# Assessment of the impact of crop cultivation on the reproduction of land resources

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**Abstract.** The paper assesses the impact of crop cultivation on the reproduction of land resources. It is determined that the change in the yield of major agricultural crops shows an upward trend. It was determined that crop yields are volatile due to natural and climatic phenomena. By comparing the values of nutrient removal with yield, it is determined that the most resource-intensive crop is corn, and the least - rapeseed. By comparing the removal and application of nutrients for the main agricultural crops, the conclusion is made about the narrow character of reproduction of land resources in Russia. It was found that for all crops, with the exception of rapeseed, there is a situation in which the removal of nutrients exceeds the volume of their application. The general conclusion of the study is the revealed trend of soil fertility reduction and degradation of land resources of the agricultural sector.

## 1 Introduction

Land resources are the main resource of the agricultural industry. They simultaneously perform the role of subject and means of labor. Crop production fully and directly depends on land resources, as they are the basis for growing grain crops. For livestock farming the importance of land is much less. Production of livestock products can be located in any area, and fodder is imported. Poultry and pig breeding are less dependent on land, and cattle and sheep breeding are more dependent on land [1].

If properly used, land resources do not wear out like other fixed assets, and on the contrary, they can even show improvement of their characteristics. There is a significant number of characteristics of land resources, which can be conditionally combined into 2 groups. The first group defines the economic characteristic of the land plot, it follows from the second, agronomic characteristic. Elements of the economic characteristics of a land plot can be: location, price, size, etc. The elements of agronomic characterization can include the level of nutrients, acidity, physical and mechanical properties, level of pollution, etc. The elements of agronomic characterization can be: location, price, size, etc.

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Agronomic characteristic determines the price of the land plot, i.e. its economic characteristic [2].

Changes in the characteristics of land resources occur under the influence of both natural and climatic phenomena and human actions. Human actions have the most destructive impact on the characteristics of land resources. In the process of land resources utilization, there is a process of reproduction, which can be narrowing, simple and expanded. If in the process of using a land plot its characteristics deteriorate, the stock of nutrients is reduced, such process is called narrow reproduction. If the balance of nutrients and the characteristics of the land plot do not change in the process of its use, the reproduction is simple. The activities that ensure an increase in soil fertility and improvement of the characteristics of land plots determine expanded reproduction [3].

Over the last decade Russia has become one of the world leaders in the export of food products, the main ones being grain, sunflower seeds, corn, rapeseed and soy. This leadership allowed to increase the profitability of agricultural production and its modernization, and the country's budget received additional foreign exchange earnings, which is generally positive. However, there is a question of soil fertility preservation. In conditions of significant volumes of production, the question arises as to whether high results are achieved due to intensive or extensive use of land resources [4].

Thus, the relevance of the study is determined by the need to assess the impact of crop cultivation on the reproduction of land resources.

## 2 Purpose of the study

The purpose of the study is to assess the impact of crop cultivation on the reproduction of land resources. This goal required solving the problems of forming the values of nutrient removal of main agricultural crops, estimating the yield of main agricultural crops and the application of mineral fertilizers for the harvest, as well as comparing the application and removal of nutrients with the harvest.

The object of the study is economic processes of agricultural production that determine the level of crop yields, nutrient removal and application, as well as the reproduction of soil fertility.

The hypothesis of the study is based on the fact that significant results of agricultural production in Russia and the volume of food exports are accompanied by inefficient use of land resources, which is manifested in their degradation and depletion.

## 3 Material and research methods

The main sources of statistical data for the study were the Federal Service for State Statistics of the Russian Federation and the Ministry of Agriculture of the Russian Federation.

The theoretical and methodological basis of the study was formed on the basis of theoretical provisions, methodological approaches and concepts of agricultural economists.

The methodological basis of the study was formed by such scientific methods as analysis, synthesis, abstraction, induction, deduction, horizontal and other tools that allowed to realize the purpose of the study.

The research methodology has the following sequence. The initial stage of the study was to determine the values of nutrient removal by their types and main agricultural crops. These values were obtained from several information and methodological sources. The values of nutrient removal differ from source to source, which is acceptable in principle, since nutrient removal differs depending on plant variety, soil and climatic conditions. In

this regard, values close to the minimum were selected. Further, the yields of the main agricultural crops are estimated, as well as its changes. The traditional methodology assumes measurement of yield in c/ha, but since the values of nutrient removal are in kg/t, for convenience the yield was converted to t/ha. The final step was to calculate the removal of nutrients with yields of the main crops and compare them with the volume of nutrient application.

## 4 Results of the study and their discussion

Crops are unique elements of agricultural production. The main differences of crops are based on the biological features of plants, which determines the technology of their cultivation and directions of their use. The main science in crop production is agronomy, which is the science that studies the peculiarities of crop cultivation and proposes the most efficient cultivation systems.

One of the peculiarities of agricultural crops is the amount of nutrient removal. The source of nutrients is soil and fertilizers applied by economic entities. The volume of nutrients removed is determined by biological features of crops and their varieties, natural-climatic and soil conditions. The volume of fertilizers applied is determined by economic conditions of management. Since in agronomic literature there are close, but different values of nutrient removal, it was decided to focus on the minimum values. Differences in nutrient removal are different due to biological characteristics of specific varieties, soil and climatic conditions (determining the level of nutrient assimilation) (Figure 1) [5-7].

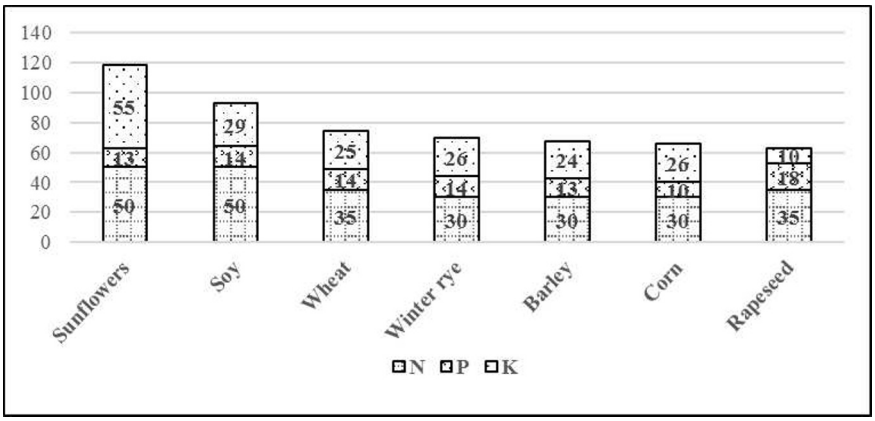


**Fig. 1.** Size of nutrient removal by crops, kg/t.

Figure 1 shows that sunflower is the most resource-intensive crop, followed by soybeans, which are technical crops. Such grain crops as winter rye, wheat and spring barley have similar values of nutrient removal. Differences are practically insignificant, including those caused by vegetation period, which is higher in winter crops. The leader among grain crops in potassium removal is winter rye, and in nitrogen - wheat. These crops have equal phosphorus consumption. The lowest consumption of nutrients among the studied grain crops is observed in spring barley, which is due to the growing season. Corn and spring rapeseed are important fodder and technical crops. Among them rapeseed is the leader in nitrogen and phosphorus removal (35 kg/t vs. 30 kg/t and 18 kg/t vs. 10 kg/t). In terms of potassium removal, maize is ahead of rapeseed by 16 kg/t. Among the studied crops, maize for grain and rapeseed contains the least amount of nutrients per unit of production.

Let us consider the data on yields of the main crops, for convenience of comparison they were converted from the traditional system (c/ha) to the total (t/ha) (Table 1) [8].

**Table 1.** Data on yields of major agricultural crops in Russia in 2018-2022, t/ha.

| Cultures | 2018 | 2019 | 2020 | 2021 | 2022 | Growth rate (%) 2022 to 2018 | Deviation (+, -) 2022 from 2018 |
|---|---|---|---|---|---|---|---|
| Spring barley | 2.05 | 2.26 | 2.47 | 2.13 | 2.78 | 135.61 | 0.73 |
| Spring wheat | 1.68 | 1.77 | 1.88 | 1.85 | 2.38 | 141.67 | 0.70 |
| Winter rye | 2.01 | 1.73 | 2.44 | 1.72 | 2.47 | 122.89 | 0.46 |
| Corn for grain | 4.81 | 5.7 | 5.08 | 5.25 | 5.99 | 124.53 | 1.18 |
| Spring rapeseed | 1.24 | 1.32 | 1.63 | 1.51 | 1.71 | 137.90 | 0.47 |
| Soy | 1.47 | 1.57 | 1.59 | 1.59 | 1.79 | 121.77 | 0.32 |
| Sunflower | 1.6 | 1.83 | 1.59 | 1.62 | 1.78 | 111.25 | 0.18 |

According to the data of Table 1, it can be seen that the agricultural sector shows good results, which is confirmed by the growing trend of yields of the main agricultural crops. The greatest relative growth of yield is observed in spring wheat. During the study period it increased by 41.67% or 0.7 t/ha. The greatest absolute growth of yield is observed in corn for grain. During the study period from 1 hectare of corn for grain yield increased by 1.18 tons, which in relative measurement amounted to 24.53%. Good value of yield change is observed for spring barley (+ 0.73 t/ha), rapeseed and winter rye (+0.47 and 0.46 t/ha). The smallest value of the absolute change in yield is for soybean (+0.32 t/ha). The smallest value of yield change is observed for sunflower for grain 11.25% or + 0.18 t/ha. This situation can speak about the achievement of maximum results limited by climatic conditions and biological features of cultivated varieties.

In general, the yields of the main agricultural crops show upward dynamics, with some elements of instability due to natural and climatic phenomena. For all grain crops (barley, wheat, and winter rye) and spring rapeseed, the year of yield decrease was 2021. Also yield of winter rye decreased in 2019. Yield of corn for grain and sunflower showed a decrease in 2020. These changes are obvious consequences of unfavorable natural-climatic changes.

Soil fertility reproduction can occur in several directions simultaneously and includes many tools and techniques. One of the main tools is the application of mineral and organic fertilizers that restore the balance of mineral nutrients and humus. Science-based farming requires fertilizing to the extent necessary to fully recover the removal of nutrient yields. However, economic conditions do not allow this principle to be followed. In one case, to get the result in a short time simply predatory use of the land. As land is depleted, the organization is eliminated and land is sold. On the other hand, food prices do not allow the use of science-based fertilizer standards, as this is beyond simple payback.

Let us assess the level of soil fertility reproduction under the main agricultural crops in Russia (Table 2) [6].

**Table 2.** Estimation of soil fertility reproduction under the main crops in Russia, kg.

| Cultures | N | P | K | Amount of NPK removal | Amount of NPK applied | Deviation of removal from application | % of requirement coverage |
|---|---|---|---|---|---|---|---|
| Spring barley | 83.4 | 36.14 | 66.72 | 186.26 | 81 | 105.26 | 43.49 |
| Spring wheat | 83.3 | 33.32 | 59.5 | 176.12 | 81 | 95.12 | 45.99 |
| Winter rye | 74.1 | 34.58 | 64.22 | 172.9 | 81 | 91.9 | 46.85 |
| Corn for grain | 179.7 | 59.9 | 155.74 | 395.34 | 81 | 314.34 | 20.49 |
| Spring rapeseed | 59.85 | 30.78 | 17.1 | 107.73 | 124 | -16.27 | 115.10 |
| Soy | 89.5 | 25.06 | 51.91 | 166.47 | 64 | 102.47 | 38.45 |
| Sunflower | 89 | 23.14 | 97.9 | 210.04 | 46 | 164.04 | 21.90 |

The data in Table 2 show that the sum of NPK removal is the highest for corn and sunflower 395.34 and 210.04 kg. The nutrient inputs of these crops are 81 and 46 kg, respectively. Thus, only 20.49% of corn crop nutrient removal is covered with fertilizer and 21.9% sunflower nutrient removal. Nutrient removal by cereal crops (barley, wheat and rye) does not differ much from each other. And the leader in nutrient removal among cereal crops is spring barley. Comparing the volumes of nutrient removal and application of nutrients by cereal crops, we can say that almost half of the nutrient removal is covered by the applied fertilizers, which is positive, but far from the ideal state. Soy is not the most resource-intensive crop, the sum of NPK removal is only 166.47 kg, which at application of 64 kg provided 38.45% coverage of nutrient requirements. Rapeseed is the only crop for which the application of fertilizers overlaps their removal. At removal with yield 107.73 kg was applied 124 kg, which provided 15.1% more coverage of nutrient requirements. In general, it can be said that Russia realizes predominantly narrow reproduction, which is negative for ensuring food security of the country in the long term.

## 5 Conclusions

Thus, the significant results of the agricultural sector of the country, on the one hand, are the result of increased fertilizer application, the use of more productive plant varieties, effective plant protection products, as well as the improvement of technologies. On the other hand, the analysis has shown that the application of nutrients significantly lags behind the removal of nutrients with the harvest. This trend indicates that the form of reproduction of land resources is narrowed. If the negative balance of nutrient removal is maintained, the depletion of land resources will occur in the future, which will certainly adversely affect the food security of the country.

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