Éva Kuruczleki (ed) 2024: Navigating the Future: Digitalization, Sustainability, and International Business, Szeged, DOI: https://doi.org/10.14232/gtk.nfdsib.2025.2

Role of digitalization and digital skills: The case of the agricultural sector

Patrik Urbán

The rate of digitalization significantly increases productivity within various economic sectors. Digitalization shapes the development of numerous sectors, however, there are sectors where digital transformation is lagging behind, like in the case of agriculture. Digitalization is influenced by capital, motivation, infrastructure, technology availability, and digital skills. Among all factors, in agriculture, one of the barriers to digitalization is the lack of digital skills.

For this reason, the aim of the study is twofold: it aims, first, to underscore the critical role of digitalization and to better understand the importance of digital skills, and, second, to reveal the obstacles of digitalization in the agricultural sector. In addition, the study examines the subskills of digital skills one by one, providing a comprehensive review of capabilities, thereby offering the reader a broader understanding of one of the primary influencers of digitalization.

Keywords: digitalization, digital skills, agriculture

1. Introduction

In the knowledge-based economy, information technology serves as a fundamental pillar (Vas 2009), therefore, it is almost indispensable to digitalize if one enterprise wants to enhance its operations in all economic sectors. In addition, it has been proved by several researchers experienced in this area of research that the productivity of business actors can be highly increased due to digitalization (Gray–Rumpe 2015, Isensee et al. 2020, Mammadli–Klivak 2020).

This is true for the Hungarian economic actors in all economic sectors. One sector in both Hungary and all over the world is highly affected by digitalization, namely, the agricultural sector. However, in this sector, as researchers concluded (Klerkx et al. 2019, Szőke–Kovács 2020), the speed of the digitalization process is not progressing as fast as in other sectors (such as the automotive or educational sectors).

In the meantime, there are several perils appearing all around the world, endangering global and local food production, for example, the climate crisis, wars, global food shortages, growing population, and the overall demand for food is rapidly increasing (Adams et al. 1998, Pereira 2017). Subsequently, the agricultural sector must keep pace with this increasing demand, otherwise further food shortages are inevitable. One solution to increase food production for the agricultural actors is the implementation of digital technologies. Digital technologies can help producers enhance productivity through various methods (Chandio et al. 2024, Nagy 2019, Gavrilova 2021, Bőgel 2018, Sung 2018, Berta 2018, Dajka–Oláh 2023). As a practical example based on Chandio et al. (2024) demonstrates, the internet can rapidly increase the dissemination of information online that is required by the labor in the field. This information dissemination process helps farmers increase their

productivity. Another example from Ozdogan et al. (2017) shows that digitalization increases food production through the utilization of drones. The drone technology operated by the users can cultivate the same amount of area in less time, or the drone technology can cultivate more area at the same time, both leading to higher productivity.

Digitalization can be increased in various ways, like increasing capital, motivation, infrastructure, the availability of technology, and digital skills, as stated by several researchers (Rupeika et al. 2022, Nallusamy et al. 2015, Van Dijk 2006). For this reason, the present study reveals, on the one hand, the most relevant factors, including the lack of digital skills, which hinder digital transformation in the agricultural sector, and, on the other hand, the most critical factors in terms of digitalization and particularly emphasizes the necessity of digital skills. The main research question is the following: what are the critical factors shaping digitalization, with a specific focus on the necessity of digital skills, and how do these factors impede the level of digitalization in the agricultural sector?

To answer this research question, first, the relevance and the elements that affect the level of digitalization will be highlighted. Since one of the main obstacles to digitalization is a lack digital skills, the paper describes the notion of digital skills in detail. Finally, the paper shows the already existing evidence related to digitalization in agriculture, a sector that has many challenges to face.

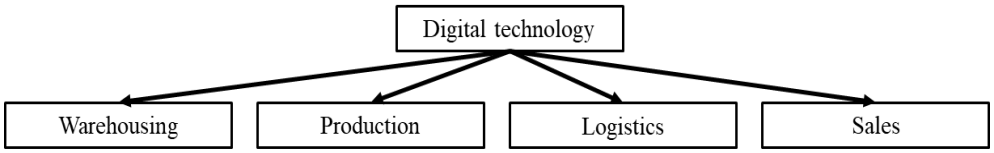
2. Relevance and elements of digitalization

To gain a deeper insight into the relevance of digitalization, first, it is necessary to describe what digitalization is from an economic perspective. In addition, it is essential to overview the economic impacts of digitalization, and the root causes of the lack of digitalization among the business actors. Therefore, I will provide a broader context of how digitalization shapes the economy and what factors hinder digitalization.

Researchers define digitalization in a diverse manner. The present study builds on the definition formulated by Gray and Rumpe (2015, p. 1) since this definition provides a clear understanding and examines digitalization from an economic perspective. According to this study, "digitalization in economic life is equal with the utilization of digital technologies (such as the internet, computers, smartphones) by economic actors to transform business (models) in a way that results in increased operational efficiency."

The effects of digital technologies on business actors are considerable. Teng et al. (2022) and Isensee et al. (2020) stated four key areas in the life of an average business actor that are being highly affected by the utilization of digital technologies in a positive way (Figure 1).

Figure 1. The four main areas affected by digitalization in the case of actors from the business sphere

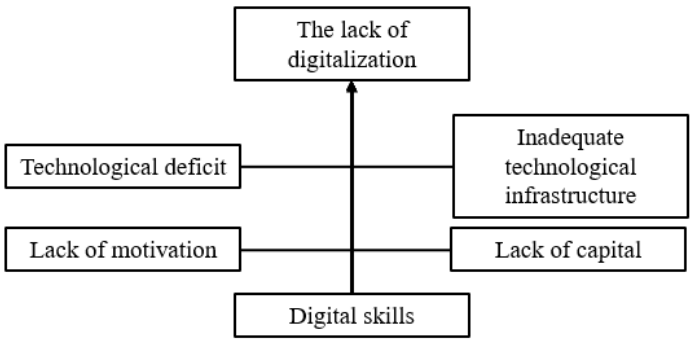


Source: own construction based on Teng et al. (2022) and Isensee et al. (2020)

Based on the studies by Teng et al. (2022) and Isensee et al. (2020) the following can be concluded. Warehousing, as a part of the operational functions of one business actor's life, is certainly being affected by digital technologies. For example, an enterprise resource planning (ERP) system being operated on a computer by the administrators can help the storage processes of a business become more transparent, thereby reducing storage costs, and helping track the available supplies accurately. Production operations can be similarly enhanced thanks to digitalization, because an ERP can once again help the production operations by monitoring the movements of the items in production, reducing the costs, and increasing the transparency in the production area. The logistics processes can be also enhanced due to the availability of digital technologies; online freight order websites and tracking modules can help spare resources for both the customer and service providers during the logistics operation. The sales department operations can be also increased with the help of digital technologies: webshops, email-based correspondence, and other utilizable tools can speed up the interaction between the customers and the webshop salespersons.

Despite this, it has been already proved that digital technologies are not available for all economic actors, for several reasons. To gain a better insight to the connection of digital technologies and economic science, we need to analyze these root causes, and I will do so based on the studies of Rupeika et al. (2022), Nallusamy et al. (2015), and Van Dijk (2006), which reveal the five main reasons why digitalization is missing in the case of several business actors (Figure 2).

Figure 2. The root causes of the lack of digitalization among business actors



Source: own construction based on Rupeika et al. (2022), Nallusamy et al. (2015), Deichmann et al. (2016), Mokthar et al. (2022), and Van Dijk (2006)

The first root cause which results from the lack of digitalization is the technological deficit. This means that the technology (e.g. internet, computers) is not present or is very expensive to access for the economic actors in the market in a particular country (for example, in some African countries), which hinders digitalization. The second root cause is the inadequate technological infrastructure that might be present at a given location. This means that although the technology for digitalization is accessible to market actors, their operation is not optimized, thus their efficiency is reduced, and they do not provide a return on investment for the company (for example, slow internet connection or outdated computers). The third root cause is the lack of capital. This is equivalent to the lack of money and investible funds. Due to a shortage of capital, actors are unable to purchase products of digital technology. The fourth root cause is the lack of motivation. This is alternatively phrased as internal resistance to change. From the perspective of business actors, there may be a lack of motivation towards digital technologies, or, in other words, all necessary conditions for the use of digital technology are present for the company, yet the actor is unwilling to apply the products of digitalized technology. The fifth and last root cause of the lack of digitalization is the lack of digital skills. The use of digital products is indispensable for users to have digital knowledge, such as how to use the internet and computers. The absence of digital skills can be an impediment to the efficient operation of the technology.

All the five root causes of the lack of digitalization determined by Rupeika et al. (2022), Nallusamy et al. (2015), and Van Dijk (2006) are important in the process of digital transformation. In the upcoming analysis, I focus on the role of digital skills in the digitalization of agriculture.

3. Digital skills

In this study, among the many factors determining digitalization, a special focus is on explaining what digital skills are, since they drive productivity and innovation, and foster inclusivity in the digital age. To properly execute a deep analysis of the aspects of digital skills, first, we need to define what digital skills mean. Digital skills (or digital capabilities) can be defined as a comprehensive set of competencies required for effective use and understanding of digital technology (Van Laar et al. 2017, Van Dijk–Van Deursen 2014). Digital skills consist of six subskills (Figure 3). Several studies have been examined to have these subskills properly determined, therefore we will have a better insight to the core elements of digital skills. We will determine the components of digital skills one by one in the next paragraphs.

Figure 3. The six subskills of the digital skill

Skill name	Definition	Reference
Operational skills	Technical competencies to use a computer (a.k.a. button knowledge)	Van Dijk and Van Deursen (2014), Van Deursen et al. (2014)
Formal skills	Associated with browsing and navigating digital technology (e.g. internet), and understanding its structure like menus and hyperlinks	Van Deursen–Van Dijk (2011)
Information skills	The ability to search, select, and evaluate information on digital media, is crucial in media with an abundance of sources and content like the Internet	Saikkonen–Kaarakainen (2021), Van Dijk–Van Deursen (2014)
Communication skills	Required for digital media that focus on communication, encompassing the use of email, instant messaging, social media, and online community participation	Siddiq et al. (2015), Van Dijk–Van Deursen (2014), Orjuela (2021)
Content creation skills	Increasingly vital in the era of Web 2.0, these skills involve creating user-generated content such as blogs, social media posts, and multimedia materials	Orjuela (2021), Van Dijk–Van Deursen (2014)
Strategic skills	The ability to use digital media as a tool for achieving personal or professional goals, involving critical thinking and decision-making in the digital space	Van Dijk–Van Deursen (2014)

Source: own construction based on the studies mentioned above

Based on the research of Van Dijk and Van Deursen (2014) and Van Deursen et al. (2014), operational skills can be defined as the technical competency required to use and operate digital technologies, such as computers. This basic skill, often referred to as "button knowledge," is essential for initiating the operation of digital devices. Mastery of operational skills is necessary not only for computers but also for a variety of other digital equipment including drones, monitors, docking stations, and more. Furthermore, this skill involves understanding the basic hardware and software functionalities, such as turning devices on and off, adjusting settings, and installing applications. It serves as the foundation upon which more complex tasks, like software troubleshooting and network configuration, are built. As digital technologies evolve, the scope of operational skills expands to include newer interfaces and connectivity options, highlighting the importance of continual learning and adaptation in the technologically driven economic world.

Formal skills, as identified in the studies of Van Deursen and Van Dijk (2011), are associated with the ability to browse, and navigate digital technologies, such as the Internet and cloud-based software, and understanding the structures within these technologies, like menus and hyperlinks. This skill involves the ability to efficiently locate, select, and utilize the various functions and features presented in digital interfaces. It extends to the comprehension of layout sources and visual hierarchies that guide users in interacting with complex digital environments, such as websites,

online platforms, and specialized software. Moreover, formal skills involve recognizing and interpreting common icons and symbols used in digital interfaces, which facilitate the use of software applications and internet navigation without extensive textual instructions. Individuals proficient in formal skills are better equipped to manage multiple windows or tabs, use search engines effectively, and follow navigation paths within software or websites. This competency is crucial for efficient digital literacy as it enhances the user's ability to adapt to new and unfamiliar technologies, and software quickly. Additionally, these skills are fundamental for avoiding common mistakes in digital environments, such as phishing scams and misleading links, by enabling users to distinguish reliable from unreliable digital content. As digital platforms evolve, the continuous development of formal skills remains vital for keeping pace with new digital formats and interactions.

According to Saikkonen and Kaarakainen (2021), information skills encompass the critical competencies needed to effectively search for, select, and evaluate information across various digital media. This skill set is particularly vital in environments like the Internet, which is characterized by a vast and ever-expanding array of sources and content. These skills not only include the ability to use search engines and databases with precision but also to distinguish the credibility and relevance of the information obtained. In their research, the authors emphasize the importance of critical thinking in the digital age, where information is abundant but variable in quality. Van Dijk and Van Deursen (2014) expand on this by highlighting that information skills also encompass the capacity to synthesize and integrate information from multiple digital platforms into cohesive knowledge. These researchers advocate for the development of these skills as part of a broader digital literacy initiatives, underscoring their significance in education, professional development, and personal development in navigating the digital landscape. As the digital divide continues to narrow, information skills become increasingly fundamental in enabling individuals to participate fully in the information society, bridging the gap between mere access to technology and the ability to leverage its full potential for personal and societal advancement.

According to studies by Siddiq et al. (2015), Van Dijk and Van Deursen (2014) and Orjuela (2021), communication skills in the realm of digitalization are diverse and involve more than just the ability to send and receive messages. They require proficiency in the use of various communication tools such as email, which demands an understanding of formal and informal styles, attention to detail, and the ability to transmit messages in a clear and coherent manner. Instant messaging, by contrast, often requires concise language and immediate reactions, with an emphasis on quick responses that adhere to the informal etiquettes of real-time digital conversations. When it comes to social media, communication skills involve crafting messages that are engaging and appropriate for the intended audience, understanding the cultural aspects of different platforms, and managing digital relationships. They include the understanding to navigate the rapidly changing trends and viral phenomena that characterize social media landscapes. Moreover, participation in online communities requires a set of communication skills that facilitate collaboration and contribution in forums, discussion groups, and other interactive platforms. This means not only sharing information but also providing feedback, fostering

discussions, and building relationships with others who share similar interests. Effective communication in digital media also includes being vigilant about the digital footprint that one leaves behind, understanding the permanence of online posts, and navigating the implications of public and private settings. It involves a sensitivity to context, audience, and the evolving norms of digital interactions, where misunderstandings can arise quickly due to the lack of non-verbal interactions. Therefore, digital communication skills are as much about interpersonal intelligence and empathy as they are about technical ability.

Orjuela (2020) and Van Dijk and Van Deursan (2014) concluded the following about content creation skills. These skills are a critical competency in digitalized life, where user-generated content is important in the digital landscape. These skills are not limited to the mere ability to produce text-based content like blogs; they also involve the creation of a diverse level of multimedia materials, including social media posts, videos, podcasts, infographics, and more. Effective content creation requires a high amount of creativity and technical know-how. Creators must be experts at using various tools and platforms to craft their content, whether that is video editing software for a YouTube channel, graphic design software for compelling visuals, or content management systems for maintaining a blog. A keen eye for design, the ability to tell a story, and an understanding of the principles of search engines are also part of this skill set. Moreover, the capacity to engage and grow an audience is integral to content creation skills in the digital environment. This involves understanding analytics to measure content performance, using feedback mechanisms to interact with the audience, and leveraging social media algorithms to maximize content reach and impact. Creating content also involves a strategic component; knowing when to post, what to post, and where to post is crucial for resonating with the intended audience. Content creators must also be aware of the ethical implications of their creations, ensuring that they respect copyright laws and contribute positively to digital discourse. With the spread of content creation tools, individuals now have the power to influence, educate, and entertain large audiences. As such, content creation skills are becoming increasingly important not just for personal expression, but also for professional marketing, education, advocacy, and even as a means of civic engagement.

Strategic skills in the context of digital media usage are essential for individuals aiming to achieve specific personal or professional objectives based on the study of Van Dijk and Van Deursen (2014). These skills extend beyond basic functionality and content creation to include a deep understanding of the digital environment and the ability to leverage it effectively. This skill set requires critical thinking to evaluate the most effective ways to reach an intended goal. For instance, someone with strategic digital skills might analyze which social media platform is most suitable for promoting a particular type of business or message, considering the platform's predominant user demographics and content format. Strategic skills also involve decision-making capabilities, such as determining the optimal time to post content for the best engagement or identifying which digital tools can streamline work processes. These skills include the capacity to set clear, measurable goals and to adjust strategies based on feedback and analytics data. In the professional sphere, strategic skills can translate into managing a brand's online presence, running targeted

advertising campaigns, or networking with industry professionals. For personal objectives, this could involve building a personal brand, engaging in online learning, or even managing one's digital identity and privacy. Ultimately, individuals with strong strategic skills in digitalization can make informed choices that align digital actions with desired outcomes, whether they're looking to grow a business, develop a personal brand, or simply use digital tools more effectively in their daily lives.

All the operational, formal, information, communication, content creation, and strategic subskills are vital for the improvement of digital skills. The improvement of any of these competencies can lead both to the enhancement of one's digital skills and the actors's productivity with the leverage of digital technologies. If a business actor is aspiring to increase its digital readiness, it is indispensable to enhance digital skills.

4. Digitalization in the agricultural sector

Digitalization has an impact on numerous sectors and can offer various benefits to the actors within those sectors, including the agricultural sector, which is tasked with providing solutions to numerous global challenges. In agriculture, digital technologies such as drones, GPS-based positioning, artificial intelligence, the Internet of things, satellite weather forecasting utilization, and automated systems are becoming widespread, contributing to increased productivity and efficiency (Nagy 2019, Gavrilova 2021, Bőgel 2018, Sung 2018, Berta 2018, Dajka–Oláh 2023). In addition, the digital products improve the quality of the operational processes of the agricultural actors, for example, humidity-, temperature- and soil moisture measurement methods, and crop health status monitoring methods (Sung 2018, Berta 2018). Other than that, the collective and systematic utilization of the digital products (like in the example of smart agriculture, or agriculture 4.0) can shape the whole methodologies of the agricultural operation itself (Zambon et al. 2019, Somosi–Számfira 2020, Bazsik et al. 2022). However, it is also known that despite the global spread of digital technologies in agriculture, it is one of the sectors where change cannot occur as rapidly as in other sectors, for example, the automotive industry or education sector (Szőke–Kovács 2020, Somosi–Számfira 2020, Bazsik et al. 2022).

Hungary, particularly the Southern Great Plain region, is one of the areas where agriculture is a promising sector thanks to its vast area of cultivatable land and economic potential. According to the Hungarian Central Statistical Office (KSH 2023), the Southern Great Plain region employs more than one quarter of the total agricultural employees in Hungary. Other than that, the agricultural sector contributes twice as much to the GDP compared to the EU average. In addition, the agricultural sector has a share with more than 10 billion EUR per year in the balance of export trade. However, compared with other developed countries, the country shows a significant lag in the speed of agricultural digital innovation (Szőke–Kovács 2020, Nagy 2019, Somosi–Számfira 2020). In Hungary, agricultural actors innovate much less in digital technologies and their spread is much slower compared to their counterparts in other developed countries (Szőke–Kovács 2020, Nagy 2019, Erdeiné 2020).

For Hungarian agricultural small and medium-sized enterprises, most of the products and services offered by digital technologies are available on the market, with few actors facing external obstructive factors. Yet the actors are not open enough to adopting these technologies, and the implementation of these digital technologies is not proceeding quickly enough, proving the lack of enhanced digitalization in agriculture (Szőke–Kovács 2020, Nezamova–Olentsova 2022). The most significant obstructive factor regarding digital innovation for actors in Hungarian agriculture is very similar compared to the data detailed in Figure 2.

Rupeika et al. (2022) offer an insightful analysis (Figure 2) of the factors hindering digitalization, positioning that the absence of necessary technological resources can significantly block the adoption of digital innovations among the agricultural actors. This phenomenon is significantly evident in the agricultural sector. The authors explain that in regions where technological development is insufficient, agricultural entities face substantial challenges in integrating advanced digital technologies into their operational frameworks. Specifically, in less developed countries, such as certain nations within Africa, there exists a definite deficit in the availability of essential technological tools and infrastructure. This scarcity not only restricts the direct application of digital technologies but also limits the potential for technological education and skill development among agricultural workers. Consequently, this lack of technological readiness undermines the ability of these regions to enhance agricultural productivity and efficiency through digital means. As a result, the gap in digital adoption between developed and developing regions continues to widen, highlighting the critical need for targeted technological investments and interventions to bridge this divide.

Nallusamy et al. (2015) identified insufficient capital (Figure 2) as a fundamental barrier to digitalization across various business sectors. This assertion is supported by Deichmann et al. (2016), who specifically highlight the agricultural sector as an area where this challenge is particularly frequent. The financial limitations faced by actors within the agricultural industry often stop them from acquiring advanced digital technologies that are crucial for enhancing productivity. Capital insufficiency restricts their ability to invest in new equipment and technologies, such as precision agriculture tools, automated systems, and data analytics software. Without the financial resources necessary to make these investments, agricultural producers are unable to leverage the benefits of digital technology, which can lead to increased yields, improved crop management, and greater overall efficiency. Consequently, the lack of capital not only hinders the immediate potential for technological adoption but also affects the long-term sustainability and competitiveness of farms. Addressing these financial barriers is essential to facilitate broader digital adoption and to foster economic growth within the agricultural sector.

Rupeika et al. (2022) asserted another fundamental blocking point to digitalization in the agricultural sector, which they identified as the inadequacy of existing technological infrastructure (Figure 2). They noted that the utilization of outdated technology models, which are not compatible with the demands of new digital technologies, alongside issues like slow internet connectivity, significantly hinders productivity enhancements in the agricultural sector. Such older systems, including outdated computers and other technological tools, lack the capability to

effectively support and integrate advanced digital solutions. Consequently, cutting-edge technologies such as drones, GPS, and remote sensors, which include humidity trackers critical for precision agriculture, remain underutilized. This underutilization comes from the older infrastructure's inability to process and transmit the large volumes of data these technologies generate, or to support the complex algorithms they employ. Therefore, without substantial upgrades to the technological infrastructure, the agricultural sector cannot fully leverage these innovations to increase production efficiency and crop yields. This situation underscores the urgent need for investment in modernizing technological frameworks to ensure that the agricultural industry can fully capitalize on the benefits of digital advancements.

Van Dijk (2006), Rupeika et al. (2022), and Deichmann et al. (2016) highlighted an additional significant barrier to the implementation of digital technologies: a lack of motivation (Figure 2). They assert that reluctance or resistance to learning and investing time in understanding digital technologies often leads enterprises to disregard the opportunities these technologies offer. This resistance is particularly pronounced in the agricultural sector, where the stakes for technological adaptation can be high. Furthermore, Deichmann et al. (2016) observed that this lack of motivation is especially dominant among older generation members within the agricultural community. These individuals often exhibit considerable hesitance, if not outright resistance, to adopting new digital tools, thereby creating a formidable obstacle in the digital transformation process. This resistance is not merely a refusal to adopt new technologies but often comes from a deeper skepticism toward the perceived complexity and the disruptive nature of digital innovations. Overcoming this generational divide is crucial for the effective integration of digital technologies into agricultural practices, necessitating targeted strategies that address these motivational barriers and foster a culture of continual learning and adaptation.

The low level of digital skills in the agricultural sector (Figure 4) is also present, which has multiple root causes.

Figure 4. The root causes of the lack of digital skills among the business actors in the agricultural sector

Root causes	Reference
Lower education level (elementary school or high school) Insufficient development of the agrarian university facilities No proper education for agricultural actors in technology	Hasan et al. (2022), Kale et al. (2016), Trukhachev–Apazhev (2019), Torres et al. (2020), Mokthar et al. (2022)

Source: own construction based on the studies mentioned above

Hasan et al. (2022), Kale et al. (2016), and Torres et al. (2020) collectively identified a significant deficiency in digital skills within the agricultural sector. As illustrated in Figure 5, this deficiency comes from multiple fundamental issues, the most prominent being the lower educational levels dominant among agricultural

workers. Typically, with their level of education being elementary or high school, these individuals often lack the necessary digital skills required to effectively employ and integrate digital technologies into agricultural operations (Trukhachev−Apazhev 2019, Torres et al. 2020, Mokthar et al. 2022). This gap in skills hinders their ability to leverage these technologies for improved productivity and efficiency. Further complicating this issue, Mokthar et al. (2022) highlighted the absence of proper educational programs for agricultural workers compared to other sectors. This discrepancy underscores a need for enhanced educational offerings that are specifically designed to meet the unique needs of the agricultural sector. Additionally, Trukhachev and Apazhev (2019) pointed out the scarcity of agrarian-focused educational institutions relative to other fields, which limits the opportunities for agricultural actors to receive specialized training. This educational shortfall means that for many in the agricultural sector, acquiring the necessary digital competencies is not just challenging but often unattainable. Addressing these educational and training deficiencies is crucial for equipping agricultural workers with the skills needed to capitalize on digital technologies, thereby enabling the sector to meet contemporary challenges and enhance its competitiveness.

5. Conclusion

The main aim of this study has been twofold. First, I have examined the relevance and elements of digitalization putting emphasis on the analysis of one of its components, namely, digital skills. I have evaluated the economic effects of digitalization in four main business spheres where digitalization significantly impacts productivity: warehousing, production, logistics, and sales processes. I have described the main root causes of digitalization among the business actors, which consist of five elements: technological deficit, lack of motivation, lack of capital, lack of inadequate technological infrastructure, and lack of proper digital skills. Subsequently, I have examined the core elements of digital skills, which consist of six subskills: operational, formal, information, communication, content creation, and strategic skills. Each subskill was thoroughly analyzed, providing with a broader vision about the core elements of the digital skill.

Second, I have examined the situation of digitalization in the agricultural sector. Digitalization has its impacts on the agricultural sector, which is facing numerous challenges around the world (climate crisis, ongoing conflicts, reduction of cultivable land, and increasing populations), and the agricultural sector needs to maintain its level of productivity if it wants to keep up the production levels with the increasing demands. The spreading of digitalization in the agricultural sector is progressing as in other sectors, but at a reduced rate, which can be traced back to the root causes of the following: the lack of technology, lack of adequate technological infrastructure, lack of capital, lack of motivation, and lack of digital skills. The lack of proper digital skills is one of the main root causes that could be enhanced to improve productivity. I have evaluated the main root causes of the lack of digital skills among the agricultural enterprises and the main reason can be led back to the lack of proper education among the agricultural business actors.

A future study's aim can be to deepen the research on the economic effects of digitalization and more emphasis on the analysis of digital skills in the aspect of economics. More specific focus should be put on the possible improvements, solutions, and recommendations for the digital skill-related problems of agriculture.

References

Adams, R. M. – Hurd, B. H. – Lenhart, S. – Leary, N. (1998): Effects of global climate change on agriculture: an interpretative review. *Climate Research,* 11, 1, 19-30. https://www.jstor.org/stable/24865973 Date of access: 13 April 2024

Bazsik, I. – Bujdosó, Z. – Koncz, G. (2022): A magyar gazdák helyzete a mezőgazdaság 3.0 és 4.0 korában: Agrár depriváció és társadalmi innováció. *Acta Carolus Robertus*, 12(2), 111-131. DOI: 10.33032/acr.2907

Berta, O. (2018): A digitalizáció szerepe és jelentősége a modern mezőgazdasági vállalkozásoknál egy kutatás tükrében. *Jelenkori társadalmi és gazdasági folyamatok,* 13(1-2), 55-66. DOI: 10.14232/jtgf.2018.1-2.55-66

Bőgel, Gy. (2018): Digital transformation in agriculture. *Magyar Tudomány*, 179(5), 693-701. DOI: 10.1556/2065.179.2018.5.12

Chandio, A. A. – Amin, A. – Khan, I. – Rehman, A. – Memon, A. (2024): Can digitalization improve agriculture? Exploring the impact of ICT on grain food production in SAARC countries. *Information development* (online) DOI: 10.1177/02666669231225945 Date of access: April 1, 2024.

Dajka, M. F. – Oláh, I. (2023): The overview of the concept of agriculture 4.0 and its possible ways of innovation. *Studia Mundi – Economica,* 10(3), 33-45. DOI: 10.18531/sme.vol.10.no.3.pp.33-45

Deichmann, U. – Goyal, A. – Mishra, D. (2016): Will digital technologies transform agriculture in developing countries? *Policy Research Working Paper*, 7669, 1-30.

Erdeiné, K. G. Sz. (2020): A precíziós gazdálkodás jelentősége a mezőgazdaság versenyképességében. *Multidiszciplináris kihívások, sokszínű válaszok*, 2(1), 1-19. DOI: 10.33565/MKSV.2020.02.03

Gavrilova, N. G. (2021): Impediments to the digitalization of agriculture in Africa. IOP Conference Series: Earth and Environmental Science, 032014, 981-988.

Gray, J. – Rumpe, B. (2015): Models for digitalization. *Software & Systems Modeling*, 14, 1319-1320. DOI: 10.1007/s10270-015-0494-9

Hasan, K. – Masriadi, X. – Muchlis, X. – Muktarrudin, X. – Aftah, R. M. – Syakban, M. N. (2022): Digital skills in the optimization of agricultural technology among millennials. *Proceedings of the 3rd International Conference on Social Science, Political Science, and Humanities*, 1-10. DOI: 10.29103/icospolhum.v3i.149

Isensee, C. – Teuteberg, F. – Griese, K.-M. – Topi, C. (2020): The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of Cleaner Production*, 275, 1-19. DOI: 10.1016/j.jclepro.2020.122944

Kale, R. B. – Meena, M. S. – Rohilla, P. P. (2016): Determining factors and levels of E-skills among agriculture experts of Krishi Vigyan Kendras in India. *Journal of Agricultural Science and Technology*, 18, 1749-1760.

Klerkx, L. – Jakku, E. – Labarthe, P. (2019): A review of social science on digital agriculture, smart farming and agriculture 4.0, New contributions and a future research agenda. *NJAS - Wageningen Journal of Life Sciences*, 90-91, 1-16. DOI: 10.1016/j.njas.2019.100315

KSH (2023): *Magyar Statisztikai Évkönyv* 2023. Központi Statisztikai Hivatal, Budapest.

Mammadli, E. – Klivak, V. (2020): Measuring the effect of the digitalization. http://hdl.handle.net/11159/3795. Date of access: April 1, 2024.

Mokhtar, W. N. H. W. – Izhar, T. A. T. – Zaini, M. K. – Hussin, N. (2022): The importance of digital literacy skills among farmers for sustainable food security. *International Journal of Academic Research in Business and Social Sciences*, 12(1), 235-246. DOI: 10.6007/IJARPED/v11-i1/12104

Nagy, D. (2019): Digitalizáció az agráriumban. In: Fekete D. (ed.): *Városfejlődés és Agrárinnováció a Kárpát-Medencében*, X, 39-48.

Nallusamy, A. – Balasubramaniam, S. – Chellappan, S. K. (2015): Use of information and communication technology (ICT) to achieve information literacy in agriculture. *International Journal of Agricultural Extension*, 3(2), 111-122.

Nezamova, O. A. – Olentsova, J. A. (2022): The main trends of digitalization in agriculture. *IOP Conf. Series: Earth and Environmental Science*, 981, Doi:10.1088/1755-1315/981/3/032018

Orjuela, Y. R. G. (2021): Digital skills for communication and content creation: Can B-learning greatly influence them? *HOW Journal*, 28(1), 45-68. DOI: 10.19183/how.28.1.568

Ozdogan, B. – Gacar, A. – Aktas, H. (2017): Digital agriculture practices in the context of agriculture 4.0. *Journal of Economics, Finance and Accounting*, 4(2), 184-191. DOI: 10.17261/Pressacademia.2017.448

Pereira, L. S. (2017): Water, Agriculture and food: Challenges and issues. *Water Resource Management*, 31(10), 2985-2999. DOI: 10.1007/s11269-017-1664-z

Rupeika, X. – Apoga, R. – Petrovksa, K. (2022): Barriers to sustainable digital transformation in micro-, small-, and medium-sized enterprises. *Sustainability*, 14(20), 13577, 13558. DOI: 10.3390/su142013558

Saikkonen, L. – Kaarakainen, M. T. (2021): Multivariate analysis of teachers' digital information skills: The importance of available resources. *Computers & Education*, 168(2), 104206. DOI: 10.1016/j.compedu.2021.104206

Siddiq F. – Scherer R. – Tondeur J. (2015): Teachers' Emphasis on Developing Students' Digital Information and Communication Skills (TEDDICS): A new construct in 21st century education. *Computers & Education*, 92-93, 1-14.

Somosi, S. – Számfira, G. (2020): Agriculture 4.0 in Hungary: The challenges of 4th Industrial Revolution in Hungarian agriculture within the frameworks of the Common Agricultural Policy. In: Udvari B. (ed.) *Proceedings of the 4th Central European PhD Workshop on Technological Change and Development*, 4, 162-189.

Sung, J. (2018): The fourth industrial revolution and precision agriculture. In: Hussmann, S. (ed.): *Automation in agriculture, securing food supplies for future generations*. IntechOpen, DOI: 10.5772/intechopen.69016

Szőke, V. – Kovács, L. (2020): Mezőgazdaság 4.0 – relevancia, lehetőségek, kihívások. *Gazdálkodás*, 64(4), 289-304.

Teng, X. – Wu, Z. – Yang, F. (2022): Research on the relationship between Digital Transformation and Performance of SMEs. *Sustainability*, 14(10), 1-17. DOI: 10.3390/su14106012

Torres, T. Z. – Souza, M. I. F. – Cunha, L. M. S. – Carvalho, J. R. P. – Daltio, J. – Mangabeira, J. A. C. (2020): Mediatic, informational and digital skills and competencies in students from agricultural family schools and rural family home, in the Amazon Biome, Brazil. *Creative Education*, 11(8), 1469-1496. DOI: 10.4236/ce.2020.118107

Trukhachev, V. – Apazhev, A. (2019): About training of personnel for digital agriculture. *Advances in Intelligent Systems Research, International Scientific and Practical Conference*, 167, 1-4.

Van Deursen, A. J. A. M. – Helsper, E. J. – Eynon, R. (2014): Measuring digital skills. *From Digital Skills to Tangible Outcomes project report*. DOI: 10.13140/2.1.2741.5044

Van Deursen, A. J. A. M. – Van Dijk, J. A. G. M. (2011): Internet skills and the digital divide. *New Media & Society*, 13(6), 893-911. DOI: 10.1177/1461444810386774

Van Dijk, J. A. G. M. (2006): Digital divide research, achievements, and shortcomings. *Poetics*, 34(4-5), 221-235. DOI: 10.1016/j.poetic.2006.05.004

Van Dijk, J. A. G. M. – Van Deursen, A. J. A. M. (2014): *Digital skills: Unlocking the information society*. New York: Palgrave Macmillan.

Van Laar, E. – Van Deursen, A. J. A. M. – Van Dijk, J. A. G. M. – De Haan, J. (2017): The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, 72, 577-588. DOI: 10.1016/j.chb.2017.03.010

Vas, Zs. (2009): Közelség és regionális klaszterek: a szoftveripar Szegeden. *Tér és Társadalom*, 23(3), 127-145. DOI: 10.17649/TET.23.3.1261.

Zambon, I. – Cecchini, M. – Egidi, G. – Saporito, M. G. – Colantoni, A. (2019): Revolution 4.0: Industry vs. agriculture in a future development for SMEs. *Processes*, 7(1), 36-52. DOI: 10.3390/pr7010036