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DIGITAL AGRICULTURAL EDUCATION IN HUNGARY

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Abstract
With the advent of the digital era in the middle of the 20th century and the German government's introduction of Industry 4.0 in 2011, conventional industries shifted into an economy built on massive Internet and Information and Communication Technologies (ICT). The ICTs such as big data, cloud computing, the Internet of Things (IoT), mobile devices, artificial intelligence, 5G network, etc., are not only being used in a variety of businesses but also by an increasing number of people globally. There is no doubt that the use of digital technology in a variety of sectors has effectively increased productivity and decreased costs. Digital agriculture is one of the logical conclusions of Industry 4.0 growth. However, implementing ICT in agriculture may be severely hampered by the risks associated with digital agriculture. One of the main obstacles is unclear Digital Agricultural Education (DAE), a market gap formed by the explosive rise of digital agriculture but with little research. In this exploratory study, we used content analysis as a research methodology, aimed to comprehend Hungary's efforts in digital agriculture education and investigate the challenges by presenting practical examples.

1 Introduction

Digitalization has acquired universal acceptance as a potent tool for socioeconomic and environmental advancement since the start of the twenty-first century. The transformation of every element of the business, government, and society based on the widespread application of both established and emerging digital technologies is referred to as "digitalization"[1]. From a fundamental point of view, digitalization is the act of turning information into a digital (i.e., computer-readable) format and making it available on digital devices for faster, more convenient reading[2]. Digitalization has undergone a transformation and has been used in a variety of industries, and it is now widely acknowledged as a potent tool for development in most areas [3]–[6]. In order to promote the adoption of digitization by 2030, the European Commission includes a section on the digital transition in its "Declaration on European Digital Rights and Principles"[7] to encourage the spread of digitization by 2030. The government of Hungary likewise views digitization as a useful tool for advancing the nation's socioeconomic and environmental development [8] [9][10].

Among many of the applications of digital transformation, digital agriculture has received great attention as one of the core studied objectives[11]–[13]. Digital agriculture includes but is not limited to smart agriculture and precision agriculture, it is a tool that digitally collects, stores, analyzes, and shares electronic data and/or information in agriculture associated with digital technologies such as GPS, drones, sensors etc.[11]. Agriculture 4.0 which is also called "the Fourth Agricultural Revolution" according to the Food and Agriculture Organization of the United Nations (FAO), is a

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well-known topic worldwide[14], it is consistent with digital agriculture, which both deals with technological transformation and increased farm productivity[15], [16]. Digital agriculture in Hungary also plays a pivotal role in agricultural and sustainable development, especially when the frequency of extreme weather becomes higher and the digital path is inevitable for agriculture[8], [17].

Agriculture is one of the keys and basic industries regarding the survival and sustainable development of humankind. Digital agriculture mainly deals with two of the Sustainable Development Goals (SDGs): No.2 Zero Hungry and No.9 Industry, Innovation, and Infrastructure[18]. One of the most important long-term concerns facing the globe in the twenty-first century is the sustainable production of enough healthful food. Climate change and unsustainable resource use endanger global food security. In order to meet this challenge, agricultural food and food systems must be rapidly transformed. In this context, digital agriculture may be a key component of the transformation program. They can improve economic benefits first[19] by reducing chemical inputs and labor requirements, improving agricultural productivity and efficiency, and creating new market opportunities; second, they can bring social and cultural benefits[20] by improving communication and inclusiveness; and third, they can bring environmental benefits by optimizing resource use and adapting to climate change[21]. Even though digital agriculture is so important that many scholars have studied it from various aspects, there is only a little attention on the education of digital agriculture.

People's perceptions of digital agricultural education (DAE) are still based on what is taught about it in schools and how education benefits digital agriculture, according to the scant study on this topic.[22][23]. Since DAE is a brand-new concept, there is no clear description of it as of yet. As a result, we'd like to talk about our own thinking: The subject of "Digital Agriculture Education" (DAE), also known as the "New Farmer" of the twenty-first century, is intended for secondary, vocational, and above-level education. It focuses on teaching theoretical knowledge of digital agriculture as well as the practical operation of digital agriculture application scenarios. DAE is a highly intentional but young field; unlike traditional and interdisciplinary education, its subject matter is not yet standardized or organized. We, therefore, offer our observations and innovations from this underappreciated element of DAE based on our examination of the comprehensive literature review and reports on digital agriculture in order to promote a wide range of interest and higher-quality research in the future. DAE has the potential to enhance digital agriculture in Hungary, given the country's concentration on digital growth and its own comparatively advanced level of agricultural development.[24]–[26].

In addition to developing specialized software to process data and introducing robots and drones into agriculture, there are also some plans and initiatives, including the usage of blockchain technology.[27], [28]. The use of IoT devices in agricultural settings that allow for the remote transmission of plant-related data presents us with a host of new opportunities. [29]. Therefore, farmers must improve or acquire new digital skills and capacities in order to prepare for the impending digital shift. Regarding talent, there are two issues: on the one hand, the "new farmers" lack the knowledge and skills necessary, and on the other, farmers and small and medium-sized agricultural businesses need a thorough understanding of digital agriculture. DAE can offer a fresh opportunity to make learning new information and abilities in digital agriculture more convenient with regard to this problem. The use of innovative educational techniques and models, such as creating personal learning environments or personal learning clouds, is also made possible by information and communication technology (ICT) tools.

Obstacles to the development of digital agriculture which has inevitably led to the creation of digital agricultural education. However, there are few papers about it and certain challenges for educators or trainers [22]. There are not many papers on digital agriculture education, and there are a few challenges for teachers or trainers, like if the subject matter of DAE can be taught with both benefits and drawbacks and whether it can be done in a suitable manner. The application and manipulation of many digital technologies require professional talents, and in terms of education, teaching and research on digital agriculture are insufficient, so we need to emphasize digital agriculture education. At the same time, digital agriculture is evolving quickly and is an unavoidable trend for the future. This education is unique from other disciplines/fields in that it has not received much attention, and there is no specific curriculum or standardized system to educate digital agriculture professionals, yet it is extremely important in agricultural education.

2 Methods

We cannot deny the prosperous development of smart agriculture and digital agriculture technologies. However, in the new era, it is also true that there is a lack of talent to implement digital agriculture [30]. Therefore, as a niche of agriculture 4.0 emerging, digital agriculture education plays an important role in the diffusion of digital agriculture [31]. To better understand the situation of digital agriculture education in Hungary and provide valuable suggestions for the policymakers, we conducted this exploratory research by research methodologies: content analysis [32] and reviewing massive secondary research to bridge the research and studies gap. The literature and data are from the prestigious journal, the Hungarian official government webpage, etc. In order to have a comprehensive understanding of "how" to adapt and utilize digital agricultural technologies to gain more profits, at the same time, take care of the environment, we also considered Roger's Diffusion of Innovation Theory (DOI) [33], [34], the key for agrifood actors to adopt digital agriculture technologies is to make them perceive these technologies.

3 Results

Hungary has great potential in agriculture, and the trend and big leap are going to digitalization and precision agriculture [35]. Digital agriculture and precision agriculture are the priority of Hungary, even though the current step is still in its infancy, according to Agricultural census studies from Hungary's Central Statistical Office [36], [37]. We have found the effort of Hungary in digital agriculture and digital agricultural education and the barriers to the propagation of digital agricultural education.

3.1 Hungary's effort in digital agriculture

Collaboration is the paramount enhancement for excellent digital agriculture transformation. Participation in the Rural Development Programme of the European Union's Common Agricultural Policy is a stimulating step for Hungary to boost digital agriculture [38]–[40]. And Hungary is also trying to learn best practices from other intergovernmental relations, such as the Smart Farmer Programme [35]. Hungary is one of the seven European countries in collaboration with the Regional Strategies 4 FOOD project, promoting the data, information, and cognitive technologies in the agrifood value chain [41]. Hungary's National Digital Agricultural Strategy (DAS), one of the first in Europe[42] emphasized that future agriculture is based on information and knowledge, which is creating a policy foundation and strengthing agricultural research for the incorporation of digital agriculture into everyday practice [35], [43]. Some essential pillars are forming this strategy. For example, Hungary's Digital Welfare Program (Digitális Jólét Program (DJP) or Digital Success Programme in English), launched in 2015, aids the infrastructure investment and education for everyone to prepare Hungary for digital transmission [44]. The establishment of Hungary's Digital Agricultural Academy is to explore the possibilities of digitalization in Hungary, obtain vital knowledge, and compile a digital plan through participation events, an online interface, and Farm Advisory System. According to the minister of Hungarian Agriculture, Digital Agricultural Academy stands for a new page of Hungarian agriculture [42]. Smart Farm Accountancy Data Network is a pilot project to integrate sectorial data for future Common Agriculture Policy [43].

3.2 Hungary's effort in digital agricultural education

According to Hungarian Digital Agricultural Strategy (DAS), technical education has paramount significance in the propagation of digital agriculture, as well as precision agriculture, especially the focus on adults' education[25]. For example, the use of drones is a focus at the University of Szeged [35]. The Minister of Agriculture suggested that Hungarian universities should offer more courses bridging IT and agriculture, and this program will also bring a lot of job positions [25]. Since October 2021, the Digital Agricultural Academy of Hungary, based at Hungarian University of Agricultural and Life Sciences, started to provide free online courses to Hungarian producers and farmers to help them use digital tools and methods in farming. The offered courses consist of how digitalization

changes our lives and how digital tools are used in farming, fruit and vegetable agriculture, such as IT, satellite technology, decision-making theory and methods, drones, and so on [45].

The government of Hungary announced the Digitális Jólét Program (DJP) or Digital Success Programme in English (Digital Welfare Program) in 2015 and extended it into Digital Success Programme 2.0 in 2017, and the improvement of the Digital Success Programme 2030 based on the success of DJP 1.0 and 2.0 in 2020. This program is aimed develop digitalization and make all Hungarians and business get benefit from it [46], [47]. The Hungary's Digital Education Strategy completed in 2016, as a part of the Digital Welfare Program (Digitális Jólét Program (DJP) or Digital Success Programme in English) and one of the pillars of the Ditial Success Programme, covered the entire Hungarian education and training to improve Hungarian competitiveness [26], and suggested that digital education should be brought into the classroom as digitalization is an inevitable trend for everyone [48]. In 2021, The Digitális Jólét Program (DJP) or Digital Success Programme (Digital Welfare Program), the Hungarian University of Agriculture and Life Sciences (MATE), Széchenyi István University (SZE), and the University of Veterinary Medicine Budapest (UVMB) signed a mutual agreement to realize the purpose of Digital Agricultural Academy's strategy. For example, the University of Veterinary Medicine Budapest (UVMB) established the Digital Food Chain Education, Research, Development, and Innovation Institute (DEOKFII) [24].

Besides the practice from government, we can also find some good practical examples from university. For example, the functiong of Digital Agricultural Academy, which is a platform open for everyone, under the Hungarian University of Agriculture and Life Sciences [49]. The service there is: News; Events; Knowledge base;Digital experimental farms; E-learning platform; educational, etc. The concept of the platform is to open wider the digital platform for everyone and its aim is to prepare Hungarian producers in the Carpathian Basin for the use of digital solutions. Digital Agricultural Academy helps producers navigate among digital solutions, plan the digital transition of their own farms, and select and use truly effective solutions.

3.3 The barriers to digital agricultural education

Precision agriculture is regarded as the crystalization of agriculture revolution 3.0 in 1980 [50]. While smart agriculture, digital agriculture or agriculture 4.0 is the revolution of precision agriculture since 2010 [51]–[53]. According to the survey conducted by Takácsné et al. [38] in 2016, the main barrier stopping the propagation of precision agriculture in Hungary is the high investment and inadequate information. However, the educational level of agricultural practitioners decides the information sources, such as colleagues, media, companies, or professional consultants [36]. According to a survey conducted in 2019, the "only" fact that hinders digital agriculture success is the farmers' knowledge level. Digital agriculture education and financial support are still inadequate in Hungary. And it is highlighted the importance of digital agriculture education amongst the young generation [17]. Because the spreading of digital agriculture is slow amongst aging farmers, however, young people are not active in agriculture in Hungary [17], [45]. However, as a niche of digital agriculture, the potential barriers of digital agriculture education can be two unclear aspects as well. For example, can teaching content contain both opportunities and threats of digital agriculture at the same time? And is the teaching approach inclusive and equitable to digital agriculture [23]?

4 Discussion

4.1 Concluding remarks and suggestions to Hungarian policymakers on digital agriculture education

We have witnessed the effort made in digital agriculture and digital agriculture education in Hungary, such as the practice in Regional Strategies 4 FOOD 4.0 Revolution project [41], National Digital Agricultural Strategy, Digital Agricultural Academy [42], Smart Farm Accountancy Data Network [43], Digital Welfare Program (Digitális Jólét Program (DJP) or Digital Success Programme in English) [44, p. 5], Digital Education Strategy [47], participation in the Rural Development Programme of the European Union's Common Agricultural Policy [38], [39] and so on. However, we still need to consider the efficient solutions to improve digital agriculture on the view of digital agriculture education, which is still at infancy stage [36], [37]. Subsidies and appropriate information

can be efficient solutions for fostering the slow growth of digital agriculture [38]. Based on the literature studies, we also provide some valuable suggestions for Hungarian policymakers on the digital agriculture education process. Of course, there are already successful practices in Hungary, which we suggest to maintain.

4.1.1 Build workshops or programs for both educators and students

Teachers or educators play important roles in offering knowledge and information to those students who take part in the digital agriculture industry [54]. Therefore, we suggest Hungary also should pay attention to both teachers' and students' education in digital agriculture technologies and information. We take successful experience from Australia, where agriculture is the fastest growing industry and 90% population is in rural areas. The joint program The Teacher Farm Experience (TeacherFX) was a free two-day event in 2018 aimed to improve educators' knowledge and interest in advanced technologies. Teachers were able to visit farms to get an insight into the advanced technologies, billeted with local farmers to experience the farm life for accurate information, and undertake training on utilizing livestock tracking [22, p.]. Student Farm Experience Program (StudentFX) involved youth in urban to spend one week in rural to experience rural life and understand food and fiber production [55].

4.1.2 Boost digitalization education on all levels and strengthen subsidies

Parents are also playing an important role in youngth digital education [48] as well as digital agriculture education. Therefore, we suggest that digital agriculture education should focus on all levels of education, from kindergarten to university studies, and all the actors, such as parents, teachers, educators, and society. As a member of the EU, the subsidies or financial support to Hungary can be insufficient. Therefore, Hungary should support the process of digital agriculture at a national domestic level [17].

4.2 Limitaitons and suggestions

Due to page limitations, we are not able to extend our research to primary studies. The limitation of our research also provides a suggestive research direction for future researchers. To better implement digital agriculture technologies from the respective of digital agriculture education, we have to focus on the in-field situation and analyze the risk level of digital agriculture education. Therefore the in-field investigation can be conducted from two aspects: firstly, the practice of digital education level, such as teaching approaches, teaching content range, etc., in the whole country, from preschool education to high-level institutions. Secondly, the digital agriculture education level among different agrifood value chain actors, such as students who are majoring in agriculture or related, agricultural company employees and employers, and so on.

5 Conclusions

To conclude our research, we would like to start by answering two questions stated at the beginning of this article. Hungary has strengthened its intergovernmental relations in digital agriculture by proactively participating in various collaborative programmes and established kinds of pilot projects to make more progress of its own. Additionally, research academies and universities in Hungary have offered vocational-above-level education in digital agriculture to enhance people`s professional skills and knowledge of digital technologies applied in agriculture. Moreover, The Hungarian government has launched the DJP programme to improve the competitiveness of their DAEs and collaborated with universities and research institutes to provide better quality DAEs for the Hungarian people and the Hungarian University of Agriculture and Life Sciences's open platform Digital Agricultural Academy for everyone. Even though, there are still many barriers to DAE such as inadequate financial support and the young generation`s inactivity in agriculture. Furthermore, we studied what is digitalization and digital agriculture and why they are important through a detailed literature review. Also, we explained the impacts of them on agriculture and the food system by combining two SDGs. Especially, we gave our apprehension of Digital Agriculture Education and why we chose to make further research on it. Likewise, we introduced the importance of DAE and drew the problems concerning DAE in the first place. Then, we used Roger's Diffusion of Innovation

Theory (DOI) and content analysis as our main research methods while focusing on the DAE in Hungary. Afterward, a detailed analysis of Hungary`s efforts in digital agriculture and DAE was developed followed by the barriers to DAE universally. Finally, we brought forward our suggestions and recommendations about DAE for policymakers, educators, and students to enhance their knowledge in the future.

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