The platform ecosystem of the regional agro-industrial complex: the concept of structure and approaches to assessment

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Abstract. The modern agro-industrial complex and its branches, in order to fulfill the conditions of the economic and innovative development of the country, must represent high-tech areas of economic activity. Digitalization – the widespread use of information technology – plays a primary role in this process. For agriculture, this direction can be implemented by creating a unified computerized system of the industry, namely, a platform ecosystem of the digital agro-industrial complex. Within the framework of this article, the concepts of the platform economy are considered, the degree of use of digital platforms in organizations by type of economic activity is studied. A comparative analysis of Russian digital platforms used in agriculture has been performed. The concept of the structure of the platform ecosystem of the digital agro-industrial complex, involving the introduction of a regional digital platform, is presented. An algorithm and a methodological approach to assessing the effectiveness of the implementation and functioning of the digital platform of the regional agro-industrial sector are presented.

1 Introduction

Today, at all levels of government in the Russian Federation, the need for the formation of a digital economy and society is recognized, and information and telecommunications resources are considered as one of the key drivers of sustainable development in all areas of industrial activity. Most often, we are talking about the creation and implementation of various electronic platforms as the basis of a concretized information system for digital interactions between economic entities. Some examples of successful functioning of digital platforms and services already exist in certain industries – the State Information System of Housing and Communal Services (GIS Housing and Communal Services), the Unified Medical Information and Analytical System (EMIAS), the Portal of Public Services of the Russian Federation (PUBLIC Services), etc. Such a universal platform has not yet been created for agriculture, the leading sector of the economy that ensures the country's food security. Its need is indicated not only by modern trends in digital development, but also by long-term plans for the transformation of the agro-industrial complex (AIC) of the country, recorded in official regulatory and administrative documents. Thus, the analysis of the departmental project "Digital Agriculture" [1] showed that the main task in the process of

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transforming agricultural management technologies is to create a digital platform. Such an innovative tool should help reduce production costs, as well as have a direct impact on labor productivity growth. This effect can be achieved by forming a specialized system of multilateral user interaction for the exchange of information obtained through the implementation of digital technologies in the agricultural sector – cloud applications, artificial intelligence, Data Mining, robotics, the Internet of Things, e-commerce, etc.

Certain aspects of the digital transformation of the agro-industrial complex are considered in Russian and foreign studies [2-5], however the emphasis is on describing the disparate elements of digitalization, while the issues of large-scale integration of interconnected IT solutions into the agro-industrial complex remain open. The problem of developing approaches to the formation of the agro-industrial complex platform ecosystem at the regional level has not been fully studied, and a unified methodology for evaluating the effectiveness of the implementation and functioning of the digital platform of the regional agro-industrial sector has not been developed in scientific theory.

Therefore, the purpose of this work is to propose a conceptual model of the platform ecosystem of the regional agro-industrial complex, based on the introduction of a digital platform, as well as the development of an algorithm and methodology for a comprehensive assessment of the effectiveness of its implementation and functioning.

2 Materials and Methods

In the course of the study, the authors used methods of analysis, scientific generalization and synthesis of existing materials on the digital economy, digital platforms, and digitalization of the agro-industrial complex. Therefore, the theoretical basis of the work consists of scientific publications by Russian and foreign scientists considering aspects of digital transformation of various sectors of the economy and, above all, agriculture.

The information sources of the study are statistical data from the bulletins and collections of the Federal State Statistics Service (Rosstat), as well as information and reference materials published by the Higher School of Economics (HSE).

The issues of digitalization and concentration of information technologies in various sectors of the economy are receiving great attention in the international arena. Thus, at the United Nations Conference on Trade and Development (2021), the Unctad Digital Economy report highlighted the high impact of digital platforms that are designed to systematize and process data, forming digital intelligence: "Cost arises in the process of converting raw data – analyzing and processing collected data to obtain digital intelligence – which It can be monetized for commercial purposes or used to solve public problems. Data has no value if they are not systematized and processed" [6, p. 4].

No less interest in the development of the digital economy, the use of information technologies, as well as the formation and implementation of digital platforms is also being paid in Russia [7-8]. They have not only theoretical, but also practical implementation. Thus, according to the data of the Higher School of Economics [9], the digital technologies used in Russian organizations are (Fig.1):
In the agricultural sector, their application differs somewhat: agro-industrial organizations use technologies for collecting, processing and analyzing big data the most (23.3% of the total number of organizations); artificial intelligence technologies are in least demand (2.9%), Fig. 2:

One of the strategically important areas of digital technology development is the introduction of digital platforms. The Institute for Statistical Research and Economics of Knowledge of the Higher School of Economics published research materials [10], according to which in 2021, 14.7% of organizations in Russia used digital platforms. Most often – in the Ural Federal District (16.3% of the total number of organizations), the Central Federal District (15.5%) and the Northwestern Federal District (14.9%). The least spread of digital platforms is observed in the Far Eastern Federal District – 12.6%, respectively. An analysis of the level of distribution of digital platforms by region revealed that the top five included Moscow (21.8%), Irkutsk (21.7%), Novgorod (20.5%), Tula (20.2%) regions and the Republic of Tatarstan (18.3%) [10].

Let's consider organizations using digital platforms by type of economic activity (Fig. 3).
The analysis shows that digital platforms are most widely used in the financial sector (33.2%), in higher education (31.9%), wholesale and retail trade (24.6%), as well as the information technology industry (21.3%). Other industries are implementing digital platforms at the level of 8 -12%. But even such indicators confirm the importance of using digital platforms in the development of a modern economy based on information and knowledge.

3 Results and Discussion

More recently, the concept of "platform economy" or "digital platform economy" has appeared in scientific circulation [11-14], as a type of economic activity based on the widespread use of digital platforms – online systems that provide comprehensive IT solutions for interaction between users. The range of services in this case is completely diverse – from information and reference to commercial transactions. Foreign scientists [15-16] define the platform economy as a new model of economic formation in which digital platforms, playing the role of intermediaries between market participants, contribute to reducing transaction costs through the use of a package of digital technologies for working with data.

Therefore, it can be stated that the concept of a platform economy is inextricably linked with digital platforms that are being implemented in all sectors of economic activity.

For agriculture, the concept of a national digital platform is being developed primarily by scientists implementing the plan of the departmental project of the Ministry of Agriculture of the Russian Federation "Digital Agriculture" [1]. Lanit-Integration, a company commissioned by the Ministry of Agriculture of Russia, developed and presented a conceptual model of this platform in 2020. According to the proposed structure, it should consist of six sub-platforms that will contribute to the digitalization of such areas as: industry data collection; land use and land management; agrometeoroprognosis; storage and distribution of information materials; information support and provision of services; etc. [17].

In addition, there are alternative concepts of digital platforms for the agricultural industry. For example, the partner company, which includes Agrosignal, Digital Agro and Cognitive Pilot, intends to create an agroecosystem for digitalization of farms in the agricultural sector. Scientists believe that their IT product, which combines full-cycle agro-ERP, as well as
unmanned equipment control technologies, will be used by 30% of farms in the agro-
industrial complex market [18].

Another constructive principle of the development of the digital platform of the
agricultural and industrial complex is presented by the staff of the A. A. Nikonov All-Russian
Institute of Agrarian Problems and Informatics (Moscow). In their view, the structure of the
digital platform should be hierarchical, covering the production and technological level of
the enterprise; the level of material and financial support; the management level; etc., in order
to best meet the various needs of all participants in the economic activity of the industry. It
is precisely such an information and software complex that could become a single digital
platform for the agro-industrial complex [19].

Today, in addition to concepts, domestic digital solutions are already functioning and
actively used by farmers in practice, which, although pointwise, help farms optimize
production activities (Table 1).

<table>
<thead>
<tr>
<th>Name of the platform / URL</th>
<th>Characteristic</th>
<th>Developer</th>
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<tbody>
<tr>
<td>ExactFarming / <a href="https://exactfarming.com/">https://exactfarming.com/</a></td>
<td>A digital agriculture platform that combines various IT solutions for the agro-industrial sector, which are structurally distributed among three user groups: agricultural producers, seed and agrochemistry producers, banks and rhinestone companies.</td>
<td>Itysphere LLC</td>
</tr>
<tr>
<td>Your farming / <a href="https://svoefermerstvo.ru/">https://svoefermerstvo.ru/</a></td>
<td>Combines technologies and online solutions for agribusiness with the capabilities of the bank; a &quot;one-stop shop&quot; system (marketplace, more than 60 services (harvest forecast, TV seminar, farmer's school), preferential financing) for farmers, business owners and employees of agricultural enterprises.</td>
<td>JSC &quot;Rosselkhoznadzor&quot;</td>
</tr>
<tr>
<td>DigitalAgro / <a href="https://digitalagro.ru/">https://digitalagro.ru/</a></td>
<td>A platform that provides IT products and services for agribusiness, in particular services such as: scouting, agroconsulting, auditing, agricultural laboratory; digital products: YES.Assistant, Agricultural Signal, Cybergeetar.</td>
<td>Digital Agro LLC</td>
</tr>
<tr>
<td>SmartAgro / <a href="https://smartagro.ru/">https://smartagro.ru/</a></td>
<td>The system allows you to fully automate planning, monitoring and analysis of the results of field work; contains an agronomic unit, agricultural scouting, engineering unit, finance and KPI, operational and annual planning, control of finished products, cadastral control; has mobile applications that synchronize with the web version of the system.</td>
<td>SmartAgro with the support of the Skolkovo Foundation</td>
</tr>
<tr>
<td>Agrosignal / <a href="https://agrosignal.com/">https://agrosignal.com/</a></td>
<td>A comprehensive digital platform for agribusiness management; offers software tools for crop rotation planning, monitoring the work of equipment and employees, data analysis and reporting.</td>
<td>Infobis LLC</td>
</tr>
<tr>
<td>AgroMon / <a href="https://agromon.ru/">https://agromon.ru/</a></td>
<td>Application software installed on a PC, as well as a mobile application used to manage a crop production enterprise. It allows you to plan seasons, manage field work, conduct online inspection of crops, as well as receive expert advice and generate financial statements.</td>
<td>JSC &quot;Bayer&quot;</td>
</tr>
<tr>
<td>RSM Agrotronic / <a href="https://rostselmash.com/agrotronic/">https://rostselmash.com/agrotronic/</a></td>
<td>An ecosystem of services designed for technical and managerial monitoring of agricultural machinery; it allows using sensors integrated into the on-board system of agricultural machines to control their parameters, generate and analyze field yield maps, determine the optimal routes of equipment.</td>
<td>Rostselmash Group of Companies</td>
</tr>
<tr>
<td>Agrobot / <a href="https://avrora-robotics.com/ru/">https://avrora-robotics.com/ru/</a></td>
<td>A computer system that allows you to automate a significant part of field work by organizing the autopilot of agricultural machinery.</td>
<td>Avrora Robotics</td>
</tr>
<tr>
<td>Cloud service &quot;Field History&quot;/<a href="https://info.agrohistory.com/">https://info.agrohistory.com/</a></td>
<td>Service for the management of agricultural enterprises (contains an electronic journal of an agronomist; crop rotation planning in the fields; monitoring of equipment; reporting; cadastral plots; satellite monitoring; precision farming).</td>
<td>Geomir LLC</td>
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Such a large number and variety of IT solutions for agriculture once again confirms the interest of farmers in the latest trends demanded by participants in the economic market, namely, digital platforms.

It is important to note that most of the concepts and online services listed above are aimed at reaching a large economic cluster - in fact, users from all over the country. In addition, they are aimed at implementing disparate or point-by-point elements of digitalization. On the one hand, this approach has a significant and positive impact, since it will attract the maximum number of users to the platform from virtually all regions of Russia, as well as consolidate data from various sectors of agriculture in one place – the platform's database. But from a practical point of view, in our opinion, a more appropriate option is to create a digital ecosystem of the agro-industrial complex, which will include customized platforms that take into account the peculiarities and specifics of each region.

Thus, we are talking about creating a digital platform as the basis of the platform ecosystem of the regional agro-industrial complex. We share the opinion [20-21] that the concept of a digital platform should include both the technological (software) design itself and the platform business model.

Considering the technological aspect of the platform's functioning, we have identified five modules in its architecture (Fig. 4), which will allow: to accumulate and store industry information; search, filter, sort and analyze data using, among other things, methods of working with Big Data; interact with market participants in the process of creating innovative and investment projects for agriculture (start-ups); to form the human resources potential of the industry from the point of view of developing its digital competencies, as well as to effectively and promptly recruit staff; use the platform's design service in order to create the necessary set of mobile applications for the agroindustrial complex industry.

The digital agribusiness platform as a business model is a platform for direct interaction between various market participants, taking place in B2B (Business-to-Business), B2C (Business-to-Consumer), G2B (Government-to-Business) and G2C (Government-to-Consumer) formats and transactions between them. The target users of the platform and their interaction are shown in Fig. 4.
The introduction of a digital platform into the field of economic activity can manifest both a variety of favorable conditions for the development of the digital ecosystem, and have a number of risks characterized by negative consequences. Therefore, the issue of evaluating the effectiveness of the use of the regional digital agribusiness platform is particularly acute. In this case, the effects can be of various directions: organizational, technical, technological, labor, economic, network, etc. [22]. But, from the point of view of the expediency of implementing a regional digital agribusiness platform, it is important first of all to compare the economic effect obtained through the creation and implementation of a digital solution, as well as the costs incurred during its implementation, that is, to assess economic efficiency. Obviously, as a basis in this matter, it is necessary to use a comprehensive analysis involving an assessment of the effectiveness of all modules and elements of the digital platform by calculating a system of interrelated qualitative and quantitative indicators.

The economic efficiency of any technical or technological transformations, including digital ones, is a kind of conceptual triad:

1) efficiency, as the ratio of benefits received (income) and costs incurred (costs). The introduction of a digital platform will be advisable if the value of this indicator is positive;
2) efficiency as the degree of achievement of the goals of transformational processes (effectiveness). The introduction of a digital platform will be justified if the planned results (targets) in the agro-industrial complex of the region are achieved by the specified deadline;
3) efficiency as the level of rationality of the resources used (optimization under conditions of uncertainty). An objective sign of the correct operation of the digital platform should be an improvement in the quality of management decisions associated with numerous

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**Fig. 4.** The platform ecosystem of the regional agro-industrial complex. Source: author's development.
risks (reducing the number of errors, faster achievement of strategic goals by regional agricultural producers).

In our opinion, such a comprehensive assessment of the effectiveness of the functioning of the digital agribusiness platform will allow a systematic assessment of both economic and managerial results.

In an aggregated form, the methodology for evaluating the effectiveness of the functioning of the digital agribusiness platform at the regional level should consist of the following elements of a linear algorithm (Fig. 5):

- **Evaluation of the effectiveness of functioning the digital platform of the agro-industrial complex**

**Fig. 5.** Algorithm for evaluating the effectiveness of the functioning of the digital agribusiness platform. Source: author's development.

The proposed methodology allows not only to quantify the full range of effects from the functioning of the digital platform in the agro-industrial complex, but also to identify "bottlenecks", key problems in individual digital modules and elements. This will allow the regional government to make appropriate decisions on time to overcome the identified difficulties and allocate the necessary resources (administrative, financial, managerial) to level the identified problem areas and transform them into new potential growth points.

### 4 Conclusion

Summarizing the above, we note that the introduction of the presented conceptual model of the digital platform will ensure the creation and development of the platform ecosystem of the regional agro-industrial complex. The digital platform, as an effective tool for data collection, analysis, monitoring and forecasting of the parameters of the development of sectors of the national economy, will allow to accumulate and scale the experience gained from the merger of science and practice. The algorithm and methodology presented in the article for evaluating the effectiveness of the functioning and implementation of the digital agribusiness platform can be used as the basis for one of its additional modules, as a result of
which, through artificial intelligence, the system will be able to independently assess the prospects for digitalization of individual farms and industries. The approbation of the proposed methodology is the subject of further scientific research.

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