The use of resource-saving technologies in crop production

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Abstract. Crop production is one of the most important branches of agricultural production, which ensures food security and independence of the state. The primary task of farmers is to supply the population with high-quality agricultural products. Agricultural production is associated with many factors, some of which have a negative impact on its development. The transition to energy and resource-saving technologies is an essential condition for the further development and functioning of the agricultural sector. The introduction of resource-saving technologies will ensure the preservation and restoration of soil fertility and the environment, the rational use of production resources and the full realization of the agricultural potential.

1. Introduction
Crop production is one of the fundamental branches of agricultural production; the food security of the state and the level of providing the population with high-quality and ecological food depend on its development.

A significant part of the agricultural area in the Russian Federation is devoted to the production of grain and leguminous crops. Wheat has spread, accounting for about 60% of all cereal areas, as well as barley, corn and oats. Plant-growing products provide the population with the necessary food, industry with raw materials, livestock - feed. Forage crops account for about 20% of all sown areas.

The development of crop production is facilitated by: increasing soil fertility, providing modern machinery and equipment, chemicalization and automation of agricultural production, the availability of highly qualified specialists and a scientific base. It should also be taken into account that the plant growing industry has its own characteristics, which are associated with the influence of natural conditions on plants, the seasonality of production, and the peculiarity of using land as the main means and subject of labor [1].

Taking into account the factors influencing the growth and development of agricultural crops will increase the volume of production, improve its quality and ensure a continuous production process through the introduction of modern innovative resource-saving technologies.
2. Materials and methods
In modern studies [2-4], resource conservation is considered as a set of measures aimed at the conservation use of raw materials, materials, energy, labor and other resources necessary for the implementation of production activities. The problem of using resource-saving technologies in domestic production is expressed by high labor costs. World experience shows that labor costs for the production of crop products in developed countries are 2-3 times less than in domestic [5-6]. The management of agricultural organizations is forced to look for ways to reduce costs through the introduction of modern energy and resource-saving technologies that ensure rational resource consumption.

Resource-saving technologies are based on the following principles [7-8]: minimal tillage, ensuring the preservation of plant residues on the soil surface, the use of science-based crop rotations, the selection of highly effective crop varieties, the implementation of measures to improve soil fertility, integrated approaches to pest control and diseases.

The analysis of scientific papers [9-12] makes it possible to single out the main directions for the use of resource-saving technologies in crop production: technical - the use of modern highly efficient machines and equipment; technological - the introduction of innovative resource-saving technologies for the production of crop products; organizational - optimization of production processes aimed at the conservation and efficient use of available resources, organization of accounting and control over them.

The purpose of the study is to summarize the main trends in the use of resource-saving technologies in the production of crop products. The study is based on the theoretical positions of Russian and foreign scientists in the field of application of resource-saving technologies in agriculture. The work uses logical, monographic and statistical methods. The information base of the study was formed on the basis of statistical data from the Federal State Statistics Service and annual reports of agricultural organizations in the Krasnodar Territory.

3. Results
Currently, agricultural machinery is presented in the form of a huge variety of machines, units and implements. Modern agricultural machinery makes it possible to solve resource saving issues: reduce operating costs; increase the useful life due to the use of composite alloys; speed up technological processes; increase labor productivity; perform several agricultural practices at the same time.

In agricultural organizations of the Krasnodar Territory, combined sowing complexes and pneumatic seeders for zero technology of the following manufacturers are common: Great Plains Manufacturing Inc. (USA), John Deere (USA), Kuhn S.A. (France), Lemken GmbH & Co. KG (Germany), HORSCH Maschinen GmbH (Germany), OJSC BobruiskSelmash (Belarus) and others.

The use of modern agricultural machines and units allows for strip tillage, with an adapted fertilizer application system and direct sowing, use of a multifunctional approach to agricultural machines, reduce the load on the soil with wide-profile tires and dual wheels, subsurface and band application of fertilizers and herbicides.

According to the agricultural enterprise "Agro-Soyuz" for the cultivation of 10 thousand hectares, it is necessary to use a fleet of machinery, consisting of 9 agricultural machines. Sowing is carried out by one combined sowing complex, the productivity of which is about 140 hectares per day, and the consumption of diesel fuel is about 5 liters per hectare. A machine operator, a driver carrying seeds and fertilizers, an agronomist are involved in the sowing process. For plant protection, a sprayer is used, the productivity of which is up to 650 hectares per day. Six combines in the storage bunker carry out harvesting.

Figure 1 shows a HORSCH tillage sowing complex that sows on stubble.
Modern technologies for the production of crop products are based on environmental and energy-saving no-till systems that provide soil protection measures focused on the expanded reproduction of soil fertility, the transition of the farming system to low-cost bio-farming (non-mechanical tillage). The use of direct sowing seeders allows you to place the seeds of agricultural crops at the required depth, while ensuring the preservation of the vegetation layer.

The analysis showed that in order to obtain stable and guaranteed yields, it is necessary to adapt the no-till system to specific farming conditions, while the main problem is obtaining autumn seedlings from a non-fallow predecessor. The use of this technology will significantly reduce the energy consumption for tillage.

For the period from 2015 to 2020 in agricultural organizations of the Krasnodar Territory, the area under no-till technology increased by 3.1%, and under the “minimal tillage” technology by 8% (table 1).

A limiting factor in the development of minimum tillage technologies in agricultural organizations of the Krasnodar Territory is the low level of use of modern agricultural machinery. An analysis of the fleet of the main types of machines and units showed that the number of machines for sowing from 2015 to 2020 decreased from 5467 to 5080 units, or by 7.1%, but fertilizer machines and sprayers increased by 16.1% and 23.6% respectively (table 2).

A new one that has all the parameters of energy and resource-saving technologies compensates for the disposal of old, morally and physically worn-out agricultural machinery. However, at present, the pace of renewal of the agricultural machinery fleet has slowed down due to financial problems.

The efficiency of using resource-saving technologies is based on the optimization of production processes. The introduction of the principles of lean production allows agricultural enterprises to overcome crisis phenomena, as well as to determine effective and reliable ways to minimize resource costs. An analysis of agricultural organizations in the Krasnodar Territory showed that cost savings are possible by optimizing the composition of machine and tractor units. The use of modern sowing complexes SZB-9, MPK-4, Agrator-9800, APP-6A allows increasing productivity by 1.5-2 times.
Table 2. The fleet of the main types of equipment in agricultural organizations in the Krasnodar Territory, units

| Type of equipment                         | 2015   | 2017   | 2018   | 2019   | 2020   |
|------------------------------------------|--------|--------|--------|--------|--------|
| Tractors                                 | 17439  | 17705  | 17395  | 17380  | 17542  |
| Plows and harrows                        | 14371  | 13197  | 12741  | 12544  | 12451  |
| Seeding machines                         | 5467   | 5349   | 5227   | 5168   | 5080   |
| including seeders                        | 5043   | 4865   | 4759   | 4717   | 4609   |
| Machines for applying organic and mineral fertilizers | 2203   | 2380   | 2410   | 2496   | 2558   |
| Tractor sprayers and dusters             | 2317   | 2712   | 2682   | 2815   | 2864   |
| Combine harvesters                       | 3086   | 3239   | 3324   | 3363   | 3341   |

The qualifications of machine operators play an important role in resource saving. The analysis showed that more skilled workers in agricultural production, using the same basic characteristics of agricultural machinery, receive 20-30% more products as a result of reducing losses and increasing labor productivity. The optimal operating parameters of the agricultural machine allow saving up to 45% of fuel and lubricants. Accounting and monitoring of compliance with production processes improves the quality of tillage, eliminates downtime, increases the operating time of machines and units through the use of GPS technologies.

4. Discussion

Resource conservation is a complex process consisting of many components. The results of studies of agricultural organizations in the Krasnodar Territory confirm that each farm has reserves that can reduce the level of resource costs for the production of agricultural products and obtain an additional effect per unit area. The organization of an effective accounting and control system makes it possible to find growth potential.

The use of resource-saving technologies in crop production is not always associated with the purchase of new agricultural machinery and units. First of all, it is necessary to focus on highly efficient seed material, crop rotations, compliance with agrotechnical measures, and economical use of available resources.

The introduction of modern resource-saving technologies for the production of agricultural products allows you to get a positive effect (Figure 1).

![Figure 2. Efficiency of implementation of resource-saving technology.](image-url)

A competent approach in the production of crop products, which takes into account the biological characteristics of crops, their interaction with fertilizers and pesticides, the impact of agricultural practices and agro-ecological conditions on their growth and development, as well as improving the
level of training of managers and specialists in agricultural production, will ensure the maximum realization of the biological potential of an agricultural plant.

5. Conclusions
The vector of development of modern agriculture is the transition to energy and resource saving, biologization and biofarming, which will provide the population with high-quality food, livestock-feed, and industry - raw materials. The withdrawal of the agricultural sector from the crisis and an increase in the level of import substitution is possible due to such areas as the use of resource-saving technologies and equipment, as well as ways to organize highly efficient agricultural production. The introduction of minimal and no-till technologies in the organization makes it possible to increase soil fertility, reduce the environmental burden and switch to a conservation mode of land use. The use of modern technologies requires efforts from both agricultural producers and the scientific community. Obtaining high yields of crop products, preserving and expanding the resource potential of agriculture for future generations should be based on evidence-based conservation methods of agricultural production.

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