Digital transformation of agricultural industry

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Abstract. Introduction: Until recently, in our country, agriculture as a sector of the economy had low automation of business processes. At the present stage, digitalization and automation of the maximum number of agricultural processes is a conscious necessity. The task of it is the maximum automation of all stages of the production cycle to reduce losses, increase the productivity of agricultural business, optimal resource management. Materials and methods: This article use abstract logic and calculation and constructive methods. The historical experience of the formation of a multi-structure is considered, the digital stage is allocated. The system of comprehensive indicators of efficiency of agricultural production of various forms of management by types of efficiency is offered. Discussion: At the first stage agricultural producers on the basis of developed indicators of digital efficiency determine the level of digitalization for its further increase. At the second stage of implementation of elements of digitalization it is necessary for agricultural organizations to participate in the developed business model for the introduction of digital technologies, which will contribute to the development of agricultural production, growth of entrepreneurial activity and increase the sustainability of rural areas. Results: Based on the analysis of economic literature, foreign digital technologies used in advanced agricultural organizations of various forms of ownership in Russia are highlighted. It is concluded that the intensive introduction of digitalization and the Internet of things in agriculture will turn the industry less affected by it into a high-tech business due to the explosive growth of productivity and reduce unproductive costs and ensure food security of the regions and the country as a whole.

1. Introduction
We live in a special era when new generation technologies are being introduced in all spheres of human life. The widespread use of big data, robotics, virtual and augmented reality, the Internet of things, adaptive systems, bio, and Neurotechnology have long ceased to be innovative in the classical sense but rather moved into the category of those phenomena that we must learn to manage competently.

Digitalization gives hope for the continuation of the process of human social development, which has already led to a sharp improvement in the quality of life of a billion people.

To achieve this, multi-stakeholder collaboration is needed to achieve the three main objectives:
- distribute the benefits of technological breakthroughs fairly;
- to keep them from the inevitable negative effects;
- to ensure that new technologies will expand, not limit, the capabilities of all the inhabitants of the earth.

The technologies that are at the heart of digitalization are largely interrelated. Promising technologies should be considered neither as simple tools that are completely under our conscious control nor...
as external forces that cannot be controlled. Instead, we should try to understand: how and where human values are embedded in new technologies and how technologies can be used for the common good, the protection of the environment and human rights.

All interest groups should engage in a global dialogue on how technology is changing the systems around us and affecting the lives of every human being on the planet. In particular, discussions related to the management of advanced technologies and their role should be more broadly presented.

On the basis of the analysis of economic literature [1-9] the basic conditions for the development of the agricultural sector in the near future are identified:

- after 25 years, agriculture on the gross output index exceeded the level of 1991;
- after 25 years, agriculture on the livestock production index reached about 80% of the 1991 level;
- the average long-term level of grain production is 100 million tons – the level of the 80s;
- beef and milk production remain stagnant;
- opportunities for tangible growth of state support are exhausted;
- depending on the import of breeding material and seeds, technologies, equipment and machinery, finished products, including plant protection products, feed additives, etc.
- opportunities for expansion of agricultural exports are significantly limited;
- digitalization of all business processes as one of the elements of improving the efficiency of agricultural production.

2. Materials and methods

There is no consensus in the economic literature on the definition of specific periods and stages of formation of diversity in Russia, a rational combination of forms of management to improve the efficiency of agricultural production and the organization as a whole. The multi-layered structure of the Russian economy in the process of its historical development was characterized by alternating movement from simplification to complication and vice versa. Studying the evolution of the formation, development, and extinction of structures, the authors in their works previously identified 4 periods – pre-revolutionary, post-revolutionary, modern and new period of development of multiculturalism in the country (Table 1).

The pre-revolutionary period was represented only by small forms of management. In the course of structural transformations in the post-revolutionary period, a multi-structured agrarian structure was formed in agriculture, represented by various forms of management (agricultural organizations, peasant farms, households). The modern period is characterized by the formation of market relations and the emergence of a legislative framework that makes it possible to develop these forms of management. The new period is characterized by the strengthening of state support for all forms of management.

In 2006 and up to the present time (a new period of development) there was a strengthening of the role of the state in the development of small farms and agricultural organizations with the adoption of the national project "Development of agriculture" [10].

In 2017, both in agriculture and in the country's economy as a whole, the authors highlighted the digital stage. The potential for the introduction of advanced information technologies in domestic agriculture is huge. And the prospect for the development of the digital economy, including agriculture, is one of the topical topics for discussion both in the scientific sphere and at the state level. By Decree of the President of the Russian Federation No. 203 of May 9, 2017 "On the strategy of the development of the information society in the Russian Federation" [11] the main state priorities in this area were identified. In July 2017, the program "Digital economy in the Russian Federation" [12] was approved, the implementation of which should ensure the introduction of digital technologies in the daily life of society and this is especially important for agricultural residents. In the Strategy of scientific and technological development of the Russian Federation, approved by presidential decree of December 1, 2016 No. 642, stated that it is necessary the development of technologies, which, among other things, provide a transition to a highly productive and environmentally friendly agriculture, the devel-
opment and implementation of systems for the rational use of chemical and biological protection of plants and animals [13]. According to the authors, the following structures function on the modern, new and digital periods:

- family consumer lifestyle;
- family business;
- private;
- the public way;
- the cooperative way;
- social order.

**Table 1.** Periodization of the formation and development of multi-structure in agricultural production in Russia

| No. | The name of the period | Period          | Ways                                                                 |
|-----|------------------------|-----------------|----------------------------------------------------------------------|
| 1   | Prerevolutionary       | from ancient    | the individual peasant, the state, landlords, community-based, tribal, |
|     |                        | times to 1917   | capitalist, artisanal, craft state, co-operative, individual labor   |
| 2   | Post-revolutionary     | 1917-1990       | family consumer, family business, private, state, cooperative, public |
| 3   | Modern                 | 1990-2006       | family consumer, family business, private, state, cooperative, public |
| 4   | New                    | 2006 – 2017     | family consumer, family business, private, state, cooperative, public |
| 5   | Digital                | 2017 - present  | family consumer, family business, private, state, cooperative, public |

Taking into account the different opinions [14,15,16, etc.] of the concept of efficiency and taking into account the allocation of the digital stage, the authors propose a system of indicators that allows a comprehensive description of the efficiency of agricultural production in different forms of management and proposes to highlight another type of efficiency – digital. Performance indicators are arranged by type of efficiency. First, the most significant types of efficiency and their indicators are presented (Table 2).

**Table 2.** Types and indicators of agricultural production efficiency of various forms of management.

| Order of significance | Types of efficiency | Agricultural organizations | Peasant (farmer) economy | Households (HN) |
|-----------------------|---------------------|---------------------------|--------------------------|-----------------|
| 1         | Innovative | - the coefficient of commercial innovation efficiency | - the coefficient of budget innovation efficiency | - the coefficient of social innovation efficiency |
| 2         | Digital     | % automation of business processes in an organization, % | -% of funds aimed at automating business processes in an organization (of the total amount of funds received) % | -% annual update of licensed programs; |
|           |           |                           |                          | - the share of costs allocated to training (retraining) employees to work with software products; |
|           |           |                           |                          | - the proportion of employees who use software products for the computerization of production processes; |
|           |           |                           |                          | - the proportion of internal workflow conducted through automation |
### Budgetary Economic
- Budget subsidies attributable to the results of economic and financial activities per 1 ha of agricultural land, land, rub.
- Profit before tax on all activities on 1 hectare of agricultural land (including subsidies from the budget, without subsidies from the budget), RUB.
- Net profit of the organization on 1 hectare of agricultural land, RUB.
- Profit before tax for all activities, including subsidies from budgets, RUB.
- Profit before tax for all activities without subsidies from the budget, RUB.
- Net financial result (profit minus loss of the organization), RUB.
- Increase in revenue received from the area (from livestock), processed (grown) by state support (acquisition of fuels and lubricants, fertilizers, leasing equipment, etc.), RUB.
- Savings in production costs by increasing material costs from the area (with livestock), processed (grown) at the expense of state support (acquisition of fuel, fertilizers, feed, leasing equipment, etc.), RUB.

### Social
- Subsidies for agricultural products per 1 agricultural worker, rubles.
- The number of attracted workers in the agriculture sector, in which products were subsidized, pers.
- The share of wage costs in total subsidies, %

### Technological Natural
Production of main products (potatoes, vegetables, milk, meat in live weight, etc.) per 100 hectares of arable land (agricultural land), c

| Monetary | Natural |
|----------|---------|
| Land allocation, RUB/ha | Production of main types of products (potatoes, vegetables, milk, meat in live weight, etc.) per 1 hundred square meters of agricultural land, kg. |
| Labor intensity, RUB/RUB | Monetary |
| Capital productivity, RUB/RUB | Earth productivity, rub. |
| Material consumption, RUB/RUB | |

### Economic Natural
The productivity of C/ha

| Monetary | Natural |
|----------|---------|
| Production profitability, % | Productivity kg/hund |
| Profitability of sales, % | Productivity, kg |
| Gross output per 1 RUB. costs, RUB. | Monetary |
| Gross income for 1 RUB costs, RUB. | Gross output per 1 RUB. costs, RUB. |
| Net income per 1 RUB of expenses, RUB | Natural |
| Number | Social | Natural | Environmental |
|--------|--------|---------|---------------|
| 6      | The birth rate in rural areas, % | Level of availability of comfortable housing, sq. m | Number of organic agricultural products obtained, C |
|        | Level of availability of comfortable housing, sq. m | Provision of children with places in kindergartens and educational institutions, places. | The ratio of the obtained organic products to the total volume of products (by types of products), % |
|        | Provision of health facilities in rural municipal areas, % | Provision of children with places in kindergartens and educational institutions, places. | The level of environmental friendliness of the territory on emissions of pollutants into the atmosphere. |
|        | % of rural population morbidity, % | Level of transport accessibility, seats for 1 person. | The level of losses of agricultural products from man-made pollution. |
|        | A number of students of universities, colleges of the agrarian profile, people. | Availability of paved roads, km | Earth preservation (to preserve the acreage) |
|        | Unemployment rate, % | Monetary Income level per 1 family member, RUB. | The volume of genetically modified raw materials used for food production in the region; |
|        | Level of mechanization, automation of production processes, % | The level of paid services for 1 person, RUB. | Monetary The ecological and economic effect on 1 RUB. costs, adjusted for the amount of ecological and economic damage, RUB. |
|        | The coefficient of the population in rural areas | The coefficient of aging of the rural population; | The ecological and economic effect on 1 RUB. costs, adjusted for the amount of ecological and economic damage, RUB. |
|        | Average life expectancy in rural areas; | The ratio of average wages in rural areas to the minimum subsistence level | These indicators can be used to assess the activities of various forms of management for specific types of efficiency, including digital. The introduction of new information technologies in agriculture will increase the efficiency and manageability of information flows, so this type of efficiency is in second place. |
|        | The coefficient of aging of the rural population; | The ratio of average wages in rural areas to average wages in the region | Calculation of these indicators by types of efficiency and by forms of management, their analysis and comparison will allow drawing conclusions, to determine trends in the development of agricultural producers. |
| 7      | Monetary Consumption Fund per employee, rub. | | 3. Discussion |
Digital tools and technologies help to address information asymmetries and provide users with more free and faster access to information. On the basis of the conducted research, the typology of digital technologies for agriculture is offered. It includes four groups:

1. Agricultural knowledge and information systems:
   - collection of information among various forms of management;
   - information management;
   - providing relevant information to various forms of management.
2. Tools and services that provide market access and market opportunities.
3. Automation of business processes in various forms of management.
4. Automation of the process of ensuring food security in the region

Currently, in agriculture, the main factors of production are data in digital form. It is necessary that all information about the ongoing production processes should be collected in a single array of data, the analysis of which can take appropriate measures and significantly improve production efficiency. The question of creating a single information space of agriculture, and, accordingly, agricultural science, is still open [17 p. 282].

Currently, in Russia, support for the market of advanced agricultural technologies takes place at the Federal level. In the framework of projects such as the Internet Initiatives Development Fund (IIDF), the Skolkovo Foundation and the Skolkovo LLC, venture investments as well as government non-profit organizations, including the Innovation Promotion Foundation. Such assistance includes the establishment of incubators and programmes to attract mentors and industry experts to work with high-tech entrepreneurs on their products and business plans; the construction of office and laboratory infrastructure to promote business development and product development; the provision of tax incentives and access to a wide range of sources of funding through the organization of demonstration events and competitions of enterprises.

The rapid development of new technologies for the collection, management, transmission and use of information in digital format has led worldwide to a radical transformation of methods of agriculture and the functioning of the agro-industrial complex of the Nizhny Novgorod region. These changes come to the fore in agricultural holdings, where advanced digital technologies are used. However, many farmers in the region, especially small and medium-sized ones, do not even have permanent access to the Internet and do not have the skills to take advantage of digital technologies. The low level of demand for technology leads to missed opportunities and crop losses in the region. The authors propose in the Nizhny Novgorod region to create a model of interaction between the government, businessmen and the scientific community for the introduction of digital technologies in the regional agro-industrial complex and work in a single digital space. These models have already been created and are actively working in many regions of Russia (for example, Perm region).

Agricultural business community makes an order for the development of projects in the field of digitization the scientific community and IT companies, they are developing these projects, consider the effectiveness of the implementation based on the basis of expert selection (bodies of the state and the legislature jointly with the scientific community and the IT community) these projects are recommended for implementation.

This business model will allow to combine the competence of educational institutions in the region in the field of IT for more active development of this sphere of scientific and practical knowledge. The created structure will facilitate the interaction of participants and eliminate unnecessary competition. Together, members of business model will be able to reduce the time and material costs of innovative developments in the field of IT for the agro-industrial complex.
4. Results

The authors of this article based on the analysis of economic literature [17,18,19,20] identified foreign digital technologies used in advanced agricultural organizations of various forms of ownership in Russia:

In plant growing:
- **No-till** - zero tillage;
- **Strip-till** is a gentle tillage technology;
- precision farming;
- global positioning technology (GPS);
- geographic information systems (GIS);
- productivity assessment technologies (**YieldMonitorTechnologies**);
- technology variable rate (**VariableRateTechnology**);
- Earth remote sensing technology.

In animal husbandry:
- renewal of breeding stock and improvement of genetic potential;
- robotic milking;
- automatic milking system (milking parlor);
- automatic animal feeding stations;
- computer control of the herd;
- automated monitoring of herd reproduction processes.

The advantages of the main digital technologies were evaluated and determined by agricultural producers of Russia.

Nowadays global positioning systems provide a significant improvement in the accuracy of most agricultural operations performed by mobile units without the use of technological gauge or other devices in agricultural organizations.

The main advantages achieved by the use of geographical information systems are the reduction of the costs of controlling the use of sown areas by conducting remote monitoring based on satellite images, including the determination of the boundaries and areas of fields occupied by winter and spring.
crops under steam, as well as the assessment of harvested crop areas; the identification of locus of grain crops destruction, effective damage assessment, etc.

Based on the above, the authors determined the vector of development of the Russian agro-industrial complex in the medium and long term - the formation of a new domestic "breakthrough" digital and technological base, including the need to perform:

1. To develop and implement an effective mechanism of commercialization of innovations both in the field of technologies and in the field of digitalization and their transfer to agro-industrial production.
2. Neutralize the problem of dependence on imports of breeding material and seeds, technologies, equipment and machinery, finished products, including plant protection products, feed additives, etc.

What awaits us in the future, from the transition to a digital AP to - radically changes will occur:

- production technology;
- organizational structure;
- competence of personnel;
- the system of relations with suppliers;
- model of activities;
- employee payment mechanisms;
- financial, management and tax accounting and much more.

The digital economy plays an important role in assessing the food security of the region. We believe that digital technologies will allow:

- optimizing the logistics of supply of raw materials;
- optimizing the composition of the raw material zone of the region according to predetermined criteria;
- calculating the required domestic volume of food production based on the population of the region and its gender composition;
- determining the necessary volume of production of raw materials in the region, as well as the need for resources for its production (acreage, livestock, availability of livestock facilities, agricultural machinery, and labor), based on the planned productivity.

In order to realize economic benefits from digital transformation in agriculture, Russia must continuously carry out research and development aimed at building a global architecture, designed for simultaneous operation of different industries; to achieve great maturity of the market, including such aspects as the way of thinking of users, and pricing structure; as well as increase public partnership in its framework to create a sustainable business model by promoting broad use of digital technologies at all levels of the agricultural sector.

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