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THE DIGITALIZATION OF AGRICULTURE AS A PRIORITY DIRECTION OF RUSSIAN ECONOMIC'S DEVELOPMENT

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Abstract

The way to the Russian digital economy passes through widespread usage of information and communication technologies. In General, digital economy is an activity, where digital (electronic, virtual) data are the key factors of production. Digitalization is a saturation of the physical world with electronic and digital devices, means and systems and establishment of electronic communication exchange between them, that actually creates an integral interaction of the virtual and physical worlds, that is cyber-physical space. THE main goals of digital development are the following: acceleration in economic growth and investments attraction; transformation of economic sectors into competitive and effective; technological and digital modernization of production; accessibility for citizens to the benefits and opportunities of the digital world; the realization of human capital, the development of digital industries and digital entrepreneurship. The need for digitalization of the agro-industrial complex is obvious - the implementation of the principles of the digital economy will allow to create an institutional environment that will meet modern realities and will generally allow to improve production efficiency. The article is devoted to aspects of the Russian economy digitalization; approaches to the definition of "digital economy" are analyzed; goals and tasks of digital transformation in agriculture are explored; possibilities of end-to-end technologies application of the program "Digital economy of the Russian Federation" in agro-industrial complex are identified; problems and perspective directions of digital technologies approbation in agriculture are defined.

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Keywords: Agro-industrial complex, digital economy, digitalization, efficiency, technologies.

1. Introduction

The dynamic development of agricultural production requires the implementation of modern technologies for collecting and processing of information that is necessary to solve production and management problems (Boyko, Yevnevich, & Kolyshkin, 2017; Butyrin, 2016).

Most of them can be solved with the help of information technologies and hardware and software means of getting, processing, analyzing and displaying of data. The Ministry of agriculture of Russia has developed a Federal scientific and technical program for the development of agriculture in 2017-2025 (Federal scientific and technical program for the development of agriculture for 2017-2025, 2017), that provides the growth of the production volume of agricultural enterprises by a quarter by implementation of digital agriculture, robotics and automation programs in the agro-industrial complex. Concerning this, an increasing number of the Russian Federation subjects in their regional programs includes the tasks of creating information systems and the formation of information resources on agricultural land on the basis of the monitoring of these lands and accounting information on their condition and usage as a part of the system of state information support in the field of agriculture.

2. Problem Statement

Currently, the main reason for the progressive economic growth in the leading countries of the world are innovations, therefore, a significant acceleration of informatization and digitalization of agriculture is one of the most important sectors of the economy, it should be regarded as a key factor in the sustainable development of the state.

Coordinated actions of all participants– professionals with new competencies, high financial costs, developed IT-structure, methodological and legal support are required in order to create and operate a digital system of the agricultural sector Digitalization of business processes will allow the Russian economy to move to a new stage of development and provide it with competitive benefits.

3. Research Questions

1.What is digitalization?

2.What are the end-to-end technologies of the program "Digital economy of the Russian Federation" that can be used in the agro-industrial complex?

3. What are the problems and perspective directions of digital technologies approbation in agriculture?

4. Purpose of the Study

Analyze approaches to the definition "digital economy"; explore goals and tasks of digital transformation in agriculture; identify possibilities of end-to-end technologies application of the program "Digital economy of the Russian Federation" in agro-industrial complex; define problems and perspective directions of digital technologies approbation in agriculture.

5. Research Methods

The methodological basis of research is in the systematic and institutional approaches to the formation of a digital platform for the effective development of the agricultural and industrial complex. Methods of comparison and analogies, analysis and synthesis were used during the research. As a methodological base we used normative legal documents in the field of digitalization of the Russian Federation economy and the organization of sustainable development of the agro-industrial complex.

6. Findings

Digitalization of the agro-industrial complex had a number of preceding stages, such as automation, electronization and informatization (table 01).

Table 01. Stages, that preceded digitalization of agro-industrial complex

Stage	Title	Chronology	Contents	Reserve in agriculture
I	*Automation*	late 1960s–late 1970s.	Implementation of computer equipment to control the processes; creation of ACS and APCS	Solution of accounting tasks of agro-industrial complex and linear programming tasks in order to optimize the placement of agricultural production
II	*Electronization*	early 1980s–early 1990s	Implementation of personal computers and electronic sensors	Creation of personal computer networks in pilot projects under control of trained agricultural specialists
III	*Informatization*	mid 1990s–early 2000s	Use of Internet and various kinds of software, including ERP, CRM, EAM etc.	Creation of a wide range of state information systems

The first stage of the computer and electronic equipment implementation for the management of agro-industrial complex was based on the creation of automated control systems (ACS) and automated process control systems (APCS). The year 1967 can be considered as the beginning of this stage in our country, when A. I. Kitov was approved as the chief constructor of "Typical industry automated control system", and V. M. Glushkov was approved as the head of it. In agriculture, the beginning of the work on automation was connected with the attempts to create ACS-agricultural or ACS-Ministry of agriculture, started in 1972.

It should be noted, that in the Russian agro-industrial complex automation of routine work without intensification of intellectual capabilities of managers took place to a greater degree. Moreover, informatization in agriculture was slowed down by the lack of the "social order", of the appropriate level of the consumers technical and socio-educational readiness to accept this idea. In General, the work on ACS in the USSR is difficult to call successful, although some relatively effective, often cited as samples, automated systems of ACS "VAZ", ACS "Lvov" and other were created.

The second stage connected with the occurrence of personal computers and rather effective electronic sensors in 1980-ies. At the suggestion of GDR leader E. Honneker, the process of implementation of these devices started to call officially electronization. From the mid 1980-ies within

the framework of the integrated program on scientific and technical progress of the member countries included in the Council for mutual economic assistance (CMEA) the electronization of agriculture took place The electronization program was an attempt to learn from the successful experiences of Japan and France, which, through their programs, were able to reach the world leading positions in a short period of time.

The program was launched on a large scale. In several pilot projects (Shpakovsky district of Stavropol Krai and Kuban agro-industrial complex "Kuban" of Krasnodar Krai) hundreds of personal computers were connected in the network and were able to function, trained agricultural specialists worked on them more or less successfully. However, these works were interrupted in the early 1990s by the liquidation of CMEA and the Soviet Union collapse.

Since the mid-1990s, the third stage of development under the name of informatization began. In technical terms, it was based on the much more sophisticated foreign personal computers and the rapidly gaining strength Internet that had flooded the country. Together with computers a variety of software arrived, including not only accounting systems, but also ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), SCM (Supply Chain Management), EAM (Enterprise Asset Management) and other. These management systems were quickly explored by our enterprises, certainly including agribusiness enterprises (Gnezdova, 2017; Ognivtsev, 2018; Garifova, 2014; Nissen, Lezina, & Saltan, 2018).

In recent years, there has been a growing interest of various levels in intensifying the implementation of information technology. At the St. Petersburg international economic forum of 2018 at the session "Internet technologies in agro-industrial complex: creating new opportunities" state secretary, deputy Minister of agriculture of Russia, Ivan Lebedev said that the fundamental trend in the development of agriculture is digitalization, that allows to increase the level of agricultural production and ensure the profitability of the industry. Digitalization is the use of digital technologies in order to change the business model and provide new opportunities for acquisition of income and value creation; it is the process of transition to digital business.

The term "digital economy" was introduced by Don Tapscot in 1997 году. In addition to this term, such synonymic constants as Internet Economy, Web Economy, Electronic economy, New economy are used. Let us consider the interpretation of this term by foreign and Russian scientists (table 02).

Table 02. Structure of the term "digital economy"

Author	Components of digital economy
D. Tapscot	Knowledge management, digital communication, virtualization, molecularization, integration through the internet, avoiding intermediaries, convergence, innovation, customization of consumption, instant response, globalization, the growth of contradictions in society.
T. Mesenbourg	E-business infrastructure, including software, computer technology, e-commerce, the increase in the value of traditional industries with the use of digital technologies, the difference in the value of the workforce of the digital economy in comparison with the traditional (demographic and worker characteristics), changes in the added value of products and services of the digital economy (price behavior).
A. Kuncman	Sphere of production, distribution and consumption of scientific and technical

	information by means of digital information technologies
R. Asanov	Business specializing in electronic production, fulfills production processes, money transfers as well as management and interaction with customers wit the help of the internet technologies
B. Panshin	Public administration, consulting and information services, finance, wholesale and retail trade as well as the provision of various public, personal and social services

At the legislative level by the order of the Russian Federation Government of the July 28, 2017. No. 1632-p the state program "Digital economy of the Russian Federation" (further – the Program) was approved. The document provides the use of the several extremely effective in the future, innovative digital technologies, called end-to-end technologies, at all levels (Figure 01).
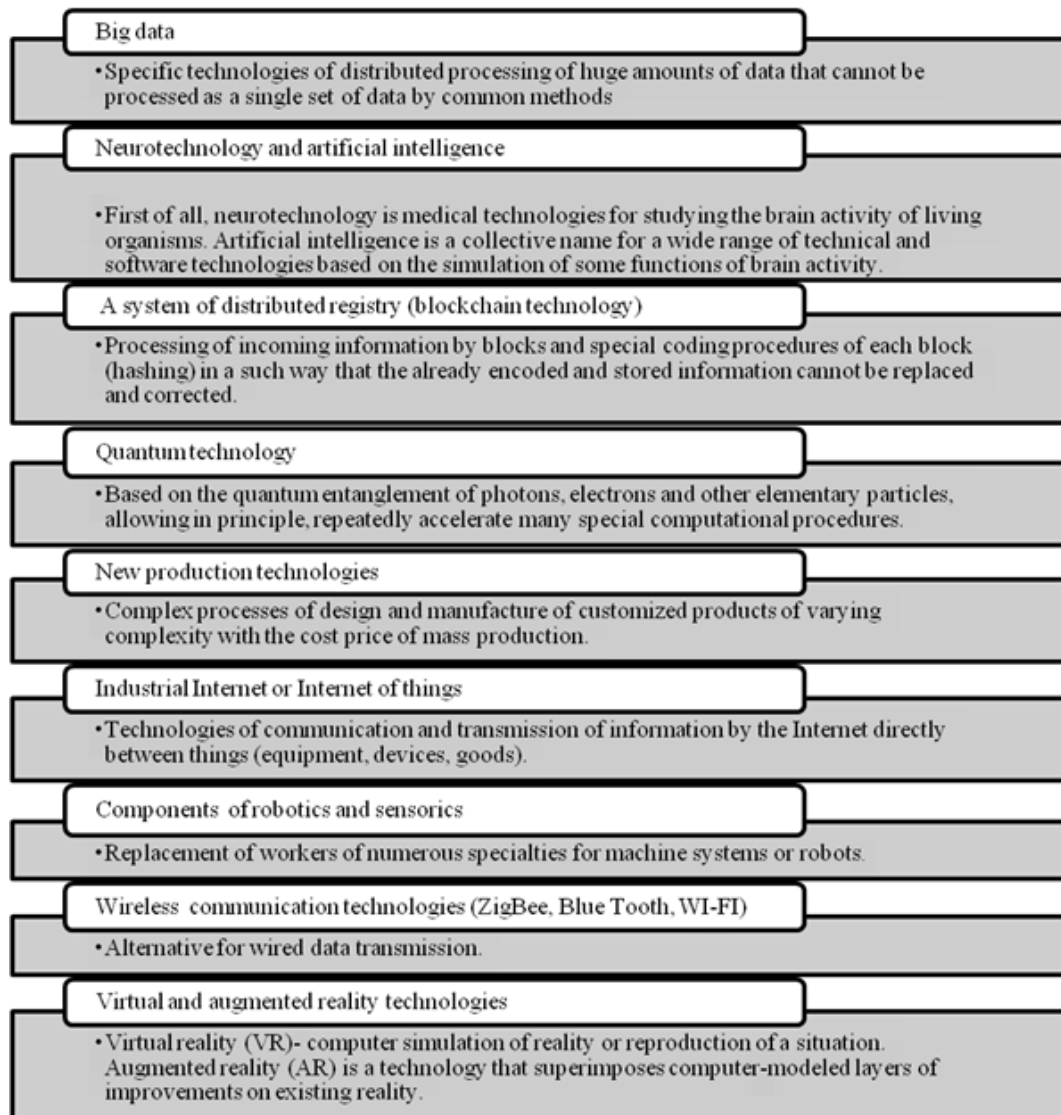
Figure 01. End-to –end technologies of the program "Digital economy of the Russian Federation" (the Program "Digital Economy of the Russian Federation", 2017)

The described priority technological platforms will allow to ensure effective communication and the creation of promising commercial technologies, high – tech, innovative and competitive products based on the participation of all the concerned parties-business, science, government, public organizations (Regulation on the formation and functioning of the Eurasian technological platforms of April 13, 2016). In the agricultural sector their realisation can be presented in the following way (Figure 02).

|	
Big data	In agriculture there is a constant need to meet big data, and this end-to-end technology will be widely used in the digital platform of agro-industrial complex.
A system of distributed registry (blockchain technology)	In agriculture, the blockchain technology can be used for the introduction of distributed databases for purchase and sale transactions and land lease for the solution of many other problems.
Quantum technologies	These directions are in the stage of formation and their practical use in the sphere of agro-industrial complex is unlikely in the next decade
New production technologies	New production technologies can be used in the processing industry and in the longer term in agriculture.
Industrial Internet or Internet of things(IoT)	IoT has already been used in agro-industrial complex, and the use of this technology will grow rapidly.
Components of robotics and sensorics	In agriculture, there soon will be a replacement of workers of numerous specialties for machine systems or robots. In the next decade the practice will include an artificial intelligence system that will perform the functions of drivers, tractor drivers, harvesters, etc.
Wireless communication technologies(ZigBee, Blue Tooth, WI-FI)	These technologies are especially important for agriculture because of its infrastructure and production facilities territorial remoteness.
Virtual and augmented reality technologies	These technologies can be used in the production and in the training of specialists in the field of agriculture.

Figure 02. Opportunities for the realization of the technological platforms of the program "Digital economy of the Russian Federation" in agriculture

Without any doubt, one of the most important "subject areas" of the economy for which a digital platform is needed is the agro-industrial complex. In terms of digitalization in agriculture Russia has the 45th position in the world (Maslennikov, 2017). Therefore, at the moment at the government level, programs and road maps for the digitalization of agriculture are being developed. Thus, the tasks of the digital transformation of agriculture are the following:

- transition to digital agriculture, precision agriculture, active use of digital technologies to increase productivity;
- integration of flows of farmers objective data and public data to the platform of digitalization in agriculture in order to ensure global planning and provide accurate guidance to market participants, also including AI;
- creation of a public structured bank of knowledge and technologies in the context of sub-sectors of agriculture and regions;

- formation of mechanisms and support measures for the implementation of digital systems in agriculture;

- ensuring traceability of agricultural products (tags, chips, identifiers, technologies, devices, systems);

- stimulation of domestic developments and provision of the access to various digital open platforms (digital field, herd, machinery and greenhouses management, etc.);

- creation of conditions for the industry transition to the end-to-end production cycle with minimization of intermediaries and trade margins;

- implementation of the online trading platforms and systems to promote agricultural products;

- formation of proposals for the adjustment of regulatory legal acts and regulatory and technical requirements for the transition to the figure;

- formation of the educational-methodical complexes (standards, methods of the program) of training;

- ensuring compatibility of production processes and standards with global standards for the Russia's leading position as an exporter of agricultural products (Digital economy indicators, 2017);

Thereby, we can say that the key elements of digitalization of agriculture are the following (Figure 03):
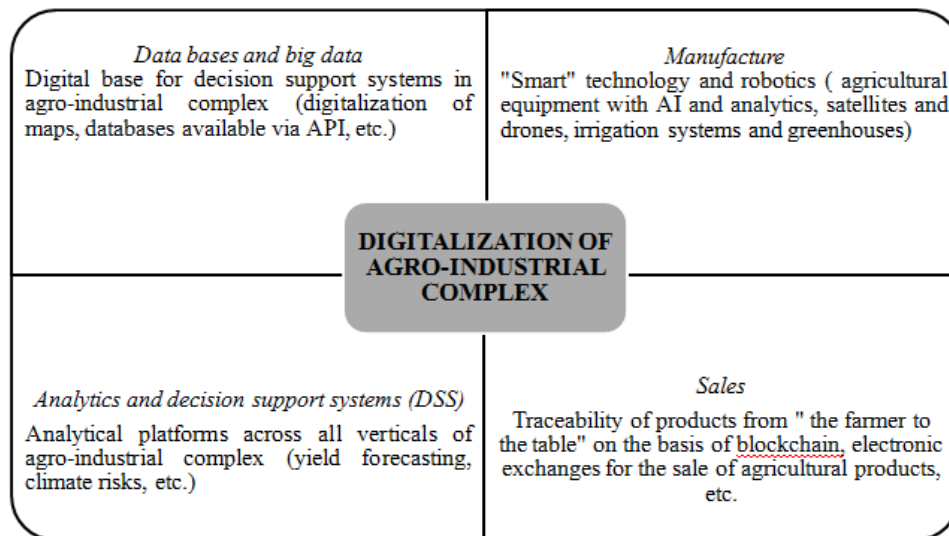
Figure 03. Key elements of agro-industrial complex digitalization

Today, digital technologies in agriculture are accomplished in two directions – in order to increase productivity and reduce losses. The efficiency of agricultural production is quite low: about 40% of production is lost at the stage from cultivation to processing, another 40% – during processing, storage and transportation. "Internet of things" (IoT) is an effective tool in achieving a new level of digitalization, it is a network of Internet-connected objects that can collect data and exchange data coming from embedded services (Fedorov, 2018). Application field of the IoT technology in agriculture covers various areas: precision agriculture; "smart farms"; "smart greenhouses"; raw material management, storage of

agricultural products; agricultural transport management; "big data". At present, a roadmap for the development of the IoT in the agro-industrial complex is being developed at the government level, according to it the share of agricultural enterprises that use the IoT should reach 30% by 2019 (Aletdinova, 2017; Bublik, Lukina, Chuvilin, Shafikov, & Yunusova, 2018).

Geolocation, precision agriculture and integrated fleet management have become the industry standard in agriculture in the last decade. Effective use of land, increasing yields at average of 15-20%, optimization of operating costs, reduction of used volumes of agrochemicals, fertilizers and seeds allows the implementation of the above mentioned standards of agriculture, precision agriculture, in particular.

Today the question of the safety of raw materials during its collection and further transfer is one of the most pressing issues in the Russian practice of agriculture. To solve this issue, it is necessary to equip the fleet with special GPS-modules, which, except the ability to monitor the current location of a single unit of transport, also allows to reduce fuel consumption up to 20% due to the proper route building. In addition, the installation of appropriate sensors on the transport allows to track the weight of the transported raw materials, therefore leveling the possibility of fraud on the part of staff.

Special sensors and software for monitoring are specially designed to optimize the conditions and methods of storage of agricultural products. Thus, algorithms specified by means of special software can monitor the state of products in real time, such as carbon dioxide content, temperature and humidity level inside the storage. Such software based on the data loaded into it will help to make a decision on the future of raw materials, the need for its further processing or sale.

"Smart" greenhouses and" smart " farms can also be implemented into the practice of agricultural production management, it will provide significant savings through more efficient consumption of water, fertilizers and chemicals by such greenhouses and farms. In addition, these technologies will help to optimize the number of the staff looking after of crops, as well as minimize the losses arising from the human factor.

The use of special sensors and monitoring software tools included in the complex of "smart" farms helps to increase the productivity of animals and, as a result, improve the quality of the final product due to the implementation of automated systems of cattle fattening and milking at the agricultural enterprises. The use of software and hardware tools for monitoring the health of livestock helps to increase the milk yield up to 40%.

The ultimate level of automation of agricultural activities, increasing yields and quality of final products is a key goal of "smart" agriculture.

Until 2025, the total minimum economic efficiency coming from the implementation of modern digital technologies in agriculture in Russia can be about 469 bln rubles according to the preliminary estimates of experts. This result can be achieved by saving resources and consumable materials, reducing crop and fuel losses, happened as a result of theft, increasing revenue due to the growth of product quality and yield, and finally by the optimization of staff costs (Golova & Sukhovey, 2018; Matveeva, Nikitaeva, & Chernova, 2018; Romanova, 2017; Skvortsov, Skvortsova, Sandu, & Iovlev, 2018).

Despite all of the aforesaid, market experts pay attention to a number of barriers blocking the the speed and efficiency improvement of the implementation of advanced technologies in the industry (table 03).

Table 03. Challenges on the way to realize the potential of digitalization in Russian agriculture

Barrier	Contents	Ways to overcome
The predominance of subsidiary farms and small farms in the structure of agricultural production	Inaccessibility of modern means of mechanization and automation of labour, and also fertilizers and chemicals for such farms. As a result-low labour productivity, wages and high unit costs per unit of production; low level of management automation of enterprise resources	Improve the level of mechanization and automation to the global average, it becomes possible in the transition to the consumption of automation cloud model; introduce elements of automated resource management and reduce the impact of the human factor at all the stages of production and marketing of agricultural products.
Debt burden of large farms	In 2016, agricultural producers were given loans in the total volume of more than 1.5 trln rub. In this regard, even when an embedded system of subsidization of interest rates is used, the entrepreneurs repay their debt by the greater part of their profit, not directing it to the implementation of modern technologies.	Significantly reduce the risks of crediting the agricultural manufacturers and, as a result, significantly reduce the rates on bank loans, which, in turn, have a strong impact on the cost of final products.
Prevalence of cheap and low-quality food in the structure of consumption	The share of expenses on food in Russia is 50% of household expenses. Thus, the consumption of meat and meat products in Russia in 2016, according to Rosstat, was 73.5 kg per person, the consumption of milk and dairy products per person amounted to 239 kg (at norm of 325 kg), the consumption of vegetables and melons amounted to 111 kg , fruits and berries – 64 kg per person (at norm of 120-140 kg of vegetables and 90-100 kg of fruits and berries).	The opportunity to provide customers with the products that contain information about the used seeds, preservatives and fertilizers brought into the product at all stages of production and marketing. This will allow to sell the products, produced according to special requirements, at special prices, for example, products for infant or dietary food, or environmentally friendly products.
Limited ability of the Russian agricultural producers to buy modern equipment	There are no optimally equipped and staffed with qualified staff dealer and service centers for the sale and maintenance of agricultural machinery, precision farming technologies are not sufficiently developed and implemented.	The development and implementation of the contract model of the equipment life cycle will fundamentally reduce the risks of agricultural manufacturers, as well as it will considerably increase the availability of small farms automation and mechanization Development and administration of the business model for the rental of equipment instead of its purchase with the possibility of payment upon consumption or by the collective use of equipment.
Long chain of intermediaries-wholesale and retail companies	Small agricultural manufacturers have to hand over manufactured goods to wholesale networks often below their cost due to lack of access to the store shelves directly. It should be noted that up to 90% of the margin from the sale of such goods remains in wholesale and retail networks and banks. The selling price of such products in case of low quality is quite high concerning the level of real available income.	The implementation of advanced digital technologies at agricultural enterprises can significantly reduce transaction costs in the case of purchase or sale of goods, as well as to minimize the supply chain. This will allow the resellers to maintain the same margin level of 5% while reducing the trade margin from 85% to 25-35%. At the same time, due to the increase in sales and consumption, the absolute values of the margin can theoretically reach an indicator exceeding the above mentioned in 1.5-2 times.

Low level of communication and IT infrastructure development	At the moment, the territory of the agricultural lands in Russia is covered by the communication networks to an insufficient extent, because of this sometimes it is impossible to provide data transmission by various digital devices in real time.	Reducing or subsidizing of the cost of the land for the possibility to place objects of communication on the part of the state, on the part of entrepreneurs – the development and investment in the appropriate infrastructure, for example, the laying of the new communication lines or the construction of antenna and mast structures.
Localized IT- solutions	Developed localized IT solutions for the implementation at the enterprises in the agricultural sector are not currently available on the Russian market. Therefore, enterprises faces a situation when the market can provide a variety of separate proposals, but without the possibility of adaptation of such solutions to their needs or without the possibility of integrating such solutions among themselves at the enterprise.	The widespread implementation and distribution of various kinds of modern digital technologies, such as cloud applications, Internet of things technology, services for managing the large amounts of data, modernization of communications used in rural areas, and finally, the development and implementation of the model of agricultural machinery rent.

The joint work of developers and integrators of IT solutions in agriculture, investors, representatives of the expert community and authorities will help to overcome the existing barriers that are on the way to the implementation of digital technologies to the agricultural sector of the Russian economy, accelerate the transfer of the industry to a new technological level of development.

7. Conclusion

The world has already entered the era of information method of production. In 2020, the fourth part of the world economy will pass to the implementation of digitalization technologies that will allow the businesses to work effectively. Developed countries are rapidly promoting innovative technologies, where the digital platforms, artificial intelligence and robotics dominate. The Russian economy in General and the agricultural sector in particular need to be integrated into this process to improve the efficiency of agricultural production and preserve the environment.

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