Economic aspects of agroecological assessment of soils (lands) of the Azov-Kuban lowland

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Abstract. The paper discusses the main approaches to assessing the qualitative state of soils. ‘Normal’ and ‘normative’ crop yields are calculated. Comparison of the obtained calculated yields, depending on the properties and composition of soils, with the actual yield is made. It was concluded that the yield decreases when moving from not prone to degraded soils. Using the methods for ‘normal’ and ‘normative’ crop yields, the production value of soils was assessed. The indicator of ‘normative’ yield is analyzed taking into account the value of the agroecological potential. It is concluded that the use of ‘normative’ yield is the most appropriate for assessing the production value of soils in agricultural production, since this method reflects the difference between soils of better and worse quality. For comparison, the data on determining the assessment of the qualitative state of soils according to the bonitet score of agricultural crops are given. Studies have shown that due to the manifestation of degradation processes in soils, the production value of soils is currently decreasing. It was concluded that the dynamics of the structure of the soil cover, composition and properties of soils led to the lost profit due to the short products received.

1 Introduction

Agroecological factors are one of the factors affecting the quality of soils [1-3]. These include: climate, relief, soil and others. D.S.Bulgakov developed a system of agroecological assessment of soils, which is based on the standards of soil fertility. Some researchers, when assessing the agroecological potential of arable land in Russia, use the methodology developed in the Department of Agroecological Soil Assessment of the V.V.Dokuchaev Soil Science Institute under the guidance and with the participation of Corresponding Member of the Lenin Academy of Agricultural Sciences I.I.Karmanov, which consists in determining the points of productivity of leading agricultural crops on the basis of the soil-agro-climatic index. A. N. Kashtanov and V. E. Yavtushenko used the contour and ameliorative organization of territories in the development of a methodology for an agroecological assessment of slope lands. The method of agroecological assessment of lands proposed by V. I. Kiryushin [4] is based on an adaptive landscape farming system.

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I.I. Vasenev, V.G. Khakhulin and others proposed a method of agroecological typification of lands and soils in the agricultural landscape. A.E. Kudryavtsev developed a methodology for agroecological assessment of soils [5], which makes it possible to assess the current state of soil fertility and establish the type of its degradation. In our opinion, this approach makes it possible to use soil resources more efficiently, to give reliable and scientifically substantiated forecasts for the introduction of methods of their rational use, ensuring an expanded reproduction of soil fertility. The advantage of this method is that it reflects the temporary changes in soil properties within the soil and climatic zones, which makes it possible to determine the presence of various types of degradation and their intensity.

One of the most popular methods for assessing soil quality is the assessment of soils according to V.D. Ivanov. This assessment is based on the doctrine of V.V. Dokuchaev about soil as a natural and historical body, where soil fertility is determined by genetic characteristics and properties. The grading scale used in this technique is based on a 100-point closed system and 10 groups of indicators of soil properties and characteristics. These indicators of soil properties and features include: agrophysical properties, hydrological conditions, geomorphological conditions, thickness of the humus horizon, humus content, absorption capacity, saturation of soils with bases, acidity, supply of basic nutrients, degree of washout, alkalinity, salinity, carbonate content and small contour of the soil cover [6-8].

In the context of obsolescence of data on soil surveys carried out in the 60-80s of the last century, the need to obtain relevant information is increasing. The last areas of continuous soil survey in the Krasnodar Territory were Abinsky (2000), Seversky, Yeisky, Krymsky (1999), Krasnodar (1999) and Novorossiysk (1994) [9,10].

2 Materials and methods

To identify the level of productivity of soils in agriculture, a quantitative indicator is used that reflects the real or potential quality of soils – the bonitet score. Some researchers [11, 12] calculate the bonitet score on the basis of the soil-ecological index approved by the V.V. Dokuchaev Soil Science Institute, developed by I.I. Karmanov, using domestic and foreign experience. The soil-ecological index is calculated based on the climatic parameters of the region and soil-agrochemical properties.

One of the indicators reflecting the production value of soils is ‘normal’ and / or ‘normative’ yield. In fact, these two indicators are summaries in order to assess the quality of the soil in relation to agricultural goals, but the approaches to determining them are different. ‘Normal’ yield is the average annual actual yield, reduced to the regional average, with a comparable level of agricultural technology and farming intensity [13]. The advantage of this approach is that it is calculated according to the correlation and regression model, which can be updated de-pending on the temporal change in factors affecting the ‘normal’ yield. The disadvantage is that there is no ac-counting for the yield of agricultural crops in relation to the structure of the soil cover; such an accounting was performed once to develop a methodology for cadastral valuation of land. Although, in our opinion, taking into account the structure of the soil cover should be a fundamental factor for the development of various farming systems.

The advantage of the approach to assessing the qualitative state of soils according to the ‘normative’ yield is that it takes into account the main properties of soils, including negative ones (humus content, thickness, content of physical clay, compaction, waterlogging, etc.). The ‘normative’ yield of agricultural crops is an indicator of soil fertility with economic factors averaged over the estimated area (the amount of mineral fertilizers, labor costs, the use of agricultural machines, etc.) [14]. The ‘normative’ yield is calculated taking into account the agroecological potential. The value of the agroecological potential characterizes the influence of climatic conditions on the yield of grain crops.
(according to I.I. Karmanov) and is determined for a specific study area. In the course of our re-search, the ‘standard’ yield was calculated for all agricultural crops. The materials of the Guidelines for assessing the quality and classification of lands according to their suitability for use in agriculture were used in the calculation (Ogleznev A.K. et al., Moscow 2003) [15].

In our opinion, the value of the bonitet score reflects the real quality of the soil relative to the cultivated crops. The data we obtained during the research showed that the bonitet score for winter crops is higher in the regions of the Central natural and climatic zone and is 87 in the Novokubansky and Timashevsky districts, and in the city of Krasnodar - 80. In the municipal districts of the Northern natural and climatic zone, the bonitet score for winter grains amounted to 75 in Beloglinsky and Yeisky districts, in Kanevsky district - 68.

3 Research results

In order to determine the most appropriate method for assessing soil fertility in relation to cultivated crops, we calculated the indicators of ‘normal’ and ‘normative’ yields, which showed that in municipal areas, the indicator of ‘normative’ productivity decreases from chernozems to less fertile soils in terms of composition (meadow-chernozem tight compacted soils). For example, in the Timashevsky district on common chernozems, the yield for cereals was 55.8 c/ha, and on meadow-chernozem compacted soils - 21.1 c/ha. In Krasnodar on leached chernozems, the yield was 56.8 c/ha., and on meadow-chernozem compacted soils it decreased to 21.8 c/ha. In Yeisky district on common chernozems, the yield for cereals was 48.3 c/ha, and on meadow-chernozem compacted soils - 18.0 c/ha. Such a decrease in the value of the ‘normative’ yield is caused by the fact that when cultivating certain agricultural crops, it is necessary to take into account soil differences, since the potential yield of agricultural crops depends on the properties of soils.

On the basis of the indicators calculated by us for ‘normal’ and ‘normative’ yields, graphs were built (Fig.1-3), the comparison of which gives grounds to assert the following:

— in general, there is a single tendency towards a decrease in the value of yield (normal and normative) during the transition from chernozems to less agronomically valuable soils;

— ‘normative’ yield most correctly reflects the influence of the dynamics of the agricultural production value of soils, since when using this indicator, a large differentiation of its value is manifested depending on the properties of the soil;

— attention is drawn to the fact of complete coincidence of the values of normal and normative yields for meadow and meadow chernozem compacted soils in Timashevsky, Yeisky and Kanevsky districts or their proximity in the municipal district of the city of Krasnodar.
Fig. 1. Comparative assessment of the dynamics of the yield of winter cereals in the context of the structure of the soil cover of the Timashevsky district: 1 - common chernozems; 2 - typical chernozems; 3 - meadow chernozem; 4 - meadow-chernozem tight; 5 – meadow-chernozem compacted.

Comparison of calculated yields with actual yields shows the closest approximation of it to the ‘normative’ yield rather than to the ‘normal’ one, which, in turn, indicates the correct choice of approach to assessing the production value of soils.

The main criteria for assessing the quality of soil (land) resources are economic. In order to assess the degree of influence of soil indicators of lands on the proceeds of an agricultural enterprise, we calculated gross income, which in our studies was a criterion for the level of soil fertility or lost profit due to the short products received, taking into account the dynamics of soil areas. Thus, in the Novokubansky district, the area of typical and
ordinary chernozems, weakly washed out and weakly deflated, decreases, and the area of medium washed and moderately deflated chernozems, meadow chernozem, incl. tight and flooded, increases.

Table 1. Economic aspect of agroecological assessment of soils.

<table>
<thead>
<tr>
<th>District</th>
<th>Soil</th>
<th>Yield* , c/ha</th>
<th>Area, ha</th>
<th>Dynamics</th>
<th>Lost profits due to a decrease in area and (or) a decrease in yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1980</td>
<td>2018</td>
<td>area, ha</td>
<td>yield, c/ha</td>
</tr>
<tr>
<td>Novokubansky</td>
<td>Typical and common chernozems, slightly washed out and slightly deflated</td>
<td>56.2</td>
<td>10035</td>
<td>97750</td>
<td>-2609</td>
</tr>
<tr>
<td></td>
<td>Typical and common chernozems, moderately washed out and moderately deflated</td>
<td>45.1</td>
<td>11249</td>
<td>13858</td>
<td>+2909</td>
</tr>
<tr>
<td></td>
<td>Meadow chernozem, incl. tight and flooded</td>
<td>53.5</td>
<td>9273</td>
<td>11242</td>
<td>+1124 2</td>
</tr>
<tr>
<td>Timashevsky</td>
<td>Typical and common chernozems</td>
<td>55.8</td>
<td>12337</td>
<td>11206</td>
<td>-11305</td>
</tr>
<tr>
<td></td>
<td>Meadow chernozem tight</td>
<td>30.6</td>
<td>2310</td>
<td>9354</td>
<td>+7044</td>
</tr>
<tr>
<td></td>
<td>Meadow-chernozem and meadow compacted</td>
<td>21.1</td>
<td>10860</td>
<td>13151</td>
<td>2291</td>
</tr>
<tr>
<td>Krasnodar</td>
<td>Leached and common chernozens</td>
<td>56.8</td>
<td>59157</td>
<td>44542</td>
<td>-14615</td>
</tr>
<tr>
<td></td>
<td>Meadow-chernozem (idiomorphic) tight</td>
<td>40.1</td>
<td>1156</td>
<td>4176</td>
<td>+3020</td>
</tr>
<tr>
<td></td>
<td>Meadow-chernozem tight</td>
<td>38.2</td>
<td>758</td>
<td>7357</td>
<td>+6599</td>
</tr>
<tr>
<td></td>
<td>Meadow and meadow chernozem compacted</td>
<td>21.8</td>
<td>2131</td>
<td>7128</td>
<td>+4997</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>1990.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* "normative" yield according to Karmanov

In the Timashevsky district, typical and common chernozems are decreasing, while tight meadow chernozems are increasing. And in Krasnodar, leached and typical chernozems decrease, while compacted tight meadow chernozems increase.

In general, being guided by the indicators calculated by us on the dynamics of soil area and yield, we came to the conclusion that the lost profit in the areas under consideration amounted to 1.937.493.54 thousand rubles (Table 1), of which:

Novokubansky district – 211.519.267 thousand rubles;
Timashevsky district – 816.250.817 thousand rubles;
Municipal District of Krasnodar – 909.723.46 thousand rubles.

4 Discussion
Studies on the agroecological assessment of the soils of the Azov-Kuban lowland made it possible to conclude that, taking into account changes in agroclimatic, anthropogenic, agrochemical and soil factors, in a number of districts (Timashevsky, Novokubansky, Krasnodar), there are significant changes in the production value of the land. Most adequately reflects the degree of influence of the above factors on the production value of soils from all the considered indicators – ‘normative’ yield.

As a result of the manifestation of degradation processes in the above districts, the soils that are the most fertile and best in composition have passed into worse and less fertile, and therefore, their production value has decreased.

With a variety of approaches to assessing the quality of soil for agricultural purposes, they all have their advantages and disadvantages. The data calculated by us on the two approaches allowed us to conclude that, on the one hand, ‘normal’ productivity could give us the most reliable information if there are data on crop productivity, in relation to the structure of the soil cover. On the other hand, the ‘normative’ yield more adequately reflects the difference between the soils of better and worse quality. The problem of using this indicator is that it is calculated for grain crops, the value of the ‘normative’ yield for the rest of the crops we get according to insufficiently substantiated conversion factors.

In this regard, we concluded that from the existing approaches, the ‘normative’ yield most clearly makes it possible to assess the quality of soils in relation to grain crops and to see the difference between the yield obtained from different soils, i.e. soils subject to and not subject to degradation processes.

References


4. V.I. Kiryushin, M. Kolos, Theory of adaptive landscape agriculture and design of agricultural landscapes 443 (2011)


scientists named after V.V.Dokuchaev and All-Russian with int. participation
scientific. Conf. 43–44 (2016)
9. V.I. Kiryushin, N.N. Dubachinskaya, A.V. Trubnikov, O.V. Galaktionova, Experience
of agroecological land assessment for the design of adaptive-landscape farming
systems in AgroGIS. Geoinformation technologies in agriculture: materials of the
11. V. Blum, V. Stolbova, Achievements of science and technology of the agro-industrial
complex: theoretical and scientific-practical j. 30(7), 11–13 (2016)
of the Kuban. State and dynamics of soil fertility in connection with the productivity of
agriculture. Materials of the IX International Symposium of “Commonwealth of
Agrochemists and Agroecologists” 38–48 (2017)
13. Y. Zaitseva, E3S Web of Conf. 244, 03017 (2021)
https://doi.org/10.1051/e3sconf/202124403017
15. Y. Zaitseva, Investment management and state investment policy 2(91), 753-757
(2018)