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## DIGITAL AGRICULTURE – THE CASE OF THE AUTONOMOUS PROVINCE OF VOJVODINA

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### ABSTRACT

Agriculture as a crucial economic sector has changed rapidly in the last few decades, more than in previous centuries, because of technological achievements that opened a niche in the international agricultural sector known as digital agriculture. The conception of digital agriculture in practice and consequences on agricultural productivity is a way to response to significant climate changes. The evaluation of the current circumstances is made through the cases of digital agricultural companies in Vojvodina which could help and enhance regional economic growth. This study has utilized a case study method to evaluate the present conditions of digital agriculture appliances in Vojvodina. The results of the research will be a case study analysis of the companies using and developing digital agriculture technologies in the agricultural sector, as well as the presentation of potentials in this niche - digital agricultural sector in the Autonomous Province of Vojvodina. The authors of the paper consider the suggested model in this sector a vehicle that could run not only the economic growth in Vojvodina and Serbia, but also the regional economic growth.

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## Introduction

Agricultural production is under many challenges worldwide. Population growing dynamics will radically change demographics towards the end of the century. Projected growth in the world's population is likely to be concentrated in Africa and South Asia and in the world's cities. According to Food and Agriculture Organisation of UN "by mid-century, two-thirds of the global population will live in urban areas. Low-income countries will see large increments in the age group of 15 to 24 years. The population will continue to grow in South Asia until mid-century and in sub-Saharan Africa until at least the end of the century. By the year 2100, Asia and Africa are expected to be home to a combined population of 9 billion, out of the projected 11 billion people who will inhabit the Earth" (Food and Agriculture Organization of the United Nations (FAO, 2017). Climate change increasingly causes stress to cultivated plants, but there is also the emergence of new diseases and pests. Some weeds and diseases have developed resistance to preparations that we have used successfully in production until recently. We have had relatively low purchase prices for the most important cereals for a long time. These are the facts that require a serious approach within the entire field production process.

Having in mind new challenges in the protection of the most important field crops, the introduction of new technologies is a precondition for achieving successful and profitable production. This primarily means effective protection of crops from weeds, diseases and pests with cost optimization, increased yield and quality. Precisely such actions give a good opportunity to convey new knowledge to our farmers, as well as possibilities of applying new solutions. In this study, we tend to analyse present circumstances, challenges and opportunities in the protection of the most important crops through the introduction of new technologies in the range of digital agriculture.

Based upon the digital agriculture applications that have already been implemented in Vojvodina, the companies that are discussed in the paper have made significant progress as far as raising consciousness of farmers and other involved parts of the agricultural sector in Vojvodina. While the quality of these applications is parallel with their quality in developed countries, the scope of use is still not on satisfactory level. Digital agriculture practices in Vojvodina are implemented on high level from the very beginning, but there are more steps to be done for acceleration, in terms of volume and scope. Like in the developed countries, EU countries and the USA, will enable the expansion of agricultural production vision in the Western Balkan region. Institutes and knowledge transfer centres of universities will be able to transform the accumulated scientific knowledge into initiatives and put the ecosystem focused on digital agriculture in practice. In this context, the development of a digital agriculture action plan and support of this strategy with related policies and implementations, to develop digital farming in the whole region, supports of government have strategic priorities.

## Literature review

As it has been pointed out in literature, digital agriculture could be defined as digitization of the various aspects of the agricultural value chain. Also it could be defined as targeted information services useful for farmers to practice new technologies, in that way increasing not only productivity, but profitability, as well. In such type of agriculture, mobile phones and the Internet are important resources, as they are tools which enable farmers to make informed decisions, regarding their farming activities. This is of great importance primarily for the rural areas in developing countries. In developed countries, e.g. in the USA, digital agriculture is advanced, but it is also applicable to smallholder farmers around the world, e.g. in Africa. The agricultural sector is the basic sector for the most African countries and their economies, employing nearly 80% of African population, which are mostly small-scale farmers. In the last few years, the Internet has experienced a fast growth in Africa, and the usage of mobile phones is rapidly rising (Olaniyi, E., 2018). Agriculture is without a doubt the most important sector in this country, as far as economic development is concerned. This economic sector plays an important role for labour market, i.e. employment, presenting the basis for food production and continuation of natural cycles on the Earth. Development of countries is connected to the agricultural development. Agriculture continues to play an essential role for the emerging economies. The 3/4 of India's working population is employed in agricultural sector (Sarkar J.P., Chanagala S., 2016).

As authors of Digital Transformation and Serbia claim, "the new digital economy is the economic activity resulting from billions of online connections between people, businesses, data, devices and processes. The new digital economy has created great possibilities for individuals, enterprises and countries to improve competitiveness strategies using new technologies." (Pitić S., Savić N, Verbić S., pp. 108, 2018). The Strategy for the Development of Digital Skills in the Republic of Serbia for the period of 2020 to 2024 will determine unique and complete directions of action in the field of improving digital skills in the Republic of Serbia, having in view the results achieved so far and the desired directions of capacity development for the entire companies for the use of modern information and communication technologies, development of information society and digital economy in the Republic of Serbia. The strategy was built upon the Agenda for New Skills for Europe and the European Action Plan for sustainability (European Commission, 2016) having in mind that these documents concretize the goals set by the Strategy Europe 2020, and represent the basis for directing strategic and reform processes and development priorities for candidate countries for the European Union membership, including the Republic of Serbia. The main problems of the perceived lack of digital skills in the field of education and training are as follows: digital development skills for all citizens, development of digital skills in relation to the needs of the labour market, as well as monitoring of the further development of this area by ICT experts.

## Materials and methods

The authors of the paper start with the hypothesis that the growth in the sector of digital agriculture could be a starter and vehicle for employment and economic expansion in the short term. In order to test the starting hypothesis, a case study of IT companies that are using and developing digital agriculture platforms is applied. The case study (Yin, R., K., 2003) method is used for the verification of the paper's hypothesis, as there is not enough relevant data for the analysis of this topic by other methods. After the extensive analysis of the literature and studies, we could notice that there are certain articles which cover this topic, many new strategies, action plans, case studies, practical implementations, etc. We also noticed a lack of quantitative data in this field. Understandably, as authors Laurens, K., Jakku, E., Labarthe, P. (2019) confirmed with their study "There is a lack of overview of how this field of study is developing, and what are established, emerging, and new themes and topics. An exploratory literature review shows that five thematic clusters of extant social science literature on digitalization in agriculture can be identified: 1) Adoption, uses and adaptation of digital technologies on farm; 2) Effects of digitalization on farmer's identity, farmer's skills, and farm work; 3) Power, ownership, privacy and ethics in digitalizing agricultural production systems and value chains; 4) Digitalization and agricultural knowledge and innovation systems (AKIS); and 5) Economics and management of digitalized agricultural production systems and value chains." In order to contribute to the ongoing efforts for fostering awareness of the importance, possibilities and benefits by enhancing digital agriculture, we performed the analysis of digital agricultural enterprises in Vojvodina.

The methods used, in the scope of this research and during the analysis, are the case study, the parsing and comparison method. Also, during the interpretation of given results, the descriptive method is used, as well as the empirical method. The case study method (examples of good practice in developed countries, BioSense Institute, Greensoft and Inosens) enabled us, through the experience of good practice examples analysis, to reach valuable conclusions and guidelines. New insights were based on the inductive and deductive method.

## Results

The new paradigm (FAO, 2017) includes scientific knowledge of numerous agronomic procedures and measures, which enable the implementation of these principles, that is, saving input, while increasing the yield, quality and health safety of food. The basics of the new agricultural paradigm are:

- Reducing the intensity of tillage, which although until recently considered necessary, disrupts its structure and leads to loss of nutrients, moisture and reduction productivity;
- Permanent land covers for moisture conservation and nutrients;
- Periodic cultivation of legumes, which enrich the soil, on plots depleted by cereal cultivation;
- Crop rotation, according to established principles (crop rotation);

- Precise agriculture, which means timely performed agricultural work, high productivity, reduced number of operations and lower labour costs. Plants and livestock get exactly the treatment they need, which has been determined with a precision that man does not have.

With the intention to expand numerous agronomic procedures and measures anticipated by The New Paradigm of FAO, we have analysed the current situation in the companies that deal with digital agriculture in Vojvodina, we have examined current regulations, laws, and strategies in Serbia and we have compared the amount of total arable land in Serbia with land covered by digital measures, in order to determine the potential for the expansion of digital agriculture from Vojvodina to the entire available arable land in Serbia.

The area of agricultural land covers 5,734,000 hectares (0.56 ha per capita), and the arable land (0.46 ha per capita) covers about 4,867,000 hectares of that area. About 70 percent of the total territory of Serbia is the agricultural land, while 30 percent is under forests. (Serbian Government, 2020)

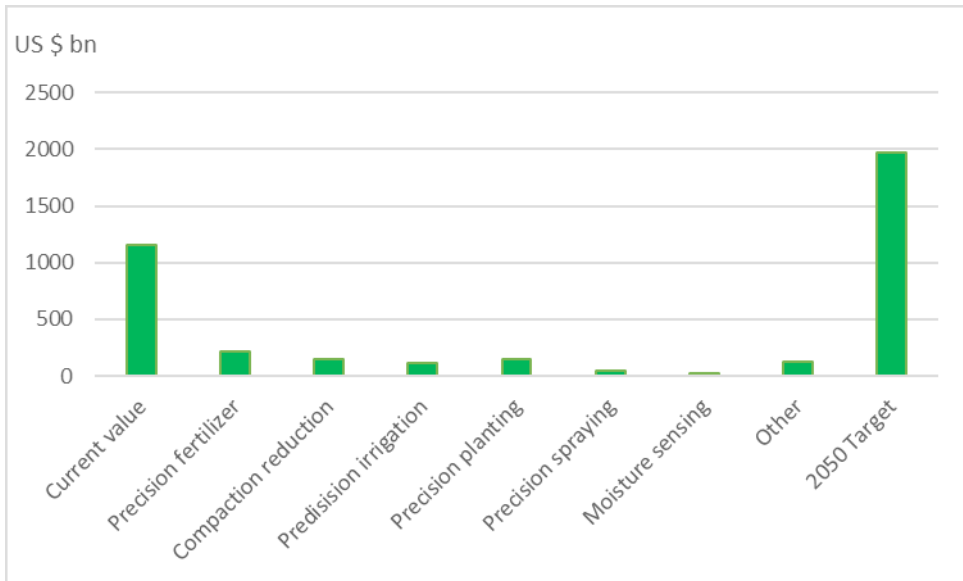
The paradox is that Serbia is the only country in the region in which the area under irrigation systems was reduced last year. According to the data of the Republic Bureau of Statistics, in 2018, only 46,823 hectares of agricultural land were irrigated, i.e. 1.5 percent of the total arable land, which is seven percent less than the year before. In recent years the share of agriculture in the realization of the GDP of Serbia was within the interval of 9 - 11 percent. However, if we look at the overall contribution of agriculture to other sectors of the economy, the food industry and producers and processors of inputs and raw materials, this share exceeds 30 percent of total GDP. (Voice, 2020).

According to The Regional Report of the World Bank Group (2018), agriculture in the Republic of Serbia is generally characterized by very low productivity, i.e. relatively low yields per hectare or per capita, as well as the lack of a process industry. It is known that yields in the Republic of Serbia are lower due to the inefficient use of modern agro-mechanic and agro-technical measures and that this is often compensated by lower labour, energy and land costs, but more dynamic growth of competitiveness requires increased productivity.

The contact with the farmers could be complicated. Over the last five years manufacturers who cultivate large areas years have been very accepting of suggestions and would like to hear and apply this to their fields, but the biggest obstacle is the lack of investing capital. It is even more difficult to explain the economic justification of implementing new technologies to producers who process smaller surfaces. Even though we have financial reports and evidence from developed countries, our farmers are faced with difficulties to implement the digital farming technology.

The report published by Goldman Sachs (2016) highlights the significant increase in expected yields based on the technological improvements being introduced by precision agriculture. This report estimates that these new technologies will allow for 70% higher yields on the existing agricultural land. This converts into a total market of \$240 billion by 2050. The below figure shows how different technologies will influence the global crop value in the USA.

**Figure 1.** Farming technology is core to delivering a 70% increase in global crop production  
Global crop value in US \$ billions



Source: Precision Farming, Goldman Sachs Group Inc., pp. 17.

From this report we can see that digital technologies will have a major impact on the agricultural industry. It is clear that the US and European markets are the most attractive. This figure is another key indicator that the adoption of these solutions will only increase due to the value that they are bringing to farmers (Ivanov, I., 2018).

**Table 1:** Benefits of digital agriculture to various stakeholders in the agricultural sector:

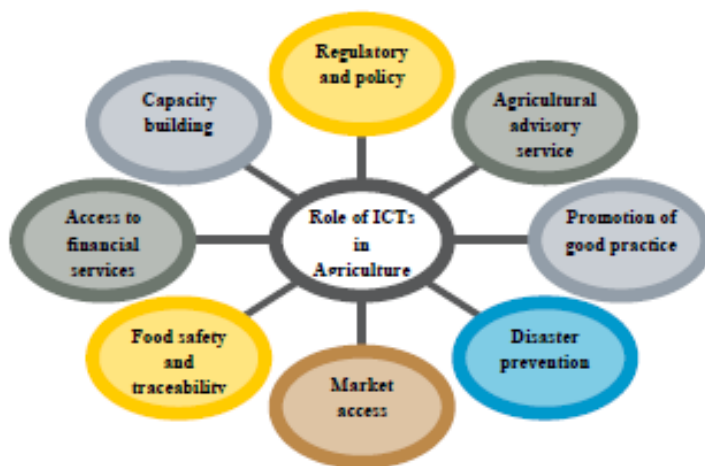
Benefits for farmers:	<ul style="list-style-type: none"> <li>Creating virtual cooperatives</li> <li>Access to contractors</li> <li>Access to educational and consulting services</li> <li>More direct market access with fewer intermediary steps</li> <li>Access to agricultural services via mobile devices:</li> <li>Predictions of price movements of goods</li> <li>Track weather forecast and trends</li> <li>Mapping of agricultural land</li> </ul>
Benefits for contractors:	<ul style="list-style-type: none"> <li>Visibility by a large number of farmers</li> <li>A competitive environment</li> <li>Electronic contracting and reporting</li> </ul>
Benefits for investors:	<ul style="list-style-type: none"> <li>Electronic farm records (files)</li> <li>Agricultural Land Exchange</li> <li>Crop structure predictions</li> </ul>
Benefits for educational services:	<ul style="list-style-type: none"> <li>Easy communication with farmers</li> <li>Immediate access to all relevant information</li> <li>The competitive environment of other agronomists</li> </ul>
Benefits for public administration:	<ul style="list-style-type: none"> <li>Strategically important information for policy making and decision making</li> <li>Contribution to the system for identification of agricultural parcels</li> <li>Contribution to the State Geodetic Authority</li> </ul>

Benefits for chemical sellers:	Information on the health of plants Biophysical parameters indicating the need for supplements Crop structure predictions Access to a large number of agronomists and educational services
Benefits for innovative small and medium enterprises:	Access to the technological framework for the development of value-added services BioSense accelerator

Source: Biosens (2020.) [https://biosens.rs/?page\\_id=7745&lang=sr](https://biosens.rs/?page_id=7745&lang=sr)

As presented in Table 1, supporting the continuing model of digital solutions in Vojvodina's agriculture companies as a model of growth for regional development could only contribute to all vital factors of human society (private sector, government, university, society). In Figure 2 there is the description of what is the role of ICT in agriculture. To presume that the technology is highly adopted and will continue to be adopted by farmers, we can explore some of the benefits that come with digital agriculture technology. The main advantage that digital agriculture technology brings includes: efficiency in the use of resources like fertilizers, chemicals, fuel, water, etc., improving quantity and quality of produced agriculture products, higher yield in same amount of land.

**Figure 2.** Role of ICT in agriculture.



Source: FAO (2016)

The main obstacle, beside the economic power of the farmers themselves, is their view that their current way of running business is quite satisfactory, or that their technology is very complicated and therefore could not be considered profitable. The state can contribute to education, because it is in the interest of the state to apply modern technology in agriculture in order to increase production and preserve natural resources. Advisory services are the route through which information should reach farmers. To succeed in this, they must have trained counsellors. The Provincial Secretariat for Agriculture has taken a step forward in this regard and advisers in the territory of Vojvodina are familiar



with the technology of data collection in electronic form, with the spatial component, etc. It is necessary to raise awareness about the protection and conservation of natural resources (land, water), as well as about saving time and energy through the use of new technologies in agriculture. It is necessary to engage both farmers and the public in the digital education.

As presented in Table 2, three major players in the field of digital agriculture of Vojvodina are the BioSense Institute, Greensoft, which is the member of TeleGroup system and InoSens.

**Table 2:** Three main players in the field of digital agriculture situated in Vojvodina

<p>BioSense Institute</p>	<p>-Research and Development Institute for IT in biosystems was founded by BioSense Centre, which is the existing organizational unit of the Faculty of Technical Sciences, University of Novi Sad, and it has been working as a research center within the University of Novi Sad for many years</p> <p>-internationally recognized multidisciplinary scientific research centre; it is one of the most developed and most modern scientific research centres in Southeastern Europe and has existed for eight years. It operates on two levels - within the Faculty of Technical Sciences and at the University of Novi Sad. So far, it has successfully implemented as many as 14 FP7 projects, with a total budget of over 10 million euros in donations, i.e. non-refundable funds that were directly invested in scientific projects and salaries of scientists. So far, it has won 4 projects in the “Horizon 2020” program (Autonomous Province of Vojvodina, 2020)</p> <p>-By creating innovative solutions that are available to all farmers regardless of the size of their farm, the BioSense Institute has a vision to provide small farmers in the region with advanced technologies at affordable prices, which would enable them to survive in a globally competitive environment</p> <p>-The development of the integrated agricultural monitoring system of the BioSense Institute can offer many benefits to different stakeholders in the agricultural sector</p> <p>-The ultimate goal of the BioSense Institute is to link the efforts and results of various research groups into a single integrated system for agricultural monitoring. This system will provide data sets that will lead to revolutionary progress in the agricultural sector, not only in terms of increasing efficiency, reducing pollution and saving money, but also in terms of how the agricultural activity is understood and performed, making agriculture an acceptable professional choice for younger generations of farmers</p> <p>-The digital farm is actually a real farm, on which agricultural production is carried out. On the other hand, it is demonstration goods, an educational tool where students of agricultural schools, students of agricultural faculties, but also farmers themselves can learn a lot about the implementation of modern technologies. The digital farm was established within the ANTARES project of the BioSense Institute, funded by the European Commission and the Republic of Serbia (E-kapija, 2020).</p>
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Greensoft	<p>-founded in 2012</p> <p>-developer of software solutions specializing in the management of agricultural production processes</p> <p>-guided by the fact that there is no appropriate business software in the global market that would allow the agricultural sector to adequately manage complex production processes, with the aim of increasing yields and profits, and reducing overall operating costs</p> <p>-developed software solutions specializing in the management of agricultural production processes and all types of land, based on GIS technology. Author's Software Solution "AgroLIFE," which is patented by the Institute for the Protection of Intellectual Property of Serbia, allows customers to efficiently and optimally plan and run a complete agribusiness</p> <p>-currently covering 1.2 million hectares with its platform, with great ambitions on a global level and hope to cover the entire territory of the Republic of Serbia.</p> <p>-mostly market-oriented, but interested in all forms of cooperation, with over 3000 private household users and over 50 users among public authorities.</p> <p>-Since 2014, as a member of the TeleGroup system, their vision has been to place the existing group of IT products intended for agribusiness on the global market and to create new products for intelligent agriculture and water management</p>
InoSens	<p>-innovative company in Serbia, founded as a spin-off of the University of Novi Sad. Its mission is to accelerate the transfer of innovative ICT technologies to the agribusiness sector</p> <p>-engaged in the design and development of sensors, deployment of Wireless Sensor Networks and the application of advanced remote sensing techniques for optimizing economic performance and environmental sustainability in agriculture</p> <p>-developing platforms and applications for optimization of farming activities on the field, targeting large farming estates with emphasis on vineyards and apple orchards</p> <p>-the company is developing remote sensing platform for crop classification and natural hazards monitoring - <i>CropSupport</i>. Promotion of the use of blockchain technology in the agribusiness sector in the Western Balkans is just one of the many projects of the company</p>

Source: BioSense Institute, Greensoft, Inosens, E-kapija (2020).

Agriculture is one of the areas undergoing the most dynamic changes, and today, more than ever, producers have the imperative to increase yields, grow quality products, and at the same time reduce costs.

### Discussions

There are many described case studies and research models (Barkovic, D., et al, 2018, Ćuković, I., 2017, Lakote, M., et al, and 2019) in digital agriculture across the region – in Croatia, Slovenia, Bosnia. The common denominators of all these successful examples are obvious benefits for agriculture as the main initiator of regional development. What is missing are quantitative data processed in form of more extensive statistical and econometric analysis, which could be used for evaluating the actual policies, strategies and action plans. It is imperative to produce safe and quality food, and digital agriculture is the right tool for that mission. The goals shown in the paper cannot be achieved in the short term, as there is a technological lag of Vojvodina's agriculture, but if we expand the benefits of digitalization of agriculture in Vojvodina, economy growth could be made.

In the recent decades in the region of Vojvodina, the growth of IoT technology is noticeable. The IoT based monitoring system for agriculture has been used to maximize the yield of crops by monitoring the environmental parameters and thus providing the necessary information to the farmer remotely. The proposed system is mainly developed for the betterment of farmers. The use of IoT over other technologies enables us to deploy it in any type of monitoring areas, making it flexible and robust. As we have described in our research and evaluation of the current circumstance through the 3 cases of digital agriculture companies in the Vojvodina Region, they have started to enhance regional economic growth. The results of our case study analysis confirmed that digital agriculture applications in Vojvodina's companies are improving education, implementation and prevalence of digital agriculture technologies in the agricultural sector, as well as capacity building in this niche – fulfilling potential of digital agriculture sector in the Autonomous Province of Vojvodina. The suggested model in this sector is a vehicle that could run not only the economic growth of Vojvodina and Serbia, but the regional one, as well.

Revolution in agricultural machines occurred a century ago. Half a century ago there was a revolution in agricultural chemistry. A decade ago, the new revolution in agricultural information technology started and it is called digital agriculture. We couldn't even assume that the basic factor of production - through agriculture - would be connected to digital technologies. We are now in the midst of a whirlwind of these developments and in a few years we will not be able to recognize the same digital agricultural landscape. According to FAO estimates, by 2050 we will need to produce 70% more food. The population is growing, therefore it is taking away land, and more food needs to be produced. Therefore, we need to find a way to increase productivity per unit area and not to disturb nature. Based on the analysis of the agricultural structure and circumstances in Vojvodina, we can conclude that digital agriculture can provide the significant regional economic growth. With The Smart Specialisation Strategy, The Strategy for Development of Digital Skills in the Republic of Serbia for the period from 2020 to 2024 and the three ongoing initiatives with a systematic approach in digitalisation of agriculture, we can expect radical changes in the agricultural policy in Autonomous Province of Vojvodina. Enhancing the technological modernisation in agriculture is a necessity for our presence and for our future.

### **Conclusions**

According to the United Nation's Sustainable Development Goals, digital agriculture has enviable potential to increase economic contributions through expansion of market opportunities, agricultural productivity and cost efficiency. Also, there are environmental benefits through the optimized resource use and through adaptation to climate change, as well as, social and cultural benefits through increased communication and inclusivity.

The fourth industrial revolution, which "smart" and interconnected machines and systems, also coincides with further discoveries in various areas, from determining the genome sequence to nanotechnology, and from renewable sources to quantum

computing. The correlation and connection between these technologies and their interaction in the physical, digital and biological field is the key exceptional benefit of fourth industrial revolution which significantly differentiate it from the previous industrial revolutions (Lakota, M., Stajko, D., Vindiš, P., Berk, P., 2019). As Weltzien (2016) anticipated, the interoperability and digital networking of agriculture enabled new process control systems. If we are concerned that the value added through the new technologies in digital agriculture is the extension associated with the agricultural products and that the main brunt is still on the weather risk, environmental and climate change, we can be sure that all indicators for decision making are better positioned by the usage of information and communication technology.

Likewise, four emerging thematic social science clusters, with great potential are identified: 1) Digital agriculture socio-cyber-physical-ecological systems conceptualizations; 2) Digital agriculture policy processes; 3) Digitally enabled agricultural transition pathways; and 4) Global geography of digital agriculture development. This future research agenda provides the ample scope for future interdisciplinary and transdisciplinary science on precision farming, digital agriculture, smart farming and agriculture 4.0 (Klerkx, L., Jakku, E., Labarthe, P., 2019). Declaration of cooperation on 'A smart and sustainable digital future for European agricultural and rural areas' was signed by twenty five European countries, who will take a number of actions to support successful digitalisation of agricultural and rural areas in Europe. This Declaration of cooperation recognises the potential of digital technologies to help tackle important and urgent economic, social, climate and environmental challenges facing the EU's agri-food sector and rural areas (European Commission, 2020). The advancement of digital skills is a necessary tool for the emerging the new technologies and their influence on the digital society and digital economy. Changes in architecture of business systems implies skills needed for employment, productivity, creativity and success. The Vojvodinian agricultural sector could use growing potentials of digitalisation in agriculture and maximise the availability of experts and new technologies, along with information security and safety of the network.

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### **Conflict of interests**

The authors declare no conflict of interest.

## References

1. Barković, Đ., Radočaj, D., Zrinjski, M., Gašparović, M. (2018). Analiza mogućnosti primjene bespilotnih letjelica u preciznoj poljoprivredi, *Zbornik radova 11. Simpozija ovlaštenih inženjera geodezije*, pp. 110-115. [in English: Barkovic, Dj., Radocaj, D., Zrinjski, M., Gasparovic, M. (2018). Analysis of the Possibility of Using Unmanned Aerial Vehicles in Precision Agriculture, Proceedings of the 11th Symposium of Certified Geodetic Engineers, pp. 110-115.]
2. Čuković, I. (2017). Upotreba gis-a u planiranju poljoprivredne proizvodnje – studija slučaja, *Sveučilište Josipa Jurja Strossmayera, Poljoprivredni fakultet u Osijeku*. [in English: Cuković, I. (2017). The Use of Gis in Agricultural Production Planning - a Case Study, Josip Juraj Strossmayer University, Faculty of Agriculture in Osijek.]
3. European Commission (2016). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Next Steps for a Sustainable European Future.
4. Retrieved from [https://ec.europa.eu/europeaid/sites/devco/files/communication-next-steps-sustainable-europe-20161122\\_en.pdf](https://ec.europa.eu/europeaid/sites/devco/files/communication-next-steps-sustainable-europe-20161122_en.pdf)
5. Food and Agriculture Organization of the United Nations FAO (2016). The State of Food and Agriculture, Climate change, agriculture and food security, Food and Agriculture Organization of the United Nations, Rome.
6. Food and Agriculture Organization of the United Nations FAO (2017). The State of Food and Agriculture, Leveraging food systems for rural transformation, Food and Agriculture Organization of the United Nations, Rome.
7. Goldman Sachs Group Inc. (2016), Precision Farming, *Profiles in Innovation* pp. 17.
8. VOICE, Vojvodina's Research and Analytical Centre, Agriculture in Serbia Has Fallen to the Level of the Poorest Countries in the Sub-Saharan Region.
9. (<http://voice.org.rs/poljoprivreda-u-srbiji-pala-na-nivo-najsiromasnijih-zemalja-subsaharskog-regiona/>, Retrieved April 22, 2020.)
10. Web site of Serbian Government, Facts about Serbia, Agriculture. (<http://www.arhiva.srbija.gov.rs/cms/view.php?id=1024>, Retrieved April 22, 2020.)
11. Autonomous Province of Vojvodina, (<http://www.vojvodina.gov.rs/sr>, Retrieved May 3, 2020.)
12. Agroplus, Use of Modern Information Technologies (IT) in Regular Field Activities of Farmers, (<https://agroplus.rs/upotreba-savremenih-informacionih-tehnologija-it-u-redovnim-poljskim-aktivnostima-poljoprivrednika/>, Retrieved May 2, 2020.)
13. Biosens Institute, ([https://biosens.rs/?page\\_id=7745&lang=sr](https://biosens.rs/?page_id=7745&lang=sr), Retrieved January 22, 2020.)
14. Inosens, (<https://inosens.rs/>, Retrieved April 27, 2020.)
15. E-kapija, BioSense Institute - Digital Farm,

16. (<https://www.ekapija.com/news/2433783/institut-biosens-digitalna-farma>, Retrieved May 5, 2020.)
17. Ivanov, I. (2018). Digital Technologies in Agriculture: Adoption, Value Added and Overview (Retrieved from <https://medium.com/remote-sensing-in-agriculture/digital-technologies-in-agriculture-adoption-value-added-and-overview-d35a1564ff67>).
18. Lakota, M., Stajanko, D., Vindiš, P., Berk, P. (2019). Automatization And Digitalization In Agriculture, *Poljoprivredna Tehnika 2019(2)*, pp. 13 – 22.
19. Laurens, K., 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.
20. Olaniyi E. (2018). Digital Agriculture: Mobile Phones, Internet Agricultural Development in Africa, *Munich Personal RePEc Archive*, (available at <https://mpra.ub.uni-muenchen.de/90359/77>).
21. Pitić S., Savić N, Verbić S. (2018). Digital Transformation and Serbia, *Ekonomika preduzeća*, pp. 118.
22. Sarkar J.P., Chanagala S. (2016). A Survey on IOT Based Digital Agriculture Monitoring System and their Impact on Optimal Utilization of Resources, *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) Volume 11, Issue 1, Ver.II*, pp 01-04 (available at [www.iosrjournals.org](http://www.iosrjournals.org)).
23. The Ministry of Education, Science and Technological Development of the Republic of Serbia (2019). Smart Specialization Strategy in the Republic of Serbia for the Period from 2020 to 2027.
24. Weltzein C. (2016). Digital Agriculture or Why Agriculture 4.0 Still Offers Only Modest Returns, *Landtechnik* 71(2),pp. 66–68.
25. World Bank Group (2018). Exploring the Potential of Agriculture in the Western Balkans. A Regional Report.
26. Yin, R.K. (2003). Case Study Research: Design and Methods, *London: Sage Publications*.