

COMMUNICATION TECHNOLOGIES AS A PREREQUISITE FOR THE DIGITALIZATION OF RURAL AREAS IN THE REPUBLIC OF SERBIA

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Abstract

Increasing productivity and competitiveness within the agricultural industry is the goal of applying digitalization to agriculture. The objective of creating a food and agriculture system that better serves consumer requirements and is robust, productive, and sustainable can be aided by technological developments. These advantages are attained in two ways: directly through industry players, such as service providers, adopting new technologies, and indirectly through the government using those same technologies to improve policymaking. By giving private sector suppliers access to new markets, offering new means for governments to monitor and enforce standard compliance, and streamlining border procedures required for perishable goods, digital technologies can facilitate commerce in agricultural and food items. The development of infrastructure is a necessary condition for the successful digitization of rural areas.

Key words: Rural development, Digitalization, Competitiveness, Technological transformation.

Introduction

Over time, the place and importance of agriculture in each nation's economic system have changed; it used to be primarily concerned with providing food security, but it is now acknowledged to be of strategic importance. For the Republic of Serbia, it is crucial to restore the agriculture and food system, stabilize the operating environment within it, and encourage domestic businesses to compete.

Given its inherent production capacity, ability to adjust to long-term market trends (such as food demand, price volatility, and global pricing dynamics), and possible contribution of the primary sector to overall economic development, this is especially pertinent. Excellent climatic and geographic conditions allow for the cultivation of unique plant and animal species that are characterized by their specificity and represent a relatively small portion of the international and global market, as well as organic (ecologically unconventional) farming in Serbia (Radosavljevic, 2017).

A greater awareness and foresight of the frequently unidentified repercussions is required by the responsible research and innovation approach (Rijswijk et al., 2021). Although progress in the agrarian sector has been comprehensive and evident in the majority of countries, its extent and pace vary dramatically. Thus, agriculture, like other sectors, reflects the overall state and level of economic and societal development. In

developed countries, the concept of modern agro-industry operates, supported by the agro-business complex.

Conversely, in developing countries, traditional agriculture persists with low productivity, diverse production primarily intended for subsistence, and is based on family farming, labor-intensive processes, minimal investments, and the transfer of fundamental production factors across generations.

Nevertheless, with the advent of globalization and market opening, there is increasing evidence of modernization in the agrarian sector even in developing countries. Increased productivity and sustainability of the agricultural sector are core policy objectives in OECD and non-OECD countries (Bureau and Antón, 2022).

Digitalization represents a decisive technological transformation of this era and, as in other sectors, will have significant impacts on agriculture. As a process, digitalization has the potential to lead to substantial changes in the functioning of agriculture, beyond discrete tools, technologies, or practices, and to offer pathways for innovation and new methods of organizing production and supply chains.

Specifically, the agricultural sector is experiencing a range of transformative trends due to digitalization, such as a greater emphasis on precision agriculture, the Internet of Things (IoT), and the use of big data to drive production and operational efficiency.

Digital technologies should give an answer to the real demand of the sector, and in particular, in those specific activities (Brunori et al., 2023). Public and private actors in agricultural and food value chains and the broader agricultural innovation system could benefit from the digital transformation of agriculture in various ways.

Digital technologies could also provide opportunities for new sources of efficiency and value creation both upstream and downstream of farms, support research and innovation, create new services for the sector, and enhance traceability and efficiency in value chains (Jouanjean, 2019).

Over the past few decades, farmers have increasingly adopted digital tools to enhance their operations (Schimmelpfennig, 2016; Du, Xiaoxue et al., 2016), a trend that was accelerated by physical distancing measures implemented during the pandemic. Reflecting this, agricultural and food sectors are increasingly composed of a blend of physical and digital elements, with growing interaction between them. The radical transformation heralded by the digitalization of the economy has yet to be fully realized within global agricultural systems (Khanna, 2021; Birner et al., 2021).

Competitiveness of the agro-sector as a goal of digitalization

Historically, the transformation from subsistence to commodity production occurred, alongside the integration of the agriculture and industry sectors. Socio-economic concepts have emerged concerning the reorganization of the modern agrarian sector in developed market economies and the challenges of transitional adjustment in developing countries.

Technical and technological progress is reflected in the application of new knowledge and practices aimed at increasing productivity while simultaneously preserving natural

resources. In the professional literature, this type of advancement is referred to as the "Green Revolution."

The role of agriculture in rural development in Serbia is crucial from several aspects. Here is how each of these factors relates to this topic:

1. **Modernization of Agriculture:** Serbia has implemented a range of initiatives to modernize its agriculture. This includes investments in infrastructure, technology, and farmer education. The adoption of modern techniques and technologies can enhance the productivity and competitiveness of Serbian agriculture, creating new opportunities for rural development.
2. **Market Access:** Ensuring that farmers have access to both domestic and international markets is vital. Serbia has worked on improving trade agreements and facilitating the export of agricultural products. This can help farmers expand their businesses and increase revenues, contributing to rural development.
3. **Support for Farmers:** The Serbian government provides various forms of support to farmers, including subsidies, loans, and advisory services. This support can assist farmers in investing in modernization, improving production, and increasing profitability. Additionally, education and training on new methods and technologies play a key role in supporting the development of this sector.
4. **Rural Tourism:** Serbia has significant potential for developing rural tourism due to its natural beauty, cultural heritage, and traditional rural lifestyles. Tourism development can create new job opportunities, improve infrastructure, and contribute to the sustainable development of rural communities.

Overall, agriculture plays a central role in the rural development of Serbia, with modernization, market access, support for farmers, and rural tourism being key factors that contribute to the sustainable and comprehensive development of rural areas.

Digitalization refers to the adoption of information and communication technologies, including the Internet, mobile technologies and devices, as well as data analytics, to enhance the generation, collection, exchange, aggregation, combination, analysis, access, searchability, and presentation of digital content, including for the development of services and applications.

The agricultural sector faces numerous challenges related to climate change, resource sustainability, and the increasing societal demands from a growing population, alongside the need to ensure economic stability for farmers while reducing their environmental impact.

These agricultural issues are also relevant to rural development, which additionally contends with more pronounced problems such as demographic changes, inadequate infrastructure hindering access to services, lack of social services and cultural activities which may exacerbate social exclusion, and the preservation of traditional values in a "globalized" world.

Nanotechnologies, such as "smart dust," have enabled highly precise monitoring of agricultural production and planning of corrective actions (Busch, 2010). The technology of Radio Frequency Identification (RFID) is particularly significant in

tracking agricultural production and the movement of products from fields to retail shelves. These technologies have substantially improved inventory management systems.

More generally, the use of computers and the Internet has enhanced administrative efficiency, especially in larger companies. Information and communication technologies have also facilitated the automation of trading financial instruments related to agricultural products, thereby increasing the efficiency of market operations.

Lastly, information and communication technologies have eased the formation of business networks and reduced the significance of physical distance, both in agriculture and other economic activities (von Braun, 2007).

Infrastructure Development as a Pathway to Integration into Global Agricultural Trends

Digitalization is not an end in itself but can serve as a catalyst that aids in integrating and utilizing acquired knowledge in further processes. It enhances community connections through market access, fosters systemic thinking, and enables quicker and more effective responses to sudden global shocks, thereby improving the quality of life in rural communities.

Digital transition is one of the key policy priorities in the EU aimed at achieving sustainable development and fostering economic stability through digital innovations, while also focusing on biodiversity preservation, environmental protection, and ensuring sustainable food production for future generations. This comprehensive approach seeks to bridge ecological challenges with digital technology.

Since 1990, the quantity and quality of digital technologies available to farmers have significantly advanced. The use of computer and internet technologies for managing crops and livestock began to evolve, driven by factors such as increased computing power, faster internet speeds, greater connectivity, reduced technology costs, and the rise of big data paired with advanced analytics.

These developments are fueling the current wave of digitalization, which promises to support sustainability, productivity, and resilience goals in commercial agriculture.

Digital technologies, including the internet, mobile technologies and devices, data analytics, artificial intelligence, and digitally delivered services and applications, are transforming agriculture and the food system.

There are abundant examples across various stages of the agricultural and food value chain: automation of agricultural machinery allows for precise input adjustments and reduces the demand for manual labor; remote satellite data and in-situ sensors enhance accuracy and reduce costs in monitoring crop growth and soil or water quality; and traceability technologies and digital logistics services offer the potential to streamline supply chains for agricultural and food products while providing reliable information for consumers.

The level of infrastructure development in countries is represented by the variable of internet usage prevalence. This variable is defined as the proportion of internet users

within the total population of a country, in line with the approach of Suha and others (Suh and Khan, 2003).

Telecommunication infrastructure as a key component in modern economy

Telecommunication infrastructure is particularly significant in the modern economy, as it facilitates information gathering, establishes connections with international markets, and reduces production and transportation costs.

Numerous empirical studies have demonstrated that information and communication technologies (ICTs) have a positive impact on the export performance of countries. Increased use of ICT makes producers in countries with more advanced and widespread information and communication technologies more export-competitive, and thus, a positive impact of this variable on exports is expected. Between 2014 and 2022, infrastructure development has shown consistent growth (Table 1). The most significant advancement in infrastructure was recorded in 2018, with a 4.9% increase compared to 2017. The total growth over the observed period amounts to 20.4%.

Table 1. Infrastructure Development in the Republic of Serbia, 2014 – 2022 (%)

Year	Number of inhabitants in Serbia	The number of the population that uses the Internet in Serbia	Development of infrastructure
2014	7,131,787	4,478,762	62.80
2015	7,095,383	4,526,854	63.80
2016	7,058,322	4,566,734	64.70
2017	7,020,858	4,774,183	68.00
2018	6,982,604	5,090,318	72.90
2019	6,945,235	5,563,133	80.10
2020	6,899,126	5,588,292	81.00
2021	6,834,326	5,569,975	81.50
2022	6,664,449	5,544,821	83.20

Source: Author's processing based on Statistical Office of the Republic of Serbia (SORS) data

Achieving rural development can be realized through infrastructure development in rural areas rather than by protecting farmers with protectionist measures. Of course, there are potential issues with this approach. It is possible that the state budget, particularly in developing countries, may become excessively strained if there are insufficient funds for such assistance programs.

To study the primary prerequisites for digitalization, households with internet access are analyzed, as internet penetration reflects infrastructure development. Over the period from 2016 to 2022, the number of internet users has increased, with 83.2% of Serbia's population using this service by 2022 (Table 2). Significant differences are observed between urban and other areas of Serbia regarding internet access.

The largest gap was noted in 2016, where 18.7% more urban residents used the internet compared to rural areas, while the smallest difference of 10.9% was observed in 2021.

At the beginning of the observed period in 2016, 53.8% of the population in rural areas had internet access, whereas by the end of the period in 2022, there was a 22% increase.

This data indicates a positive trend in the first prerequisite for the digitalization of rural areas.

Table 2. Percentage of Households with Computers and Internet by Type of Settlement, 2016 – 2022 (%)

	Years	2016	2017	2018	2019	2020	2021	2022
Indicator	Type of settlement							
Households that own a computer, by type of settlement [%]	In total	65.8	68.1	72.1	73.1	74.3	76.7	77.0
	Urban settlements	73.3	73.5	78.2	79.5	81.6	82.4	82.9
	Rest	54.0	60.7	61.8	62.1	61.8	67.2	67.2
Households that have an internet connection, according to the type of settlement [%]	In total	64.7	68.0	72.9	80.1	81.0	81.5	83.2
	Urban settlements	72.5	72.9	78.3	85.8	87.1	85.6	87.6
	Rest	53.8	59.8	63.9	70.5	70.4	74.7	75.8
Households that have a broadband Internet connection, according to the type of settlement [%]	In total	57.8	61.9	72.5	79.6	80.8	81.4	83.2
	Urban settlements	66.8	67.5	77.9	85.6	87.0	85.6	87.6
	Rest	44.0	52.3	63.5	69.5	70.1	74.5	75.8

Source: Author's processing based on Statistical Office of the Republic of Serbia (SORS) data

Potential new technological interventions include:

- **Internet of Things (IoT):** IoT technology can be employed to monitor crops, livestock, and water, allowing farmers to manage resources more effectively and reduce losses.
- **Blockchain in Supply Chains:** Implementing blockchain technology can enhance transparency and reliability in the supply chain, particularly for agricultural products. This could improve market access and ensure farmers receive fair prices for their products.
- **Advanced Energy Technologies:** Utilizing renewable energy sources such as solar panels and mini-hydropower plants can enhance access to electricity in rural areas, which is crucial for supporting community development and attracting investment.

A combination of innovations and technological advancements can foster sustainable, resilient, and prosperous rural communities worldwide.

Demographic profile of rural areas as a key parameter of infrastructure development

The agricultural sector must adapt to a multitude of growing challenges, including climate change, widespread environmental degradation, a shortage of agricultural workers, increasing population, and changes in dietary patterns. Rising temperatures can trigger a series of events that culminate in the collapse of socio-ecological systems,

characterized by increased frequency and severity of extreme weather events. These events, such as heatwaves, storms, floods, and droughts, are driven by the ongoing use of fossil fuels and unsustainable land and energy practices. Conventional precision agriculture technologies are expected to be a major part of the solution to these challenges. The frequency of global disasters is anticipated to rise sharply by 2030 if current trends continue (Tešić et al., 2023). Many rural areas in Serbia are facing depopulation, characterized by a decrease in the number of residents. This trend can result from migration as well as a declining birth rate. Depopulation can lead to economic and social challenges, such as the closure of schools, shops, and public services due to a lack of population.

The ongoing decline in the rural population in Serbia represents a significant obstacle to the development of Serbian agriculture. The rural population decreased from 4,028 thousand in 2011 to 3,760 thousand in 2021.

Women are leaving rural areas at a higher rate than men. In some regions, this trend is so pronounced that there are up to three times more women leaving rural areas compared to men (Group of authors, 2012).

In addition to the aforementioned issues, it is important to note that demographic trends can vary across different rural areas in Serbia, depending on factors such as geographic location, economic conditions, and infrastructure availability.

Table 3. Migrant Population by Type of Settlement and Gender, 2020

Area	Type of Settlement	In-Migration (%)		Out-Migration (%)	
		Male	Female	Male	Female
Serbia - North	Urban	79	77	77	74
	Other	21	23	23	26
Serbia - South	Urban	49	48	51	46
	Other	51	52	49	54
Republic of Serbia	Urban	68	66	67	62
	Other	32	34	33	38

Source: Migration Profile of the Republic of Serbia for 2021, Government of the Republic of Serbia, p. 58

In 2020, there was a noticeable outflow of the female population at 54%, while 49% of the male population left rural areas in the southern part of Serbia. The demographic profile of the northern rural areas of Serbia indicates an outflow that is twice as small compared to the southern part. The outflow of the female population is 4% higher than the inflow, both for the entire territory of Serbia and for the northern (3%) and southern (2%) regions.

The lack of infrastructure, the significant digital divide between developed and developing areas, and low digital literacy are fundamental issues that hinder the integration of developing countries into the digital economy.

One of the most significant cluster support programs in Uruguay was established in 2005 with financial assistance from the Inter-American Development Bank. This is the Cluster Competitiveness and Production Chains Program (PACC).

In Uruguay, sector-specific support programs are not well-developed, but there are several programs aimed at this sector, particularly for small producers. The first program was initiated by the Planning and Development Service with the goal of digitalizing and developing transportation infrastructure. This program managed to mobilize \$100 million with contributions from the Inter-American Development Bank.

The second support program, Pronarra-Fida, was established in 1994 with the aim of promoting the economic and social life of the poor population in rural areas. Although not specifically designed for the dairy cluster, it benefited the sector the most. The program included activities such as producer training, securing financial resources, and providing technical assistance to over 2,000 milk producers, amounting to approximately \$5 million (Caballeros, 2019). The Program also included cooperation and networking with the agroindustry and other sectors.

The Indian e-Choupal project uses internet technology to provide farmers with access to market information, agricultural advice, and input purchases at favorable prices, thereby improving agricultural productivity and the income of rural communities.

Rural telemedicine programs in Africa, implemented by various telemedicine organizations, provide residents with access to healthcare services via mobile phones and the internet, reducing the need for travel to remote healthcare centers.

Conclusion

Considering the sector at the national level, it can be concluded that Serbia has significant arable land resources. Due to this potential, further investments in agriculture should be made to ensure that the sector's share of the gross domestic product is consistently increasing. When comparing the total amount of arable land used for specific agricultural crops with arable areas in the Netherlands, it can be concluded that Serbia has a large potential, but due to the lack of modern technology, it is not competitive in the market. To improve the current situation in the country, it is necessary to develop additional programs to subsidize farmers. Sector development would also reduce the current level of poverty in the country. By investing efforts and financial resources into the food and agricultural sector, Serbia can significantly reduce the level of poverty.

Digital technologies can help governments enhance the efficiency and effectiveness of existing policies and programs and design better ones. For example, freely available high-quality satellite imagery dramatically reduces the cost of monitoring many agricultural activities. This could enable governments to move towards more targeted policies that compensate farmers based on observed ecological outcomes. In addition to monitoring compliance with environmental policies, digital technologies allow for the automation of administrative processes for agriculture and the development of expanded state services, such as advisory or consultancy services (Mihailović et al, 2021; Mihailović, Radosavljević, 2020).

To improve the situation in rural communities in Serbia, efforts should be focused on infrastructure development, encouraging entrepreneurship and diverse economic activities, enhancing the education system and access to basic services, and promoting inclusive social policies that consider the needs and perspectives of rural populations.

Innovations and technological advancements play a crucial role in supporting sustainable development and addressing demographic challenges in rural areas. Here are some ways in which innovations and technology contribute to this goal:

1. **Improving Agricultural Productivity:** Innovations such as precision agriculture, the use of drones for crop monitoring, smart farming machinery, and soil condition sensors allows farmers to increase productivity and reduce production costs, helping rural communities remain sustainable.
2. **Better Access to Healthcare:** Telemedicine enables rural communities to access medical services without traveling to urban centers. Mobile apps and health monitoring devices can also provide valuable information and support to rural residents.
3. **Remote Education:** Technology allows rural schools to access quality remote education. Online courses, digital materials, and interactive tools can enhance educational opportunities in rural areas and provide access to knowledge that would otherwise be unavailable.
4. **Increased Access to Information:** The internet and mobile technologies enable rural residents to access information about the market, weather forecasts, government support programs, and other important resources. This can help improve the economic situation and empower the community.

Education, financial, and informational support represent solutions to initially increase market shares, and subsequently, with stable business competitiveness, retain these market segments and expand into existing and new markets.

Policymakers need to address specific barriers to technology adoption among farmers while ensuring both the provision of infrastructure and appropriate incentives upstream in digital innovation markets. Governments have a special role in ensuring strong competition in technology input markets; facilitating the provision of adequate telecommunications services; accelerating capacity building in good data management; strengthening advisory and other agricultural services; and promoting the upskilling or reskilling of the agricultural workforce. More detailed representative information at the country level about the adoption and costs and benefits of new technologies as experienced directly by farmers is needed. This need is especially acute in the livestock and specialized crops sectors, where evidence typically comes from small sample studies.

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