Theoretical and methodological aspects of digitalization in agriculture

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Abstract. The article discusses the essence of the basic approaches to the definition of the concept “digital economy”. There is a lack of elaboration on the issues of establishing the mechanism of transition from the traditional economy to the digital one and justification of the criteria allowing to fix the moment of this transition. A critical analysis of the contents of the program “Digital Economy of the Russian Federation” is conducted in the paper. The content of the categories “digital platform” and “digital ecosystem” is disclosed. Certain provisions regulating the conditions for implementing the digital transformation of economic systems are given. It is noted that the present stage is marked with the formation of the theoretical and methodological basis of the digital economy; insufficient attention is paid to the issues of the digital development of individual branches of social production, including agriculture. The paper argues that certain limitations on achieving the potential for the digitization of agriculture are imposed by the current structure of the agrarian sector of the economy of the Russian Federation. Therefore, it is highly necessary to adopt a state strategy to overcome the information backwardness of the agrarian sector and the formation of basic conditions for the initiation of the digital transformation of the most technologically advanced economic entities of the agrarian sector and the industry as a whole. The paper provides a list of basic information management tasks, the solution of which would create prerequisites for transferring agriculture to digital technologies, along with the principles reflecting the basic provisions of the formation of digital agriculture. The paper provides a directional digitalization model, which assumes active regulatory influence of the state on the processes of designing and developing industry digital platforms and ecosystems and the formation of macroeconomic conditions for creating and introducing digital technologies into business practice.

1. Introduction

High rates of scientific and technological progress (in particular, the development of computer technology and their penetration into various spheres of human activity) objectively determined the formation of prerequisites and conditions for the economy moving into a new phase. In order to identify them, the term “digital economy” has been introduced. Introduction to the scientific revolution of a new term requires not only a discussion of its internal content, but also the formation of a theoretical and methodological basis for studying the essence, directions, and intensity of digitalization processes in the economy, along with the development possibilities of individual sectors.
of social production and human activities provided by digital technologies. With the adoption of the program “Digital Economy of the Russian Federation” in 2017 [1], research in this area has acquired particular relevance, especially since the problems of developing and using digital technologies had moved from the plane of theory to the plane of practical solution. In addition, the prospects for digitalization of industries that are not among the priority areas declared by this program, such as agriculture (which features determine certain specifics of the development and implementation of the sectoral model of the digital economy), remain unclear.

The purpose of the study is to uncover the theoretical and methodological issues of the development of the digital economy and the specifics of digitization of agriculture.

2. Methods
Research is based on the study and synthesis of scientific approaches to the study of the development of digital economy and the use of digital technologies in agriculture.

3. Results
In the modern economic literature, there are many approaches to the definition of “digital economy,” within which it is considered both as a set of markets operating on the basis of information and communication technologies, and as an industry associated with the creation of the element base, hardware, and software for implementing the information society model, both as a system of public relations, formalized with the help of digital information and communication technologies, and as a combination of electronic technologies for organizing business processes and managing them, and as a way of obtaining transformational effects when switching to new information and communication technologies, and as a new paradigm of economic development in accordance with the concept of “Industry 4.0”, which assumes a qualitatively new model of integrating production and consumption based on digital technologies, and as a kind of virtual environment that complements the reality in terms of improving the efficiency of production, exchange, distribution, and consumption [2-13].

Such a variety of interpretations of the digital economy objectively generates a multiplicity of approaches to the formation of a theoretical and methodological basis for the study of this economic phenomenon.

Our approach to the study of the digital economy is based on the dominant economy as a process of production, exchange, distribution, and consumption of economic goods, the essence of which remains unchanged at all stages of the evolution of society. We propose to consider the digital economy, first of all, as a certain stage of social development, from the beginning of which information acquires the status of a key resource, and information technologies can significantly increase the efficiency of reproduction processes at all levels at all stages of their flow.

In forming the theoretical and methodological basis of the digital economy, it is crucially important to understand the mechanism of transition to the digital economy from the traditional one and to develop criteria that allow fixing the moment of this transition. These questions are still undeveloped. However, without addressing them, it is impossible to ensure the effectiveness of digitalization process management.

It is especially important to understand the mechanisms of transition to a digital economy at the level of individual fields of activity and sectors of social production. Obviously, the sphere of trade digitalization mechanisms will differ significantly, but the effectiveness of interrelations of economic agents of various spheres and industries can be ensured only when they all achieve the minimum required level of digital interaction and integration into a single digital space.

The overwhelming majority of researchers refer to the process of transition of economic systems of various levels to the digital economy model as a digital transformation that defines the goals and ideology of this transition, priority areas and objects of digitalization. But, as a rule, the emphasis is on
digital transformation of business and relatively large business structures, while systemic problems of digital transformation of individual branches of social production are beyond the scope of research.

The program “Digital Economy of the Russian Federation” highlights the following main digital technologies: big data; neurotechnology and artificial intelligence; distributed registry systems; quantum technologies; new production technologies; industrial internet; components of robotics and sensorics; wireless technology; virtual and augmented reality technology. Moreover, this list is not considered closed and may be adjusted as a result of the creation of new technologies.

The text of the program states that its development and implementation are carried out within the framework of state policy aimed at creating a favorable environment for the development of the digital economy of the Russian Federation. This program is the legal basis and reflects the list of key institutions that determine the conditions for the development of the digital economy. The scale of the tasks in combination with their innovative content objectively led to the emergence of a number of issues that are debatable in nature.

For example, the program defines a set of criteria reflecting the level of development of the digital economy in such areas as the formation of a digital ecosystem, staffing, the formation of research competencies and technological groundwork, information infrastructure and information security. But they do not assess the significant differentiation of industries and regions by the level of economic and information development and their readiness to implement the strategy of transition to the digital economy, do not address the problems of digitalization of industries characterized by technological lag, do not declare the role of the state in overcoming this lag and the prospects for their development focusing state attention on areas such as health care, “smart cities,” and public administration. We do not deny the expediency of concentrating resources and efforts on priority areas, but point to the need to understand the prospects for the digital development of the macroeconomic framework, to ensure the balanced development of all its elements, to solve the problems of unemployment in terms of job losses due to the mass adoption of digital technology.

At present, there is a spontaneous process of focal development of the digital economy, where various countries, large corporations, industries, and fields of activity act as peculiar “centers”, demonstrating the potential of digital technologies and the scale of competitive advantages acquired with their help, even in the early stages of digital transformation and development of new business models.

At the same time, it should be understood that a full-scale transition to a digital economy cannot be made in the near and even medium term. We need a realism of understanding the modern level of informatization of various aspects of public life, the quality of the existing scientific and technical groundwork, practical significance for the social development of certain digital technologies. It is no coincidence that there are more and more supporters of the version that the idea of the digital economy was born as a response to the need of large corporations to form new global markets for electronic products, i.e. not digital technologies are created as a result of their demand, but the demand for digital technologies are formed by their manufacturers, based on their own interests.

Awareness of having remote prospects for a full-scale transition to the digital economy has led to the fact that the priority goals of the development of the digital economy in the national strategies of the countries included in the Organization for Economic Cooperation and Development have been the following: expansion of e-government functions; development of telecommunications and information infrastructure; the formation of skills and competencies associated with the use of information and communication technologies; increasing the level of information security and protection of personal data; expansion of regulated access to information resources; adaptation of information and communication technologies to the needs of individual fields of activity, industries and business entities; development of digital identification technologies; e-commerce development; ensuring consumer protection; increasing the Internet availability and maintaining its openness; digital content development, etc. [14, 15]. Digital economy is represented as a kind of add-on that provides large-scale penetration of digital technologies in the industry and the field of traditional economy and fundamentally changing the system of interaction of economic agents through the formation of digital
ecosystems (an ecosystem in the theory of the digital economy is a complex system that provides the interaction of heterogeneous agents, which can be people, robots, software systems, and other subjects of the digital economy). That is, the digital economy does not cancel the traditional economy, but only expands its capabilities, while significantly influencing its structure and determining the pace of development of individual industries and areas of activity.

It should also be recognized that the effectiveness of introducing digital technologies largely depends on the level of technological and information development of industries and fields of activity. Digital technologies themselves do not generate economic benefits, they only allow it to be strengthened. And if the industry or field of activity has a low level of technical and technological development, their digital transformation will require, first of all, solving the problem of eliminating their technological backwardness. Unfortunately, the program does not reflect the position of the state on this issue, but allows one to create certain technological groundwork, based on which in the future it would be possible to digitize individual industries and fields of activity.

The technological basis of digital ecosystems is formed by digital platforms, which are a complex of technological solutions that form the digital interaction environment of interconnected subjects of the digital economy, allowing to solve problems determined by the specifics of individual industries and fields of activity, and ensure their integration into higher-level digital ecosystems. At the level of business entities, digital platforms are often identified with automated information systems focused on the implementation of promising business models that involve the wide use of digital technologies.

It should be noted that digital transformation should cover all levels of social production: from individual economic entities to the state as a special subject of the digital economy. Obviously, different models of digital development will be used at different levels, but the ideology of digitalization should provide a balance of interests of the whole society, business structures and individuals. It is here that the role of the state as a natural macro-regulator of social development processes is especially clearly manifested and the need arises to form a fundamentally new digital platform of public administration.

The digital economy model requires a radical modernization of management ideology and at the level of economic entities, as well as the implementation of fundamentally new methods of informatization of management processes, ensuring the transition from the schemes of fragmentary automation of individual management tasks to an integrated management information system based on the formation of digital platforms, taking into account sectoral features of the control object, the level of its structural and functional complexity, the intensity of internal and external information flows, the amount of information circulating in the control system, and the level of its heterogeneity, the specifics of the digital technologies used, and the composition and structure of the digital ecosystem, etc. The transition to a digital economy from a traditional economy should be based on the following provisions:

- Digital economy is an objective stage of social development, involving the transition to the use of fundamentally new technologies for organizing the processes of production, exchange, distribution, and consumption of economic goods and their management;
- Each phase of reproduction requires the use of specific digital technologies, reflecting its essence and features of the organization, as well as technologies that ensure the interconnection of all phases and the synchronization of their flow;
- Differentiation of spheres of activity, industries, and territories according to the level of informatization and readiness to implement the digital economy model requires the development of a variety of strategies for digitization of socio-economic systems at various levels in order to ensure balanced development of administrative and territorial entities;
- A digital platform should be developed for each line of business and industry, ensuring the implementation of a set of functions and tasks that are typical for each industry and area and the integration of economic entities into a single information space;
− A lack of a unified strategy for the transition to a digital economy or inadequacy of the strategy to the capabilities of society and its actors can not only lead to inefficient use of limited financial resources but also discredit the idea of the digital economy;
− The transition to a digital economy can be accomplished by achieving an adequate level of development of information infrastructure and information and communication technologies;
− The high dependence of the country on foreign countries in the field of hardware and software implementation of digital technology causes a significant level of risk in the implementation of a large-scale transition to a digital economy;
− A sharp increase in information volumes and an increase in the intensity of information flows in the transition to a digital economy requires the transformation of existing management systems at all levels and the development of a new methodology for managing the development of economic systems;
− The massive introduction of digital technologies objectively determines the increase in labor productivity and a significant reduction in jobs in traditional industries and fields of activity, which would require the development of a strategy to solve the problems of reducing the employment rate of the population;
− A large-scale transfer of information into digital format necessitates a fundamental increase in the level of information security and data protection from an unauthorized access with an abrupt increase in the volume of information resources.

It is necessary to recognize that at the present stage of the formation of the theoretical and methodological basis of the digital economy, insufficient attention is paid to the issues of digitalization of individual branches of social production. Agriculture is also among the sectors which digitalization strategy is not yet at the state level.

Realizing the need for digital transformation, economic entities of the agrarian sector are trying to intensify the processes of informatization of their activities, while maintaining the existing business model, which allows them to significantly increase productivity and quality of management, but does not provide the conditions for the formation of a digital platform adequate to the requirements of the digital economy. So, for example, the implemented technologies of precision farming, involving the collection and use of large volumes of information obtained using various sensors, are practically not integrated with corporate information systems widely used in business practice; the fragmented nature of the information fund does not allow to ensure the complexity of solving cross-cutting management tasks; a low level of development of e-commerce platforms significantly limit the efficiency of supply and sales activities, etc.

Certain restrictions on the realization of the potential of digitization of agriculture are imposed by the existing structure of the agrarian sector of the Russian Federation, characterized by a high proportion of consumer farms or a low level of marketability, characterized by a low level of innovation and investment potential and information development.

It is obvious that under present conditions a massive shift of agriculture to the digital economy is not possible by virtue of the low level of informatization of agricultural production, and in connection with backlog level information infrastructure development in rural areas and IT-training of a large part of managers and agricultural specialists. That is why it is necessary to adopt a state strategy for overcoming the informational backwardness of the agricultural sector and the formation of basic conditions for the start of digital transformation of the most technologically advanced economic entities of the agricultural sector and the industry as a whole [16, 17].

Currently, we can talk about the three main ways of informatization in agriculture: spontaneous self-organization of individual subjects, state centralized management of informatization processes, and directed informatization, involving the stimulation of the processes of using information technologies and the formation of conditions for the activation of digital transformation processes. If the first two paths can be considered unpromising [18], then within the third framework – the implementation of several ideologies for the development of digital platforms, adapted to the sector-
specific nature of the agricultural sector, – is possible. The first type ideology is based on borrowing
digital platforms developed by foreign companies and adapting them to the needs of domestic
agricultural producers and agricultural production management bodies. As an example, borrowing
technologies of precision farming and herd management. The ideology of the second type involves the
own development of digital platforms, the design of which is carried out on the basis of system-wide
requirements formulated by the agricultural authorities at all levels, whereas in the framework of the
third type of ideology, the design of digital platforms is carried out based on the existing and potential
needs of agricultural producers. But the implementation of each of these ideologies requires a
nationwide strategy for digitization of agriculture, ensuring the formation of efficient digital
ecosystems and the inter-and inter-sectoral interaction of digital platforms at various levels.

In addition, it should be noted that the transfer of agriculture to digital technologies requires the
solution of such basic information management tasks as:

- Establishing a complete list of management tasks solved through the use of information
technology, and information necessary and sufficient for their decisions;
- Analyzing the intensity and cyclical nature of information flows and identification of the
  information needs of management subjects;
- Providing regulated access to network information resources, reflecting the state and
development trends of the external environment;
- Regulating operations for the collection, systematization, transfer, storage, processing of
  information, and its provision in accordance with the information needs of users;
- Optimization of information interactions between economic entities of the agricultural sector
  among themselves, government authorities, and economic agents at all levels;
- Integrating agricultural producers into a single information space of higher-level systems
  based on the principles of interaction within digital ecosystems;
- Overcoming the lag in the development of information infrastructure and the possibility of
  using information and communication technologies;
- Establishing a base of economic and mathematical models, allowing to explore alternative
development options for business entities and higher-level economic systems;
- Ensuring information security of business entities and protecting information from
  unauthorized access. Including personal data;
- Integrating various information technologies and systems within a single digital platform or
  the transition to the use of standard digital platforms, etc.

Only if these problems are solved, it will be possible to argue about the prospects for transferring
Russian agriculture to the rails of the digital economy, but the theoretical and methodological basis of
digital agriculture should be started to form now.

One of the components of the methodology for the formation of digital agriculture is a set of
principles reflecting the main provisions of this process:

- A principle of prioritizing information (assumes that information acquires the status of a key
  factor of production, ensuring the possibility of effective use of other resources);
- A principle of information relevance (implies that the available information must fully meet
  the information needs of users, but not be redundant);
- A principle of increasing efficiency (associated with the reduction of time to search for
  information, its collection, systematization, processing and provision to the user);
- A principle of developing means of objective control (ensures an increase in the objectivity of
  information and the possibility of its receipt in real time);
- A principle of adequacy of the material and technical base (requires ensuring the adequacy of
  the level of technical-technological and information development of the complexity of the
  information tasks being implemented);
A principle of information integration (necessitates the integration of all subjects of the digital economy into the multidimensional information space of systems of various levels);
A principle of optimization of information interaction (associated with the creation of conditions for the formation of digital ecosystems of different levels);
A principle of complexity (focused on overcoming the fragmentation of information support systems and the use of universal digital platforms);
A principle of methodological unity (determines the general methodological approaches to the formation of digital platforms and digital ecosystems, ensuring their rational interaction with each other);
A principle of openness (guarantees the possibility of upgrading digital platforms and ecosystems in accordance with the development of digital technologies);
A principle of balanced development (provides for the implementation of systemic measures to prevent the technological gap between individual industries and areas);
A principle of accessibility (ensures the availability of digital technologies for all economic entities of the agrarian sector and benefits generated in the digital economy for the entire rural population), etc.

One of the basic ideas of the digital economy is the maximum integration of production with final consumption, i.e. the orientation of production systems to the needs of specific individuals. Agriculture in this context occupies a special niche, being mainly a supplier of raw materials for food production (in the initial form, according to various estimates, only 4-8% of agricultural products are consumed), which determines the specifics of the digital transformation model of the agricultural sector [19].

4. Discussion
The key areas of the digital transformation of agriculture are proposed to be:

- Digitalization of technological and production processes associated with the development of the Internet of things (equipping machines and equipment with microprocessor devices and various kinds of sensors), robotization, and production automation, etc.;
- Developing digital platforms that ensure the complexity of solving industrial and managerial tasks and the integration of subjects of agricultural production into the multidimensional space of digital ecosystems;
- Modernization of the information management system for agricultural management by optimizing the composition and structure of information resources, providing open access to them and developing tools that ensure the implementation of a set of tasks for system management of agricultural production;
- Developing information infrastructure, increasing the reliability of communication channels and speed of information transfer, availability of information and communication technologies and electronic services;
- Optimization of information interaction with the suppliers of resources and services and consumers of manufactured products, as well as the widespread use of e-commerce technologies.

As a promising model of digital transformation of agriculture, a model of targeted digitalization is proposed, suggesting an active regulatory impact of the state on the design and development processes of sectoral digital platforms and ecosystems and the formation of macroeconomic conditions for creating and introducing digital technologies into economic practice.

5. Conclusions
The phenomenon of the digital economy should be the object of a close study both from the standpoint of developing the theoretical and methodological basis of this economic phenomenon, and from the standpoint of many practical aspects of the digital transformation of economic systems at all levels. A broad discussion should start on the functionality of digital platforms focused on the needs of agricultural production entities; the processes of studying the experience of developed countries in using digital agriculture technologies and assessing the prospects for their adaptation to the conditions of the Russian economy should be intensified; the initiated research on the development of strategies and concepts for the digitization of agriculture, highlighting the stages of digital transformation and the expected results.

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