Monitoring the use of mineral fertilizers in rural areas of the region

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Abstract. The article reviews the main approaches to the use of fertilizers in agricultural production. A discussion about the advantages and disadvantages of the use of mineral fertilizers in rural areas within the framework of the provisions of sustainable development and the concept of green economy has been revealed. On the example of the Russian Federation and rural territorial economic systems, using monitoring tools, the dependence of wheat yield on the use of mineral and organic fertilizers was studied. The continuing importance of mineral fertilizers in matters of ensuring the food security of the world community has been established.

1 Introduction

The global tasks of providing food to the rapidly growing world population, achieving the parameters of food security of states and territories necessitate increasing the production volumes of the agrarian economy, using all resources and potentials to increase the efficiency of economic activity in rural areas. The conditions of modern economic uncertainty have stimulated an increase in demand for crop production, and above all wheat (Russia is the largest importer). In this regard, in a number of states, the possibilities of additionally increasing their own production of wheat are currently being studied [1]. Undoubtedly, these trends will manifest themselves in the positive dynamics of the production and consumption of mineral fertilizers, which, along with organic fertilizers, are designed to restore soils depleted during the operation of agricultural land and increase their biological activity. We can assume that modern agriculture is based on an understanding of the cycle of chemicals and nutrients that ensure the fertility of agricultural land and the yield of cultivated crops.

The structure of world consumption of mineral fertilizers is made up of nitrogen fertilizers - about 56%, phosphorus fertilizers - 24%, potash fertilizers - 20% [2]. In addition to the Russian Federation, China, the USA and India are the largest producers of mineral fertilizers. Currently, there is a tendency to increase the consumption of mineral fertilizers, primarily in the developing countries of Asia, South America and Africa. For many years, a significant share of the Russian Federation's exports has been determined by foreign supplies of mineral fertilizers (USD 12.5 billion in 2021). The largest consumers of...
Russian mineral fertilizers in recent years have been Brazil, China, the USA, Poland, Finland - countries with highly developed agricultural production.

It should be noted that at present the principles of the concept of sustainable development have been adopted and are being implemented by the world community [3]. Considerable popularity in the broad public circles of individual countries has received the theme of the "green" economy. The public demand manifested itself in the discourse observed in the scientific community about the environmental damage to rural areas caused by the use of mineral fertilizers. Thus, the scientific community was divided, on the one hand, into adherents of predominantly organic (environmentally friendly) farming, on the other hand, into followers of the traditional combination of mineral and organic fertilizers in crop production.

The scientific literature provides examples of the positive impact on the productivity and consumer properties of various crops from the use of organic fertilizers. At the same time, there is a higher efficiency of using mineral fertilizers, along with their higher cost [4]. Thus, in some years, the cost of purchasing mineral fertilizers from Russian producers exceeded 25% of the cost of wheat [5]. Noteworthy is the position of those researchers who believe that increasing the culture of agriculture [6], including through the combined use of mineral and organic fertilizers, ensures high yields and resistance to diseases of crops [7].

Contributing to the scientific discussion, the authors of this article set themselves the task of considering in dynamics the dependence of crop yields on the use of mineral and organic fertilizers in order to identify the economic benefits from their use.

2 Materials and methods

As an analytical basis for the study, a set of agricultural organizations of the Russian Federation and the Perm Territory, specializing in the cultivation of wheat, was considered. The choice of this crop is due to its importance in the agricultural production of Russia - in the structure of sown areas, its share exceeds 60% [8]. The indicators for 2000-2019 were interpreted (in terms of the gross wheat harvest in 2000-2021). The choice of the time interval of observations was due to the period of reforming the agrarian sector of the Russian economy and the restoration of agricultural activities in the rural areas of the country. Correlation coefficients were used as an assessment tool in order to correlate between wheat yield and the application of mineral and organic fertilizers for the study period.

3 Results

We propose to analyze the main indicators of wheat production in the Russian Federation and the Perm Territory.

Figure 1 shows the dynamics of the gross wheat harvest in 2000-2021.

The content of Figure 1 allows us to trace diametrically opposite trends in wheat cultivation in the Russian Federation and the Perm Territory.

Among the reasons for the steady decline in this indicator in the Perm Territory are the region's location in the zone of risky farming, the unprecedented large-scale liquidation of agricultural enterprises and a sharp decline in the number of people employed in the agricultural sector of the economy, miscalculations in the activities of regional agricultural authorities.

In the period under study, we can state the positive dynamics of the use of mineral fertilizers in the agricultural sector of the Russian economy, associated primarily with stable demand in the global market (Figure 2).
At the same time, the agricultural enterprises of the Perm Territory slightly increased the values of this indicator by the end of the period under review and significantly lagged behind the all-Russian indicators. At the same time, the world's largest producer of potash fertilizers operates in the region.

A positive trend in 2000-2018 is also evident in the use of organic fertilizers (Figure 3).
At the same time, from figure 3 we also see a significant lag of the Perm Territory from the average Russian indicators.

Let's trace the relationship between the level of fertilizer use and wheat yield on the results of comparing the indicators of the Russian Federation and the Perm Territory (Figure 4).

Our selection of indicators made it possible to identify the relationship between the yield of wheat and the volume of mineral and organic fertilizers (Figure 5).

**Fig. 4.** Wheat yield centners per hectare for 2000-2021.

**Fig. 5.** Correlation coefficients for the application of mineral and organic fertilizers and wheat yield for 2000-2019.

So Figure 5 clearly demonstrates the significant impact of the combined use of mineral and organic fertilizers on wheat yields in Russia as a whole. At the same time, in the rural areas of the Perm Territory, the level of influence of mineral fertilizers on wheat yields is extremely low, and organic fertilizers are significantly behind the national indicators.

### 4 Discussion

The results of this study naturally raise the question of the priority of the so-called "just transition" to sustainable food systems and the new fundamental values of the "green economy". We agree with the position of those scientists who insist on additional cost-benefit analysis [9] on a global scale. It is necessary to understand the lack of a homogeneous environment for the comprehensive distribution of organic fertilizers both
among states and territorial economic systems [10]. Program activities of the European Union to reduce the use of mineral fertilizers by 20% and achieve at least 25% of the area of agricultural land included in organic farming [11], without taking into account the growing needs of the world population, raise serious concerns. At the same time, the issue of an excess of chemicals and their compounds in agricultural lands [12], in particular nitrates [13], cannot be ignored, especially in highly industrialized states with their accumulated environmental problems, risks and threats.

5 Conclusion

The results of this study allow us to assert the preservation of the role and importance of mineral fertilizers not only in improving the efficiency of agricultural activities, but also in the tasks of ensuring the food security of the world population. Currently, in our opinion, the global community is not ready for a massive reduction in the use of mineral fertilizers and their replacement with organic fertilizers. At the same time, the combined use of mineral and organic fertilizers allows a more balanced approach to the issues of sustainable development of rural areas on the principles of a green economy.

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