techsoc.2023.102224>.
- [2] Bodescu, Dan, Alina Sîrghiea, Roxana Nicoleta Rațu, Ciprian Chiruță, Răzvan-Nicolae Mălăncuș, Dan Donosă, and Alexandru-Dragoș Robu, 2024. "Relevant Skills for Employment and Entrepreneurship in the Agri-Food Sector". *Sustainability*, vol. 16, no. 2. article 787. <https://doi.org/10.3390/su16020787>.
- [3] DiplománTúl Higher education statistics, 2024. URL: <https://www.diplomantul.hu/>
- [4] Eurostat – General overview, 2024. URL: <https://ec.europa.eu/eurostat/web/digital-economy-and-society/database/comprehensive-database>
- [5] FIR, Higher education statistics, 2024. URL: <https://firstat.oh.gov.hu/kepzesi-letszamstatisztika>
- [6] Kieu, Q. T. (2024). Insight into the demand for digital skills at the workplaces of agricultural engineering graduates in Vietnam. *Journal of Adult and Continuing Education*, 0(0). <https://doi.org/10.1177/14779714241237450>
- [7] Miloš S. Dimitrijević (2023). Technological progress in the function of productivity and sustainability of agriculture: The case of innovative countries and the Republic of Serbia. *Journal of Agriculture and Food Research*, Volume 14, article 100856, ISSN 2666-1543, <https://doi.org/10.1016/j.jafr.2023.100856>.
- [8] Monica Addison, Isaac Bonuedi, Albert Abraham Arhin, Bernice Wadei, Ebenezer Owusu-Addo, Ernestina Fredua Antoh and Nathaniel Mensah-Odum, 2024. Exploring the impact of agricultural digitalization on smallholder farmers' livelihoods in Ghana. *Heliyon*, vol 10, issue 6, article e27541. ISSN 2405-8440. <https://doi.org/10.1016/j.heliyon.2024.e27541>.
- [9] Nora Ndege, Fiona Marshall and Rob Byrne, (2024). Exploring inclusive innovation: A case study in operationalizing inclusivity in digital agricultural innovations in Kenya. *Agricultural Systems*, Vol. 219, article 104033. ISSN 0308-521X, <https://doi.org/10.1016/j.agsy.2024.104033>.
- [10] Ramalho Ribeiro, Ana, Billy Goodburn, Luis Mayor, Line F. Lindner, Christoph F. Knöbl, Jacques Trienekens, Daniel Rossi, Francesca Sanna, Remigio Berruto, and Patrizia Busato, 2023. "Skill Needs for Sustainable Agri-Food and Forestry Sectors (II): Insights of a European Survey". *Sustainability*, vol. 15, no. 5. article 4115. <https://doi.org/10.3390/su15054115>
- [11] S. Bansal, M. Agarwal and S. Naraynan, "Technology Distraction and Skill Development–Effect on Employability", 8th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2022, pp. 1674-1678, doi: 10.1109/ICACCS54159.2022.9785000.
- [12] Thais Dibbern, Luciana Alvim Santos Romani, Silvia Maria Fonseca and Silveira Massruhá, 2024. Main drivers and barriers to the adoption of Digital Agriculture technologies. *Smart Agricultural Technology*, Vol.8, article 100459, ISSN 2772-3755. <https://doi.org/10.1016/j.atech.2024.100459>.
- [13] Zhou, Ziyang, Ziwei Li, Guangyan Chen, Jinpeng Zou, Mingling Du, and Fang Wang, 2024. "Digital Literacy Level and Formal Credit Constraints: Probit Analysis of Farm Households' Borrowing Behavior in China". *Agriculture*, vol. 14, no. 6. article 832. <https://doi.org/10.3390/agriculture14060832>