Maintaining the reliability of agricultural machinery in the complex of developing an engineering and technical system

Yuri Kataev [1*], *Ekaterina* Malykha [2], and *Evgeniy* Gradov[1]

[1]Federal Scientific Agro-Engineering Center VIM, 1 Institutsky proezd, 5, Moscow, 109428, Russia
[2]Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Timiryazevskaya Street, 49, Moscow, 127434, Russia

Abstract. The increase in the reliability of agricultural machinery is ensured by the efficiency of the machine repair and maintenance system and the engineering and technical service of the agro-industrial complex, which meets the requirements of progressive technologies for their support throughout the entire life cycle. The article presents the principles of development of the engineering and technical system for maintaining the reliability of agricultural machinery based on the use of digital technologies. It is noted that at present the engineering and technical system in the agro-industrial complex of the Russian Federation is characterized by insufficient efficiency due to the outdated organizational and managerial structure for the provision of technical services and the low level of technical readiness of agricultural machinery, which does not provide agricultural producers with the required level of its reliability. The proposed modern engineering and technical system of the agro-industrial complex with the introduction of digital and resource-saving technologies, including remote diagnostics of machines, is able to ensure resource conservation, increase the technical level, quality and reliability of equipment.

1 Introduction

Modern technical and technological systems that ensure a high technical level of agricultural machinery in the agro-industrial complex (AIC) are based on intelligent technologies throughout the entire life cycle of machines [1-5].

The main areas in improving the engineering and technical system (ITS) are:

– optimization of organizational and structural transformations of the system;

– formation of an economically advantageous system of production and technological service for agricultural producers;

– ensuring effective repair of agricultural machinery with a technical readiness factor of at least 0,93-0,95%;

* Corresponding author: ykataev@mail.ru

– improvement of diagnostics of units and assemblies of complex agricultural machinery using digital technologies.

2 Purpose of research

Purpose of research – study of experience in improving the engineering and technical system in organizing all types of technical support for agricultural machinery in modern conditions using intelligent technologies.

3 Materials and methods

Engineering and technical service plays a special role in the agro-industrial complex. Modernized ITS allows for significant savings in the working time of agricultural producers. For example, in a typical family farm both in Russia and abroad, up to 80% of the farmer's working time is spent on equipment maintenance, and about 10% on logistics and sales.

This is due to the fact that the existing service system in the agro-industrial complex does not fully meet the economic and technological requirements of most agricultural producers [6-8].

In the context of the shortage of skilled labor observed in modern Russian agriculture, the demand for ITS services will only grow. As the industry moves to an innovative path of development, the need for ITS modernization will increase. This requires a significant increase in the cost of labor in the engineering segment of agriculture. Having analyzed the situation in the country's agriculture, having studied foreign experience and relying on the goals of developing the agricultural economy, it is possible to formulate a concept of the optimal construction of the ITS in the market conditions of the development of the agro-industrial complex.

The main principles of the concept include: integration of services; modularity and flexibility; innovation and technology [9].

It is necessary to create agro-service centers that will combine a full range of services for servicing agricultural machinery, from repair and maintenance to the supply of spare parts and the provision of consulting services. It is worth noting that the ITS should be modular and flexible so that farms can choose and pay only for those services that they need, and help adapt to the changing needs of agricultural producers. The introduction of advanced technologies, such as remote monitoring and predictive maintenance, will increase efficiency and reduce the costs of technical support of agricultural machinery.

The most important factor in the effective operation of the ITS is the availability of qualified personnel. Training of specialists working in the ITS system should be continuous and cover the entire spectrum of intelligent technologies in servicing agricultural machinery, i.e. the ability to effectively work with equipment and devices with the appropriate software [10].

The implementation of the optimal ITS will provide potential benefits:

– reduction of working hours and equipment maintenance costs, which leads to increased labor productivity;

– increased reliability and efficiency of agricultural machinery, reduced failures and crop losses;

– improved quality of agricultural products due to the use of serviceable equipment and compliance with technological requirements;

– increased competitiveness of farms by reducing production costs and improving product quality;

– development of rural infrastructure and creation of new jobs in the ITS sphere.

The implementation of the optimal ITS concept is an integral part of the transition of Russian agriculture to an innovative development path. Integrated, modular, innovative and financially accessible service systems contribute to increased efficiency and competitiveness of all agricultural enterprises in the agro-industrial complex [11]. The goals of the new stage of agricultural modernization (development of the industry using new technologies) are to provide the country's population with its own food and develop its export potential, increase labor productivity by 4-5 times based on innovative methods of intensifying production and creating a new generation of material and technical base [12-14].

4 Results and discussion

The Innovation Implementation Program for Agricultural Consumers in terms of developing an engineering and technical system for maintaining the reliability of agricultural machinery provides great opportunities for obtaining the maximum economic effect for agricultural producers in many areas, including:

– standard projects for the optimal construction and operation of enterprises of the engineering and technical infrastructure of agriculture;

– innovative technologies, equipment, devices based on intelligent developments;

– new polymeric materials that ensure the renovation of worn-out parts and units of agricultural machinery;

– the use of nanomaterials in technological operations to increase the resource of the most critical parts of agricultural machinery;

– the creation of an effective resource-saving environmentally oriented system for the disposal of agricultural machinery "Agricultural Recycling";

– effective, environmentally friendly, low-cost methods of preservation and technologies for the preparation of bulk and concentrated feed;

– machine science-intensive technologies for the production of competitive priority groups of livestock products;

– intelligent methods for diagnosing parts and units of energy-intensive agricultural machinery;

– digital systems tools in individual areas of the engineering service of the agro-industrial complex.

The implementation of these works is based on mechanisms and principles that involve the following stages, presented in Figure 1.

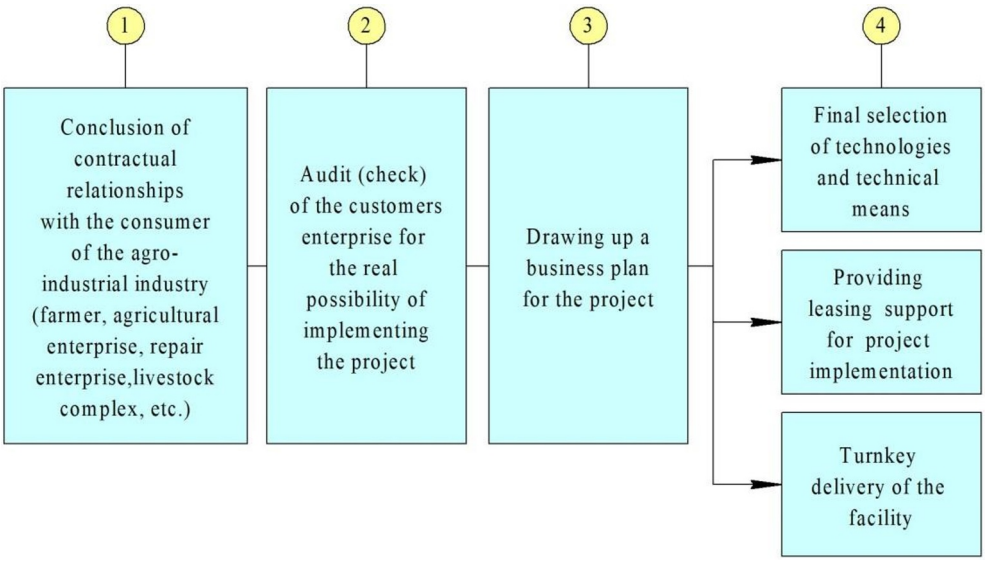

Fig. 1. Completing stages of work on the implementation of innovative technologies.

At the same time, neither party can dictate its terms, and the relationship should be based on the establishment of interaction and priorities in cooperation with scientific institutions and agricultural universities in solving the main problems associated with the development and implementation of new technologies, the preparation of training programs that can be implemented for a wide range of specialists in the agro-industrial complex, ensuring a high level of use of agricultural machinery and equipment. One of the most optimal options for reducing the cost of agricultural producers for technical support of complex agricultural machinery is the use of factoring. Factoring technology is built in such a way that service enterprises providing all types of maintenance of agricultural machinery receive payment in full immediately after the completion of the services rendered, the customer - the agricultural producer is provided with an acceptable deferment of payments. Figure 2 shows a functional diagram of the interaction of factoring partners.

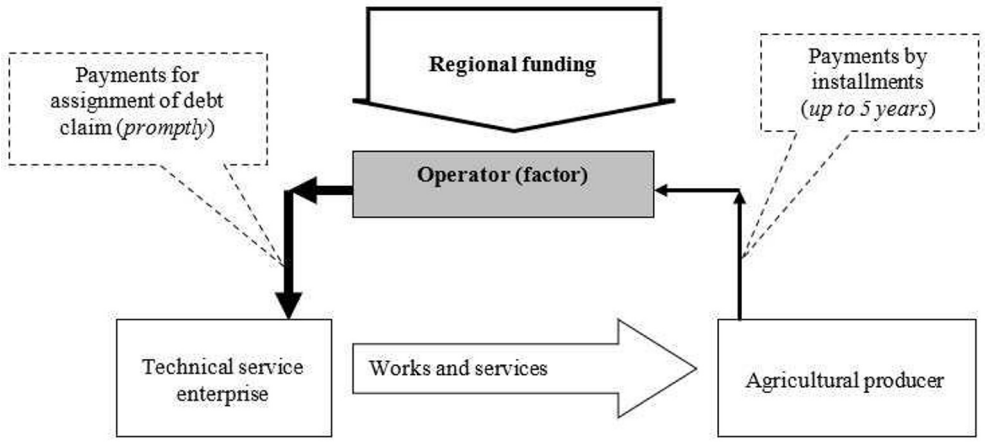

Fig. 2. Functional diagram for factoring.

In the presented scheme of work on factoring at the regional level, the source of financing can be banks, interested investors, as well as state support from the regional administration. Such experience of supporting agricultural producers in servicing agricultural machinery has been practiced for more than 10 years in the ITS of the agro-industrial complex of some regions of the country. The effectiveness of such interaction of partners is the technical readiness of agricultural machinery in these regions at a very high level (93-95%). At the same time, an analogue of the factoring scheme of settlements between counterparties has been implemented.

Thus, the possibilities of reducing the financial costs of agricultural producers during the technical service of energy-intensive machinery in operation are realized both by minimizing costs at the required level of performance of the required mechanized work, and by using a factoring mechanism that allows observing the economic interests of all counterparties. One of the most important factors in solving the problems of improving the maintenance of complex agricultural machinery (tractors, combines) is the introduction of online monitoring systems based on neural network modeling, characterizing the technical condition of complex agricultural machinery [15-18]. Devices for collecting information on the reliability of equipment in online mode [19, 20] are shown in Figure 3. They allow timely detection of emerging failures, degree of wear and emergency situations during the operation of complex agricultural machinery. The monitored indicators can characterize both the general technical condition of the equipment and individual units and assemblies included in its design [21-24].

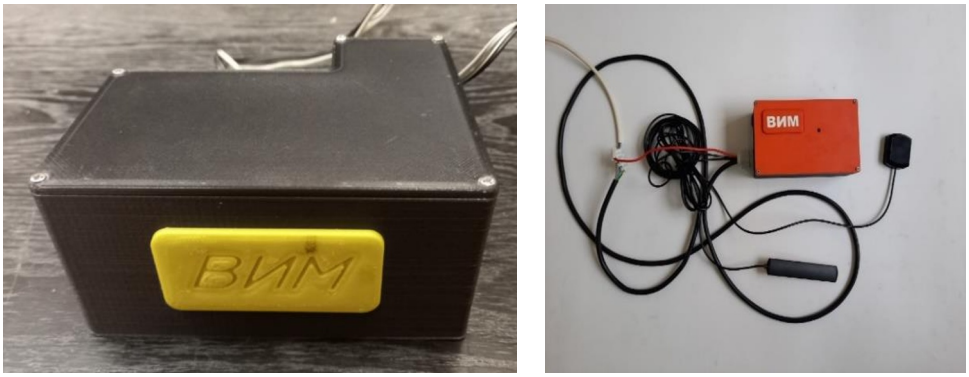

Fig. 3. Diagnostic devices for online monitoring of the technical condition of complex agricultural machinery.

5 Conclusions

Considering the need for import substitution of both agricultural machinery itself and the types and methods of its technical support throughout its life cycle, a special task is to determine the most optimal organizational forms in the ITS structure that allow all agricultural producers, including those with medium and low economic levels, to maintain machines at a high technical level. The experience of conducting technical service, including factoring in ITS in individual entities, can actually be applied in many agricultural regions of the country.

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