SOME ASPECTS OF SMART TECHNOLOGY APPLICATION IN AGRICULTURE OF THE REPUBLIC OF SERBIA[1]

Zoran Simonović[2], Nikola Ćurčić[3]

Abstract

The application of smart technology in agriculture is a kind of third green revolution in the development of agricultural production. The authors believe that agricultural production must be organized in a modern way. The application of smart technology in agriculture represents the future of production. This attitude is quite acceptable if one takes into account that smart agriculture meets modern food production trends that require great efficiency in the use of all elements involved in production. It is precisely the efficiency of agriculture that is viewed through the achieved level of productivity, which is observed through the ratio of the number of employees and the volume of arable land, but also through the use of modern technologies used in production. In this sense, smart agriculture is a modern technology that can respond to current problems that exist on the world and are related to food production. The application of intelligent technology in agriculture is carried out through an Internet system through essential sensory networks through which applications are administered to various agricultural systems such as irrigation, fertilizing, spraying, etc. Climate change affects the change in agricultural production as well as food production, which certainly influences the transformation of the entire agriculture. Climate change, on the other hand, supports the development of smart precision agriculture, because precise agriculture can be adequately addressed. At the end of the paper, the authors gave results of research related to the knowledge and possibilities of applying smart technology in agriculture in the Republic of Serbia. The aim at the research is to gain insight into how many agricultural producers know about the benefits that smart technology provides in with production.

Key words: *application of modern technology in agriculture, Information and communication technologies in agriculture, climate change, production, Serbia.*

---

[1] Paper is a part of the research at the project no. III 46006 - Sustainable agriculture and rural development in the function of accomplishment of strategic goals of the Republic of Serbia within the Danube region, and project TR-31051 - Improvement of biotechnological procedures as a function of rational utilization of energy, agricultural products productivity and quality increase, financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia, for the project period 2011-2014.

[2] Zoran Simonović, Ph.D., Scientific Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: zoki@medianis.net.

[3] Nikola Ćurčić. Ph.D., Docent, University Union – Nikola Tesla, 11000, Belgrade, Faculty of Management, Njegoseva 1a, 21205 Sremski Karlovci, Serbia, Phone +381 21 21 551 85, E-mail: nikolacurcic@yahoo.com.

Introduction

Modernization and advancement of agriculture in many respects depend on the introduction of new working methods. In the first place, they are industrial assets, industrial labor organizations, and the application of new technologies such as smart agriculture. This leads us to believe that the development of agriculture and its production is dictated by factors outside of agriculture. Agriculture is basically just a base and a starting point for economic development, and the impetus for development comes from the modern industry.

Agriculture should be viewed in two respects. On the one hand, agriculture is important as the primary producer of food and other plant and animal products and this importance is undoubtedly increasing. On the other hand, agriculture is the basis of initiating economic development. How much agriculture will serve as a basis of a faster economic development depends not only on the natural basis of agriculture, but also on social, economic and political and other moments.[4]

In this respect, the development of the concept of smart agriculture, which represents the application of modern Information and Communication Technologies (ICT) in agriculture, should be considered. By applying these technologies, it can be freely said that the so-called, third green revolution.

Following the cultivation of plants and the genetic revolution, this third green revolution takes over the agricultural world with a variety of ICT solutions such as precision machines, internet-related "things", such as interconnected machines, devices, objects to animals and humans, and actuators, system geo-positioning, large data analysis (Big Data), unmanned aircraft, drones, robots and the like. From the perspective of agricultural producers, smart agriculture should provide added value of the farmer through decision support or through more efficient use of resources. Therefore, the Smart-AKIS Network includes three interconnected narrow-band technologies of smart agriculture:

- Information systems management: Systems for collecting, processing, storing and distributing data onto the appropriate format in order to make the business on the property faster and more efficient;

[4] Simonović, Z., Jeločnik, M., & Vasić, Z. (2012). Economic Position of Serbian Agriculture in the Transition Period. *Economics of Agriculture, Institute of Agricultural Economics*, 536-546.

- Precision agriculture: Manage both spatial and time variables in order to improve economic return on investment, with reduced use of input raw materials and reducing environmental pollution. This includes Decision Support Systems at the level of the entire property aimed at optimizing the return to investment, with an unchanged level of investment. This is facilitated by the widespread use of GPS, GNSS, terrain shots by cameras set on throats, the latest generation of hyper temporal photos made by Sentinel satellites, which create map maps showing all relevant factors that can be measured (for example: land yield, characteristics terrain / topography, favorability for organic production, humidity level, nitrogen level, etc.);
- Agricultural automation and robotics: The process of applying robotics, automated control and artificial intelligence at all levels of agricultural production.

Methodology and data sources

We think that our work has a research character, and this was a subordinate method. In the research of the application of smart technology in agriculture, we applied several methodological approaches. 1) The research had to rely on foreign and domestic literature. This literature was important to studying the application of smart technology in agriculture today in the world. 2) Author's research in the thematic field was used. 3) At the end of the research carried out by the Institute of Agricultural Economics and its associates in the previous period.

In general, the research relied primarily on foreign literature. As far as domestic sources are concerned, they are scarce and insufficient for a more comprehensive examination of the problem of smart agriculture. We believe that not only in the world but also in our country there is an increased interest in researching the application of smart agriculture from various modern aspects: from the aspect of sustainable development, production of healthy - environmentally sound food, from the viewpoint of proper use of agrarian resources, water, the natural environment at all. Foreign literature on these problems was used. That is why it was one of the tasks of this research to study and present the latest insights on this issue. Internet information that is numerous and important should also be mentioned.

Special attention is paid to periodicals (scientific journals) and to scientific consultations (Chamber of Labor), as the current problems that influence the development of smart agriculture is better observed.

A brief overview of the development of smart technology in agriculture in the world

Through the application of modern technology, agriculture has undergone major changes in the past century. The emergence of concentrated agricultural production characterized by the intensive application of new inputs for production, such as electro-mechanical motor-driven devices, agro-chemicals and the use of new and modified plant and animal materials (such as highly widespread breeds and varieties). This new agricultural practice led to the application of better farming management techniques, all in order to meet the growing consumer demands for reliable supply of consistently high quality, safe, diversified and nutritious food products.[5] The situation in agricultural production, which strives for continuous advancement and improvement of technologies and techniques, certainly influenced the development of smart agriculture.

The premise of the application of smart technology in agriculture is based on a large number of precise information's necessary for decision making. Direct comparison of the long-term parameters obtained from the plot enables optimal use of the means of operation, minimizing environmental risks, increasing the quality of products and, above all, increasing the profitability of production and / or profits.[6]

It should be noted that the application of smart technologies in agriculture is not a completely new concept. In fact, the application of these technologies has its beginnings as far back as the 1960s, when farmers of developed countries for the first time started to use laser-controlled controls for precisely leveling or irrigating large agricultural areas. Cloud,[7] with work on the computer and the Internet of Things (IOT) are

[5] Opara, L. (2004). Emerging technological innovation triad for smart agriculture in the 21st century. Part I. Prospects and impacts of nanotechnology in agriculture.

[6] Marković, D., Pokrajac, S., Simonović, V., & Marković, I. (2013). Ekonomska evaluacija GPS tehnologije u poljoprivredi Srbije. *Škola biznisa*, *3-4*.

[7] The idea of the Cloud technology is based on the fact that all the information that is necessary for the user (whether it's applications, documents, hardware, or anything else) is available at all times, of course with the pre-requisite that an internet connection is previously

two actual concepts. They together represent the hard core of the next generation information technology industry. Shortly after President Barack Obama proposed the concept of the "smart planet" in 2009, Chinese Prime Minister Vane encouraged the development idea of China's feeling, which mainly emphasized the need for the development of IOT and strategic new industries. IOT is closely related to Cloud and computer workmanship in the way that IOT acquires powerful computer tools through cloud-based work on the computer and cloud computing on the computer the highest quality IOT-based channel. China is a typical agricultural land with the production of rice, pork, fruits, freshwater products and many other types of foods that are being sold worldwide. Agriculture, rural areas and farmers are particularly important when it comes to reforming the modernization.[8]

Although the term "internet of things" was skewed in 1999, IOT-enabled technologies, such as sensor networks, existed since the 1990s. Due to the advancement of sensor and cloud technology (Cloud), processing and storage capabilities and reducing the cost of sensor production, the growth of sensor application has increased over the last five years.[9] The European Commission has predicted that by 2020 it will be connected to 50 to 100 billion devices with the Internet.[10] There are three IOT components that enable smooth operation of such systems. Those are:

1. Hardware - composed of sensors, actuators and embedded communication hardware
2. Tools - for data storage and computer tools for data analysis and
3. Presentation - new easily understandable visualization and interpretation tools that have great access to different platforms and can be designed for different applications.[11]

---

established. So, cloud in some way represents the service of delivering services instead of the product itself.

[8] Tong Ke, F. (2013). Smart agriculture based on cloud computing and IOT. *Journal of Convergence Information Technology*, *8*(2).

[9] Perera, C., Zaslavsky, A., Christen, P., & Georgakopoulos, D. (2014). Sensing as a service model for smart cities supported by internet of things. *Transactions on Emerging Telecommunications Technologies*, *25*(1), 81-93.

[10] Sundmaeker, H., Guillemin, P., Friess, P., & Woelfflé, S. (2010). Vision and challenges for realizing the Internet of Things. *Cluster of European Research Projects on the Internet of Things, European Commission*, *3*(3), 34-36.

[11] Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future generation computer systems*, *29*(7), 1645-1660.

Management in smart agriculture is related to a specific location. The basic idea is to do everything right, in the right place, at the right time. This idea is as old as agriculture, but during mechanization of agriculture in the 20th century, there has been a strong economic pressure on treating large fields with the application of unique agricultural practice. Precision agriculture provides a way of automating a specific location, using information technology, thus managing the management of a specific site practically in commercial agriculture. Smart agriculture encompasses all those agricultural production practices that use information technology or adapt the input to achieve desired outcomes or monitor these outcomes (egg Variable Speed Application (VRA), yield monitor, remote sensing).

Lovenberg-DeBoer and Svinton (1997) define the management of a specific location as an electronic control and control that is used to collect data, process information, and support decision-making for time and spatial distribution of inputs for crop production. They point out that the focus is on agronomic, but the arguments relate to agricultural crops and to electronic labeling of cattle.[12] But not only that, but also agricultural machinery used in agricultural production.[13]

In smart agriculture technology, the wireless sensor network is used to obtain different information about supervised objects of the collaboration with various integrated miniature sensors. With the built-in information process and random only organized wireless networks, the information is sent to the user terminal. Based on the characteristics of automation, organization and data concentration only, the wireless sensor network can be applied to obtain land moisture data in the field, and then the data is fused and transmitted automatically to provide a high efficient platform for downloading data on humidity of the field the most optimal irrigation would take place.

Wireless sensor networks are the basis of a smart irrigation control system. In particular, important sensory knots are used by researchers and farmers to collect field data. In addition, for the purpose of implementing smart irrigation, only the moisture content in the soil is obtained from the sensor

[12] Bongiovanni, R., & Lowenberg-DeBoer, J. (2004). Precision agriculture and sustainability. *Precision agriculture*, *5*(4), 359-387.

[13] Primicerio, J., Di Gennaro, S. F., Fiorillo, E., Genesio, L., Lugato, E., Matese, A., & Vaccari, F. P. (2012). A flexible unmanned aerial vehicle for precision agriculture. *Precision Agriculture*, *13*(4), 517-523.

nodes, but it does not contain any amount of water. However, the amount of water is a very important factor of the growth and development of this technology. The smart irrigation control systems mentioned are commonly used for wire communication and a centralized control scheme. The efficiency of such an organized system is small. Taking into account the price, wireless sensor network cannot be temporarily applied to agriculture. For this reason, the smart irrigation control system is developing not fast enough. At this stage of smart agriculture development, it is necessary to reduce the cost of wireless sensors, devices for controlling irrigation and maintenance of hardware and software.[14]

But despite all of the foregoing, in the last few years research in the field of wireless sensor networks has experienced an expansion due to lower prices of sensors and radio transceivers (RPP - radio transceiver) for communication at small distances, so today it is possible to make relatively cheap mote, devices that are equipped with sensors, processor, RPP and independent power supply. By networking these devices, it is possible to make BSM, which can monitor the phenomenon from a distance and transmit the information about an arbitrary location on a global network, the Internet, a device for controlling irrigation and maintenance of hardware and software.[15]

The impact of climate change on the development of smart agriculture

Today agriculture is facing great challenges. The fact is that almost one billion people go to bed every day. It is also predicted that by 2050 humanity will be increased by just over two billion people.[16] In addition, food consumption standards are changing as the average person in the world becomes richer and consumes more food and more meat. There is increased competition of soil, water, energy and other inputs in food production. Climate change poses additional challenges to agriculture, especially in developing countries. At the same time, many current agricultural productions are detrimental to the environment and represent the main source

[14] Xiao, K., Xiao, D., & Luo, X. (2010). Smart water-saving irrigation system in precision agriculture based on wireless sensor network. *Transactions of the Chinese Society of Agricultural Engineering*, *26*(11), 170-175.

[15] Zogović, N., & Dimić, G. (2008). Zahtevi i tehnološke mogućnosti komunikacionih sistema u preciznoj poljoprivredi.". In *Konferencija TELFOR, Beograd*.

[16] Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., ... & Hottle, R. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, *4*(12), 1068.

(19-29%) of emissions of anthropogenic emissions of greenhouse gases.[17]

Climate change influences the change in agricultural production and food production, and certainly also affects the transformation of entire agriculture, with the aim of supporting global food security and poverty reduction. Climate change introduces greater uncertainty and risk among farmers and creators of agrarian policies, but on the other hand they do not have to lead to a paralysis of production.[18] Technology in smart agriculture should be integrated and transformed into a clear approach to addressing food safety issues and must be in line with climate change. It must be established at all levels from a local to a global level. It should be based on research, aligning agricultural policy of the state of the field and must provide investment in agriculture. All this should be established through private and public sectors of civil society in order to achieve the level and rate required for the changes. With the right practice, policies and investments, the agricultural sector can move to smart agriculture, which can result in a decrease in food insecurity and poverty in the short term. On the other hand, it will contribute to reducing the impact of climate change and the risks associated with food safety in the long term.

Possibilities of applying smart technology in agriculture in Serbia

Serbia has favorable natural conditions for the development of diverse agricultural production. As it is known, it is located in a favorable area of northern latitude characterized by four seasons and four climate zones. That is why various plant and animal production can be developed: cereals, industrial plants, fruits and vegetables, seeds and planting material, medicinal herbs, large and small cattle. In addition to climate, land is the most important natural condition for the development and distribution of agriculture. Soil fertility is subject to change and is directly influenced by climate, hydrological and biological changes, as well as people's activities.
According to the current documents and Strategies of the Government of Serbia, it can be concluded that agriculture represents an important segment of Serbia's economic development. The importance of agriculture for the national economy is that in addition to the economic one, it has a social and ecological component. On the basis of everything exposed, we can conclude

[17] Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. *Annual Review of Environment and Resources*, *37*, 195.
[18] Vermeulen, S. J. et al. (2013). Addressing uncertainty in adaptation planning for agriculture. Proc. Natl Acad. Sci. USA 110, 8357–8362.

that Serbia's agriculture has the necessary level that is necessary for the production of food. However, despite the high potential in the agricultural production sector resulting from favorable climatic conditions, natural characteristics of the land and available water resources, it has not yet been sufficiently exploited.[19]

Scientific research work in our agriculture takes place in scientific research organizations or institutes. Also, in almost all agricultural faculties, departments or departments of a scientific unit are formed within the institutes dealing with scientific work.

The public interest in greater production of agriculture would be further complemented by the engagement to appropriate scientific institutions. These institutions would contribute to a good mastery of technical and technological achievements, or better use of new machines and technological procedures for cultivating new varieties of plants and animals. In the application of smart agriculture these institutions would become irreplaceable.

In this context, the Government of Serbia is 02.10.2017. in cooperation with the BioSens Institute opened the Center of Digital Agriculture of Serbia.

The Center is one of the first results of the joint work of the Government of Serbia and the researchers of the BioSens Institute on the introduction to information technologies in agriculture. The Center is an example of the practical application of innovative IT solutions and digitization in order to increase the efficiency and competitiveness of domestic agriculture.

During the opening of the Digital Agriculture Center of Serbia, the AgroSens digital platform will be putting into operation, whose basic services are free of all farmers. The platform enables the mobile phone to become a tool through which timely, geographically precise and relevant information on agricultural production activities is exchanged. These are data that have practical application: satellite monitoring of crop conditions, localized weather data, and digitized data on chemical and mechanical composition of the land, the activity record on the plot, the catalog of seeds and chemical preparations, and a catalog of state-of-the-art technological solutions for precision agriculture.[20] In this way, Serbia

[19] Simonović, Z., (2014). Upravljanje agrarom Srbije u tranziciji, Institut za ekonomiku poljoprivrede, Beograd, str. 124-132.
[20] http://www.agrosmart.net/vesti/otvara-centar-digitalne-poljoprivrede.html

joined the creation of conditions for the development of smart agriculture.

Questions related to the application of smart agriculture in Serbia

We are keen to find out how much our agricultural producers know the possibilities of applying smart technology in agriculture. We asked our farmers a few questions. The first question relates to informing farmers about the possibilities of using smart agriculture. As Table 1 shows, only 4% of the third party claims that it knows a lot about the possibilities of applying smart technology in agriculture.

Table 1. *Informing agricultural holdings about the possibilities of using smart technology in agriculture?*

answers of respondents	number of respondents	participation in %
quite familiar	4	4.44
medium	18	20.00
little	39	43.33
not known	29	32.22
in total n=90	90	100.0

Source: *Calculation of the author based on the survey.*

Nearly two-thirds of respondents did not have or heard little about smart technology in agriculture. This tells us how much this topic is new and how little or no it is talked about. The next question we asked the bearers was whether you would use smart agriculture in your agricultural production.

Table 2. *Would you use smart technology in your production?*

answers of respondents	number of respondents	participation in %
yes	31	34.44
no	42	46.67
no answer	17	18.89
in total n=90	90	100.0

Source: *Calculation of the author based on the survey.*

We got interesting answers to this question. Over 46% would not use smart agriculture, while using 34%. Based on this answer, we can conclude that there are many farmers that do not know the benefits of applying smart technology in agriculture. There is also lack of interest in introducing new technologies in agricultural production.

And on the basis of the next question, we can notice that the percentage structure of the respondents is moving in the large ignorance of the topic by the respondents. Just 60% of respondents did not even want to answer this question. Only slightly more than 5% see their interest in investing in smart agriculture.

Table 3. *Do you know that investments in smart technologies create conditions for cheaper production?*

answers of respondents	number of respondents	participation in %
yes	5	5.56
no	7	7.78
partially	24	26.67
no answer	54	60.00
in total n=90	90	100.0

Source: *Calculation of the author based on the survey.*

Better introduction to our agricultural producers with this issue would certainly be useful and productive for our agricultural production. Serbia's agriculture has to respond too many of the challenges that a wait on the road to the EU. It is precisely in this sense that our reformed agricultural policy must be organized, which would rely on the application of technical, technological and ecological standards in agriculture, which should be able to form modern models of agricultural producers and entrepreneurs, which would be equal to the agrarian entrepreneurs in the European Union.

Perhaps the solution to our agricultural producers is their joint organization of the form of cooperatives or other associations for agricultural producers, with the aim of making it easier to procure funds that are necessary for the application of smart agriculture. At present, cooperatives in Serbia are practical organizations. Most of the cooperatives in the modern way of doing business tend to think about fulfilling their current obligations. This way of thinking influences that the cooperative movement properly looks at the way to the future. The Cooperative Movement is today focused on pragmatic inclusion, responding to the given opportunities in order to adapt to the changes.[21]

[21] Simonović Z, Mihailović B, Milovanović Z. Cooperatives and farmers association as a model of entrepreneurship in Serbian agriculture regarding the case of Nišava district. Ekonomika poljoprivrede 2016; 63(2):699-712.

Conclusion

The application of smart technologies in agriculture has great potential that can advance agricultural production, primarily based on more precise and efficient use of resources. Many countries like the United States have done a lot to develop this technology. To mention that the percentage of agricultural producers using smart-technology technologies ranges from 20-80%, in Europe this share ranges in a modest range from 0 to 24%. And the Republic of Serbia is entering this European average. And other countries in the world like China and India are increasingly investing and developing this kind of agricultural production. On the basis of everything ahead, we can freely say that smart agriculture represents the future.

The reasons for the accelerated development of smart agriculture technologies should also be sought in the fact that climate change has a significant impact on the current way of agricultural production and food production. In this way, they certainly influence the transformation of the entire agriculture. The ultimate goal of developing smart agriculture would be to support global food security and reduce poverty and hunger.

Smart agriculture technologies should not be targeted exclusively to large, developed agricultural farms, but could be a factor that will support the development of other forms of farming. We think primarily of small family farms and organic production in agriculture. The application of smart agriculture technology could improve the reputation for agricultural producers in European consumers, society as a whole, and adapt them to market conditions. Smart Agriculture can bring benefits in terms of environmental protection, by reducing water use or by optimizing the use of different pesticides.

At the end of the paper, the authors gave a survey on the possibilities of applying smart technology technologies to the holders of agricultural holdings in the Republic of Serbia. They found that farmers in Serbia are not sufficiently familiar with the possibilities and benefits of applying smart agriculture in their farms. We believe that Serbian agricultural producers should be more active and more involved in projects that imply the implementation of smart agriculture. The state could do a lot to facilitate the implementation of smart agriculture, because in this way, Serbia's agriculture is preparing for the upcoming times, which, in all likelihood, will increasingly be conditioned by climate change. This could be done primarily by subsidizing the production and use of systems used in smart agriculture.

Literature

1. Bockel, L., Sutter, P., Touchemoulin, O., & Jönsson, M. (2012). Using marginal abatement cost curves to realize the economic appraisal of climate smart agriculture policy options. *Methodology*, *3*(1).

2. Bongiovanni, R., & Lowenberg-DeBoer, J. (2004). Precision agriculture and sustainability. *Precision agriculture*, *5*(4), 359-387.

3. Cvijanović, D., Simonović, Z., & Mihailović, B. (2011). Težišta i ciljevi novijih reformi agrarne i regionalne politike Evropske unije. *Ekonomika poljoprivrede*, *58*(3), 359-370.

4. Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future generation computer systems*, *29*(7), 1645-1660.

5. Xiao, K., Xiao, D., & Luo, X. (2010). Smart water-saving irrigation system in precision agriculture based on wireless sensor network. *Transactions of the Chinese Society of Agricultural Engineering*, *26*(11), 170-175.

6. Karun, S., Manjeet, S., & Ankit, S. (2017). Design and development of a yield monitor for grain combine harvester. *Poljoprivredna tehnika*, 42(1), 11-20.

7. Li, L., Xiaoguang, H., Ke, C., & Ketai, H. (2011, June). The applications of wifi-based wireless sensor network in internet of things and smart grid. In *Industrial Electronics and Applications (ICIEA), 2011 6th IEEE Conference on* (pp. 789-793). IEEE.

8. Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., & Hottle, R. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, *4*(12), 1068.

9. Marković, D., Pokrajac, S., Simonović, V., & Marković, I. (2013). Ekonomska evaluacija GPS tehnologije u poljoprivredi Srbije. *Škola biznisa*, *3-4*.

10. Mihailović B, Tepavac R, Kovačević M. Application of factor analysis in evaluation of the consulting development in Serbia. Ekonomika poljoprivrede 2012; 59(2):229-242.

11. Mihailović B., Simonović Z., & Ćurčić N. (2017). Agricultural resources and development priorities of the municipality of Stara Pazova. *Ekonomika Poljoprivrede*, *64*(1), 259-274.

12. Njegomir V, Tepavac R, Bikicki T. Risk management in agriculture under climate changes. Ekonomika poljoprivrede 2016; 63(4):1403-1416.

13. Opara, L. (2004). Emerging technological innovation triad for smart agriculture in the 21st century. Part I. Prospects and impacts of nanotechnology in agriculture.

14. Perera, C., Zaslavsky, A., Christen, P., & Georgakopoulos, D. (2014). Sensing as a service model for smart cities supported by internet of things. *Transactions on Emerging Telecommunications Technologies*, *25*(1), 81-93.

15. Primicerio, J., Di Gennaro, S. F., Fiorillo, E., Genesio, L., Lugato, E., Matese, A., & Vaccari, F. P. (2012). A flexible unmanned aerial vehicle for precision agriculture. *Precision Agriculture*, *13*(4), 517-523.

16. Sundmaeker, H., Guillemin, P., Friess, P., & Woelfflé, S. (2010). Vision and challenges for realising the Internet of Things. *Cluster of European Research Projects on the Internet of Things, European Commision*, *3*(3), 34-36.

17. Simonović, Z., Jeločnik, M., & Vasić, Z. (2012). Economic Position of Serbian Agriculture in the Transition Period. *Economics of Agriculture, Institute of Agricultural Economics*, 536-546.

18. Simonović, Z., (2014). Upravljanje agrarom Srbije u tranziciji, Institut za ekonomiku poljoprivrede, Beograd, str. 124-132

19. Simonović, Z., Mihailović, B., & Milovanović, Z. (2016). Cooperatives and Farmers Association as a Model of Entrepreneurship in Serbian Agriculture Regarding the case of Nisava District, *Ekonomika poljoprivrede*, 63(2), 699-712.

20. Subić, J., & Jeločnik, M. (2017). Economic Effects of the Solar and Wind Energy use in Irrigation of Vegetable Cultures. International scientific meeting: „Sustainable agriculture and rural development in terms of the Republic of Serbia strategic goals realization within the Danube region - development and application of clean technologies in agriculture - *Thematic Proceedings*, 37-55.

21. Sun, Q. B., Liu, J., Li, S., Fan, C. X., & Sun, J. J. (2010). Internet of Things: Summarize on Concepts, Architecture and Key Technology Problem [J]. *Journal of Beijing University of Posts and Telecommunications*, *3*(3), 1-9.

22. Tong Ke, F. (2013). Smart agriculture based on cloud computing and IOT. *Journal of Convergence Information Technology*, *8*(2).

23. Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. *Annual Review of Environment and Resources*, *37*, 195.

24. Vermeulen, S. J. et al. (2013). Addressing uncertainty in adaptation planning for agriculture. Proc. Natl Acad. Sci. USA 110, 8357–8362.

25. Zakić N, Vukotić S, Cvijanović D. Organisational models in agriculture with special reference to small farmers. Ekonomika poljoprivrede 2014; 61(1):225-237.

26. Zogović, N., & Dimić, G. (2008). Zahtevi i tehnološke mogućnosti komunikacionih sistema u preciznoj poljoprivredi.". In *Konferencija TELFOR, Beograd*.

27. http://www.arhiva.srbija.gov.rs/cms/view.php?id=1024 (15.09.2017)

28. http://www.agrosmart.net/vesti/otvara-centar-digitalne-poljoprivrede.html (03.10.2017)