

Ecological Arrangement of Lands of Voronezh Agricultural Enterprises for Environmental Management

Chechin D.I.

Department of Land Survey and Landscaping
Voronezh State Agrarian University n.a. Emperor Peter I
Voronezh, Russia
nedicova@emd.vsau.ru

Nedikova E.V.

Department of Land Survey and Landscaping
Voronezh State Agrarian University n.a. Emperor Peter I
Voronezh, Russia
nedicova@emd.vsau.ru

Postolov V.D.

Department of Land Survey and Landscaping
Voronezh State Agrarian University n.a. Emperor Peter I
Voronezh, Russia
nedicova@emd.vsau.ru

Linkina A.V.

Department of Land Survey and Landscaping
Voronezh State Agrarian University n.a. Emperor Peter I
Voronezh, Russia
Anna_linkina@rambler.ru

Abstract—Voronezh region is the most important agrarian region of the Russian Federation and has the richest land area of 5,221.6 thousand hectares with the most fertile chernozem soils. The region has favorable natural and climatic factors for crop growth, the hydro-thermal coefficient (HTC) is about 1.0. As a result of non-compliance with the laws of nature and excessive agrarian pressure, the negative impact of adverse natural phenomena (degradation, deflation, soil erosion, droughts, hot winds, etc.) increases. Soil fertility has decreased over the past century and a half. Modern agricultural production is the most important branch of environmental management. The territory of an agricultural enterprise is arranged on the basis of projects of on-farm land management of agricultural enterprises. In the on-farm land management, an organizational and territorial basis is created for adapted farming. The farming system can be considered as a complex mechanism of agrarian nature management. The main goal of the system is creation of conditions for rational use of arable land. The rational use of arable land in agricultural production is careful use, conservation and reproduction of natural potential — soil fertility. The conditions can be created if agriculture is one of the most important branches of state nature management. In this case, on-farm land management should be considered as a complex mechanism for the environmental management of territories of agricultural enterprises, and agriculture as an adapted system of environmental management. The main scientific and methodological provisions of the agrarian environmental management were implemented when developing the landscape-ecological farming systems in Voronezh region based on the decisions of the regional government and the Government of the Russian Federation.

Keywords — *agrarian use of land; land management; agrolandscape; agriculture*

I. INTRODUCTION

As of January 1, 2017, the area of agricultural land in Voronezh Region occupied 4,182.2 thousand hectares. Agricultural land occupied 4 077. 6 thousand hectares, which is equal to 78.1% of the area of the region. The most intensively used type of land is arable land occupying 3,049.9 thousand hectares. The plowing ratio of agricultural land is 0.75. This indicates a high agrarian load on land resources, which often exceeds environmentally acceptable parameters. Against this background, the influence of adverse natural processes is increasing.

Water erosion covers 17.8% of the area, 8.4% is exposed to deflation. There are watering and waterlogging processes in 12.3% of the territories; salinization and alkalinity - in 20.1% of agricultural land. Against the background of increasing anthropogenic load, this is of particular concern.

Modern agriculture should follow the principles of agrarian nature management, be of zonal nature and take into account natural and climatic factors and conditions of a particular territory. Farming should be adapted to the landscape - ecological features of arable land. Modern landscape is the ecological system of agrarian nature management. It is a complex set of links which is in agreement with the basic laws of nature. The territorial basis is formed in the process of land management.

The area of Voronezh region is divided by the Don River into two specific areas. On the right bank there is the eastern outskirts of the Central Russian Upland with a pronounced wavy relief dissected by river valleys, rivers, streams, beams, ravines. On the left bank, in the northeastern part, the Oka-Don lowland is located, and the southeast is represented by the Kalach upland. Unique geographic and morphological features determined quite favorable natural and climatic conditions for

agriculture. These conditions are significantly differentiated by natural agricultural zones. The region is geographically located on the territory of two natural agricultural zones: forest-steppe and steppe. The conditional boundary between the zones runs along the valley of the Tikhaya Sosna River to its confluence with the Don River, then along the Don River to the mouth of the Bituyuga River, and then to Talovaya and in the direction of Borisoglebsk. The line of separation of climatic zones coincides with the optimal amount of moisture which is around 1.0.

The northern part of the region is a forest-steppe, and the southern territory is a steppe with a pronounced relief. Taking into account the variability of natural and climatic conditions in the region, five natural and agricultural microzones can be distinguished. The forest-steppe is differentiated into three microzones: northwestern, central and eastern ones. In the steppe zone, there are two microzones: south-west and south-east ones.

The relief of the territory of Voronezh Region differs significantly due to the fact that it is confined to the Central Russian Upland on the right bank of the Don River, and the Kalach Upland located between the Don and Khopra rivers, and in the Oka-Don Lowland. The local basis of erosion in the microzones is different. It is 213 m.

The ravine-girder network whose length is about 0.8 km/sq. influences the relief of the region. It varies from 0.4 km/sq in the central micro zone to 1.3 km/sq. km in the southwest microzone. Ravines are linear manifestations of water erosion formed on steep slopes under the influence of surface slope runoff under intense weather conditions, a reduced soil-protective role of vegetation, and low erosion resistance of the soil [52].

The relief as a set of outlines of the earth's surface, bearing the historical imprint of agro-climatic processes is one of the main energy natural factors which determines all ecosystem regimes of natural landscapes (nutritional, thermal, aquatic, air, etc.). It is being transformed.

II. METHODS AND MATERIALS

The theoretical and methodological basis was modern agricultural production under the environmental crisis. The agrotechnological load on land resources is constantly growing. Negative natural phenomena (water erosion and soil deflation, destructive processes of waterlogging, land salinization and alkalization, etc.) lead to degradation of land, soil and vegetation. Negative processes cause irreversible environmental disturbances, reduce stability of agricultural landscapes in the region. It is impossible to prevent degradation of agricultural landscapes and their ecosystems by individual reclamation processes. A constructive mechanism for solving landscape ecological problems of agricultural use of land is land management.

On-farm land management of agricultural enterprises and agriculture are closely interrelated. The object of land management of agricultural enterprises and agriculture is land as a component of nature. One of the main requirements of on-farm land management of agricultural enterprises is the need

for rational use of land resources. To overcome the landscape - ecological crisis in the agricultural sector, an integrated approach based on the laws of nature is required. The basis of agriculture is land resources.

The organizational territorial basis for agriculture develops in the process of on-farm land management. In this case, on-farm land management should be considered as a system of measures for environmental management, and adaptive farming as a system of environmental management. On-farm land management and agriculture are two interrelated mechanisms aimed at solving the problem of careful and rational use of land resources in agriculture.

The paper aims to create required organizational and territorial conditions for reducing and preventing the negative impact of adverse natural phenomena (degradation, deflation, soil erosion, droughts, dry winds, etc.), sustainable agricultural landscapes with balanced agro-ecosystems and to ensure careful and rational use of land resources under adaptive farming. It also aims to ensure preservation and reproduction of soil fertility, rational use of land resources, and create conditions for efficient nature management in order to increase food security of the nation.

Based on the integrated soil-erosion surveys of land, the land structure was improved. Calculations for 5 classes of potential dangers were carried out according to the VNIIZ and ZE method. Taking into account the erosion danger, the structure of sown areas was improved, the share of soil-protective crops was reduced to 20%. Systems of the differentiated use of arable land were developed.

In the process of environmental management of the agricultural landscapes, a system of forest reclamation activities was developed. The system involved creation of main and auxiliary forest shelter belts on arable land with a steepness of up to 1.5°, planimetric drainage forest belts on steep slopes of 1.5° through 250–350 meters, 100 m shrub curtains and near-forest belts along the arable land boundary and the hydrographic fund. There were areas of continuous afforestation on degraded agricultural land. Muddy filters were created on the bottoms of the beams in 350–450 meters. Afforestation of arable land was brought to optimal parameters (4–5%), the forest cover proportionally increased in view of its erosive danger. On the girder slopes of the hydrographic fund, a complex of earthen hydraulic structures was designed: water retaining shafts, drainage shafts, dams on the tops of ravines, etc.

To implement these measures, projects were developed for: forest reclamation, construction of hydraulic structures, improvement of land, etc.

The system of organizational and territorial measures creates sustainable agricultural landscapes, favorable agroecological conditions for maintaining adaptive farming systems, preventing soil degradation and increasing soil fertility.

III. RESULTS

As a result of the development and implementation of environmental (ecological - landscape) farming systems in the basic farms of Voronezh Region, organizational and territorial conditions were created to increase sustainability of agricultural landscapes. The structure of the acreage was improved, differentiated crop rotations were organized. Forest cover of the territory increased by 3-10%, afforestation of arable land was brought to the optimum 4-5%, full protection of arable land from the negative influence of wind was ensured. Working areas are processing with a slope of up to 1°, there are no erosion hazardous zones. Calculations were carried out and optimal conditions for reproduction of humus and N, P, K. and soil fertility improvement were created.

The ratio of different areas is characterized by the structure of the land fund which is a clear reflection of the natural features of the area influenced by the historical development system of agriculture, agricultural development of territories under these zonal conditions. The existing zonal differences influenced the structure of agricultural land and characterize the degree of agricultural development of the territory. As a result of the negative impact of unfavorable natural processes and anthropogenic conditions of production, the structure of the land fund is changing and the land quality is deteriorating.

The structure of land reflects the economic aspect of land use. For agrarian regions, the share and conditions of agricultural land is of particular importance. According to the current classification, there are the following types of agricultural land: arable land, fallow lands, perennial plantings and forage lands (hayfields and pastures).

The area of agricultural land in Voronezh region was 4077, 6 thousand hectares, which is equal to 78.1% of the area of the region. This indicates intensive agrarian development of the region.

Arable land is of special importance. Arable land is systematically processed and used for growing crops. The area of arable land in the structure of agricultural land amounted to 3,049.9 thousand hectares.

A deposit was used as arable land, but it has not been used for growing crops for more than a year. This is a potential reserve of arable land. It occupies 39.3 thousand hectares.

Perennial plantations are artificially created woody, shrub or herbaceous plantations for producing fruit, berries, technical and medicinal products. This is a valuable significant agricultural land. It occupies 52.0 thousand hectares.

In agriculture, for the development of the livestock industry, grasslands are of particular value. Hayfields are land areas that are systematically used for haymaking. 159.0 thousand hectares are occupied by hayfields.

For the livestock industry, grassland is significant. Pasture is agricultural land intended for grazing farm animals. 777.4 thousand hectares are occupied by pastures.

According to the accounting data as of January 1, 2016, the area of agricultural land amounted to 4077.6 thousand hectares. Analysis of changes in the area of agricultural land

has identified minor changes. The structure of agricultural land is shown in Figure 1.

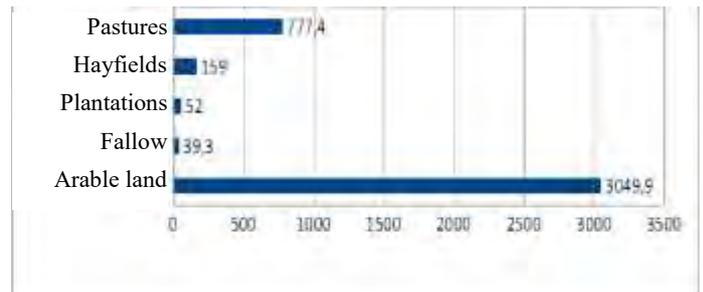


Fig. 1. The structure of agrarian lands of Voronezh region.

IV. CONCLUSION

The environmental crisis in the agricultural sector can be overcome through the formation of agricultural landscapes that are resistant to negative natural phenomena of on-farm land management. The system for organization of differentiated crop rotations, their territorial structure ensures preservation and reproduction of soil fertility, reduces damage caused by droughts, soil erosion. In ecologically balanced adaptive farming systems, an increase in crop yields by 20–25% is observed. Payback of landscape environmental activities can be achieved in 2 - 3 years.

Based on the statistical reporting figures, Voronezh region can be characterized as the largest and richest agrarian region of the Russian Federation.

Modern reality suggests that the effects of land redistribution had a negative effect on the nature of land use, reduced soil fertility, and increased degradation processes. The changing structure of land categories influenced the agricultural landscapes of the region and decreased their resistance to negative natural and anthropogenic load. The 2015 analysis showed that land degradation was observed in the whole region. The main negative processes leading to deterioration of land, soil and vegetation are as follows: water erosion and deflation, waterlogging, flooding, salinization and alkalization of land. Water erosion is typical of 17.8%, deflation - 8.4%, waterlogging - 12.3%, salinization and alkalinity - 20.1% of agricultural land. The above-mentioned ecological degradation processes destabilize agricultural landscapes of the region. Single processes of land reclamation cannot prevent agricultural landscapes and their ecosystems from degradation.

The main environment-stabilizing lands occupy about 631.7 thousand hectares, including 471.7 thousand hectares of forests. Forests of protective significance occupy 164.7 thousand hectares. The rate of afforestation of the territory of Voronezh region is 12.1%. The forest area on agricultural land is 39.9 thousand hectares, and tree-shrub vegetation covers 155.2 thousand hectares. The area occupied by protective plantings is 146.2 thousand hectares, which is 3.8% of the area of agricultural land.

The consequences of the land reform taking place in the context of an acute social economic and legislative crisis have negative impacts on the use of land. The landscape ecological state of land is deteriorating, significant areas of arable land are not used. Erosion, deflation and soil degradation, soil fertility are negative consequences of the land reform. When using arable land, violations in the structure of sown areas are allowed, scientifically-based crop rotations are not developed, and farming is often conducted haphazardly.

The current state of land resources is characterized by large zonal, natural-landscape diversity. To overcome the crisis, comprehensive planning of development of agricultural territories along with proposals for protection of land resources, creation of conditions for the rational use of agricultural land, preservation and improvement of soil fertility, maintaining balanced farming regimes are needed. These conditions can be formed when designing sustainable agricultural landscapes with balanced farming regimes. When constructing a sustainable structure of agricultural land, there should be proposals for development of rural infrastructure, creation of the agricultural landscape with an optimal human living environment. The current situation requires territorial arrangement for agriculture and reformatting of all measures into the environmental management system of agricultural landscapes in order to implement the adapted agricultural use of nature. To solve the conceptual tasks, it is necessary to improve the methodological approaches to organization of the territories of arable land of agricultural enterprises. Field agricultural landscapes must be inscribed into zonal conditions and resistant to negative natural phenomena and agricultural load.

Acknowledgments

The presented scientific and methodological provisions were tested in accordance with the decrees of the administration of Voronezh region. "On the implementation of environmental systems of agriculture in the area" No 973 of September 26, 1996. A list of 110 basic farms for approbation of theoretical and scientific-practical provisions of the methodology for organizing and constructing sustainable agricultural landscapes and implementing adaptive,

environmentally balanced farming systems was approved by Order No. 395-P of April 11, 1997 "On the coordinating council for implementation of ecological landscape farming systems". The program of implementation of the project of an ecological - landscape system of agriculture in the farms of Voronezh region" was approved on January 14, 1998.

The work carried out in Voronezh region is supported and regulated by the Government Decree of November 8, 2001 No 780 "On the federal target program" Improvement of soil fertility in Russia for 2002-2005 " which says that "taking into account the experience of creating a modern model of the ecological-landscape system of agriculture in Voronezh region, the Program aims to develop this system in the farms of Voronezh region. Relevant activities and federal, regional and extrabudgetary funding are provided by the Program. It is planned to conduct on-farm land management based on the ecological-landscape farming system, change crop rotation and the structure of sown areas for 390 farms. "The work continued in accordance with the resolution of the administration of Voronezh region" On the approval of the Regulations on the draft adaptive landscape system of agriculture and soil protection" on February 4, 2014.

References

- [1] A. N. Naliukhin, A. A. Zavalin, O. V. Siluyanov, D. A. Belozerov, «Influence of Biofertilizers and Liming on Vetch–Oat Mixture Productivity and Change in Sod-Podzolic Soil», *Russian Agricultural Sciences*, Vol. 44, Issue: 1, pp. 58–63, 2018.
- [2] J. Langhammer, S. Roedlova, "Changes in water quality in agricultural catchments after deployment of wastewater treatment plant", *Environmental Monitoring and Assessment*, Vol.185, Is. 12, pp.10377-10393, 2013.
- [3] M. T. Abdo, S. R. Vieira, A.L.M. Martins et al. , "Gully Erosion Stabilization in a Highly Erodible Kandian Soil at Pindorama, São Paulo State, Brazil", *Ecological Restoration Journal*, Vol. 31, pp.246-249, 2013.
- [4] S.M. Hamitowa, A.P. Glinushkin, Y.M. Avdeev, A.N. Nalyuhin, A.V. Belyi, D.A. Zavarin, V.S. Snetilova, M.A. Lebedeva, E.D. Danilova, V.A. Semykin, I.Y. Pigorev, S.D.Lichukov, "Assessment of Microorganisms and Heavy Metals' Content in The Soils Of Arboretum Named After Nikolai Klyuev", *International Journal of Pharmaceutical Research & Allied Sciences*, Vol. 6, Is. 3, pp. 47-55, 2017.