

# Modernization of the Material and Technical Resources in Agriculture of Russia

Ivan M. Kulikov<sup>1,2</sup>, Ivan A. Minakov<sup>3,\*</sup>

<sup>1</sup>Federal Selection and Technology Center for Horticulture and Nursery, 4 Zagoryevskaya st., Moscow, 115598, Russia

<sup>2</sup>Russian Academy of Sciences, 32A, Leninsky prospect, Moscow, 119991, Russia

<sup>3</sup>Department of Economics and Commerce, Michurinsk State Agrarian University, 101 Internatsional'naya st., Michurinsk, Tambov Region, 393760, Russia

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**Abstract** The development of agriculture depends on the provision of material resources and technical means. The pursued state agrarian policy contributed to the strengthening of the material and technical resources of the industry but did not allow solving completely the problem of its modernization. The purpose of the present research is to assess the current status of the material and technical resources of agriculture in Russia and to substantiate the main courses of its modernization. The research was carried out using statistical-economic, computational-constructive, and monographic methods. Agricultural organizations are insufficiently provided with technical means and material resources that hinder using modern technologies. The available capacities for the production of agricultural machinery are not used fully, thus, 15.2% of available capacities are used for the production of tractors, 37.3% – for grain harvesters, 31.5% – for seeders, and 55.1% – for plows. A significant part of the material and technical resources is formed by imports. For some crops (vegetables, corn, sunflower, sugar beet, etc.), the share of imported seeds and hybrids ranges from 50 to 98%, crosses in the production of broilers amount to 95%, machinery – more than 40%. Purchasing material and technical resources are constrained by the increase of their purchase prices. Over 2014-2020, the average price of motor gasoline increased by 35.2%, diesel fuel – by 45.6%, insecticides – by 76.7%, combine harvesters – by 2.4 times, and milking machines and apparatuses – by 2.1 times. Modernization of the material and technical resources of

agriculture depends on factors, such as the development of industries producing means of production for the agro-industrial complex, the solvency of the agricultural sector, prices, import and export of material and technical resources, as well as state support.

**Keywords** Material and Technical Resources, Import, Export, Leasing, State Support, Agricultural Organizations, Russia

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## 1. Introduction

The production of agricultural products and their economic efficiency depend on the provision of agriculture with material resources and technical means, i.e. the development of the material and technical base of the industry since exactly the latter determines the level of production intensity and the ability to use modern technologies. The low level of equipment availability does not allow timely and high-quality performance of all agrotechnical works and the lack of high-quality seeds and breeding livestock and poultry, fertilizers, chemical plant protection products do not allow intensive agricultural production. This hinders the development of agricultural production. As a result of non-compliance with the optimal timing of agronomic measures, a significant part of the products is lost annually. Excess equipment leads to its

irrational use, which increases production costs. However, agricultural organizations are insufficiently provided with modern equipment. Thus, the availability of tractors is 38.9%, grain harvesters – 47.2%, and forage harvesters – 48.6% [1].

Increasing the state support for agricultural producers and enterprises manufacturing means of production for the agro-industrial complex contributed to the strengthening of the material and technical resources of the industry, whose significant part, however, is formed by imports. The strengthening of the material and technical base made it possible for many types of agricultural products and food to reach the threshold value of food independence indicators provided for in the Food Security Doctrine of the Russian Federation. So, in 2020, the level of self-sufficiency in vegetable oil, which is determined as the ratio of products produced in the country to their domestic consumption and is expressed as a percentage, was 195.9% with a threshold value of 90%, grain, respectively, 167.6 and 95%, sugar, 99.9 and 90%, meat and meat products (in terms of meat) – 99.4 and 85% [2]. Production of these items was based on a wide use of imported means of production (seeds, breeding material, chemicals, machinery, etc.) [3, 4]. Consequently, the problem of import substitution in industries, producing means of production for agriculture under international sanctions yet has not been solved.

The purpose of the present study is to assess the current state of the material and technical resources of agriculture and substantiate the main courses of its modernization. To achieve this goal, the following tasks have been solved: trends and factors of the material and technical base development in agriculture have been identified, the level of provision of agricultural organizations with material resources and technical means has been analyzed, and priority directions for the modernization of the material and technical base of the industry have been proposed.

## 2. Methods

The methodological approach of the study was based on the achievements of economic science, set out in the works of scientists concerning the development of the material and technical resources in agriculture [1, 5, 6]. In the course of the research, an integrated approach was used, emphasizing the simultaneous coverage of all elements of the phenomenon under study, the analysis of cause-and-effect relationships between them, and allowing substantiating methods and techniques for a comprehensive solution of the problem under consideration. In particular, the authors analyzed individual economic indicators in their interrelation and interdependence with the general development level of the material and technical resources and justified the courses of its modernization.

When conducting the research within the framework of the stated topic, statistical-economic, computational-constructive, and monographic methods were used. The statistical-economic method allows comprehensively characterizing the studied economic phenomenon based on big data analysis. To analyze the state and development trends of the material and technical base, the authors conducted a statistical observation involving the collection, processing, and analysis of initial information, and the development of specific measures based on the data obtained. At that, the following techniques were used: comparison, dynamic series, absolute and relative values, indices, and theoretical generalization. The monographic method was used to study the performance of advanced agricultural producers in the modernization of their material and technical base. The computational and constructive method was used to substantiate the main directions in forming and developing the material and technical resources for further extension.

The study used official data from Rosstat and the Ministry of Agriculture of Russia on the development of the material and technical base of agriculture for 2014-2020, the State Program on Agribusiness Development and Regulation of Farm Produce, Raw Materials and Foodstuffs Markets, the Food Security Doctrine of the Russian Federation, Strategies for the development of agricultural machinery in Russia for the period up to 2030, as well as scientific articles on the research topic.

## 3. Results

In the State Program on Agribusiness Development and Regulation of Farm Produce, Raw Materials, and Foodstuffs Markets, much attention is paid to the modernization of agribusiness. Its implementation contributed to the renewal of technical means, the construction of modern livestock and greenhouse complexes, the laying of intense gardens, the chemicalization of the industry, that is, the strengthening of the material and technical base (Table 1). The production capacity of premises for the maintenance of cattle and poultry farms is increasing at a faster pace. For 2014-2019 the commissioning of premises for cattle increased by 32.4 thousand cattle stalls, or by 31.1%, egg poultry plants – by 1966.5 thousand places, or by 9.7 times, meat poultry farms – by 149.3 mln heads of poultry, or by 14.4 times. State support for the material and technical base development of the animal husbandry allowed solving the problem of providing the country's population with pork and poultry meat, but not providing it with milk and beef according to rational nutrition standards. Therefore, at the present stage, the state needs to pay more attention to the development of dairy and beef cattle breeding.

**Table 1.** Development of the material and technical resources of agricultural organizations in Russia

Indicators	2014	2015	2016	2017	2018	2019
Availability of technical means, thousand pieces:						
tractors	247.6	233.6	223.4	216.8	211.9	206.7
plows	67.8	64.1	61.6	59.7	58.5	56.9
cultivators	97.8	93.2	90.3	87.6	84.8	82.6
seed drills	100.7	93.6	87.8	82.8	79.0	74.8
harvesters-threshers	64.6	61.4	59.3	57.6	56.9	55.0
potato harvesters	2.4	2.3	2.2	2.1	2.0	2.0
beet harvesters	2.4	2.2	2.2	2.2	2.1	2.1
irrigation machines and units	5.7	5.9	6.0	6.2	6.1	6.4
milking units	26.2	25.1	24.1	22.9	22.4	21.9
Energy generating capacities - total, mln hp	97.4	94.2	92.3	90.2	90.3	89.7
Commissioned premises, thousand cattle stalls	104.1	102.6	120.7	275.1	145.4	136.5
for pigs	1,322.4	877.2	775.7	1,335.2	567.9	970.3
Commissioned poultry farms						
Egg farms, thousand laying chickens	224.4	248.0	1,420.2	845.0	1,546.1	2,190.9
Meat chickens, mln heads per year	11.1	11.0	35.5	121.8	56.8	160.4
Mineral fertilizers applied, mln tons of application rates	1.9	2.0	2.3	2.5	2.5	2.7
Liming of acidic soils, thousand ha	254.4	238.2	222.0	239.9	292.0	303.6

Source: Compiled according to Rosstat

The measures, taken by the state for technical modernization, did not ensure an increase in the number of tractors, machines, and instruments of production in agricultural enterprises but only reduced the rate of their reduction. In 2014-2019, the tractor fleet in agricultural enterprises decreased by 16.5%, grain harvesters, respectively, by 14.8%, potato harvesters – by 16.7%, and beet harvesters – by 7.9%. The coefficient of disposal for most types of equipment exceeds the coefficient of renewal, which means less receipt of equipment than its final disposal. For example, the renewal rate of beet harvesters is 3.8%, and the retirement rate is 5.6%, for seeders these figures are 2.9 and 5.0%, respectively. The coefficients of renewal of grain and potato harvesters are higher than their retirement rate. According to the Ministry of Agriculture of Russia, the average age of a tractor is 19 years; 59% of tractors and 45% of combines, used in agriculture are over 10 years old. Depreciation of fixed assets of agriculture exceeds 40%.

By 2025, considering budget support, the state program provides for bringing the renewal of tractors in agricultural organizations to 3.4%, grain harvesters – to 5.2%, forage harvesters – to 4.8% [7]. The indicators of technical modernization, provided for in the program, are mostly fulfilled, but high depreciation of agricultural machinery contributes to the growth of its disposal, and, consequently, hinders the process of strengthening the technical base.

The acquisition of energy-saturated equipment by large agricultural holdings did not allow stabilizing energy

capacities in agricultural enterprises, although the share of this equipment in the structure of technical support has increased. During the period under review, the energy capacity in agricultural enterprises decreased by 7.9%. The achieved level of energy capacity (80 hp per employee) and energy security (198 hp per hectare of crops) do not meet the requirements of modern technologies, which hinders their use [8].

Changes in the quantitative composition of the machine and tractor fleet of agricultural enterprises affected their provision of equipment (Table 2). Over 2014-2019, the tractor fleet per thousand ha of arable land decreased from 3.4 to 2.9 pcs., the number of combine harvesters per thousand ha of crops decreased from 2.5 to 2.3 pcs., potato harvesters – from 17.2 to 14.7 pcs., and beet harvesters – from 3.0 to 2.1 pcs. As a result, the load per unit of land area has increased. Thus, the arable land area per tractor increased from 290 to 345 ha, crops (planting) per one harvester-thresher – from 408 to 437 ha, per potato harvester – from 58 to 68 ha, and per beet harvester – from 337 to 478 ha. The reduction of machinery per unit area of land and the increase in its load on the tractor and agricultural machinery is to a certain extent due to the replacement of the old less productive machinery with new high-performance ones.

Technical security varies by agricultural enterprises. Large enterprises with a higher level of state support are better provided with equipment and machinery, while small enterprises that have difficulties in carrying out

agrotechnical works in optimal terms are worse provided with the equipment.

The modernization of the material and technical base of agriculture is influenced by factors such as the level of development of industries manufacturing means of production (tractor and agricultural machinery, production of mineral fertilizers and plant protection products, seed production, livestock breeding, etc.), the solvency of the agricultural sector, prices, import and export of material and technical resources, as well as state support. These are factors that determine the supply and demand for material and technical resources, and, consequently, their acquisition by agricultural enterprises (Table 3). Over 2014-2019, the purchase of mineral fertilizers increased by 39.3%, plant protection products – by 24.2%, tractors – by 1.9%, and roller harvesters – by 19.9%. At the same time, the purchase of motor gasoline decreased by 15.6%, grain harvesters – by 19.2%, forage harvesters – by 27.0%,

potato harvesters – by 33.3%, beet harvesters – by 19.4%, milking machines, and aggregates – by 36.5%.

Difficulties with the purchase of material and technical resources are caused by the increase in their purchase prices. Over 2014-2020, the average price of motor gasoline, purchased by agricultural enterprises increased from 38,774 to 52,429 rubles/ton, or by 35.2%, diesel fuel – from 33,006 to 48,063 rubles/ton, or by 45.6%, insecticides – from 1,408 to 2,488 rubles/kg, or by 76.7%, grain harvesters – from 4,606.8 to 11,364.6 thousand rubles/piece, or 2.4 times, swatheгы – from 942.4 to 2,093.6 thousand rubles/piece, or 2.2 times, milking machines and aggregates – from 993.5 to 2,093.6 thousand rubles/piece, or 2.1 times. Purchase prices for other materials and technical resources have also increased. To a large extent, the price increase is due to the devaluation of the ruble, since a large number of imported products enter the domestic market [9, 10].

**Table 2.** Technical provision of agricultural organizations in Russia

Indicators	2014	2015	2016	2017	2018	2019
The number of tractors per thousand ha of arable land, pcs.	3.4	3.2	3.1	3.0	3.0	2.9
The arable land area per tractor, ha	290	308	320	328	337	345
The number of combines per hundred ha of crops, pcs.:						
combine harvesters	2.5	2.4	2.4	2.4	2.4	2.3
potato harvesters	17.2	14.9	15.4	16.7	14.7	14.7
beet harvesters	3.0	2.5	2.4	2.3	2.2	2.1
The crops area per one combine harvester, ha						
grain harvester	408	422	425	427	424	437
potato harvester	58	67	65	60	68	68
beet harvester	337	396	423	465	456	478

Source: Compiled according to Rosstat

**Table 3.** Acquisition of material and technical resources by agricultural enterprises of Russia

Indicators	2014	2015	2016	2017	2018	2019
Motor gasoline, thousand tons	772.8	810.8	775.1	739.8	735.0	652.5
Diesel fuel, thousand tons	4,270.3	4,274.3	4,258.4	4,287.5	4,306.5	4,223.4
Mineral fertilizers, thousand tons	2,502.3	2,633.9	2,950.3	3,170.8	3,125.1	3,485.9
Plant protection products, thousand tons	55.8	55.9	62.2	66.7	64.9	69.8
Tractors, pcs.	7,666	1,008	7,372	7,805	7,205	7,814
including tractors under federal leasing	1,803	803	1,055	786	297	1,360
Combines, pcs.:						
grain harvesters	3,359	3,254	3,914	3,686	3,186	2,714
fodder harvesters	684	574	665	635	566	499
potato harvesters	108	90	70	84	84	72
including combines under federal leasing	701	1,076	1,356	510	367	1,384
Beet harvesting machines, pcs.	98	95	167	152	124	79
Roller harvesters, pcs.	1,145	1,142	1,311	1,528	1,203	1,373
Milking machines and units, pcs.	999	1,029	747	687	627	634

Source: Compiled according to Rosstat

## 4. Discussion

During the analyzed period, agricultural enterprises increased the purchase of mineral fertilizers, which ensured an increase in the application of mineral fertilizers per hectare of crops from 40 to 61 kg, or by 52.5%, and increased the share of the area with mineral fertilizers, applied in the entire area, from 47 to 61%. However, 39% of the sown area is not fertilized, although mineral fertilizers are produced in the country in sufficient quantities with a trend of further growth of their production. In 2014–2019, the production of mineral fertilizers (with reference to 100% of nutrients) increased from 19.7 to 23.7 mln tons, or by 20.3%. About 25% of the produced mineral fertilizers were delivered to the domestic market, most of them were exported. The existing state support for agriculture does not stimulate the use of mineral fertilizers in small and medium-sized businesses.

The domestic market of petroleum products allows fully meeting the needs of agricultural producers. In 2019, 39.9 mln tons of motor gasoline were produced, of which 34.8 mln tons or 87.2% of the total volume was delivered to the domestic market, diesel fuel – 78.4 and 38.2 mln tons, respectively, or 48.7%. Agricultural enterprises purchased 652.5 thousand tons of gasoline, which is 1.9% of domestic consumption, and 4,223.4 thousand tons of diesel fuel, or 11.1% of the volume, sold on the domestic market. With the increase in prices for petroleum products, the purchase of gasoline in the country decreased, while the purchase of diesel fuel stabilized at the level of 4.2–4.3 mln tons. In foreign countries, a decrease in oil prices causes a reduction in prices for petroleum products. In Russia, the tax policy, aimed at forming the budget, does not allow this to be done.

The problem of providing agricultural producers with seeds of crops in Russia is quite acute. According to the Ministry of Agriculture of Russia, 11 mln tons of seeds were sown in 2019. The share of seeds of domestic selection amounted to 62.7%. The Doctrine of Food Security of the Russian Federation states that the threshold value for seeds of the main crops of domestic selection is at least 75%.

However, when sowing and planting many agricultural plants, imported seeds are used, and for some crops, dependence on seed imports is critical. Thus, the share of imported seeds and hybrids of sugar beet is 98%, sunflower – 56%, including that sown for grain – 77%, for silage – 19%, spring rape – 69%, vegetable crops – more than 50%, corn – 49%, and potatoes – 80%. State support is provided to seed farms, which is aimed at creating and implementing into production domestic varieties of the most import-dependent crops.

Horticulture development is also strongly dependent on imported planting material. Every year, 45.0 mln seedlings of fruit and berry crops (excluding strawberry seedlings) are used for laying orchards and berry bushes, of which about 20 mln are imported seedlings. State support to nursery breeding is provided in the form of reimbursement

of part of the costs of laying fruit nurseries and uterine plantings. However, the existing financial support does not allow increasing the production of planting material and solving the problem of import substitution in the industry [11, 12].

The development of poultry and cattle breeding in Russia is largely determined by imported pedigree material. For example, the share of imported crosses in the production of broilers exceeds 95% [13]. Significant state support for seed production and livestock breeding is provided within the framework of the Federal Scientific and Technical Program for the Development of Agriculture 2017–2025. The purpose of this program is to ensure stable growth in the production of agricultural products obtained through the use of seeds of new domestic varieties and pedigree stock (material). It is planned to reduce import dependence through the use of technologies for producing original and elite seeds of the highest categories by 30%, and production technologies of breeding material – by 20%. However, implementing this program will not allow solving the problem of import substitution in the production of seeds and pedigree material.

The provision by agricultural machinery largely depends on the volume of its production and competitiveness, as well as effective consumer demand. In recent years, in Russia, the production of most types of agricultural machinery has declined. Thus, in 2016–2019, the output of tractors decreased by 14.1%, seeders – by 6.6%, cultivators – by 16.3%, grain harvesters – by 21.3%, and milking machines – by 34.2%. However, the existing capacities for the production of agricultural machinery are not fully used. Tractor production capacities are used by 15.2%, grain harvesters – by 37.3%, seeders – by 31.5%, plows – by 55.1% [14]. The development of domestic agricultural machinery in the context of high competition in the domestic market of technical resources is possible only with state support.

The main amount of subsidies is allocated to large companies. In 2019, more than 70% of the budget funds were allocated to three plants, namely, 45.2% – to Rostselmash Combine Plant LLC, 15.8% – to St. Petersburg Tractor Plant JSC, and 10% – to CLAAS LLC. The allocated funds of state support do not allow competing on an equal footing with foreign producers in the domestic market.

Leasing is important in providing agricultural producers with equipment. In 2020, Rosagroleasing JSC supplied 9,723 units of machinery and equipment worth 38.5 bln rubles to farmers. Thus, compared to 2018, the volume of supplies of agricultural machinery increased almost twice. The leasing mechanism for supplying agricultural producers with machinery is effective and will be developed further.

The Russian market of agricultural machinery is highly dependent on imports, whose share is more than 40%. The main supplier of imported equipment is the Republic of Belarus. The equipment, produced by the CLAAS, John Deere, and Case New Holland companies is also in demand

in the domestic market. The listed foreign companies have their localized assembly plants in Russia. Among the domestic equipment, the machines of Rostselmash Combine Plant LLC and St. Petersburg Tractor Plant JSC predominate in the Russian market. In the tractor segment, the most popular is the machinery of the Minsk Tractor Plant (56%), the St. Petersburg Tractor Plant (17%), and John Deere (12%). Among the grain harvesters, the most popular are those produced by Rostselmash (58%), Gomselmash (14%), CLAAS (11%), and John Deere (10%). The main buyers of foreign machinery are large agricultural enterprises.

The Strategy for the Development of Agricultural Machinery in Russia for the period up to 2030 states that it is necessary to increase the share of domestically produced machinery in the domestic market to 80%. For this purpose, it is planned to increase the production of agricultural machinery in monetary terms to 300 bln rubles, or by three times, increase utilization of production capacities to 80-90%, or by two times, as well as export of domestically produced machinery – to 100 bln rubles or almost 10 times. Besides, it is planned to increase investment in R&D to 10 bln rubles [15].

One of the priorities of domestic agricultural machinery building is the export of machinery. It is planned to export one-third of the agricultural machinery produced domestically. Currently, this figure is 12%. Russia exports agricultural machinery mainly to near-abroad countries. The increase in exports will become the driver of the development of the domestic machinery-producing industry.

## 5. Conclusions

Modernization of the material and technical base of agriculture depends on factors such as the development of industries, producing means of production for the agribusiness, the solvency of the agricultural sector, prices, import and export of material and technical resources, as well as state support. Imported material and technical resources are widely used in the production of some types of agricultural products (sugar beet, sunflower, vegetables, poultry meat, etc.). Providing agricultural organizations with material resources and technical means based on import substitution will contribute to the development of seed production, livestock breeding, domestic agricultural machine-building, and state-supported agricultural leasing, and increasing the effective demand of commodity producers.

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