The main areas of application of information and digital technologies in the agro-industrial complex

A L Zolkin¹, A G Burda², Yu M Avdeev³ and D I Fakhertdinova⁴,⁵

¹ Computer and Information Sciences Department, Povolzhskiy State University of Telecommunications and Informatics, L.Tolstogo Street 23, Samara, 443010, Russia
² Department of Economic Cybernetics, Kuban State Agrarian University named after I.T. Trubilin, Kalinina Street, 13, Krasnodar, 350044, Russia
³ Department of Urban Cadastre and Geodesy of the Engineering and Construction Institute, Vologda State University, Lenin Street 15, Vologda, 160000, Russia
⁴ Department of Natural Sciences, Service and Tourism, Kazan Cooperative Institute of the Russian University of Cooperation (KCI RUC), N.Ershova Street, 58, Kazan, 420081, Russia
⁵ Department of Natural and Physics-mathematic Sciences, International preparatory school, Kazan (Volga region) Federal University (KFU), Kremlevskaya Street, 18, Kazan, 420008, Russia

E-mail: alzolkin@list.ru

Abstract. The article shows the features of digitalization of the agrarian sector of the economy. The main digital technologies used for the innovative development of the country's agriculture in recent years are considered. The main problems that inhibit digital transformation in agriculture are highlighted and the most promising directions for the development of the agricultural industry are shown. The issues of application of one of the elements of resource-saving technologies in agriculture (the precision farming), have been studied in details.

1. Rationale
In the past, agriculture has gone through several revolutions, each of which has brought efficiency, productivity and profitability to levels previously unachievable. Market forecasts for the next decade agree that the "digital revolution in agriculture" will generate a shift that will allow the agricultural sector to meet the future needs of the country's population [1].

Digital agriculture will create systems that are highly productive, predictable and adaptable to change, including those brought about by a changing climate. In its' turn, it can help to improve food security, profitability and sustainability.

The purpose of this article is to investigate the features of the application and development of digital technologies in agriculture in Russia.

2. Overview of the main technologies of digital agriculture
The catalyst in evolution and progress is a complex of technologies united by the common name of the Internet of Things [2]. This is a combination of fundamental discoveries in the field of data analysis (Data Science, artificial intelligence, machine learning), innovative advances in the development of...
sensors and self-controlled (unmanned) technology, which made it possible to collect data and control all objects at a level previously unattainable, as well as connected network solutions, management systems, platforms and applications that take the way of plants cultivation and animals farming to the next level.

Internet of Things (IoT) is a system of interaction and information exchange between various devices and machines, which makes it possible to automate management and control processes through various "smart devices" and significantly reduce human participation in these processes. The fields of application of IoT technology in agriculture are precision farming; Smart farms; Smart greenhouses; raw material management; storage of agricultural products; management of agricultural machinery and transport; Big data, etc. [1].

Today, the "Digital Farming" phrase has appeared along with the "Digital Economy" phrase. Digital farming describes the evolution of agriculture and agricultural technology from precision farming to agricultural production systems based on modern knowledge [3]. Digital farming uses Precision Farming technology, plus smart grids and data management tools.

The goal of Digital Farming is to apply all available information and expertise to automate operational processes in agriculture. Precision farming began when GPS signals became available to the general consumer. Combined with telematics and data management, precision farming improves the accuracy of operations and allows to manage the variability of fertility parameters within the field. The goal of Precision Farming is to provide each plant what everything that it needs to grow optimally while reducing costs (higher productivity with less costs). Big Data - is a designation of structured and unstructured data of huge volumes and significant variety, efficiently processed by horizontally scalable software tools that appeared in the late 2000s and alternative to traditional database management systems and solutions of the Business Intelligence class. The main features of Big Data are considered in several directions. Volume is all the immense amount of information coming for processing. Velocity is the speed of processing these data packages. Variety is the types of data to be processed by the machine. Starting from structured data (spreadsheets in Excel) to unstructured data (data from photo and video equipment) - all this is subject to processing and qualitative analysis - speaking in terms of "big data", the time comes for Analytics.

Precision livestock farming is a general requirement for all animal husbandry processes, which creates opportunities for cost-effective fulfilment of new requirements using modern technology, electronic identification of individual animals or groups of housing, registration of process and product data, information processing [4].

Precision Farming includes:

- units positioning - early users in the mid-1990s used GPS signals for manual control. They have further developed the technology used for differential fertilization and chemical protection. The first solutions for automatic control of units have appeared at the end of the 90s. During the 2000s, driving accuracy has been improved up to 1 cm [5];
- Monitoring and Control: During the 1990s, combine harvesters have been equipped with GPS location-based yield monitors. At the same time, the widespread adoption of fertilization variable rate application (VRA) technologies began. Low fertilizer prices and high technology costs initially limited the adoption of these technologies;
- telematics: it is a technology used to monitor the vehicle fleet. It has appeared in the early 2000s and was based on cellular technology and allowed to optimize logistics processes in agricultural production;
- data management: software for agriculture has been widely available since the birth of personal computers in the early 80s.

MyCrop is a technology-based initiative aimed at empowering farmers by providing them with information, expertise and resources to increase productivity and profitability, and thus improve the living standards [6]. It is a platform for collaboration of small farmers with the accent on the most
modern technologies (big data, machine learning, smartphones / tablet computers, etc.), innovative business models (agricultural platform as a service) and dedicated human efforts (agricultural forecasts, products and services).

MyCrop helps farmers make the best decisions and implement them in near real time, the platform allows to map land, plan crop selection, create work plans for individual farms and automate labor based on weather conditions, soil quality, disease, pest and crop data.

MyCrop is a resilient, data-driven, scalable, intelligent, self-learning platform for real-time collaboration that is a farm management and farmer planning tool that provides proactive analysis and monitoring, justification of made decisions, and serves as a platform for e-commerce (buying and selling resources and finished products).

3. Digital technology application and precision farming

One of the basic elements of resource-saving technologies in agriculture is precision agriculture [7]. Precision farming is the management of crop productivity, taking into account the intra-field variability of the plant habitat. Speaking relatively, this is the optimal control for each square meter of the field. The purpose of such management is to maximize profits while optimizing agricultural production, saving economic and natural resources. Herewith the real opportunities for the production of quality products and the preservation of the environment are opened up.

For the application of precision farming, it is necessary to use digital information that agricultural producers can receive from various sources, depending on their needs:

- Photos of fields from drones or satellites, followed by overlaying of vegetation maps on these photos.
- Installation of field sensors such as weather stations, soil moisture sensors and temperature sensors.
- Use of sensors for monitoring of equipment, for more accurate control not only over the progress of a particular operation, but also to rationalize the use of resources.
- Analysis of field soil samples to determine the necessary elements and their compounds, which can increase the specific productivity of the soil.

Precision farming includes many elements, but they can all be split into three main stages [8]:

- Collection of information about the farm, field, culture, region
- Information analysis and decision making
- Execution of decisions - conducting of agro-technological operations

Two basic conditions must be met in order to make a digital farming to be a reality. First is that smart machines shall be available (machines must be able to receive, send, generate (via sensors), and process data). Second is that machines shall be connected (communication and interface standards must enable seamless communication between machines, with business partners, and between portals).

Modern agricultural machines controlled by an onboard computer and capable of differentially conducting agrotechnical operations, precision positioning devices on the ground (GPS receivers), technical systems that help identify field heterogeneity (automatic samplers, various sensors and measuring systems, harvesting machines with automatic accounting of the harvest, remote sensing devices for agricultural crops, etc.) are needed in order to implement the technology of precision farming. [8]. The core of precision farming technology (the second stage of those discussed above) is software content, which provides automated maintenance of spatially-attributive data from the card index of agricultural fields, as well as the generation, optimization and implementation of agricultural solutions, taking into account the variability of characteristics within the cultivated field. Digital farming improves production processes through automated collection and targeted analysis of data in order to increase transparency and perform better assessment of the current situation, providing new
opportunities for operational management. For data processing and, in particular, their analysis, expert systems are available to the end user. It would be difficult or impossible to achieve for individual farms through internal data processing. In other words, farmers can now use previously unknown knowledge that comes from external partners. Networking with external partners, and in particular the automated integration of information and data, leads to a much broader knowledge base and therefore more informed and faster decision making. Solution algorithms are generated based on data collected in other areas of the production chain. Digital farming optimizes seed selection based on field conditions and the environment, and optimizes equipment for work. The data is used to improve the performance of these input products through additional services. Digital farming is already a reality in some areas: for example, GPS navigation systems used for controlled agriculture, precise fertilization of specific areas or crop protection measures within a complete production cycle using feedback [3]. This automated data processing and fully integrated, harmonized networks represent a not too distant future for agricultural production. A dedicated efforts from all interested parties are needed in order to implement such a future.

Personal computers and local computer networks are the technological basis of modern information technology used at the level of an individual agricultural enterprise. Unfortunately, the level of equipping the farms with computers is far from perfect. Many of them do not have such equipment at all. The overwhelming majority of farms do not use licensed software at all. Many farms use such information systems as "Konsultant+", "Garant", etc. Most enterprises use computer technology only for solving of internal information problems, ignoring the main advantage of modern computers as a means of communication. As the main reason for the shortage of personal computers, it is assumed that, firstly, there is no money for their purchase, and secondly, specialists who are able to "communicate" with this kind of equipment even at the user level. The psychological factor cannot be disregarded either. Thus, many highly qualified specialists who are accustomed to working with standard tools are afraid to use new technologies. But when the critical stage is passed, then the full advantage of the new technology manifests itself. Most modern farm managers understand the advantages of computer technologies, realize the need for their implementation and try to solve the problems of procurement and operation of personal computers at the expense of the very limited resources of the enterprise itself.

On the other hand, agrarians are faced with difficult tasks in the implementation of precision farming technologies. There are the issues of integrating new systems with existing business processes, and the lack of a comprehensive solution that would provide automation and transparency of all business processes. A whole block of personnel issues arises: a lack of IT specialists adapted to the agricultural sector, a shortage of agronomists capable of working with computer programs and applications, low qualifications of people who have to maintain new equipment. And the success of the entire process of introducing information technologies in agriculture in Russia largely depends on how quickly and competently these issues are resolved.

An integrated approach to the use of information and resource-saving technologies covering all production stages is needed. At the same time, management, information and resource-saving technologies are combined into a single production system that contributes to increasing production efficiency and product quality, reducing the negative impact on the environment, allowing rational use of resources.

Informatization, is the most important component of the agro-industrial complex in a market infrastructure. It shall provide:

- acceleration of scientific and technological progress in all areas of agricultural production;
- rational and high-quality use of fixed assets;
- improving the efficiency of decisions made in the structures and levels of management;
- accelerating the solution of social issues based on the provision of information services, etc.

Thus, the informatization of agriculture contributes to the integration of science and production, the introduction of innovative approaches to agricultural production, as well as the improvement of agricultural production management, taking into account the peculiarities of the country's agricultural
development in a market economy.

4. Findings
Digitalization of agriculture and rural areas will still require a lot of work. In this case, a number of particularly important factors shall be taken into account. First is that understanding the concept of digitalization of agriculture is largely inhibited by the lack of systematic, official data on this topic [6,8]. Most of the data - is only available at the country level (for example, on the level of computer literacy) without disaggregation by urban and rural areas. Network data mainly reflects coverage, but does not provide information on the quality and availability of services. There is a lack of information on government support and the regulatory framework for digitalization (which so far has been carried out indirectly) including on the availability of electronic government services and regulatory frameworks regarding connectivity and data protection.

The second problem is the significant gap in the implementation of digital technologies in the agricultural sector of developed and developing countries, as well as in global companies and in local, community, family farms [9,10]. The introduction of modern agricultural technologies is due to the availability of financial resources and the level of education. Small farmers in rural areas are disproportionately disadvantaged in this regard due to the fact that they have a limited access to infrastructure, networks and technologies.

Finally, the scale of economy is taken into account during implementation of digital agriculture. The larger the enterprise, the easier it is to implement such technologies. In this regard, large farms have an advantage over small ones. This situation generates inequality between large and small farms and, accordingly, inequality between developed and developing countries. Digital innovation and technologies that are paving the way for transformation are often not created for the scale of a small farm.

References
[1] Noraliev N H and Yusupova F E 2020 Digital technologies in agricultural industry Scientific and educational issues Scientific and technical journal 8(92) (M.: “Scientific publications” publishing house) p 4-10
[2] Internet of Things in agricultural industry (IoTAg) https://www.tadviser.ru Accessed on: 27.10.2020
[3] Mayorova M A and Markin M I 2019 Digital agriculture in production and economic activities of agricultural enterprises "Theoretical economy" periodical 2 (Yaroslavl: Yaroslavl State Technical University) p 67-71
[4] Truflyak E V 2018 Use of elements of precision agriculture in Russia (Krasnodar: Kuban State Agrarian University) p 26
[5] Digital Farming http://svetich.info/publikacii/technoe-zemledelie/cifrovoe-zemledelie-digital-farming.html Accessed on: 27.10.2020
[6] Digital technologies at the service of agriculture and countryside areas http://www.fao.org/3/ca4887ru/ca4887ru.pdf Accessed on: 27.10.2020
[7] Bikbulatova G G 2008 Precision farming technology Omsk scientific periodical Series: Earth resources Human 2(71) (Omsk: Omsk State Agrarian University) p 41-9 Precision agriculture http://www.agrophys.ru/precision_agro Accessed on: 27.10.2020.
[8] Zakharchenko N V, Hasanov S L, Yumashev A V, Admakin O I, Lintser S A and Antipina M I 2018 Legal rationale of biodiversity regulation as a basis of stable ecological policy Journal of Environmental Management and Tourism 9(3) 510-23 doi: 10.14505/jemt. v9.3 (27).11
[9] Ling V V and Yumashev A V 2018 Estimation of worker encouragement system at industrial enterprise Espacios 39(28)
[10] Morozova T, Akhmadeev R, Lehoux L, Yumashev A, Meshkova G and Lukiyanova M 2020 Crypto asset assessment models in financial reporting content typologies Entrepreneurship and Sustainability 7(3) 2196-212 doi: 10.9770/jesi.2020.7.3(49)