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Modern Tools for Sustainable Development of Territories. Special Topic: Project Management in the Regions of Russia

THE DIGITALIZATION OF MANAGEMENT PROCESSES IN AGRICULTURE INDUSTRY

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Abstract

In recent years digital technologies (AgTech) intensively penetrate into agricultural industry. Digital transformation of agricultural industry means systematic, accelerated use of modern digital technologies in agricultural industry and correlates with the trends of the development of digital economy. The main task in increasing the efficiency of agricultural production management includes automation of production processes. Nowadays it can be achieved by various digital technologies. However, the "digitalization" is not only electronically-controlled equipment that is used in precision agriculture, RFID-tags of animals, geoinformational systems and satellite navigation. Comprehensive integration of management elements in agriculture (agronomy), cattle breeding (zootechnics), accounting (bookkeeping and tax accounting) and management will allow to increase the efficiency of business activities of agricultural producers. The control system, including IoT, will allow receiving real-time information, for example, about production costs, to make targeted and error-free management decisions. In our opinion, today the ERP platforms are the tools that can connect separate elements of digital process control. Components of the entire agro complex system (drones' sensors, satellite observation, accounting software etc.) are connected to the platform when required and have the ability to work with single database with maximum use of functionality. At the state level the implementation of digital technologies will allow, for example, to create unified information system about lands, crop rotation structures, to control the implementation of measures to support agriculture in terms of subsidies, to perform online monitoring of both investment projects realization (recipients of government support) and to monitor the work of the industry promptly.

Keywords: Agricultural industry, AgTech, comprehensive integration of management elements, digital transformation, management.

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1. Introduction

"Scientific and technical innovations are the main driving forces of economic development" – the economist of the 20th century Josef Shumpeter wrote in 1912 (Schumpeter, 1982). In recent years digital technologies (AgTech) intensively penetrate into agricultural industry. Digital transformation of agricultural industry means systematic, accelerated use of modern digital technologies in agricultural industry and it correlates with the trends of the development of digital economy. Structuring and forecasting the results of business processes of agricultural production are complicated by weather conditions and natural phenomena. In 2018 according to the estimations of the Ministry of Agriculture of the Russian Federation the losses of agrarians from the introduction of the emergency situations due to unfavourable weather conditions achieved more than 6 billion roubles in 2018. This sum is around 0.1% from the gross domestic product produced by the agricultural sector in Russia. According to the assessment done by scientists from the Karlsruhe Institute of Technology (Germany) the amount of economic losses that were caused by natural disasters happened from 1900 to 2015 is equal to 7 trillion US dollars. During that period 40% of all the catastrophes were caused by floods, 25% by earthquakes, 12% by drought, 2% by forest fires and 1% by volcanic eruptions (Daniell, Wenzel, & Schaefer, 2016). This leads to the conclusion that risks from natural disasters in agricultural industry are comparable to the risks in other sectors of the economy. Technologies have evolved, become cheaper and achieved such a level that for the first time in the history of the industry it became possible to obtain data for each agricultural object and its environment, to calculate mathematically precisely the algorithm of actions and precisely predict the result, including the assessment of the impact of natural factors (Text broadcast, 2018).

2. Problem Statement

The foundation of the digital economy, the basis of its operation is a digital technology and tools that allow to collect and process large amounts of data (big data). The results of big data analysis make it possible to improve the efficiency of production, improve technological solutions and equipment, develop storage systems, sales and delivery of finished products to end customers (Digital economy in agriculture, 2019).

3. Research Questions

The efficiency of production activities improves with increasing productivity and reducing losses. According to some experts, "the inefficiency of agricultural production is still off scale: around 40% losses of production take place at the stage from cultivation to processing, another 40% take place during processing, storage and transportation". Based on the FAO data in developing countries 40% of food losses are losses during post-harvest processing, whereas in industrialized countries more than 40% of losses occur in retail and during consumption (Sheyan, 2017).

Based on the statistics of Russian Federation, the average percentage of loss of agricultural products over the past 10 years, such as grain, was 1.13% of the gross weight of harvested crop after processing, losses of meat and meat products are 0.23% of the total production. Thus, the losses during

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storage, transportation, processing and sales of meat and meat products in 2017 were around 303 thousand tons, losses of grain were 1.5 million tons (Federal State Statistics Service, 2019). According to the data published by the Federal Customs Service, wheat exports from Russia in 2017 were 32.9 million tons (Demidova, 2018). Thus, grain losses are up to 10% of the weight of the exported wheat.

Based on the experts' estimations 25% of grain losses are related to the technology of harvesting, 1% of losses happen during transportation and up to 74% of losses occur in the post-harvest period (processing and storage). Post-harvest losses of grain in the current successful situation in the world grain market - this is an unacceptable waste.

4. Purpose of the Study

The main task in improving the efficiency of agricultural production management is the automation of production processes. It is being solved today with the help of various digital technologies.

Agricultural enterprises are introducing precision farming, telemetry and telematics. The management system of the agricultural enterprise implies, among other things, the planning of the residual life of the equipment and the management of the execution of tasks. The Internet of Things (IoT) became the accelerator of the digital transformation of the industry. Thanks to it automatically generated data from satellites, drones and various sensors began to flow into the management companies of agricultural holdings. A special algorithm, IoT, when devices are equipped with technologies to interact with each other or with the external environment allows not only to obtain the necessary data, but also to manage objects and processes. System solutions in agriculture using digital technologies are summarized in Table 01.

Table 01. System solutions in agriculture using digital technologies

System solutions	Brief description of the solution
"Digital" field (precise agriculture)	Graphic display and marking of land on geographical maps, land inventory using UAVs, creating orthophotos with accurate geo-referencing to the terrain, maps of the fields of the enterprise, which can be used to solve a huge range of external and internal tasks. Crop/agricultural work monitoring systems. Control over changes in the state of sowing in various areas within the field according to remote sensing (earth remote sensing), (pictures taken from space, aerial photography done by UAVs, unmanned aerial vehicles). Application of a strictly defined amount of fertilizers and seeds to different areas of the same field, depending on the condition of the soil and crops. Automatic monitoring of yields, mapping yield levels for each field, and in future – profitability maps. Agricultural monitoring - NDVI index. Increase of yields or reduction of costs, Agrochemical survey, differentiated application of materials.
Integrated machine system	System of monitoring and control of transport. Equipment of special machinery and vehicles with GPS / GLONASS trackers that transmit data to the center of GLONASS/GPS satellite monitoring. GPS and GLONASS transport monitoring system, which allows to visualize the acreage of agricultural enterprises and work undertaken on them, to control the location and movement of the company's equipment. Automation of equipment management process (parallel driving, autopilot) with the help of navigation devices. Creation of RTK infrastructure, network of base stations (RTK - Real Time Kinematic - a set of techniques and methods for obtaining the coordinates with the centimeter accuracy using a satellite navigation system).

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	Control of fuel and consumables. Installation on refuelers of universal event counters (USS) and RFID cards of drivers (radio-frequency identification). Organization of operational monitoring of fields processing tasks, collection and transportation of agricultural products. Control of collected grain that is discharged from the combine harvesters to grain carriers and moved to the weighing platforms. The exact calculation of the volume of fuel issued for each vehicle, the misuse of fuel is practically impossible. Reporting on the performed unloading of harvesters to control the harvesting company and for the subsequent analysis.
"Digital" cattle	RFID tags for animals, tracking sick individuals, head count, movement control, feeding control, etc. Sensors in the stomach with 5 years' service life, temperature data, pH and motor activity. Installation of cameras to define the fatness, program management tribal records. The use of special software for accurate calculation of the amount and composition of mixed fodder, data for breeding. Automated milking halls, preparation of individual milk flows curves (Vartanova & Drobot, 2018). The data goes to departmental services, where rankings of milk flows, milk deficit, indices of the RDRC are done by area, region, etc. Dairy map includes statistics by region - average farm size, production data, market participants and their share.
Accounting and decision support systems	Implementation of software solutions to track the receipt of crops from each field, each combine, each grain carrier. The formation of management accounting and control of technological operations performed in the optimal time frames allows to obtain information about the operating time of the equipment, the treated area and productivity, the use of technology in the framework of technological operations. Online representation of key indicators on the company's website in real time. Data collection, storage and analysis, to track the dynamics of processes and support decision-making, including control over execution. Complex of solutions for effective management of modern (digital) enterprise. Use of platforms that support work through the Internet, including "cloud" technologies and work on mobile devices.
Single platform	For example, ERP: agro-industrial complex. Optimization of business plan in crop and livestock on the basis of different scenarios. Achieving the strategic goals of the agricultural company through operational control and effective use of land, machinery and tractor fleet, human resources. Organization of financial management based on the budgeting system. Operational control of field and repair activities. Optimization of placement of crops on fields and sites. Increasing crop yields through the optimal use of imported machinery and equipment, expensive feed and additives, plant protection products, seeds and fertilizers, control of fuel consumption. Operational provision of management of agricultural companies with reliable information for management decisions. Ensuring the possibility of forming a consolidated balance sheet of a diversified agro-industrial enterprise or group of companies. Comprehensive enterprise resource management. Customer relationship management. Management, financial and personnel accounting at the enterprise. A comprehensive solution for poultry, livestock, flour and cereal, dairy and other enterprises. Satellite support of vehicles, control of mileage, fuel consumption, unreasonable downtime, high-speed mode…

Today, agroecological factors that affect the yield have been studied, schemes of agroecological zoning of land have been created in order to control the activities and monitor the development of plants.

Thanks to the analysis of big data that is collected from sensors installed on the agricultural machinery, UAVs (unmanned aerial vehicles), manufacturers are already able to double production by controlling the entire process in crop production: from planting to harvesting. Thus, based on the experience of using the "AgroSignal" system, that controls the logistics of agricultural machinery using sensors on 150 farms with a total area of more than 2 million ha, productivity can be increased by 100%,

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savings of material values due to reduction of their losses reaches 50%, and productivity in some cases increases by 10-15% (Sheyan, 2017; Abdyushev, 2008).

5. Research Methods

The primary contribution of this paper involves synthesis practice of the use of tools of digitalization in the agricultural sector. Our methodology can be considered a form of initial project scoping to serve the agro-industrial complex in frames the development of digitalization process. Monographic, abstract-logical, economic-statistical, calculation-constructive, experimental methods of research were used in the work. The research questions in this study seeks to assess first: what industry and field-applications, technologies and topics in the agricultural sector are prevalent and have the possibility of complex use? The authors suggest further development of these studies using mathematical modelling and practice applying ERP platforms, for examples.

6. Findings

However, "digitalization" is not only electronically controlled equipment in the precision agriculture system, RFID-tags (radio-frequency identification) of animals, geo-information systems and satellite navigation. A classical scheme of process control using digital technologies in agriculture is given in Figure 01.

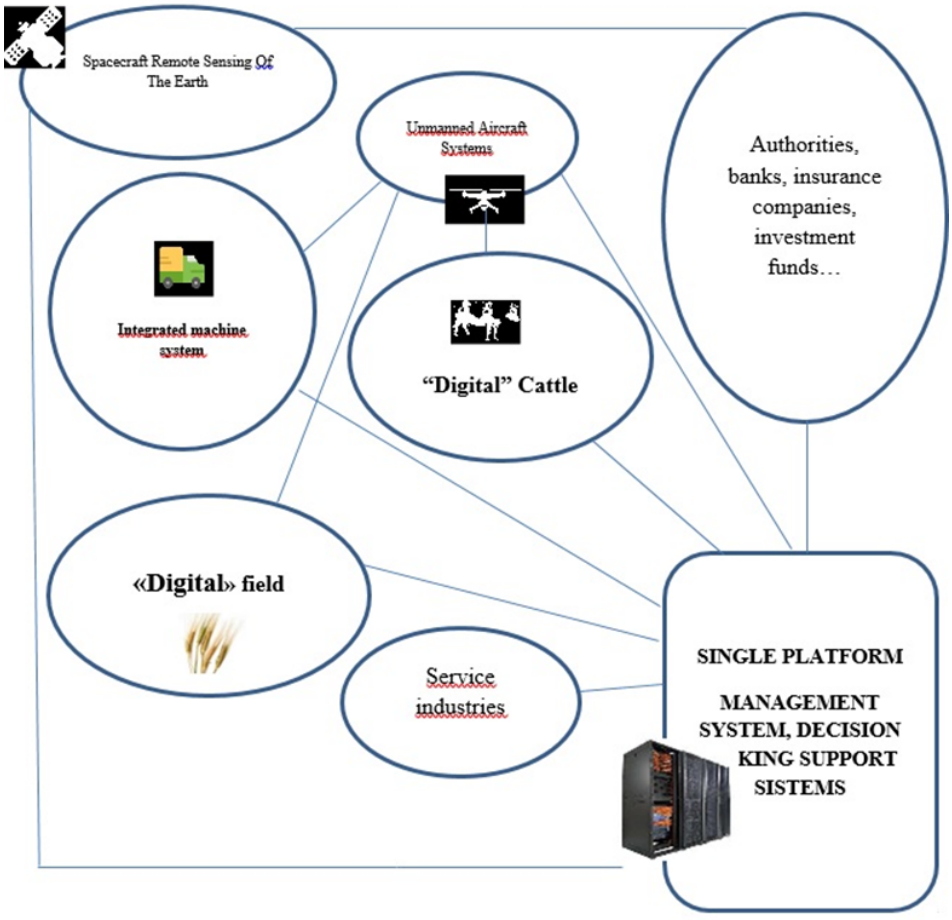

Figure 01. Classical scheme of process control using digital technologies in agriculture

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The symbiosis of knowledge of biology, zootechnics, soil science, agrochemistry, computer science (Cybernetics), production technology, management and economics in the digital environment allows to move to a new level of development of agricultural production. The use of digital technology allows to build a multi - level enterprise management system, consisting of interacting elements, combined into subsystems of several levels to achieve a common goal of functioning (objective function) - a transition from enterprise management to management of profitability of output, industry.

7. Conclusion

This way software and the creation of a database at the Federal level will allow to keep the history of milk production from different farms at the same time, taking into account each batch of raw materials for production of dairy products in the context of weight, farm, cow... The dairy market is single, transparency is inevitable. The milk card is the basis. Sources are participants of the dairy market, regional authorities of agriculture and statistics, partners, analysts, the Dairynews. And all this is combined in a mobile application-crowdsourcing service that allows market participants to enter their performance indicators. Based on these indicators the system is able to calculate the average price of milk by region. Figure 02 shows a Model of management of agricultural production in the digital environment.

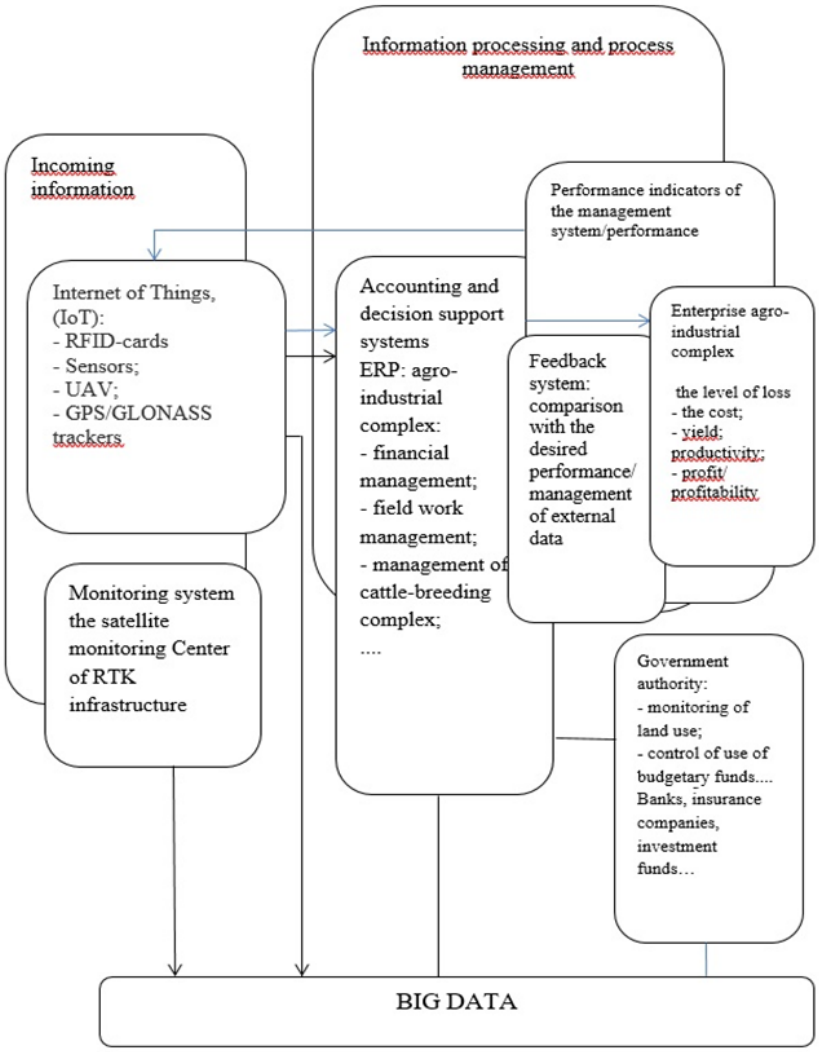

Figure 02. Model of management of agricultural production in the digital environment

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Within the framework of the state program "Digital agriculture" proposed by the Ministry of agriculture of the Russian Federation, the concept of "effective hectare" will allow to conduct by household economic monitoring of the efficiency of use of factors of production and its results in recalculation per unit of arable land. This will provide accurate information about the optimal type of household in a particular region, ensures transparent and efficient use of budgetary funds, high profitability, rationalizes the use of agricultural land, allows to increase the volume of agricultural exports.

The concept of "effective livestock and poultry" is a method of livestock management, which is based on the introduction of digital technologies: IoT, GPS and GLONASS, software, automation systems, etc., in the process of obtaining livestock products, in order to control product quality, increase of productivity, reduce the costs and realize the genetic potential of animals.

A single platform for the provision of services in the field of trade between the participants of the agricultural market. A single database will allow to perform work on the inventory of farmland, unused arable land, to assess the economic effect of putting the land into circulation....

Such business connectivity will radically change the pricing process in the agro-industrial complex as a whole. All this will lead to diversification of the structure of the export portfolio of Russia, will set trends to increase the export of agricultural products, stimulate sustainable growth of investment in the agro-industrial sector.

The process of digitalization is, among other things, fundamentally transforming industrial production, when it becomes possible that machines (equipment) exchange information with each other, there is a self-organization of various processes, and individual consumer preferences are automatically included in the production process. The level of global connectivity (with everything) will increase, bringing the human community into a state of interaction. Thus, transnational large business will be reborn into so called digital platforms, where a merging of production, services, social and telecommunication networks will take place.

There comes a period of great opportunities, but also great challenges. What kind of balance will prevail – this is a question the answer to which is to be found before the possible adverse events could happen?

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