International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

PAPER ID: 10A18F

DIGITAL SOLUTIONS OF MANAGEMENT ISSUES AND STRATEGIC PLANNING FOR THE DEVELOPMENT OF AGRICULTURE AND RURAL AREAS

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ARTICLEINFO

Article history:
Received 14 June 2019
Received in revised form 02 August 2019
Accepted 19 September 2019
Available online 30 September 2019

Keywords:
Rural territories; Management; Economics; Production processes transformation; Rural development; Development planning; Technological shifts; Agriculture development; Digital technologies; Agro-development.

ABSTRACT

The digitalization of control systems is associated with structural technological transformations of production processes and the functioning of the social sphere. Like other sectors of the economy, agriculture is undergoing structural and technological shifts, and with them a permanent global crisis. The purpose of the study is to develop part of the scientific foundations of the theory of structural and technological shifts determined by transformational processes in the agro-industrial complex and rural areas of Russia. The objectives of the study: analysis of the essence of relations arising in the process of strategic planning for the development of rural areas of Russia; characteristics of the use of digital technologies in the management of agriculture and rural areas; determination of indicators reflecting structural and technological transformations of agricultural organizations and agribusiness. The article presents the results of sociological studies conducted by the authors to assess the possibilities for managing the socio-economic development of a rural settlement in Russia and the importance of hard and soft management factors for Russian agricultural organizations.

Disciplinary: Multidisciplinary (Rural Development, Digital Technology, Economic Management,).

1. INTRODUCTION

The relevance of the study of the digitalization of control systems is associated with structural

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technological transformations of production processes and the functioning of the social sphere. Like other sectors of the economy, agriculture is undergoing structural and technological shifts, and with them a permanent global crisis. At the same time, Goldman Sachs predicts that the use of new generation technologies can increase global agricultural productivity by 70% by 2050. It is important to note that the multiplier of agricultural production for the Russian economy, according to academician Miloserdova (2016), is about five, especially important for improving state support of the agrarian economy entities and state policy in relation to rural territories [16].

Until recently, the impact of digital agriculture solutions, compared to traditional methods, was limited by the level of detail and timeliness of data, their daily shortage [1]. Agricultural producers experienced problems with planning their activities and strategic planning for rural development, in terms of their social infrastructure.

Despite the intensive use of digital technologies in the functioning of the agro-industrial complex and rural areas, the scientific foundations of economic theory that describe the industry aspect of the use of digital technologies remain poorly developed, due to cultural restrictions and the digital divide between qualified and unskilled specialists.

The purpose of the study is to develop part of the scientific foundations of the theory of structural and technological shifts determined by transformational processes in the agro-industrial complex and rural areas of Russia.

The novelty of the study is determined by the following provisions:

1) identified key trends in the transformation of the agricultural sector and agricultural organizations in Russia;
2) Structural and technological shifts in the agricultural sector and rural areas due to the use of digital technologies are classified;
3) An automation map for subdivisions of agricultural holdings and large agricultural organizations was developed;
4) generalized and expanded understanding of the use of digital solutions in management and strategic planning for the development of agriculture and rural areas, using the analysis of the application of space monitoring technology as an example.

The theoretical significance is revealed through clarification of the characteristics of the use of digital technologies in the management of agriculture and rural areas. Practical significance is determined by the formation of a list of indicators reflecting the structural and technological transformations of agricultural organizations and agribusiness, as well as the identification of areas for increasing the efficiency of agricultural production, based on the use of digital solutions to management issues and strategic planning for the development of agribusiness and rural areas.

2. MATERIALS AND METHODS

The study is based on a number of basic general scientific methods: monographic, economic–statistical, abstract–logical and others. Research methods are content analysis; comparative legal analysis of documents for the strategic development of agriculture and rural territories of Russia; special methods of sociological sciences: interpretation of the results of sociological surveys.

When analyzing the relations arising in the process of strategic planning for the development of agricultural production and rural areas, the method of complex scientific and methodological assessment of socio-economic relations was used in the development of managerial decisions.

The survey on the current state of rural territories was attended by 960 people, 120 people each,

residents of rural areas in each federal district.

In a survey aimed at assessing the opportunities for managing the socio-economic development of a rural settlement, 80 people took part – the heads of rural settlements, 10 from each federal district.

The method of complex scientific and methodological assessment of socio-economic relations was used in the development of managerial decisions during analyzing the relations arising in the process of strategic planning for the development of agricultural production and rural territories.

3. RESULTS AND DISCUSSION

3.1 LITERATURE REVIEW AND CURRENT STATUS OF THE PROBLEM

Considering the issues of management and strategic planning for the development of the agro-industrial complex and rural areas, the scientific community is divided into several large areas that consider a certain principle as a key one when organizing the functioning and regulation of the agricultural sector. There are several popular scientific and practical management strategies and planning of agricultural production and rural areas.

A number of researchers consider the strategy of using agricultural material resources and attracting investments based on the principle of optimality of the material and technical base of the industry [18,23].

"Green agriculture" at the center of production and life support systems sets environmental standards to support the normal functioning of nature. In this strategic direction, management and planning widely take into account the environmental responsibility of producers and consumers of agricultural products and foodstuffs [3,4,7,13,25,27,28,].

Social responsibility, as a strategy, involves observing not only environmental standards but also implementing social programs to ensure a high level of quality of life for the rural population – the effective functioning of the social infrastructure of agricultural production [3,5,17,21,22].

"Digital agriculture" is a strategy for adapting the agricultural sector to structural technological changes in both production and management. Digital agriculture is based on the application of digital technologies in agricultural production: artificial intelligence, big data, the Internet of things, blockchain, robotics, and others, as well as production organization concepts that reduce the human factor, for example, industry 4.0 [8,10,26,29].

Synthesis of social responsibility, digital technologies, and environmental standards is the implementation of an inclusive agriculture strategy, which is based on the involvement of various categories of the population in agricultural production to overcome poverty and other negative social phenomena [12,19]. This strategy is actively applied in countries of South Asia and Africa. The Russian analog of an inclusive management strategy, agricultural planning, and rural functioning is cooperation, including consumer cooperation.

3.2 RESEARCH RESULTS

The Canadian scientist Don Tapscott first used the term "digital economy" in his 1995 book [24], addressing organizational security issues. For almost 2.5 decades, the digital economy has acquired an institutional and infrastructural foundation, which is facilitated by the high rate of digitalization of the population. Differences in the level of population's use of digital technologies in everyday life,

the ability of the population to access broadband high–speed Internet and digital products determine the current differences in economic and social character both between states and between administrative-territorial units within them.

The industry aspect of the functioning of the digital economy shows the transformation of economic relations, their parity in the new conditions, assessed through indicators of industry profitability. The digital agricultural revolution is driven by the low cost of collecting data on everything from soil conditions to animal health and crop development, as well as data from weather stations and data collected by drones and satellites [28].

The indicated trends are structural and technological shifts that can be classified on various grounds. The key trends in the transformation of the agricultural sector and agricultural organizations in Russia: (1) global (macroeconomic): urbanization; degradation of natural ecosystems; transformation of financial systems and settlement systems; (2) industry-specific (mesoeconomic): increasing consumer demands; digitalization; (3) local (microeconomic): intensification of production.

3.3 CLASSIFICATION OF STRUCTURAL AND TECHNOLOGICAL SHIFTS

The indicated trends are the basis of structural and technological shifts that can be classified on various grounds.

–by sources of origin: economic (market and non–market), social, managerial, political, mixed;
- reach: global, transregional, national;
- on time manifestations: short-term, medium-term, long-term;
- by objects of influence: production, management, infrastructure, mixed;
- by the nature of the effect: aggressive, latent, mixed;
- by the result of the impact: destructive, positive, mixed;
- according to adaptation mechanisms: production, managerial, social, cultural, mixed;
- in relation to security: global, transregional, national, intersectoral, sectoral, mixed;
- in relation to production: modernization, innovation, management, infrastructure, mixed;
- by structure: technical, telecommunication, digital, communicative, spiritual and philosophical, socio-psychological, mixed;
- by beneficiaries: personal-social, production, managerial, mixed;
- in relation to development: ensuring crisis-free development, ensuring development through a crisis, not ensuring development (destructive);
- on threats: military, economic, biological, food, information, technical and technological, social and spiritual, and others, mixed;
- by the nature of regulation: managed, spontaneous, mixed;

According to the depth of transformation: radical, infrastructural, attributive–semantic, mixed;
- by subjects of management: subjectless (global, national), state (external and internal), commercial (transnational, transregional, national).

To study the issues of management and strategic planning for the development of the agro-industrial complex and rural areas, it is necessary to consider a set of problems caused by structural and technological shifts.

Digital technologies overcome information challenges that make it difficult for many small farmers to access the market, expand knowledge through new ways to provide extension services and provide new ways to improve supply chain management in agriculture. Although there are many promising examples of the positive impact on rural livelihoods – or “digital dividends” – they often do not scale to the expected level. The main reason is that technology can remove only some, but not all, barriers [9].

On an individual level, advances in digital technology have widened the gap between skilled and unskilled professionals. While unskilled professionals are struggling to catch up with the relentless

pace of innovation, skilled professionals are better prepared to access, implement and use new technologies, thereby increasing disproportionate benefits. This growing gap can be called the digital divide [2].

The problems that are prerequisites for using digital control systems remain relevant: the lack of a single regulatory reference information; the complexity of manual accounting; repeated duplication of information; low efficiency of managerial decision making; lack of an effective system of planning, management accounting, budget analysis, analysis and consolidation of information within holding structures.

In agricultural holdings, agricultural corporations in Russia, difficulties arise with the introduction of digital solutions to management and strategic planning for the development of agribusiness and rural areas associated with the formalization of goals and objectives for planning resource use, setting management accounting rules, staff motivation, sabotage of the implementation of decisions made, lack of sufficient digital infrastructure in rural areas, features of business processes of agricultural organizations.

Table 1: A map of the automation of the functioning of agricultural holding units from the positions of management and strategic planning

Trend	The processes
Finance	Payment management
	Work with registries
	Industry reporting
	Management / Budget Control
	Launch of the basic processes of the Unified Center for Accounting and Reporting
	Electronic document management with external partners
	Electronic document management with internal partners (units)
	Support and integration with factoring sites
	Loan portfolio management
Production	Cost accounting
	Subcontracting support on both sides
	Loss management
	End–to–end planning cycle from sales plan to raw materials procurement
	Traceability of batches of raw materials to finished products
	Manufacturing Execution System (MES)
	Program for automation of management of repairs and maintenance of production equipment (TOIR).
Transport logistics	Automated functions of logistics managers
	Integrated with logistics operators
Warehouse Logistics	Automatic route building and ordering
	Warehouse coding
Procurement	Purchase requisition funnel
	Vendor account
Laboratory	End–to–end sample handling processes
	Laboratory workflow automation
HR	KPI Planning and Calculation
	Employee Portal
TOP management	Dashbodes (sales / margin)
	Map of supplies of raw materials/seasonality

Source: developed by the authors.

Changes in the functioning of the agro-industrial complex, due to the use of digital technologies, are associated with the introduction of new technologies in the structure of the functioning of agricultural organizations and their holdings. This influence is explained by the fact that the

*Corresponding author (I.M. Kulikov). Email: 9089267986@mail.ru Volume 10 No.18 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID: 10A18D http://TUENGR.COM/V10A/10A18DM.pdf DOI: 10.14456/ITJEMAST.2019.248

agro-industrial complex consists of a limited number of large holding entities. Structurally technological changes in large–scale agricultural production are based on the automation of the maximum number of production processes, management processes, control, collection and processing of big data.

A map of the automation of the functioning of agricultural holding units from the positions of management and strategic planning, which allows us to assess the scope of digital technologies, is presented in Table 1. A map of the automation of the functioning of agricultural holding units from a management and strategic planning perspective is based on an analysis of the technologies used today in agriculture. It is necessary to divide technologies into high–level (related to management and strategic planning), field (related to production processes) and integrated (related to the creation of intelligent products and systems based on a combination of nano–, bio–, info– and cognitive (NBIC) technologies), both in a joint grouping and in other variations.

Field technologies include robotics; unmanned aerial vehicles; parallel driving systems; automatic and automated accounting systems; cartography and satellite (space) monitoring of equipment and rural areas, agricultural lands; precision farming; biotechnology and others.

The main field of application of robots in agriculture today is at an early stage. Important applications of robots in agriculture include weed control, seed planting, harvesting, farm monitoring, and soil analysis and more. Drones will provide agriculture with cutting–edge planning and strategy based on real-time data collection and processing. Drones in agriculture are a great boon for farmers and agriculture. They carry the potential for a complete transformation and revolution in agriculture and operational agricultural production and management [6].

The use of big data in agriculture allows, on the basis of the scheme: "big data – analysis – decision", to obtain data and solutions for managing plant nutrition and protection, monitoring weather conditions, and environmental parameters; positioning and navigation of agricultural machinery; agrophysical and agrochemical studies of soils; control of the quantity and quality of the crop at the stages of collection and storage, etc.

High–level technologies are the basis for the creation of more applied (industry, production) technologies. These include artificial intelligence, big data, blockchain, the internet of things (IoT).

Big data defines the benefits for management, including government, disclosed in the following cases:

– obtaining operational data on sowing and harvesting;
– accurate yield forecasts for crops and territories;
– accelerated decision–making and independence from the human factor;
– instant response in case of emergency;
– improving the quality of stimulation of state support;
– identification of causal factors to improve the performance of agricultural organizations and their units.

Intensively developing and widely used today is the technology of space monitoring of rural areas especially agricultural land.

Space monitoring – a tool for regular observations, analysis and identification of trends in the field: indicators of the state of the territory; processes occurring on it. Integration with the system of meteorological observations allows us to assess the state of crops and the influence of meteorological factors on deviations in their development.

The use of space monitoring capabilities in the agricultural management system and rural areas is

presented in Table 2.

Table 2: the Use of space monitoring capabilities in the functioning of agricultural insurance, as an element of agricultural management and rural areas

Beneficiaries	Opportunities
Agriculture	analysis of the state of crops by the NDVI index (Normalized Difference Vegetation Index); assessment of the impact of agrometeorological indicators on deviations in crop development; the ability to assess the criteria for natural hazards; transparency of the underwriting process; transparency of the loss settlement process: objectivity of the analysis of the state of insured crops, minimization of the human factor and conflict of interest during the examination
Rural areas	compilation and refinement of cadastral plots and compilation of a national cadastral map; the formation of an information base to ensure strategic spatial development of settlements and production base; providing logistic support for the implementation of social and commercial projects
Insurance companies	prompt receipt by the Insurer of information on the occurrence of events that have signs of an insured event; deviations in crop development according to the NDVI index indicators relative to average values; information about the occurrence of the insurance event provided for by the contract, when the criteria for natural hazards are achieved; the possibility of timely adoption of measures to prevent and reduce losses; prompt notification of the occurrence of the event contributes to the timely adoption of measures aimed at reducing losses; obtaining objective information on the affected areas; saving costs of doing business in part of conducting examinations; inspection of crops, including those involving independent experts, should be carried out at least 3–5 times during the term of the insurance contract; the possibility of conducting a survey not in all areas, but only where deviations in crop development are observed; the most accurate determination of standing crops; insurer's risk of bad faith

Source: developed by the authors.

It should be noted that from March 1, 2019, the space monitoring tool received official status, in the framework of the industry legislation of the Russian Federation. Giving legal status opens up prospects not only for the development of existing space monitoring applications in agricultural production but also for the creation of index insurance products.

The new generation of insurance products as an element of the risk management system in the agricultural sector of the economy that meets the requirements of digitalization is index insurance. Its essence is to significantly reduce the human factor in the interaction of insurers and customers. Index insurance is implemented according to the following algorithm: (1) the rules and conditions of insurance are established at the institutional level, as a result, the economic entity of the agro-industrial complex only needs to select an insurance company in its personal account on the public services website; (2) an application for insurance is filled out automatically, since the data of the economic entity of the agro-industrial complex are checked and confirmed by the system – the portal of public services; (3) the insurance product is based on monitoring a complex of indices (for example, vegetation index, soil moisture index and others) using the Internet of things, collecting and analyzing big data on major crops and taking into account the spatial aspect; (4) based on scientific research, a system of optimal (normal for a specific territory) indicators is established, deviation from which records the occurrence of an insured event.

Index agricultural insurance acts as a driver for the intensive use of digital solutions to management issues and strategic planning for the development of agriculture and rural areas (Table 3).

The implementation of digital solutions in the field of strategic planning for the development of agribusiness and rural areas requires the formation of an appropriate infrastructure. Firstly, it is necessary to create cultural conditions under which the organization's management and employees understand and accept the need for digital solutions. Secondly, it is necessary to implement the

technical conditions for the functioning of digital technologies in the locations of production structures and remote monitoring and control centers. The minimum conditions are providing rural areas and rural settlements with access to the Internet, at a standard level of at least 4G, and creating mobile applications that make up the technical basis for the use of digital solutions.

Table 3: Organization of agricultural insurance based on digital technologies in agriculture

Technology	Application in the agricultural insurance
Remote monitoring	Methods of insurance expertise; Index Insurance Product Development
Marketplace (e-commerce platform)	Embedding insurance proposals in agricultural platforms; A personal account of a business entity, including on subsidizing and receiving payments
Big data	Integration with government systems; Ability to use in actuarial calculations; Use to develop new insurance products
Robotization	The ability to use digitalization to capture insurance events

Source: developed by the authors.

In Russia today, agricultural producers mainly use the following digital solutions in the field of agribusiness management: 1C: Enterprise Resource Planning Agriculture (management and planning); 1C: Enterprise Resource Planning 2.4 (management and planning); 1C: Salary and personnel management (management and planning); Kontur. Diadok (electronic document management); ELMA business process and performance management system (document management and business process management); Office 365 and Sharepoint (software); Microsoft BI (analytics); ZABBIX (Monitoring); Cisco, Skype for Business, Jabber (communications) and others.

An important aspect of the implementation of digital solutions in the management of agricultural production is the consideration of management factors to reduce material and moral costs.

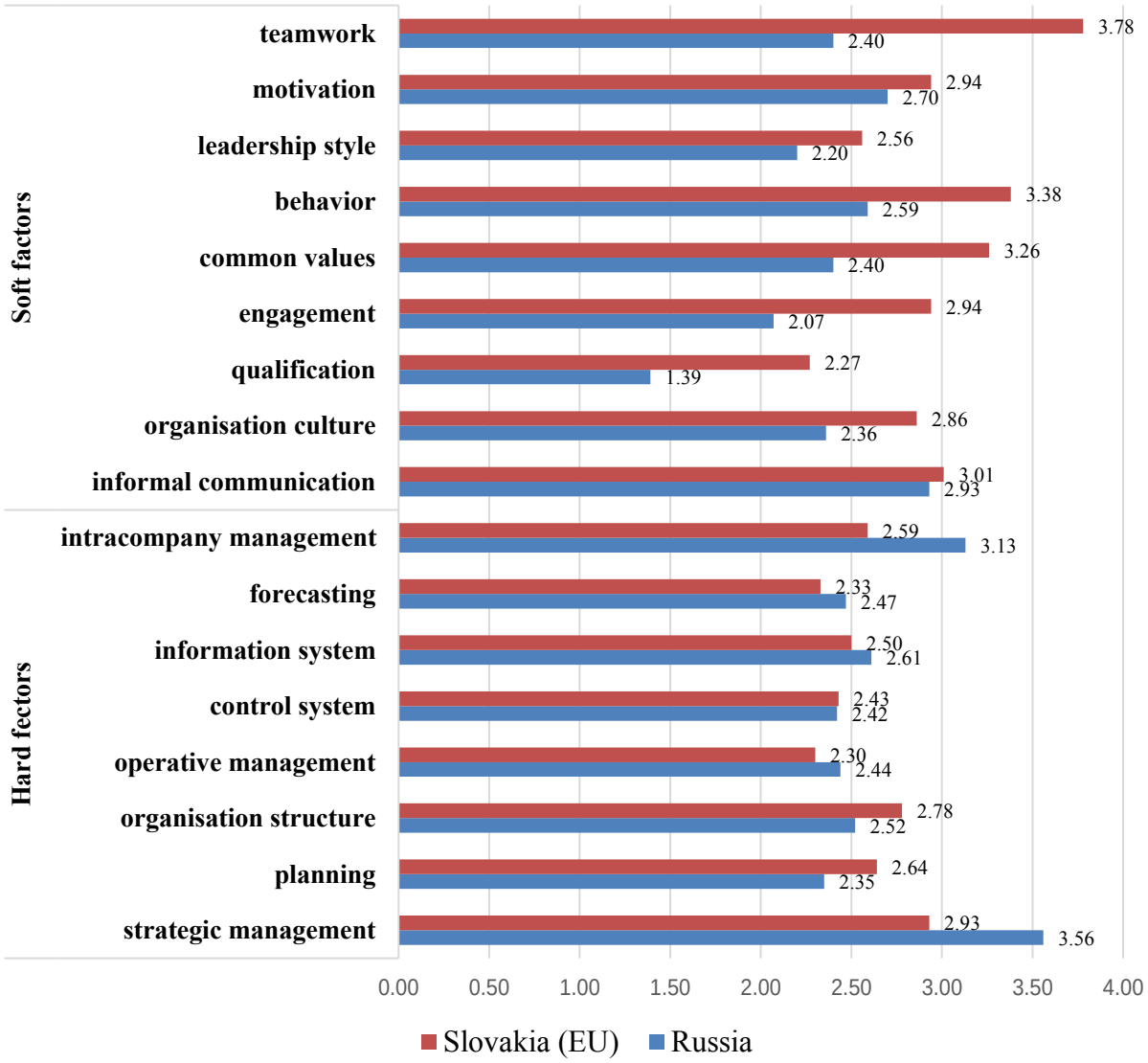
Figure 1 presents the results of our own sociological study of the importance of management factors for Russian agricultural organizations and a comparison of the results with a similar study [15] conducted among agricultural organizations in Slovakia.

In addition to the internal environment described by management factors (Figure 1), for the successful functioning of agricultural production, the external environment is critical – represented by the socio-psychological climate in the rural village closest to the agricultural organization.

Figure 2 shows the dynamics of assessments of opportunities for managing the socio-economic development of a rural settlement for 2006, 2013 and 2019, given by the heads of rural settlements.

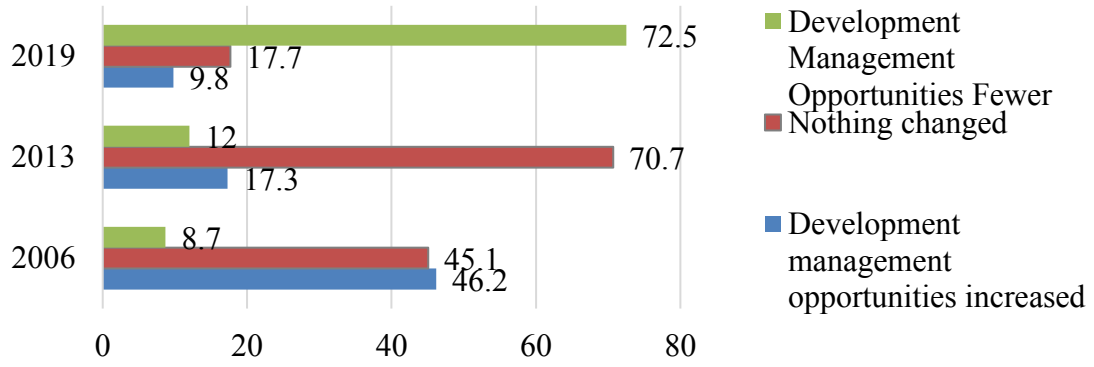
From an analysis of the data presented in Figure 2, it can be seen that there is a trend towards a negative perception of the future of rural settlements. This is due to the global urban trend, which has led to shifts in the structure of population distribution, in the implementation of life organization strategies by the population. The trend is reinforced by the strong belief that the use of digital solutions in production will lead to an increase in unemployment. Although this is poorly applicable to agricultural production. In rural areas, there is a shortage of labor, as a result of a long–term structural degradation process in Russian rural settlements.

Based on the analysis of normative legal acts and strategic development documents of the Russian Federation, a number of indicators reflecting the structural and technological transformations of agricultural organizations, the agro-industrial complex and suitable for use in strategic planning for the development of rural areas of Russia can be identified (Table 4).



Source: compiled on the basis of Jankelová N., Remeňová K., Skorková Z., Némethová I. (2019) and own studies.

Figure 1: Comparison of the importance of hard and soft management factors for agricultural organizations in Russia and Slovakia (EU) (1 is very important and 5 is the least important), in 2019



Source: compiled on the basis of 2006 and 2013. – Gorshkova M.K., Ilyina V.A., and others. (2015), 2019 – own research.

Figure 2: Assessment of opportunities for managing the socio-economic development of a rural settlement (in % of the number of respondents) in 2006, 2013 and 2019.

Table 4: Indicators reflecting the structural and technological transformations of agricultural organizations and agribusiness

Indicator	Base value	Planned Value (2024)
Share of innovation organizations,%	8.5	50
Number of graduates with higher education in IT, people	60 000	120 000
The proportion of the population of Russia with broadband Internet access,%	56.5	97
Growth in agricultural exports, billion US dollars	25.8	45

Source: developed by the authors.

Based on the set of own field studies of rural areas of Russia, the Republic of Belarus and Poland, carried out in 2018–2019, as a hypothesis for future studies, it can be assumed that the use of digital solutions to management issues and strategic planning of rural areas, the intensification of digitalization of agricultural production will contribute to rural development through the involvement of highly qualified specialists and increasing the level of accessibility of the rural population I am to the digital organization of life (through access to social networks, portals of public services, to receive many services remotely).

Digital solutions for strategic planning of rural development are based on the need to take into account information from large–scale geographical areas. The key parameters for the formation of an information base for strategic planning of rural development are data on the state of the soil, water, air, forest, and social infrastructure. The Soil–Geographic Database of Russia has been created on

the basis of a distributed network of agrarian–soil data centers, shown in Figure 3.

Source: Soil Data Center, Faculty of Soil Science, Moscow State University (soil–ab.ru)

Figure 3: Placement of Agrochemical Centers (●) in Russia, 2018

At the global level, examples of the application of digital solutions to management issues and strategic planning for the development of agribusiness and rural areas are the projects of the global soil partnership of the Food and Agriculture Organization of the United Nations, a global map of organic carbon stocks; global map of soil salinization; organization of a distributed network of national soil data centers; global map of soil pollution.

During implementing digital solutions in matters of strategic planning for the development of rural areas of Russia, it is necessary to be guided by the following principles: historical integrity; economic zoning; economic development; technological security.

4. CONCLUSION

The main directions of increasing the efficiency of agricultural production, management and strategic planning of the agricultural sector and rural areas are the conceptual directions for the implementation of digital solutions, the introduction of the latest technologies:

1. Precision Livestock Farming: accurate raw and dairy cattle breeding; accurate pig breeding; accurate poultry farming.

2. Precision Farming: farm management; management of tillage, sowing, fertilizing, plant protection, irrigation; machine management; robotics.

The key resource for further growth in agricultural productivity, ensuring a stable result and increasing competitiveness on a local and global scale are data and advanced data management systems.

They are factors that hinder the development of digital infrastructure and the intensification of the use of digital solutions in agricultural production, in addressing management issues and strategic planning for rural development in Russia. Such factors include 1) low effectiveness of state support mechanisms for small and medium enterprises, research teams and specialized agricultural educational Institutions in the field of implementation and development of digital technologies and initiatives; 2) the high cost of acquiring elements for the implementation of digital technologies; 3) lack of stable communications and the Internet in remote areas; 4) cultural restrictions on the use of digital technologies in agricultural organizations; 5) unwillingness of Russian agricultural producers to provide information; 6) legal restrictions.

The solution of these problems requires measures on the part of the professional community (industry unions and associations) and the state to digitize melons, change approaches to the development and adoption of decisions, create a culture of digital technology, create a digital infrastructure, and disseminate the best practices in the application of digital technologies.

5. DATA AND MATERIAL AVAILABILITY

This study already includes all the information about this study.

6. CONFLICT OF INTERESTS

The authors confirm that the presented information does not contain a conflict of interest.

7. ACKNOWLEDGMENT

The work was prepared with the support of the Ural State Mining University.

*Corresponding author (I.M. Kulikov). Email: 9089267986@mail.ru Volume 10 No.18 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID: 10A18D http://TUENGR.COM/V10A/10A18DM.pdf DOI: 10.14456/ITJEMAST.2019.248

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