Material and technical base of agriculture of the Krasnodar territory: composition, state and prospects of development

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Abstract. The author’s scheme of the system of resource potential of agricultural production is justified, in which the place and role of its material and technical base are determined. The analysis of the provision of agricultural producers of the Krasnodar territory with land resources, structures for various purposes, machinery, equipment, and the main types of farm animals and poultry is performed. The trends in the development of technical base of crop production in the region, including the formation of combine hi-tech fleet by private producers, increase the proportion of tractors with a high power class and a tilling machines operating, vehicle equipment with sensors and attachments that allow performing elements of precision agriculture technology. An extremely low level of development of the material and technical base of animal husbandry was established and directions for its improvement was identified.

1. Introduction

The level of development of agriculture in the country largely depends on the implementation of the import substitution program and ensuring its food security and independence in the face of sanctions pressure from Western countries. The volume and efficiency of agricultural production is largely determined by the state of the material and technical base of the industry, which should be maximally adapted to regional conditions of placement and individual characteristics of specific producers. During the period of market reforms of the agricultural sector of the economy, its material and technical base has undergone significant negative quantitative and qualitative changes. In the last 10-15 years, with the arrival of large capital in national agriculture, it was possible to stop the destructive processes in the formation of the material and technical base and ensure its renewal mainly in the most profitable agricultural sub-sectors, which allowed the country to increase significantly the production of grain, sunflower, sugar beet, pork and poultry. At the same time, most producers continue to experience difficulties in forming and updating their material and technical base, there is a strong dependence on imported seed material for certain agricultural crops and highly productive breeds of animals of foreign selection, and a significant part of machinery and equipment is still being operated beyond the terms of their standard use, which leads to an increase in the unit cost of resources, reduction of production efficiency and competitiveness of agricultural products in the national and foreign markets. Innovative transformation of the material and technical base of national agriculture, including automation, robotization, creation and development of software and technical means of digitalization in the management and organization of production processes in the industry, requires significant capital expenditures, which is very difficult in conditions of limited financial resources, high prices and risks of attracting debt capital and insufficient state support.
2. Methods and materials
When performing this research, we used data on the state of the material and technical base of agriculture in the Krasnodar territory, which are publicly available, as well as the results of the author’s own research. The research used such methods as monographic, abstract-logical, analysis and synthesis, statistical, graphical and modeling.

3. Results
Figure 1 shows the author’s diagram of the structure of the resource potential of modern agriculture, including groups of natural and biological, financial and labor resources; the material and technical base of the industry, represented in turn by the main and current production funds, including material objects of living and inanimate nature; as well as databases of industry technologies adapted to the soil and climatic conditions of the location of producers, human capital, modern scientific and technical developments in the field of informatization and digitalization of activities, as a special resource for the development of national agriculture, which can provide significant innovative transformations of the industry [1, 2].

![Resource potential of agriculture diagram](image)

Different soil and climatic conditions on the territory of the Krasnodar territory largely determined the different concentrations of agricultural land and formed on this basis the areas of specialization of agricultural producers in various agro-climatic zones of the region.

Thus, more than 75% of arable land in the Krasnodar territory is located in its Northern and Central zones, which currently produce 85-87% of grain, sunflower and sugar beet in the region. Hayfields and pastures are placed extremely uneven in the territory – 183.6 thousand ha, or 72% of all of their area is located in the southern foothill zone, which forms a good resource base for the production of cheap green fodder with the organization of grazing in the warm season in this part of the region. The largest share in the structure of the area of perennial plantings is the Anapa-Taman zone, which produces about 90% of all grapes in the region.

The analysis showed that in 1990-2018, the number of vehicles in the main types of agricultural organizations in the Krasnodar territory decreased from 3 to 15 times as part of the machine and tractor fleet (MTF) (table 1). So, at present, these enterprises have 17.4 thousand tractors and 3.4 thousand combine harvesters.
Table 1. Availability of agricultural machinery of the main types in agricultural organizations of the Krasnodar territory, thousand units.

| Main types of agricultural machinery | 1990 | 2000 | 2010 | 2019 | 2019 in % to 1990 |
|-------------------------------------|------|------|------|------|------------------|
| Tractors                            | 60.4 | 40.8 | 20.9 | 17.4 | 28.8             |
| Ploughs                             | 25.5 | 13.1 | 6.0  | 4.7  | 18.4             |
| Harrows                             | 127.5| 36.1 | 15.2 | 7.8  | 6.1              |
| Seeders                             | 24.7 | 13.9 | 6.6  | 4.7  | 19.0             |
| Grain combine harvesters            | 14.0 | 6.8  | 3.2  | 3.4  | 24.2             |
| Forage harvester                    | 4.1  | 2.8  | 0.8  | 0.4  | 9.7              |

At the same time, the reduction in the composition of MTF in agricultural organizations in the region was accompanied by an increase in the productivity of used equipment, as well as the formation of a large number of peasant farms in the region with their own machine and tractor fleet, comparable in quantitative composition to the indicators of agricultural organizations.

During the period of market reforms in the agricultural sector of the economy, the number of farm animals and poultry in the region decreased sharply (table 2).

Table 2. Livestock of farm animals and poultry in the Krasnodar territory, thousand heads.

| Animal and bird species | 1990  | 2000  | 2010  | 2019  | 2019 in % to 2000 |
|-------------------------|-------|-------|-------|-------|-------------------|
| Cattle                  | 1778.1| 920.6 | 649.0 | 538.8 | 30.3              |
| Sheep and goats         | 829.6 | 117.2 | 151.5 | 212.2 | 25.6              |
| Birds                   | 29905.0| 17854.7| 22003.9| 25930.0| 86.7              |
| Pigs                    | 2966.9| 1531.9| 1000.9| 626.9 | 21.1              |

During the period under review, the number of pigs, sheep, goats, and cattle declined most rapidly. The number of cattle in farms of all categories of the region decreased from 1778.1 to 538.8 thousand heads or by 69.7 %, the number of pigs decreased by 5 times, and sheep and goats – by 4 times.

The current level of technical and technological development of individual sub-sectors of national animal husbandry is significantly different, while the least developed sub-sectors are meat cattle and sheep breeding [3]. However, the number of sheep and goats in the region is gradually recovering. Currently, farms of all categories contain 212.2 thousand heads of these farm animals, which is already twice as much as in 2005. At the same time, the sub-sector requires more active implementation of modern achievements of scientific and technological progress, in the absence of which it is difficult to ensure the necessary profitability of production.

The number of cattle in the Krasnodar territory is mainly represented by dairy breeds, which hinders the development of specialized meat production of this type of animal, and the existing high growth rates of dairy productivity of cows in agricultural organizations in the region do not compensate for the decrease in their number and do not ensure an increase in milk production.

Despite the significant economic advantages of pig farming over other types of meat, including higher fecundity and precocity of animals, which, in turn, provides a shorter return on investment in the development of this sub-sector of animal husbandry, the number of pigs in the region is still declining.

The structure of placement of warehouses and storage facilities in agricultural organizations and peasant farms in various agro-climatic zones largely corresponds to their specific weights in the volume of agricultural production (figure 2).
Thus, 80-95% of these production facilities are located in the Northern and Central zones of the region with the most developed crop and livestock production. At the same time, when updating storage facilities at an average rate of 13-15% per year, innovations are not used enough, and currently only 6.5% of grain storage facilities and 5% of mineral fertilizer storage facilities are equipped with automatic process control systems. This indicator is significantly lower for warehouses and other types of storage. Calculations also show that as a result of the reduction in the number of farm animals in many agricultural organizations, storage facilities in animal husbandry are not fully loaded.

Currently, the area of hotbeds and greenhouses in the Krasnodar territory is about 12 million square meters, which are located in agricultural organizations (18.7%), peasant farms (14.5%) and households (66.8%). The production of protected ground vegetables in agricultural organizations in the region is characterized by a relatively high technical and technological level of development, in which more than 80% of greenhouses use technologies for growing vegetables using hydroponics, and 66% are equipped with automated control systems for the implementation of production processes. In other categories of farms, these innovations are not used in the region.

4. Discussion
The basis of the resource potential of agriculture is its material and technical base, which is an independent organizational and economic system, the elements of which are the land as the main factor of production activity, which largely ensures the targeted impact of live and materialized labor with the use of advanced scientific and technological progress to obtain competitive agricultural products, farm animals and poultry, systems of machinery and equipment for mechanization, automation and robotization of production processes in crop and livestock production, buildings and structures, as well as material and technical resources, including mainly seed material, fertilizers, plant protection products, feed and work in progress. The dimensional and structural characteristics of all these elements should be maximally adapted to the individual characteristics of a particular commodity producer, which ensures timely and high-quality performance of all production processes with minimal specific resource costs and high output of finished products per unit of land area.

Areas of specialization, the size and structure of land resources of specific producers are the most important information when justifying their needs for production facilities, structures, agricultural machinery, equipment, and other fixed and current production assets. However, the rational size of land use of newly created agricultural enterprises and complexes when they are reorganized, merged or separated is also the subject of scientific economic justification. In recent years, the region has seen a trend of consolidation of agricultural production, in which over the past 5 years the average size of their land use has increased by 20-25% and in 2020 amounted to about 5400 and 85 hectares, respectively, for agricultural organizations and peasant farms. At the same time, the rational size of land use...
for various organizational and legal forms of management should ensure the best return on the scale of production with the maximum possible efficiency of resource use.

The active part of the material and technical base in crop production is represented by the machine and tractor fleet, the quality of which largely determines the efficiency of production in the sub-sector, and in animal husbandry – the number of the main herd of farm animals and poultry, as well as systems of machinery and equipment for technical equipment of livestock farms and poultry farms.

The nomenclature and quantitative composition of the MTF shall be determined taking into account price and the technical and operational characteristics presented in the market of means of mechanization, areas of specialization, specific producers, the size of the adopted land use and agricultural technologies, which in turn must be adapted to climatic and soil conditions of the locations of production facilities in crop production.

Currently, advanced domestic agricultural organizations invest heavily in equipment due to the formation of a private high-tech harvester fleet to ensure timely cleaning of large amounts of crops while reducing production losses to a minimum, increase the proportion of tractors with a high power class and replace single-purpose tilling machines multi-purpose wide, running 5-6 different technological operations for one pass of the equipment in the field, which generally provides, significant reduction in the need for the number of power machines and agricultural machinery aggregated with them, equipping combines and machine-tractor units with sensors and attachments for field mapping, navigation and parallel driving, differentiated fertilization, selective use of protective equipment and implementation of other elements of precision farming technology.

At the same time, more than half of the fleet of agricultural machinery in the Krasnodar territory is represented by machines that have developed their depreciation resource and are operated beyond the period of standard use. Therefore, it is necessary to speed up the pace of updating the machine and tractor fleet of agricultural producers in the region.

While agricultural producers with small size of land tenure, which invest in building their own MTF, it is not always economically feasible, they should instead develop mechanisms of cooperation for joint collective acquisition and use of most expensive farm equipment that will allow each party to save on capital investment in technological modernization of its production activities. When creating such cooperatives or forming a network of machine and tractor stations (MTS) that provide paid services to agricultural producers for performing mechanized field work, it is also important to economically justify the size and structural characteristics of the material and technical base of these objects, the scheme of their territorial location with the boundaries of service zones in relation to a specific region.

According to the level of development of the material and technical base, domestic animal husbandry significantly lags behind crop production. Thus, more than 80% of equipment on livestock farms is operated beyond the terms of standard use, the rate of its renewal, as a rule, does not exceed 2-3% per year instead of the 12-15% necessary for normal reproduction, and the dependence of commodity producers on imports of machinery and equipment for mechanization of production processes in animal husbandry is about 90% [4].

For technical and technological modernization of animal husbandry in Russia, it is necessary to purchase modern automated and robotic equipment for most farms to carry out the processes of preparing and distributing feed, milking animals, cleaning manure with subsequent preparation of high-quality organic fertilizers based on it, regulating the microclimate in livestock premises and performing other operations with minimal participation of live labor [4]. As a result of the collapse of domestic specialized agricultural machinery in the post-reform period, there is practically no competitive domestic equipment for equipping livestock farms on the domestic market, and the presented foreign analogues are offered at prices 1.5-2 times higher, which multiplies the need for investment in the implementation of technical and technological modernization of the industry.

At the same time, as economic calculations show, for the return on investment in the purchase of expensive imported equipment for equipping livestock farms, as a rule, there is not enough economic effect in the amount of savings in workers’ wages generated as a result of increasing productivity and
replacing part of live labor with machine labor. Therefore, the implementation of programs for technological re-equipment of livestock farms and complexes should also ensure the saving of all production resources, a significant increase in animal productivity to create an economic effect sufficient to return large capital investments in a time acceptable at the current price of invested capital in the industry.

Agriculture has traditionally been classified as an industry with a lower level of technical and technological development compared to other areas of economic activity, which has largely shaped the attitude to work in agriculture as heavy, monotonous and intellectually meaningless. At the same time, with the creation and development of labor-saving technologies and technical means of their implementation, including digital, intelligent and robotic systems, working conditions in the industry should significantly improve [5]. As the level of robotization and automation of production processes in agriculture increases, labor productivity will increase, which will inevitably lead in the future to the gradual release of a large number of workers, for whom professional retraining and alternative jobs should be provided by this time.

A necessary condition for the technical and technological development of agriculture in the region based on the development of innovations in the field of automation and robotization of production is the widespread use of the high-speed Internet network, to which only 80.2% of agricultural organizations and 27% of peasant farms in the Krasnodar territory currently have access. At the initial stage of digitalization of agriculture, it is important to ensure the widespread use of precision agriculture technologies in the region, which are currently used by only 14.3% of agricultural organizations and less than 2% of peasant farms.

The widespread adoption of automated and robotic technologies by commodity producers is a necessary condition for further innovative development of domestic agriculture, which provides for the transition to a production method based on digitalization of all sectors and processes in the domestic agro-industrial complex [6].

5. Summary
To increase the volume and efficiency of production in domestic agriculture, it is necessary, first of all, to increase and develop the most lagging elements of its resource potential that hinder the implementation of the import substitution program to achieve the threshold values of the country’s food security doctrine, including increasing labor productivity, energy and resource conservation, increasing crop yields and animal productivity to the level of agriculture in economically developed countries. It is possible to solve these problems only on an innovative basis with the subsequent digitalization of the entire domestic agro-industrial complex, including the widespread use of robotics, artificial intelligence, the Internet of things and other digital and intelligent technologies in production activities. All this will contribute to serious innovative transformations of the material and technical base of the industry, mainly related to its active part – the machine and tractor fleet and equipment for equipping livestock farms, which will create the basis for a technological breakthrough in the agro-industrial complex.

6. References
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