The transition of the agricultural industry to digital farming: an organizational and practical approach

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Abstract. Using the example of the agricultural sector, the article examines how, as digital technologies develop, the nature of state regulation of relevant relations changes. Key problems in agricultural land use are identified, and measures to solve them are described. The transition to a unified state register of agricultural lands containing data about them in digital form will not only make it possible to quickly and reasonably make management organizational decisions, but also ensure the required comparability of the initially disparate data included in it.

1 Introduction

As certain relationships become more complex, new technical capabilities and ways to implement certain functions emerge, the digital transformation of the industry becomes a tool for modern management of the agro-industrial complex. Moreover, the functions carried out by the state (its bodies) are undergoing certain changes (for example, by 2024, about 300 government services will be provided online [7]). And we can quite confidently state that in the context of the introduction of digital technologies (digitalization), the organization of data management acts as a new important self-sufficient state function, without which both the formation of a digital economy and its regulation are impossible. It is digitalization processes that lead to the emergence of qualitatively new conditions for public administration, which include 1) decision-making based on digital technologies (thanks to digitalization, there are fewer unknowns when forming management decisions, which improves the quality of management) and 2) expanding the possibilities of interdepartmental information exchange.

Now digital, information and telecommunication technologies, which seemed to be the sphere of exclusively scientific research 20-25 years ago, are being widely introduced into both production and management processes. This refers to the risks inherent in these areas in the process of digitalization [2-3, 6, 13, 18]. This is fully applicable to agricultural land use management, and more broadly, to the organization of the farming system.

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2 Materials and methods

The article uses regulatory and methodological documents regulating the conduct of land management work, as well as the collection and processing of data on the condition of agricultural land. Abstract-logical, comparative-geographical, historical and computational-constructive statistical methods were used.

3 Results and Discussion

Modern agro-industrial complex is characterized by a multiplicity of factors that determine its results. Moreover, most of them are very variable in time and space. This includes its seasonality and territorial dispersal, the connection between production processes and the lifestyle of the workers involved in them - rural residents, etc. This determines that this area is one where digitalization is also relevant. Expert assessments of the consequences of digitalization of the agricultural sector allow us to expect at least a 25% reduction in costs due to the use of more flexible management models, making informed and prompt decisions based on current and reliable data, cost optimization and more efficient allocation of funds [8]. And the technical capabilities for this exist. Thus, among small agricultural enterprises, 55.4% use them to one degree or another; among microenterprises – 44.2%, among farmers – 24%; they are least common in private households 21.8% [1, 5]. That is, the prevalence of modern technologies decreases as the size of farms decreases (but the fact that every fifth rural household already uses these opportunities speaks volumes in itself).

Agricultural activities, like other agricultural and other types of activities, are subject to regulation [9, 17]. Among the main problems of an institutional nature that exist here are the following:

- The beginning of the current century actually became the boundary of the final transition between different stages in the organization of agricultural land use: a) extensive, when the growth in food demand due to an increase in population was compensated by the agricultural development of new lands; b) then came an intensive stage (until the turn of the 20th-21st centuries), when the increasing population density required the extraction of greater harvests from already developed areas; c) finally, the inability to compensate only by intensifying population growth and the resulting increase in land scarcity on a global scale is now obvious.
- At the same time, during the post-Soviet period, the total area of arable land in the country decreased from 132 million hectares to 122 million hectares, which was a continuation of the trend that had developed over the past half century to reduce the total area of agricultural land - from 640 to 382 million hectares (however, these lands do not need confused with farmland, in this category of land, inconveniences have decreased more, while the area of fertile land is relatively stable - 220-220 million hectares).
- There are unclaimed land shares - work has been underway with their owners for more than 10 years, and from 2025, all such shares will, by force of law, be transferred to municipalities, as a result, their area (30-35 million hectares [10]) will be comparable to area privatized in the 1990s. (but then it was no longer about real lands and plots, but only about the rights to them).
- Part of the land is not used (up to 30 million hectares); Moreover, until relatively recently, there were two different approaches to this phenomenon. Supporters of the first (the authors of this article have always been one of them) proceed from the fact that all previously developed land that was abandoned must be redeveloped again and in the future allowed to be used inefficiently, but supporters of the second approach proceeded from the fact that this area (as the use and market turnover of these lands) should be

outside of any special instruments of state regulation, believing that market self-regulation is sufficient here, and the law of equilibrium of supply and demand, the current economic situation will determine the purpose of this or that site.

A necessary condition for the rational use of land resources and the prevention of prolonged problems in this area are proper land management and information support [4, 19].

In turn, the prospects for digitalization of land management should take into account existing mathematical models and integration with previously autonomous functional-software modules in the land sector, such as: discrete models for organizing optimal crop rotations and allocating plots based on land shares (which already make it possible to "link" the preferences of owners shares and optimization of farming methods); integration with existing databases and systems for processing cartographic information about agricultural lands and calculating their cadastral value, etc. [14-15].

If this condition is met, this system will make it possible to create full-fledged three-dimensional models of various territories and significantly facilitate and speed up the processes of land management design, as well as ensure the required quality of its results. And here the key factor on which the prospects for Russian land management now depend is the work on a new edition of the relevant law. Naturally, the new land management law should make room for widespread development of digital technologies.

Also, the relevance of digitalization of agricultural land use is due to the fact that since 2022 a special state register of such lands has been maintained (hereinafter referred to as SRAL). Not only the effectiveness of the agro-industrial complex (and this is the main thing), where land acts as the main means of production, but also the validity of introducing a new register along with the long-running unified state register of real estate (hereinafter referred to as USRRE).

All this makes it advisable to comprehensively consider both universal aspects associated with the state's implementation of the function of managing a wide variety of digital data, and purely applied aspects of establishing a mechanism for interaction when maintaining the State Register of Agricultural Lands with other systems that already contain various data on agricultural lands (part of such data has already been digitized; for the other, the corresponding work remains to be done). Such data sources are:

- The unified federal information system on agricultural land (hereinafter referred to as UFISAL).
- Unified State Register of Real Estate and other data from Rosreestr.
- Reports of regional agricultural authorities.
- Results of monitoring of agricultural lands. and, of course,
- Land management materials.

Currently, the process of forming the State Register of Agricultural Lands is under active development both at the federal level and in the regions. At the same time, the information basis of this register is:

- The Unified Federal Information System on Agricultural Lands, which was put into operation back in 2018, the data of which is published on a publicly accessible portal and characterizes these lands, their fertility and the state of crops in spatial, attribute and graphic form (Figures 1 and 2).
- Unified State Register of Real Estate and other data from Rosreestr.
- Reports of regional agricultural authorities.
- Results of monitoring of agricultural lands.
- Land management materials.

One of the measures to ensure the comparability of these initially disparate data (due to the fact that they were collected according to different rules) is precisely their translation

into digital format and integration into a single database - the State Register of Agricultural Lands.

It is also important that, along with the federal State Register of Agricultural Lands, many regions are actively developing "their" databases (mainly based on the results of monitoring agricultural lands) [11-12, 16]. This may lead to a new problem - when maintaining the State Register of Agricultural Lands, along with the need to organize interdepartmental data exchange at the federal level, differences will inevitably emerge in the pace of development of similar regional systems and the saturation of the federal register with their data. Moreover, this may well repeat the situation with the automation of the state land cadastre in the mid-1990s, when regional rates of both very radical transformations in the land sector and the introduction of new technical means (including programs and databases) that supported them were different. Then, to maintain the unity of the national system of such accounting and guarantee its comparability and compatibility at different levels, the Government developed a special program, the implementation of which made it possible to maintain the unity, comparability and consistency of data both on the land fund and on specific plots. However, most likely, negative development will not occur due to the fact that the digitalization of interdepartmental exchange will first lead to the identification of facts of possible data incompatibility, and then to the adoption of measures to resolve it (i.e., the adoption of a similar nationwide program will not be required). But for this, as well as for preventing other possible "growing difficulties," clear rules are needed.

Also, the prospects for the digitalization of agriculture are associated with the introduction of technologies for growing agricultural products using the vertical farming method, which makes it possible to obtain crops using the hydroponics method, and in any room. This is especially important for northern areas, where agriculture faces the problem of limited plant growth - lack of sunlight, especially in the winter months when the days are short and the sun is low on the horizon, limits photosynthesis and plant growth. Summer, in turn, is characterized by short periods of warmth, and the growing season for plants is limited. The development of vertical farming can radically improve the food security situation in the northern territories. The emergence of such farms will entail the creation of jobs and significant savings in resources, since they use hydroponics or aeroponics, which reduces water consumption by 70–90% compared to classical agricultural methods. In addition, their placement does not require farmland, which is very scarce in the north (and in general, they need minimal areas). Such farms can be equipped with artificial intelligence - accurate, timely switching on and off of phyto-irradiators, supply of a nutrient solution will eliminate irrationality in the use of resources. Moreover, the corresponding developments are now being carried out by university science, for example, the Federal State Budgetary Educational Institution of Higher Education "State University of Land Management" is creating an Agro(bio)technopark on the basis of its geodetic test site, one of the key components of which will be an agrocluster with traditional and vertical greenhouses (this is where practical training will take place students of the newly opened educational profile "Protected Soil Engineer" at the University). Since all the clusters of this technology park will complement each other, the educational process will be carried out within the framework of not only the educational cluster, but also all others. Filming and observations from unmanned aerial vehicles of the state of crops in the agricultural cluster will improve the technologies for their cultivation and protection, etc. That is, full use of the capabilities of all clusters will provide a synergistic effect. And here digital technologies will be in demand more than ever.

4 Conclusion

Expanding the possibilities for implementing management functions in the field of agricultural land use (along with the same processes in other areas) determines the prospects for the development of the corresponding legal mechanism as a comprehensive intersectoral legal institution that combines the rules governing legal relations that arise in the production of digital data on the state of lands and crops, the search for such data in networks and resources (both public and limited distribution), their receipt and transmission, as well as from the digital information and communication technologies that provide all this. Relevant organizational and legal solutions should provide for the introduction of digital technologies in agriculture, primarily related to vertical farming, which ensures the independence of agricultural production from sunlight, climatic factors and adverse weather conditions (dry or cold periods, etc.).

References

1. A.G. Arkhipov, Digital transformation of Russian agriculture (FGBNU "Rosinformagrotekh", Moscow, 2019)
2. T.S. Bazhenova, *Digitalization of Belarus economy: prospects of the industry*, Russia in the Global World: Challenges of the XXI Century Collection of articles of the First all-Russian Student Research Conference (with international participation), 21-24 (2018)
3. V.V. Butyrin, The use of geographic information technologies in the management of the regional agricultural complex, Agrarian scientific journal, **4**, 75-78 (2016)
4. A.D. Demyanova, E.A. Schastlivetskaya, S.A. Lipski, *Information support of management of the land resources of the Russian Federation*, IOP Conference Series: Earth and Environmental Science, **350**, **1**, 012056 (2019)
5. A. Dibirov, K. Dibirova, Prospects and Problems of Digitalization of the Agricultural Economy. In: Ronzhin, A., Berns, K., Kostyaev, A. (eds) Agriculture Digitalization and Organic Production. Smart Innovation, Systems and Technologies, Springer, Singapore, **245** (2022) https://doi.org/10.1007/978-981-16-3349-2_18
6. E. Eliseeva, Digitalization of Russian companies accounting management, Information Innovative Technologies, **1**, 617-622 (2018)
7. A.A. Efremov, A.V. Kalmykova, Digital transformation and public administration (Infotropik Media, Moscow, 2022)
8. V. Erokhin, T. Gao, Handbook of Research on Globalized Agricultural Trade and New Challenges for Food Security, Harbin Engineering University, China – published in the IGI Global book series. Advances in Environmental Engineering and Green Technologies (AEEGT), ISSN: 2326-9162, eISSN: 2326-9170 (2019)
9. N.V. Komov, Russian land is the territory of the state and the most important wealth of people, Economy and Ecology of Territorial Formations, **3**, **1**, 6-14 (2019) DOI:10.23947/2413-1474-2019-3-1-6-14
10. S.A. Lipski, State and Use of Land Resources in Russia: Trends of the Current Decade, Studies on Russian Economic Development, **31**, **4**, 437-443 (2020) doi.org/10.1134/S1075700720040103
11. A. Loshakov, S. Odintsov, M. Kasmynina, M. Melnik, S. Gorbachev, Monitoring of flooded and waterlogged agricultural land of the Stavropol territory, Research Journal of Pharmaceutical, Biological and Chemical Sciences, **9**, **6**, 1611-1617 (2018)

12. A. Loshakov, D. Shevchenko, L. Kipa, M. Kasmynina, T. Malykhina, Quality monitoring the agricultural land in the Stavropol region. Research Journal of Pharmaceutical, Biological and Chemical Sciences, **9**, **4**, 897-901 (2018)
13. I.V. Makarova, K.A. Shubenkova, A.O. Bagateeva, E.M. Mukhametdinov, V.G. Mavrin, Digitalization of society - new challenges to the engineering education system, Information Innovative Technologies, **1**, 74-80 (2018)
14. T.V. Papaskiri, S.A. Lipski, *Maintaining the register of agricultural lands as a real step towards the implementation of the data management function for these lands by the state*, International Scientific and Practical Conference "Ensuring the Technological Sovereignty of the Agro-Industrial Complex: Approaches, Problems, Solutions" (ETSA-IC2023), **395**, 04003(2023) DOI:10.1051/e3sconf/202339504003
15. T.V. Papaskiri, V.N. Semochkin, E. P. Ananicheva, *Directions and methods of digital land management*, IOP Conference Series: Earth and Environmental Science, Moscow, 012130 (2020) DOI 10.1088/1755-1315/579/1/012130
16. G. Polunin, V. Alakoz, K. Cherkashin, *Regional land use by farms of the Russian Federation*, IOP Conference Series: Earth and Environmental Science, 012017 (2019) DOI:10.1088/1755-1315/274/1/012017
17. E.V. Serova, Sustainable agriculture: why we are concerned today, Russian Journal of Economics, **8**, **1**, 1-6 (2022) DOI: 10.32609/j.ruje.8.84133
18. L.S. Svintitskaya, *Digitalization of world economy: challenges and opportunities for developed and emerging economies*, Russia in the Global World: Challenges of the XXI Century Collection of articles of the First all-Russian Student Research Conference (with international participation), 114-118 (2018)
19. S.N. Volkov, T.V. Papaskiri, N.N. Alekseenko, *Land-property and land-resource information obtained as a result of land management*, IOP Conference Series: Earth and Environmental Science, Moscow, 012132 (2020) DOI 10.1088/1755-1315/579/1/012132