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Digitalization of technical service: formation and development prospects, impact on the efficiency of agricultural production

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***Abstract*— Digital technologies occupy an ever-increasing place in the development of both the economy as a whole and its individual industries, including agriculture. According to the director of the Department of Development and Management, the state information resources of the agro-industrial complex of the Ministry of Agriculture of Russia, the level of digitalization in domestic agriculture can be increased by 3-4 times. Therefore, the IT technology market in agriculture will develop at a rapid pace and serious volumes and by 2030-2035 it will reach a volume of 1.5 trillion rubles (today it is 360 billion rubles). All technologies that can be implemented using digital technologies can be transferred to digital technology in this industry. It is necessary to solve the following primary issues for the mass transition to digital technologies: to create economic conditions for the formation of optimal machinery fleet – for this it is necessary to develop domestic agricultural engineering, especially the production of tractors; to establish effective operation of the existing machine and tractor fleet using digitalization of technical services. Digital technologies are already used today: in planning work on technical services; in the instant accounting of performed work; in monitoring the technical condition of the machines; in instant determination of the residual resource, based on the information transmitted by the built-in monitoring sensors, etc.**

Keywords*— *economics, digitalization, computer technology, agricultural engineering, agricultural enterprises, technical service

I. Introduction

The entire world economy is moving to the so-called "digital" technologies in recent years, which are based on the development and use of the latest achievements of IT technologies (computer technologies). Software is more often used in production processes, which manage technological processes in all sectors of the national economy, incl. agriculture.

Today, in agriculture of the "Western world", and in Russian economically developed agricultural organizations, the following technological operations are performed using IT technologies: parallel driving of aggregates, accounting for performance and fuel consumption, determining the location of aggregates, "point-like" and dosed use of plant protection products, the use of fertilizers based on agrochemical soil research, reflected in the digital version in maps of fields – all this is in horticulture. In animal husbandry there are: milking robots and other automatic milking machines, feed-leveling robots, "digital" recording of animal productivity, composition of feeding rations concerning productivity, weight, age and other physiological data.

II. Litterature review

For research and analysis of digitalization processes, problems with digitalization in technical services in the agro-industrial complex, we will consider the publications on this issue of different authors, their approaches to the studied issue, the planned ways and directions of effective digitalization of technical services.

Authors B.A. Katz, A.Yu. Molchanov in their article "Digitalization of the processes of management of technical service and maintenance: problems and solutions" addresses the following issues:

- problems of managing technical service and maintenance and their solution within the framework of digital transformation;

- the authors believe that the digitization of technical service and maintenance and repair processes is not just another slogan, but a global development trend;

- in the opinion of the authors, the problems of managing technical service and maintenance begin with the basics – the accounting. Often, managers do not have accurate and complete information about the technical condition of all material resources in operation. To solve this problem is the creation of a database (DB) on material resources;

- another problem is that often the standards for work in service and maintenance enterprise are incomplete or outdated, as a result of the emergence of newer modern technology.

The authors believe that the modern approach to the management of technical service and maintenance consists in the optimal integrated application of various service

strategies, optimization of service programs according to the criterion of minimizing risks using elements of digital technology.

Authors K.A. Shubenkova, T.A. Nikolaev, V.D. Shevelev, N.A. Tyurin in their article "Improving the efficiency of processes in dealership-service centers using digital twin technology" concludes that the concept of subsequent service should change when digitizing the production of equipment. The manufacturer is interested in creating a proprietary service network, through which he will be able to realize the principle of responsibility for his product throughout the entire life cycle – from the moment of design to disposal. The authors put forward the idea that in the production of machinery (trucks) digital twins of the machinery itself, digital twins of their production and service systems should be formed.

The digital twin of the service system as a whole should include information on all components and assemblies, their uptime, as well as all maintenance and repair work. This requires a special approach to combine Digital Twin technology with simulation modeling of the entire complex large corporate service system, as well as the use of the Internet of Things (IoT) for collecting and analyzing information about the state of technology in real time.

S.B. Ognivtsev in his article "The concept of the digital platform of the agro-industrial complex" studies the stages of the development of information technologies, the most important trends and concepts of the modern stage of digitalization and the end-to-end technologies offered by the Digital Economy program. It justifies the need to create a digital agribusiness platform as an important component of the modern digital economy. The purpose of the digital agro-industrial complex platform development is a radical increase in the efficiency of the agro-industrial enterprises due to the widespread introduction of new digital into the production processes, including end-to-end technology. He defined the tasks and structure of the digital platform, which includes sub-platforms, relevant agrifood markets and application modules that serve to solve various practical problems.

The author provides a sub-platform for the supply of agricultural commodity producers, with material resources and services, that is, delivery, maintenance and repair of agricultural machinery. In addition, the author substantiated the stages of creating a digital agro-industrial complex platform, the necessary financial resources for this and the expected economic effect from implementation.

III. Methods

The starting point for the implementation of the basic provisions of the digital economy in Russia was the following documents: The Digital Economy of the Russian Federation Program (Order of the Government of the Russian Federation No. 1632-P of July 28, 2017); Presidential Decree No. 204 of May 7, 2018 "On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024".

Many analysts and experts immediately started talking about the fact that the "digital" revolution will allow the Russian economy to be stirred up, instantly increase labor productivity, achieve lower production costs, retool the material and technical base and increase the tractor fleet and combine harvesters by 300 thousand units [1] .

Yes, the main goal of the "digital" economy (as well as the economy in general) is to get more products and minimize losses. Digitization of agriculture, with the massive introduction of computer technologies for processing large amounts of information, will speed up decision-making processes in production management. The second direction is the modeling (the choice of several options) of the end-to-end processes of production and sale of agricultural products without intermediate links that affect purchasing prices, retail prices. Some "hot heads" in digitalization saw a decline in the role of specialists in maintaining efficient production, that management would come from the "head" and the computer.

And in the period of the digital economy emergence, I would like to analyze the current state of domestic agricultural engineering, the availability and accessibility of agricultural enterprises with the main types of agricultural equipment – tractors, grain and fodder harvesters. The data is presented in Tab. 1 and 2 and in Fig. 1 and 2.

The production of the main types of agricultural machinery in recent years can be estimated as follows: the production of tractors is reduced at an average rate of 3% per year; combine harvesters – by 1%; the growth of production of forage harvesters is 7% per year.

TABLE I. Production of main types of agricultural machinery in Russia [2]

Type of machine	Years					
	2013	*2014*	*2015*	*2016*	*2017*	*2018*
Tractor, units	7590	6738	5536	6256	6601	6284
Combine harvester, units	5848	5547	4412	6054	6842	4796
Forage harvesters, units	431	240	379	493	386	435

The analysis of the availability and accessibility of the main types of agricultural equipment is somewhat more complicated. The availability of equipment is decreasing: tractors – 4% per year, grain combine harvesters – 3%, forage harvesters – 5%. The accessibility for the above years increased from 25.6% in 2013 to 26.3% in 2018 – of tractors; combine harvesters accessibility decreased from 20.8% to 15.5%; forage harvesters – from 32.8% to 25.9% in 2018.

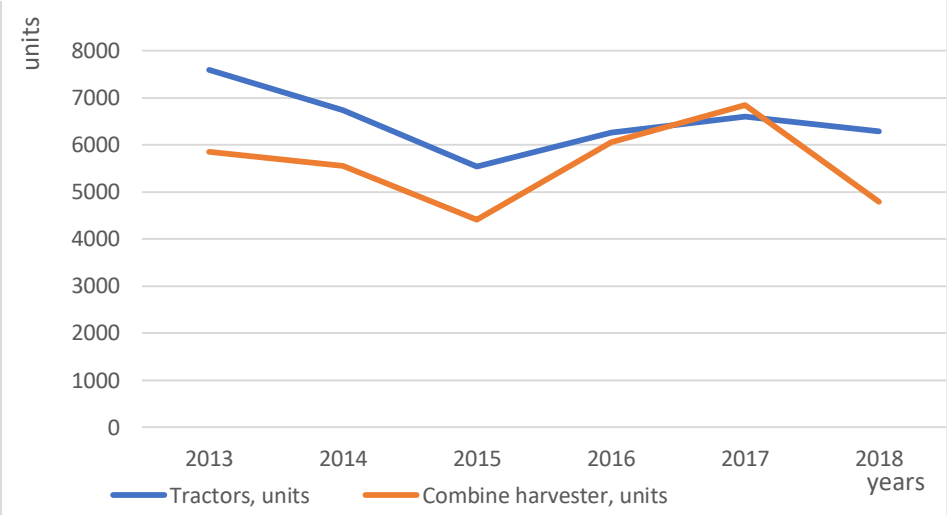

Fig. 1. Production of main types of agricultural machinery

Therefore, the statement by Alexander Gerasimova [1], the director of cloud and IT services analysis at J'son & Partners Consulting, that digitalization will increase the fleet of tractors and combine harvesters by 300 thousand units does not correspond to the actual state in Russian agriculture; or the specialists of this consulting company work in isolation from the agriculture itself, i.e. "by themselves".

Of course, it is possible and necessary to increase the number of agricultural equipment in agricultural enterprises, at least to the standard values, but for this it is obligatory to radically change the approach to the entire Russian economy, and to the agricultural economy and related industries (engineering, processing) in particular. In order to increase the machinery fleet, the coefficients of renewal and retirement technology must be in a ratio of not less than 1.2: 1, and in the period of formation – 1.25.

TABLE II. PRODUCTION OF MAIN TYPES OF AGRICULTURAL MACHINERY IN RUSSIA [2]

Type of machinery	Years					
	2013	*2014*	*2015*	*2016*	*2017*	*2018*
Tractor, thousand units	259.7	247.3	233.6	223.4	216.8	215.1
Combine harvester, thousand units	67.9	64.6	61.4	59.3	57.6	58.0
Forage harvesters, thousand units	16.1	15.2	14.0	13.3	12.7	12.6

If the state policy does not change about agricultural organizations, service industries and agricultural engineering, then we can simulate the fleet of agricultural organizations for the next 10-12 years by using the regression formula. It is possible to simulate a machinery fleet with optimal rates of renewal and disposal of equipment and calculate when we will reach an increase of 300 thousand units.

To calculate the index of change in the indicator of the current year to the past year, we use the formula:

$$\Psi_{\iota}=\frac{\Pi_i}{\Pi_{i-1}} \quad (1)$$

To calculate the average value of the index of change in the indicator for a number of years (in our case for 6 years), we use the formula:

$$\overline{Y}_6=\frac{\frac{\Pi_i}{\Pi_{i-1}}+\frac{\Pi_{i+1}}{\Pi_i}+\frac{\Pi_{i+2}}{\Pi_{i+1}}+\frac{\Pi_{i+3}}{\Pi_{i+2}}+\frac{\Pi_{i+4}}{\Pi_{i+3}}}{5} \quad (2)$$

In the calculations the *i* year is the year 2014.

For calculations of the index of change in the indicator of subsequent years (for 2018), we use the following formula:

$$Y_{>6}^{n}=\overline{Y}_6\times\frac{\Pi_{i+4}}{\Pi_{i+3}};\ Y_{>6}^{n+1}=\overline{Y}_6\times\frac{\Pi^{n}}{\Pi_{i+4}};Y_{>6}^{n+2}=\overline{Y}_6\times\frac{\Pi^{n+1}}{\Pi^{n}} \quad (3)$$

In the calculations the *n* year is the year 2019. The data of calculations of the indicators of the proposed machinery fleet is presented in Tab. 3.

We will simulate the fleet at optimal rates of renewal and disposal of equipment, i.e. with a standard $K_{renewal}$ = 10–12% ($K_{renewal}$ = 5.5% in 2018), with a standard $K_{disposal}$ = 8–10% ($K_{disposal}$ = 7.5% in 2018).

TABLE III. ESTIMATED MACHINERY FLEET OF THE MAIN TYPES OF AGRICULTURAL EQUIPMENT

Type of machinery	Years									
	2019	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*
Tractor, thousand units	206.5	198.2	190.3	182.7	175.4	168.4	161.7	155.2	149.0	143.0
Combine harvester, thousand units	56.3	54.6	53.0	51.4	49.9	48.4	46.9	45.5	44.1	42.8
Forage harvesters, thousand units	12.0	11.4	10.8	10.3	9.7	9.3	8.8	8.3	7.9	7.5

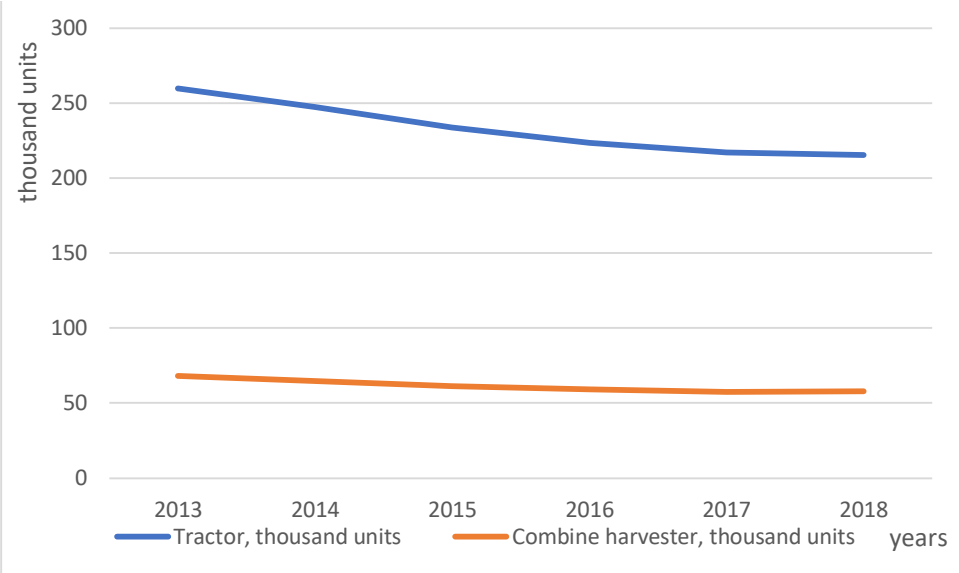

Fig. 2. Availability of agricultural equipment in agricultural organizations of the Russian Federation

In addition, the share of tractors that are used longer than the standard depreciation periods, that is, over 10 years, is at the level of 59.6%, for combine harvesters – 45.1%, for forage harvesters – 43.9%. The operation of such equipment leads to a decrease in productivity, disruption of accepted agricultural deadlines and an increase in product losses during harvesting.

The actual state of affairs in agricultural engineering, equipment of agricultural organizations with the main types of agricultural equipment and wear-out of equipment increases the role of technical service in matters of effective use of equipment and maintaining it in good working condition. Technical service should provide: high availability, maximum operating time of equipment, competent maintenance and operation, respect for the interests of producers, employee training.

The current machinery and tractor fleet is worn out by more than 60%. High-quality maintenance, repair of machines during the entire period of operation allows to increase the operational characteristics of equipment and to increase time to failure and allows equipment manufacturers to take a leading position in the sales market. With the increase in the technical level of agricultural machinery, a further increase in the efficiency of use is impossible without a radical restructuring of technical service.

Currently, the volume of service and maintenance work, especially for domestically produced equipment, has moved to the agricultural producer. But the level of development of technology, the use of modern electronic and hydraulic systems in the design implies the inclusion of manufacturers in this work; creation of corporate service system. Technical service and maintenance are becoming more complex, so for their high-quality implementation it is necessary to have regular access to extensive information. The role of information in conditions of limited provision of equipment increases significantly. The basis of high-quality technical service are the new technologies of technical service and maintenance, implementation of technical service enterprises with high-precision equipment, accessories, regulatory and technical documentation and qualified personnel.

The efficiency of the technical service enterprises depends on the effective work of agricultural organizations engaged in the production of agricultural products, which in turn depends on the quality of the performed work, the duration of the facility's location in service and maintenance, especially during spring field works, the cost of the provided services. The effectiveness of technical service is characterized by a high coefficient of technical readiness of the machine and tractor fleet and lower operating costs per unit of production or performed work. Technical availability can be enhanced by performing high-quality maintenance and repair.

Cost-effective technical service reduces the need for spare parts and repair materials, increases the service life of tractors, combines, cars and agricultural machinery. All this creates the conditions for a significant strengthening of the material and technical base of agriculture. In these conditions, a clear state policy is needed to organize modern technical services in the agro-industrial complex.

TABLE IV. ESTIMATED MACHINERY FLEET OF THE MAIN TYPES OF AGRICULTURAL EQUIPMENT WITH THE OPTIMAL VALUES OF THE UPDATE COEFFICIENTS

Type of machinery	**Years**									
	2019	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***
Tractor, thousand units	219.4	223.8	228.3	232.8	237.5	242.2	247.1	252.0	257.1	262.2
Combine harvester, thousand units	59.2	60.3	61.5	62.8	64.0	65.3	66.6	68.0	69.3	70.7
Forage harvesters, thousand units	12.8	13.1	13.4	13.6	13.9	14.2	14.5	14.8	15.1	15.4

IV. Practical significance

This obtained data was tested at the international scientific-practical conference "Digital Agriculture – Development Strategy" (2019). It is also used in the educational process and the preparation of teaching aids in the disciplines: "Technologies and equipment in the agro-industrial complex", "Service of main components and assemblies of transportation and technological machines", "Production and technical infrastructure of enterprises".

V. Conclusion

Further development of the Russian technical service provides for its organization by using digital technologies [4]. Digital technologies are already used today: in the planning of maintenance and repair, taking into account the huge number of factors that arise in the process of performing technological operations; in conducting instant accounting of the performed work, fuel consumption, movement of spare parts; in fixing and keeping records of the summed up operating time for optimizing the calendar terms of setting the machines in service; to provide information and reference materials for all interested users of agricultural equipment; to monitor the technical condition of the machines, instantaneous determination of the residual resource based on the information transmitted by the built-in monitoring sensors; depending on changing conditions (weather, organizational, technological), to optimize the compositions and modes of operation of equipment; using logistics software products, optimize stocks of spare parts and materials in warehouses of various levels, i.e. accelerate the passage of warehouse operations.

The development of technical services based on digital technologies involves the creation and improvement of information-analytical, information-consulting and information-marketing services.

Digital technologies make it possible to more rationally shape the size of the repair and maintenance base of technical service; digitalization of technical diagnostics plays a special part. One of the promising areas is remote diagnostics, which is carried out through a system of sensors installed on the components and assemblies of working machines. With the help of digital technologies, it is possible to implement a new technical service organization strategy – "prediction and prevention" of faults. Compared with the "technical condition" strategy that is currently being implemented, this strategy is a big step forward in maintaining the technical availability of the machine and tractor fleet of the country.

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