

Ecologization of the agricultural landscape as a foundation for the sustainable advancement of agricultural production

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Abstract. The article presents research covering the solution of the problem of preserving the natural resource potential of soils, their biological diversity in conditions of soil acidity in the steppe zone of the in the world. A comprehensive assessment of the condition and use of agricultural land for agricultural land use on a landscape-ecological basis (landscape-ecological optimization of agricultural land) is proposed as a toolkit. This approach covers the principles of greening land use, rational nature management, scientifically based farming systems, responding to the strategic direction of efficient agricultural production, the formation of sustainable agricultural land use and the protection of agricultural lands of the agro-industrial complex of the region.

1 Introduction

The importance of implementing the Food Security Doctrine adopted in the Russian Federation confirms the relevance of this study, based on the analysis and solution of environmental and technological problems related to the preservation and restoration of the natural resource potential of agricultural soils, as well as with the strengthening and development of the agro-industrial complex of the region [1-4].

In accordance with Chapter II "Typ Based on this, the research is based on the works of Russian scientists in the field of ecology, protection of agricultural landscapes, nature management, soil science, agriculture, agrochemistry and land management: Vernadsky V. I., Dokuchaeva V. V., Armand D. L., Dapiro E. B., Handelman M. A., Abramova N. V., Sitnikova A.M., Milkova F. N., Kiryushina V. I., Gradoboeva N. D., Reyengard Ya. R., Lopyreva M. I., Chupakhina V. M., Ermokhina Yu. I., Khrenova V. Ya., Isachenko A. G., Reimers N. F., Valkova V. F., Rogatneva Y. M., Vershinina V. V., Kochergina Z. F. and Frolova N. M. In modern conditions, with increased anthropogenic impact on agricultural landscapes, it is necessary to proceed from the fact that the scientific concept of ecologization of land use and rational nature management is based on the formation of the ecological environment of the agricultural landscape; on maintaining (preserving) soil biological diversity; on stabilizing the sustainable development of agricultural enterprises in

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close relationship with technological processes in agricultural production (ecological agriculture, crop production, etc. animal husbandry) [1-3, 5-6].

2 Materials and methods

The Closed Joint Stock Company "Severnaya", located in the northern forest-steppe of the world, was accepted as the object of research. The total land use area is 5784.80 hectares, of which agricultural land is 4965.00 hectares (arable land - 4647.00, hayfields - 77.00 hectares, pastures - 241.00 hectares). Forage lands are included in the management of the rural administration of this farm. The soils of the joint-stock company are characterized by increased fertility: the humus content averages 6.3%. As for the presence of soils with a low humus content (0-4%), their share is 6.9%. The production line of the farm has developed as a crop production, while crop production specializes in growing elite seeds of grain crops for sale. The structure of acreage over the past three years (2021-2023) is reflected in Figure 1.

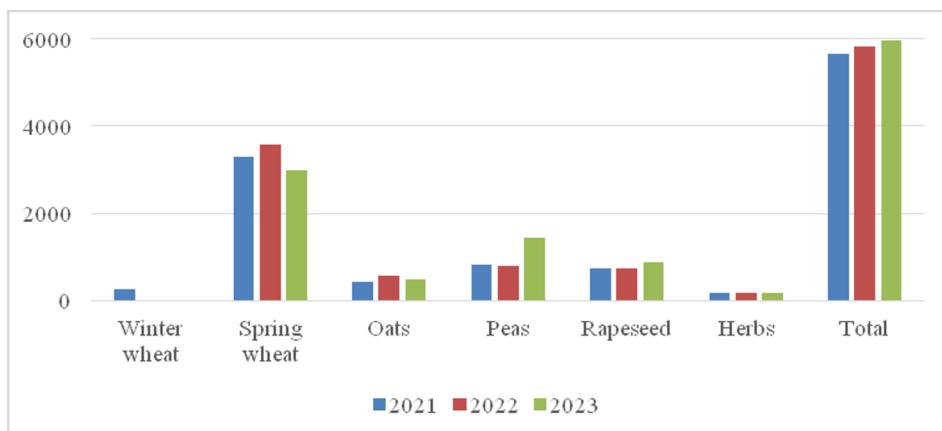


Fig. 1. Structure of acreage.

The obtained Figure 1 data indicate that the farm specializes in the cultivation of spring grain crops (more than 75% of the area). Since 2021, the farm has seen an increase in acreage for leguminous crops in order to maintain soil biological diversity. Figure 2 reflects changes in crop yields in the studied farm over the past three years 2021-2023. The highest yield of spring and winter cereals was recorded in 2022 compared to 2021 and 2023, which was facilitated by agrotechnical techniques to reduce soil acidity and the prevailing favorable climatic conditions. The cost of production for the study period decreased: for wheat by 26.8%; for oats – by 47.2%.

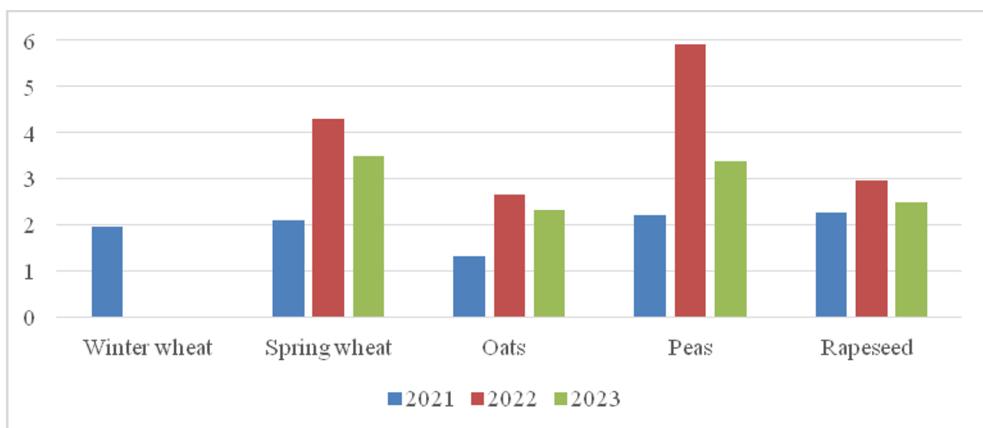


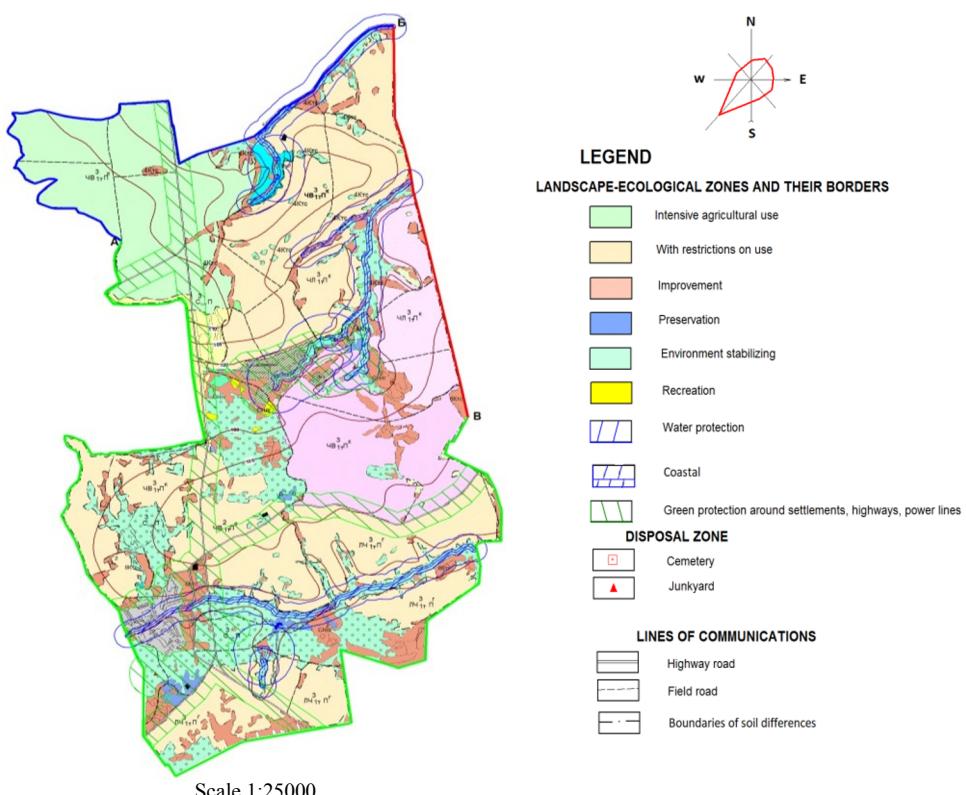
Fig. 2. Crop yield, tons/hectare.

The results of the performed economic assessment of the main types of crop production allowed us to conclude that, in general, the profitability of the farm is low and requires a revision of the existing system of crop rotation, agriculture and agricultural technology. Analyzing the economic activity in CJSC Severnoye, the authors propose a methodology covering the solution of issues related to the greening of agricultural land use as the basis for the effective development of agricultural production, preservation (improvement) of soil fertility of agricultural lands and strengthening the agro-industrial complex of the region, including [1- 3, 5-8]:

- Analysis of scientific concepts that determine the formation and stability of agricultural production in agricultural regions, as well as the protection of agricultural land.
- Analysis of scientific approaches and techniques that ensure the greening of agricultural land use.
- Carrying out inventory, special types of surveys and environmental monitoring of agricultural land.
- A comprehensive assessment of the state of economic activity of an agricultural enterprise and an assessment of the state and use of agricultural land on a landscape-ecological basis, followed by their landscape-ecological optimization.
- Definition of land resources in the long-term development of an agricultural enterprise, taking into account risks, limitations and opportunities.
- Development of a scientifically based system of agriculture and agrotechnical measures.
- Preparation of the planning and cartographic basis of the project of the on-farm organization of the use of agricultural land.
- Feasibility study of the project on the greening of agricultural land use (agrolandscape).

3 Research results

Landscape and ecological optimization of agricultural land in CJSC Severnoye, carried out on the basis of landscape and ecological zoning, allowed, first of all, to form landscape and ecological zones, establish restrictions and encumbrances in the use of agricultural land, assess both the presence and degree of manifestation of degradation processes, see Figure 3 [1, 3, 5, 7, 9].



Scale 1:25000

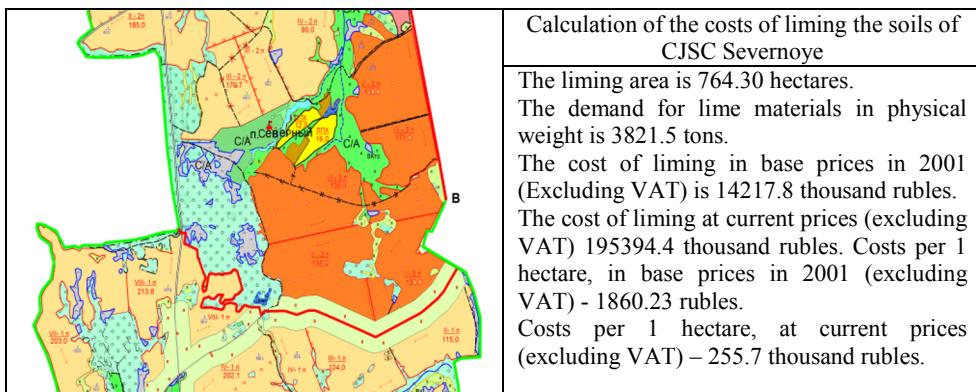
Fig. 3. Landscape and ecological optimization of agricultural lands in CJSC Severnoye on the basis of landscape and ecological zoning.

When determining the resource base in the long-term development of an agricultural enterprise, the authors carried out an assessment of the suitability of soils, covering all types of agricultural land on the farm. The basis for the allocation of classes of suitability of soils and arable land was the materials of the agrochemical survey of soils of this land use conducted in 2020. As the results of this survey showed, in the farm 1634.8 hectares or 94.7% of arable land is characterized by an acidic reaction of pH KCl <5.5 units. pH of the soil medium. The distribution of arable lands of CJSC Severnoye by the degree of soil acidity is shown in Table 3.

Table 3. Distribution of arable land by degree of soil acidity.

Groups by degree of acidity (pH KCl)											
Very strongly acidic <4		Highly acidic 4.1-4.5		Medium acid 4.6-5.0		Slightly 5.1-5.5		Close to neutral 5.6-6.0		Neutral and slightly alkaline >6.0	
hectare	%	hectare	%	hectare	%	hectare	%	hectare	%	hectare	%
-	-	-	-	759.8	44	875.0	50.7	76.5	4.4	16.5	0.9

The article offers the material of reclamation measures for liming acidic soils, given that the use of mineral and organic fertilizers on acidic soils without reclamation is not rational and ineffective. In accordance with Chapter II "Types and types of Land Reclamation", Federal Law No. 4-FZ of January 10, 1996 "On Land Reclamation", based on the results of an agrochemical survey, examination of the documentation provided, taking into account the characteristics of land plots, including geomorphology, relief, its soil-reclamation conditions, liming fields with a total area of 764.3 hectares are subject, see Figure 4.



LEGEND

LAND OWNERSHIP, LAND USE, PRODUCTION UNITS AND THEIR BOUNDARIES

CA 268.0 State-owned lands previously transferred to the rural administration

Land Redistribution Fund

Lands of private subsidiary farms

ADMINISTRATIVE BUSINESS CENTERS

The Central estate

The estate and the number of the production unit

The border between the brigades

Organization of land

Surface improvement of haymaking

Chemical reclamation liming

DETAILED ARRANGEMENT OF THE TERRITORY OF AGRICULTURAL LANDS

Field crop rotation (field number, crop rotation number, field area)

Working areas (border, number, area of the site)

Processing direction

Closed field road

Existing field road

Projected field road

Forest belts: 1 existing; 2 projected

Fig. 4 Arable lands to be limed.

The proposed type of reclamation is chemical reclamation, as for the type, it covers liming of soils. The doses of lime material are calculated for the treated soil layer of 15-20 cm, taking into account the use of a new generation of agricultural machines and aggregates in the soil treatment system. In accordance with the certificate of state registration of a pesticide or agrochemicals of the Ministry of Agriculture of the Russian Federation dated 11.09.2015 No. 773, the maximum rate of use of this agrochemical is 5.0 tons/hectare. The calculation of the costs of liming soils on the territory of the farm under study is shown in the figure 4.

4 Conclusions

The transition of agricultural land uses and their ecosystems to sustainable development is determined by the greening of land use and land tenure based on [1-3, 5, 8-10]:

- Landschaft-ecological approach to the rational organization of the use of agricultural lands and their protection.
- Traditional and alternative farming systems, taking into account climatic, socio-economic characteristics and natural and agricultural zoning.
- The development of geoinformation technologies in the agro-industrial complex. The transition of agricultural land uses and their ecosystems to sustainable development is determined by the greening of land use and land tenure based on [1, 2, 3, 5, 8, 9, 10]:
 - Landschaft-ecological approach to the rational organization of the use of agricultural lands and their protection.
 - Traditional and alternative farming systems, taking into account climatic, socio-economic characteristics and natural and agricultural zoning.
 - The development of geoinformation technologies in the agro-industrial complex. The landscape-ecological approach serves as the basis for the ecological optimization of agricultural lands with respect to the uniformity of landscape-ecological conditions and their suitability for economic use in varying degrees of intensity, as well as the basis for improvement, restoration and conservation, solving urgent problems of soil and land resources protection; updating and replenishment of agricultural machinery and equipment that ensure full (a closed) cycle of work in the sectors of specific agricultural land use; strengthening the system of the agro-industrial complex of the region.

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