Digitalization as a driver of development of domestic animal breeding

T E Marinchenko

Russian Research Institute of Information and Feasibility Study on Engineering Support of Agribusiness, the Federal State Budgetary Scientific Institution (Rosinformagrotekh FSBSI), U60 st. Lesnaya, Pravdinsky Township, Pushkinsky District, Moscow Region, 141261, Russia

E-mail 9419428@mail.ru

Abstract. The aim of the study is to analyze the level of digitalization of livestock production, determine the prospects of the process against the background of their existing strategic documents and the level of domestic developments. The study was based on the program documents, scientific publications, and data on Russian developments. The study used the monographic methods, comparative and system analysis methods, idealization and mental modeling methods, as well as a logical approach. Since the government has posed a challenge to ensure the entry of the Russian Federation in the five largest economies in the world, the transformation the agriculture through the introduction of digital technologies and platform solutions, the issue of digitalization of agriculture and livestock as less advanced in matters of digitalization is very relevant.

Keywords: agriculture, production, digitalization, digital technologies, market, state programs, trends, prospects

1. Introduction

Currently, digital data is becoming the key factor in production. This data comes from various devices and sensors located in a field, at a farm, in equipment, from weather stations, drones, satellites, and from external systems throughout the production chain. The data acquired and processed allows obtaining information of a new quality, finding patterns, forecasting while using modern big data processing techniques, minimizing risks, optimizing production and logistics costs, creating added value for all participants in the production chain, and ensuring the sale of products.

The modern model of technological development provides for the accelerated development and modernization of the Russian economy through the widespread development of the basic innovations of the fifth and accelerated transition to the sixth technological structure, the core of which is nano-, bio- and information and telecommunication (digital) technologies.

The “digital economy” term means an activity in which the key production factors are digital data, its processing and use in the modeling of production processes. The data can significantly improve the efficiency, quality and productivity of production, storage, sale, delivery and consumption [1].

To accelerate the penetration of digitalization in production, a national program entitled "Digital Russian economy" is implemented, which aims to promote the transformation of priority sectors of economy including agriculture through the introduction of digital technology and platform solutions, to
accelerate technological development, to increase the number of organizations implementing technological innovations up to 50% of their total amount, to ensure the entry of the Russian Federation in the five largest economies in the world, to create in the basic sectors of the economy, particularly in the manufacturing industry and the agricultural sector, a highly efficient export-oriented sector that would use modern technology and provided with highly qualified personnel [2].

Efficiency of the domestic livestock is significantly lower than that in the developed countries, therefore the increase in production efficiency through the introduction of modern digitalization technologies becomes operational need that allows increasing the competitiveness of agricultural producers.

A considerable amount of works of domestic and foreign authors are devoted to various aspects directly or indirectly aimed at solving the problems of agriculture digitalization; the issues of the public support, positive implementation experience, and producers’ challenges are widely covered [3-14].

The purpose of the study is to analyze the level of digitalization penetration in the domestic animal husbandry, to identify the prospects for the process in the framework of the tasks set by the government and the presence of domestic developments.

2. Materials and Methods
A base for the study was the departmental program titled "Digital Agriculture", scientific publications on the problems of digitalization of agricultural sector, data regarding Russian developments in the field of digitization of livestock. The study used the monographic methods, comparative and system analysis methods, idealization and mental modeling methods, as well as a logical approach.

3. Results
Russia occupies the 15th place in the world in the general level of digitalization and the 45th place in the world in the level of the information technology penetration in agribusiness. Based on estimates, only 13-15% of producers are able to implement the digital technology and commercialize the scientific and technical inventions.

The effectiveness of domestic agriculture is noticeably inferior to the largest economies. According to expert forecasts, 25% of the global economy will switch to the implementation of digitalization technologies by 2020. Smart farming and precision farming programs are available in dozens of countries. The pace of implementation of “artificial intelligence” technologies in the agricultural sector is growing by 22.5% annually. According to the MarketsandMarkets research company data, the size of this market will be $2.6 billion by 2025 [15-17].

Upon an initiative of the Russian Ministry of Agriculture, a framework of a national platform titled “Digital Agriculture” has been developed along with a preliminarily comprehensive examination of the current state of the level of digitalization of basic processes, and an algorithm for the digitalization of the state information resources has been developed too.

Digital data to be processed by modern software tools is considered as one of the key assets of the industry. The national platform called Digital Agriculture to be created, which is integrated with platforms of related industries, will accumulate information, industry best practices and models, as well as provide access and data processing services, which will significantly speed up the process and allow achieving a synergistic effect. The platform should become the basis for building an ecosystem of digital services and services in the agricultural sector [16].

A platform, integrated with sub-platforms of the regional and municipal levels, should provide a technological breakthrough and double labor productivity by 2024 [3].

The analytical center created for the project should determine the most effective project parameters, develop standard projects and stimulate their implementation, for which an information platform is being formed that aggregates 13,000 indicators for agricultural enterprises. The interaction of the federal system with 16 regional IT systems has been worked out.

The market for information technologies in the agribusiness is estimated at more than 360 billion rubles. The digitalization level is projected to grow five-fold by 2026, including through start-ups. The
The ultimate goal of the Digital Agriculture program is to develop and launch replicable integrated innovative projects of end-to-end intelligent systems called “Country”, “Region”, “Agricultural enterprise”, “Field (Farm)” based on domestic methods, algorithms, digital technologies, and samples of systems and devices [3, 16].

The Ministry of Agriculture of Russia involved the following databases in the implementation of the project: TsIAS SKh (Central Information and Analytical System of Agriculture) and EFIS ZSN (Unified Federal Information System of Agriculture).

TsIAS SKh is a data bank integrated with the information systems of the Ministry of Agriculture of Russia, Rosstat, Federal Customs Service, Roshydromet that has a functionality of the analysis for operational monitoring of the status and development of agribusiness facilities.

EFIS ZSN has formed the basis of the “effective hectare” area based on BigData, is integrated with the databases of Federal Agency for State Registration, Cadastre, and Cartography, and Roscosmos, which provides a map of agricultural land with a high level of verification. The service will allow, by 2021, to introduce intelligent industry planning in the entities, which involves differentiated cultivation using adapted technologies of the most profitable crops for specific areas of agricultural land and the rational use of logistics infrastructure. The “effective hectare” will allow real-time monitoring and modeling the export flows of agricultural raw materials taking into account many factors. Integration with the databases of Roshydromet and Agrochemical Centers will make it possible to forecast harvests and harvesting dates, which will form the basis of the export area called “from the Field to the Port". Such a model will take into account the forecast flows of raw materials considering the yields and the transport shoulder, that is to say, the rolling stock of Russian Railways. By 2024, the export of products will be accompanied by a paperless system "from the Field to the Port." The Smart Contracts project provides a system of intellectual measures of state support and personal accounts of subsidy recipients with electronic document management and package solutions for agribusiness (subsidy + loan + insurance). Integration with the databases of Roshydromet and EMERCOM will allow adjusting subsidies in connection with emergencies. The contracts are expected to be available in the SMART mode since 2021.

It is planned to implement the project of “smart” distribution of food production and regional differentiation, taking into account the “health map” of the population titled “Industrial FOODNET” based on data on the lack of vitamins, minerals, antioxidants in the framework of public-private partnership with transnational corporations.

The “Digital Agriculture” will be implemented through pilot regional scalable and replicable projects of end-to-end scientific and production cooperation in the concept of “Digital Agriculture” based on domestic integrated digital agricultural solutions: “Smart Farm”, “Smart Field”, “Smart herd”, “Smart greenhouse”, “Smart processing”, “Smart warehouse” and “Smart agricultural office”, which will contribute to the economic, social and technological development of the regions. It is planned that, by 2024, all agricultural data will be consolidated on a single platform, all agricultural producers will become users of digital services, and agricultural product traceability will reach 80%. [2, 16]. The objective of the departmental project is the digital transformation of agriculture through the introduction of digital technologies and platform solutions to ensure a technological breakthrough in the agricultural sector and to achieve a two-fold increase in productivity at digital agricultural enterprises by 2024 (table 1).

| Table 1. Target indicators of the departmental project titled "Digital Agriculture" [2] |
Indicator | Years
--- | ---
**Share of data on agricultural resource facilities included in the "Digital Agriculture " digital platform, %:**
agricultural land (of the total area of agricultural land) | 2019 2020 2021 2022 2023 2024
working and productive livestock (from the total number of livestock in the category ) | 25 35 50 75 90 100
farm machinery (the total number of units) | 45 60 75 90 100
**Growth rate of labor productivity (for enterprises that have introduced digital agricultural solutions), %**
| 105 125 150 175 190 200
**Ratio investment in digital products and technology of the total investment, %**
Including that in domestic development, % | 1 3 7 10 15 25
0.5 1.5 5 7 10 20
**Share of SMART contracts with recipients of subsidies, %** | 5 25 50 75 100 100
**Share of regions that have implemented planning based on the Digital Agriculture platform, %**
| 0 6 29 59 100 100
**Share of material costs in the cost of production (for enterprises that have introduced digital agricultural solutions ), % of the cost**
| 60 55 50 47 45 43
**Share of specialists in the field of the digital economy, % (of the total number of specialists, on an accrual basis), %**
| 10 15 20 30 40 50

The total economic effect from the switch of farms to digitalization-based business models can amount to more than 4.8 trillion rubles. in annual terms, the growth of labor productivity can be increased three to five times, and the growth in the consumption of information technology due to the digitalization of the agricultural sector can reach 22 % [18].

The level and rate of digitalization in livestock and crop production is markedly different. So, in 2017, the structure of investments in IT equipment included the share in livestock production amounted to only 7 % of the total costs in the agricultural sector, while in crop production was 51 % [19].

The main consumers of digital technologies in animal husbandry are large manufacturers. Demand for automated milking, feed preparation and herd management systems is growing annually. All digital innovations in animal husbandry to be offered on the world market are available in our country. In addition to robotic milking machines, there is a great demand for electronic heat period detection systems.

Almost all components of digitalization of management in livestock are integrated into herd management systems. The main requirements for such systems are switching the visual monitoring to digital one through the measured parameters; minimization of the human factor when performing production operations and entering information; transition from reactive to preventive management; minimization of the impact of individual objects of management on production indicators. The creation of “intelligent farms” envisages the development and implementation of automated centralized management through process control subsystems (feed production and feeding, herd reproduction, animal veterinary service, milking, microclimate, manure removal, etc.); automation of most operations of specialists (veterinarians, livestock specialists, engineers); information and analytical units for product quality assessment, logistics planning, etc. [20].

An example of digitalization at the state level is the creation of the Mercury system projected by the Federal Service for Veterinary and Phytosanitary Surveillance to provide electronic veterinary
accompanying documentation. This system was launched on July 1, 2018. Currently only part of the planned "from field to counter" chain concerning raw materials is working. The system will work in full after it has spread to finished products.

It is now under development the integration of information systems of the Federal Service for Veterinary and Phytosanitary Surveillance and the veterinary services in a digital platform for interfacing the monitoring and supervisory systems in the business management systems for business entities for the purpose of identification and traceability of animals and for inclusion of the complete livestock production cycle in the digital end-to-end chains.

The use of digital, automated production and management technologies in pig and poultry farming allowed for a dynamic growth of production volumes in difficult economic conditions and with increasing veterinary risks.

In the future, digital identification systems and sensors for identifying the physiological state of animals will be integrated into domestic Selex systems and will become tools for valuation work along with data processing and provision in electronic form, monitoring of the physiological state and treatment of animals, automated control of the quality of milk in the stream at milking plants (protein, fat, somatic, electrical conductivity, etc.), and non-contact remote monitoring of animal behavior.

Significant progress in the field of significance of digitalization in the selection of farm animals in the world is, in recent decades, associated with the development and implementation of technologies of gene and genomic selection. Creating DNA passports of animals requires the development of methods and test systems that allow for the genetic differentiation of breeds, types and lines of animals with high accuracy [21].

The process of digitalization of selection in dairy cattle breeding is actively ongoing in the Orenburg, Volgograd, Bryansk, Sverdlovsk, Chelyabinsk, Tyumen, Kurgan, Novosibirsk, Samara, Rostov, Astrakhan regions, the Stavropol Territory, the Altai Republic, and in the Udmurt Republic.

The studies that have been performed over the years have allowed for the development in the Russian Federation of national systems for the genetic identification of animal species compatible with the systems of pedigree cattle importing countries.

Digitalization in livestock farming will allow agricultural producers to integrate into the global space using world standards for meeting the requirements for product quality and traceability. Specialists predict the fragmentation and specialization of farms in the production of milk, reproduction of the herd, cultivation of livestock, fodder storage, slaughter, transportation and sale of products, etc. [22, 23].

4. Discussion
Digitalization of processes related to the maintenance and reproduction of animals, milk production, information collection and database generation, the development and prompt refinement of algorithms and digital models provide objective, complete and efficient "digital" display of facilities and their management. The need for constant visual observation and control is minimized. Management adjustments are promptly made.

The production and economic results, that is to say, calf yield and milk production, are increased, feed conversion is improved, insemination costs, losses due to culling and the cost of treating animals are reduced.

In livestock farming, the rate of use of digital technologies is much lower; however, there is a positive experience of farms using information from all stages of complex production processes based on a single “digital platform”.

5. Conclusions
The digital transformation of the agribusiness has become an object of increased attention of both the state and manufacturers; the formation of a high-tech infrastructure with access to all market participants is ongoing.
The technology of “precision” production in agriculture and livestock breeding is becoming a strategic necessity, the state supports its implementation, software products and platform solutions have been created, including domestic ones that have proved their effectiveness.

In the short term, the transition to advanced digital, intelligent manufacturing technologies and robotic systems should be considered as a development priority. The project developed by the Russian Ministry of Agriculture provides for the end-to-end digitalization of all data, allows simplifying the collection of statistical information, monitoring the system and promptly applying preventive measures against the system destabilization, predicting more accurately and simulating raw material and commodity flows with a multiple reduction in logistics costs, speeding up communication between government bodies and manufacturers, and also simplifying the receipt of government support measures. The system must be dynamic and transparent for all platform participants.

The basis of “digital agriculture” is not only statistical data and information from sensors, but ready-made mathematical models of production and marketing processes, which include the entire value chain of goods, allow planning volumes, quality, and profitability in geographical and time dimensions.

References
[1] Buklagin D 2017 Fifth technological structure: place of the Russian agribusiness (Economic analysis: theory and practice) V16 (Issue 1) pp 19-35.
[2] Digital transformation of agriculture in Russia 2019 (official publication, Moscow: Rosinformagrotekh) p 80
[3] Departmental project "Digital Agriculture" 2019 (official publication, Moscow: Rosinformagrotekh) p 48
[4] Ognivtsev S 2019 Digitalization of the economy and the economy of agribusiness (International Agricultural Journal) No 2 (368) pp 77-80 DOI: 10.24411/2587-6740-2019-12034/
[5] Guzueva E R, Vezirov T G, Beybalaeva D K., Batukaev A A and Chaplaev Kh G 2020 The impact of automation of agriculture on the digital economy (IOP Conference Series: Earth and Environmental Science) Vol 421 Issue 2 022047 DOI: 10.1088/1755-1315/421/2/022047
[6] Sokolova A P, Litvinenko G N 2020 Innovation as a source of agribusiness development (IOP Conference Series: Earth and Environmental Science) 421(2) 02205 DOI: 10.1088/1755-1315/421/2/022053
[7] Panov A, Panova N, Malofeev A, Nemkina E 2019 Interaction of regional agribusiness entities in the transition to a digital economy (IOP Conference Series: Earth and Environmental Science) 403(1) 012138 DOI: 10.1088/1755-1315/403/1/012138
[8] Ivanov P A, Kornilova L 2018 Financing innovation in agriculture: the basis of its digitalization (Accounting, analysis and audit in a digital economy:Proceedings of All-Russia Scientific and Practical Conference) pp 255-261
[9] Khabarov V, Volegzhhanina I 2019 Knowledge management system of an industry-specific research and education complex (IOP Conference Series: Earth and Environmental Science). 403(1), 012197 DOI: 10.1088/1755-1315/403/1/012197
[10] Serbulova N, Kanurny S, Gorodnyanskaya A and Persiyanova A. 2019 Sustainable food systems and agriculture: The role of information and communication technologies (IOP Conference Series: Earth and Environmental Science) 403(1) 012127 DOI: 10.1088/1755-1315/403/1/012127
[11] Boev V U, Ermolenko O D, Bogdanova R M, Mironova O A and Yaroshenko S G 2020 Digitalization of Agro-Industrial Complex as a Basis for Building Organizational-Economic Mechanism of Sustainable Development: Foreign Experience and Perspectives in Russia (Lecture Notes in Networks and Systems) 87 pp 960-968 DOI: 10.1007/978-3-030-29586-8_109
[12] Gravshina I N, Denisova N I, Kuzmin V N 2019 On the issue of improving the competitiveness of agricultural products of the Ryazan Region in the conditions of digital transformation. (Agribusiness; Economics, Management) No 11 pp 77-83
[13] Semkin A .G 2019 Strategic areas of the development of the regional agribusiness management
system (Economics of agriculture in Russia) No 2 pp 22-27

[14] Butyrin V V, Butyrina Yu A 2019 *Areas of digital transformation of agriculture* (Economics of agriculture of Russia) No 6 pp 9-14

[15] Marinchenko T E 2019 *Digital transformation of agriculture* (Modern agrarian economy: problems and prospects in the development of digital technologies: Proceedings of All-Russia Scientific and Practical Conference) pp 69-73

[16] *Departmental project: "Digital Agriculture"* [Electronic resource] URL: www.agro.cap.com/usercontent/minselhoz/news/2018_12/03/4fb5e435-356c-4e3a-9279-bfca943c459e/mcx.pdf

[17] Marinchenko T E 2019 *Monitoring of innovation activities in the agricultural sector* (Machinery and equipment for rural area) No 1 pp 40-46.

[18] *Automation of the Russian agricultural sector: realities and prospects* [Electronic resource] URL: https://foodretail.com/news/avtomatizatsiya-rossiyskogo-agrosektora-reali-i-perspektivi-401250

[19] Presentation of the Ministry of Agriculture of Russia (2018). URL: https://www.sas.com/content/dam/SAS/ru_ru/doc/Events/Presentation/agro-bb-2018/2-gerasimov-digitalization-of-the-agroindustrial-complex.pdf

[20] *The concept of "Scientific and technological development of digital agriculture. Digital Agriculture"* [Electronic resource] URL: https://www.coursehero.com/file/49273324/97d2448548e047b0952c3b9a1b10eddepdf/

[21] IoT in Russia: what do experts think? [Electronic resource]. http://www.csr-nw.ru/files/publications/iot_in_russia.pdf.

[22] Marinchenko T E 2019 *Digitalization as a driver of the agribusiness technological development* (Status and prospects of the agribusiness development, Proceedings of the XII Int. Scientific and Practical Conf) pp 30-34

[23] Salnikov S G *Actual areas of the Russian agribusiness digital transformation* [Electronic resource] URL: http://www.viapii.ru/