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THE ASSESSMENT OF IMPACT ECOLOGICAL STABILITY OF TERRITORY ON THE ORGANIZATION OF RATIONAL LAND USE OF AGRICULTURAL ENTERPRISES

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Abstract

The ecological condition of agricultural land use is studied and the tendencies of significant changes of the ecological condition of lands in the process of transformation of land relations are revealed. Land valuation was carried out according to the degree of anthropogenic load. The coefficient of ecological stability of the territory, which is characterized by the level of intensive land use, is determined. Scenarios for the functioning of modern agroecosystems in agricultural land use have been developed. The main directions of ensuring an effective transition to an adaptive system of agriculture for the formation of efficient agricultural land use are outlined.

Key words*: agroecosystem, degree of anthropogenic load, coefficient of ecological stability, agricultural land use, agrolandscape*

INTRODUCTION

The transfer of agricultural production in modern conditions to a fundamentally new ecological-adaptive system of agriculture, its structural change with mandatory consideration of environmental factors, legislation, requirements and approved standards is certainly an important and effective prerequisite for successfully overcoming the existing environmental crisis, which in Ukraine has affected virtually all components of its natural environment [1].

The main purpose of such a policy should be to ensure ecologically balanced farming systems for the rational use and reproduction of natural (including land) resources, optimal coordination of social, environmental and economic criteria of a particular agricultural land use (territory) [20]. The main state mechanism for the formation of such ecologically safe agroecosystems is land management. Land management is a certain indicator of society's attitude to the ways and methods of the most efficient and rational use of agricultural areas (agrolandscapes) [17]. However, social needs are not always determined by the ecological expediency of land use, so land management should be based on a deep awareness of all the negative phenomena (social, economic, environmental) that can lead a certain agricultural land use (territory) to an ecological crisis. [6, 12].

Problems of formation of ecologically safe agroecosystems in modern agricultural land uses - a subject of numerous researches of many scientists [2, 6, 8, 15, 16, 17, 3, 7, 10, 11, 12, 13, 4]. Therewith, the concept of formation of ecologically safe agroecosystems can be considered as a new approach to effective land management due to the creation of new models of adaptive farming systems. The scenarios of development and functioning of modern agricultural production are not fully studied.

The purpose of the article is to assess the impact of ecological stability of the territory and anthropogenic load on the organization of rational land use in the conditions of transformation of land relations in Ukraine.

MATERIALS AND METHODS

In the field of land protection and soil fertility reproduction, the following standards are set: maximum permissible soil pollution; quality of soils; optimal ratio of land; indicators of land and soil degradation [2]. Standards for the quality of agricultural land are set to prevent their degradation and are used to monitor the quality of soil cover [19, 10].

The ecological situation significantly affects the agro-ecological condition of the soil cover and other components of agricultural landscapes. The ecological condition of the soil is an integral indicator of its ecological stability, level of fertility and pollution. [16, 11].

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According to the calculations of I. Rytorska and E. Hoike, the coefficient of ecological stability of individual lands is: for lands under built-up areas and roads – 0.00; arable land – 0.14; forest belts – 0.38; perennial plantings, shrubs – 0.43; backyard – 0.50; hayfields – 0.62; pastures – 0.68; ponds and swamps of natural origin – 0.79; forests of natural origin – 1.00. With different composition of land, the coefficient of ecological stability of the land use area (Ke.s) [17] is calculated by formula 1:

$$K_{e.s} = \frac{\sum(K_i * P_i)}{\sum P_i} * K_r \quad (1)$$

where:

Ke.s – coefficient of ecological stability of the land of the i-th type;

Pi – land area of the i-th type;

Kr – coefficient of morphological stability of the relief (1.0 – for stable areas and 0.7 – unstable).

The coefficient of anthropogenic load (Ka.l.) characterizes the magnitude of the impact of human activities on the environment, including land resources. This indicator is determined by formula 2:

$$K_{a.l} = \frac{\sum(P_i * B_i)}{\sum P_i} \quad (2)$$

where:

Pi – land area with the appropriate level of anthropogenic load, ha;

Bi – score of the corresponding area with a certain level of anthropogenic load.

The coefficient of anthropogenic load for lands under reserves is 1; for lands under forest belts, shrubs, forests, swamps, lands under water is 2; for lands under natural fodder lands, under the meadows on the beams – 3; for lands under arable lands and perennial plantations – 4; for lands of industry, transport, settlements 5 score.

RESULTS AND DISCUSSIONS

Land management is an integral part of the economic system of society and is a complex, multifaceted process that depends on the nature of production relations, forms of land ownership and other means of production. Such features suggest that:

–economic efficiency of land use should be assessed based on the system of economic relationships and, accordingly, requires a system of land use indicators;

–in determining the economic efficiency of different types of land use must take into account, on the one hand, the collective and personal interests of land users and landowners, and on the other - the public interest;

–since land is an element of the natural environment it is necessary to take into account the conditions of soil fertility reproduction and ecological characteristics of the territory;

–when calculating efficiency indicators, it is important to highlight the effect of land management, comparing it with the corresponding costs and ensuring qualitative homogeneity and quantitative comparability of indicators (for different enterprises,

components and elements of the land management project);

–as land management projects are related to the implementation of land use improvement projects, water management, industrial and road construction, etc., it is necessary to take into account the investment efficiency of measures taken in the period before the full development of the project. As well as the cost of formation (replenishment) of fixed and current assets and related costs associated with compensation for losses and environmental protection;

– time gaps between the introduction of capital investments and obtaining the effect of them require a comparison of the effect and costs that do not coincide in time [22].

Land use can be considered in relation to the environment, material production and society as a whole. Accordingly, the overall efficiency of land use is divided into environmental, economic and social.

Due to the lack of a full-fledged market for agricultural land, land relations in Ukraine have been forced to become leased. The short duration of the lease is the main reason why most tenants do not have a careful attitude to land resources. In fact, land users are not interested in the long-term preservation of the productive properties of land that is not their property and with which they do not associate long-term economic interests. In addition, the owners of land plots are mostly elderly people who will never work on the land again and who are mostly interested in maximizing the income from renting out property. From the point of view of "big business", agriculture is often seen as a project with short-term goals, which aims to maximize income in the short term without strategic plans for the future. Thus, the former approaches to systemic land protection, which were based on centralized planning and budget financing of almost all soil protection measures in the implementation of land management, no longer work in modern conditions.

Due to the unfounded and intensification of agricultural production ekolohonebezpechnoyu current state lands became threatening, due to the constant strengthening their degradation. The latter is now one of the major production problem that makes it impossible to achieve high ecological and economic efficiency of land use.

If we compare the level of profitability of agricultural enterprises in the region with this indicator of the end of the Soviet period (since 1990), it decreased from 40.8 to 14.2%. This emphasizes once again that the opportunities for reinvestment of profits in soil protection measures in modern conditions are quite limited.

An important component of a comprehensive land use is evaluating the effectiveness of environmental efficiency. Environmental efficiency is related to the need to protect nature, reproduce and rationally use natural resources. It is manifested primarily through the impact of land management measures on the environment and the nature of land use as an important component [21].

Assessments of ecological stability and anthropogenic load of the territory are an integral part of the characteristics of agricultural lands in terms of quality.

Basic qualitative indicators that indicate the ecological balance of agrolandscapes, their sustainability and the degree of transformation under the influence of economic activity – are the coefficients of anthropogenic load and ecological sustainability [2, 8]. These coefficients make it possible to comprehensively assess how rational the structure of the land fund is.

State policy on the use of agricultural land should be based on two interrelated concepts: efficient and intensive use of land resources to provide the population with food, as well as the implementation of a system of measures for the protection of land resources [18, 3].

Rational use of land directly depends on its purpose, because only operating with a clearly defined purpose of land use can develop a list of specific methods of its use, determine the placement features of productive forces within the plot, establish the composition of land, to exercise control over the rational land use.

Soil degradation is a major food security problem in agricultural land use, creating environmental constraints for agricultural expansion.

Agroecological parameters, which are limiting factors in agriculture, include soil, climate and relief [2].

Efficient use of land resources is characterized by the coefficient of ecological stability of the territory, which characterizes the level of intensive land use.

The results of the calculation of the ecological stability of the study area are shown in Table 1.

Table 1. Calculation of ecological stability of the territory of Kyiv region

Name of lands	Coefficient ecological stability of the land, K_i	Land area (thousand hectares) , P_i	$K_i * P_i$	$K_{e.s.}$
Arable	0.14	1,367.7	191.48	-
Fallows	0.60	13.7	8.22	-
Perennial plantings	0.36	40.7	14.65	-
Hayfields	0,62	116.4	72.17	-
Pastures	0.68	136.4	92.75	-
Total agricultural land	-	1,674.9	379.27	0.23
Forests of natural origin	1.00	632.5	632.50	-
Shrubs	0.43	17.2	7.40	-
Built-up land	0.00	116.0	0.00	-
Other lands	0.00	196.0	0.00	-
Ponds and swamps of natural origin	0.79	175.5	138.65	-
Total land	-	2,812.1	1,157.81	0.41

Source: calculated by the authors according to the State Geocadastre of Ukraine.

The stability of the territory is assessed according to the value of Кес.:

–0.33 and less – land use is environmentally unstable;

–0.34-0.50 – land use is stably unstable;

–0.51-0.66 – land use is within the limits of medium stability;

–0.67 and more – land use of ecologically stable.

The coefficient of ecological stability of agricultural lands of Kyiv region is 0.23, and the territory of land use of the region as a whole – 0.41. Thus, the calculations show that the territory of Kyiv region is stably unstable, and the land under agricultural lands is ecologically unstable. The anthropogenic load factor, calculated in Table 2, shows how strongly human activity affects the state of the environment.

Table 2. Estimation of lands by the degree of anthropogenic load

Name of lands	The score impact of land on the territory, B_i	Land area (thousand hectares) , P_i	$B_i * P_i$	$K_{a.l.}$
Arable	4	1,367.7	5,470.8	-
Fallows	3	13.7	41.1	-
Perennial plantings	4	40.7	162.8	-
Hayfields	3	116.4	349.2	-
Pastures	3	136.4	409.2	-
Total agricultural land	-	1,674.9	6,433.10	3.84
Forests of natural origin	2	632.5	1,265.0	-
Shrubs	2	17.2	34.4	-
Built-up land	5	116.0	580	-
Other lands	0	196.0	0.0	-
Ponds and swamps of natural origin	2	175.5	351.0	-
Total land	-	2,812.1	8,663.50	3.08

Source: calculated by the authors according to the State Geocadastre of Ukraine.

The coefficient of anthropogenic load on agricultural lands of Kyiv region amounted to 3.84, which exceeds the average value of this indicator in Ukraine by 11.5%.

High plowing of the territory, especially agricultural lands reduces soil fertility, deepens the ecological crisis in land use. However, plowed land does not fully reflect the state of ecological and economic efficiency of land use. It is advisable to study the coefficient of plowing of agricultural land, which is calculated as the ratio of arable land to the area of agricultural land [14]. The plowing coefficient of the studied territory

was 64%, which is a negative indicator of land use in agricultural land use.

The forest cover ratio reflects the share of forests, shrubs and forest belts in the structure of all lands and is 14%, which is less than the average in Ukraine (18%). In combination with other natural resources, forest resources are an integral part of the productive forces of the country directly involved in economic development, in meeting the social needs of society, act simultaneously as a means of production, object and product of labor.

The territory of Kyiv region is characterized by a satisfactory ecological condition, plowing, the structure of agrolandscapes of which is closest to the optimal values. The landscapes of the region need minor structural changes and maintenance of the existing ecological balance in the ratio of agricultural lands [15]. In the structure of the land fund of Kyiv region, large areas are occupied by soils with unsatisfactory properties (washed away, deflated, waterlogged, swampy, etc.), which is due to anthropogenic factors and negative natural features. According to the classification of suitability categories, these are degraded and unproductive lands (low-fertile soils).

Violation of the ratio of arable land, natural forage and forest lands has negatively affected the sustainability and condition of agrolandscapes. The acute issues that arise in modern agriculture are the result of unresolved economic and environmental problems. Violation of the ratio of arable land, natural lands, forests and water resources, has caused soil degradation.

The formation of sustainable agricultural production mainly begins with the existing specialization of specific agricultural enterprises and the level of agricultural intensity.

Sustainable (sustainable) functioning of agroecosystems is based on scientifically sound specialization of agricultural enterprises, where livestock and crop production are harmoniously correlated, as well as crops that improve the soil and positively affect its fertility [1]. On this basis, the formation of the optimal structure of sown areas is carried out, a flexible system of crop rotations with the best predecessors is developed, energy-saving technologies are introduced. [2, 20].

As a result of the alienation of matter and energy, recycling is significantly increased and, accordingly, the costs of anthropogenic resources for restoring lost soil fertility and maintaining the energy potential of the entire existing agroecosystem are increased [2]. Thus, the narrow crop specialization of production systems causes a decrease in the structure of sown areas of the share of crops with a high ability to improve the environment, including perennial legumes [20]. It is the reduction of livestock, on the one hand, reduces the need to grow crops such as perennial grasses, corn, post-harvest and after mowing fodder mixtures, and on the other hand - leads to a significant reduction of manure from cattle. It is the reduction of livestock, on the one hand, reduces the need to grow crops such as perennial grasses, corn, post-harvest and after mowing fodder mixtures, and on the other hand – leads to a significant reduction of manure from cattle [1].

The agricultural lands of Kyiv region include especially valuable productive lands (54.8%) with an average humus content of 3.1%. Here you can grow almost all crops typical of the forest-steppe zone and Polissya. Investment attractiveness of the agricultural sector of Kyiv region is quite high due to favorable natural and climatic conditions, favorable economic and geographical location, developed production and market infrastructure [5].

Producers of agricultural products in the study region mainly specialize in the production of such highly profitable crops as sunflower, rapeseed, soybeans, which are soil-depleting.

During the period 1999-2019, there was a slight increase in all sown areas of agricultural crops in Kyiv region (5.66%) in Ukraine; although the redistribution of areas by crops during this period has changed significantly, namely, increased crops of highly profitable export-oriented crops. This is evidenced by the structure of sown areas of Kyiv region from 1999 to 2019 (Fig. 1).

Thus, the sown area under sunflower from 1999 to 2019 increased by 87.66%, which violates the crop rotation system and leads to soil depletion. The sown area of cereals and legumes in the period from 1999 to 2004 increased by 20.38%, and from 2004 to 2019 decreased by 8.16%. Crops under sugar beet have significantly decreased (from 1999 to 2019 there was a decrease in area by 77.42%), as they are being displaced from crop rotation by more profitable but lower cost crops.

Failure to comply with crop rotations, the pursuit of high profits, neglect of land protection measures, constant «soil fatigue», soil depletion – all this leads to the inevitable degradation of soils.

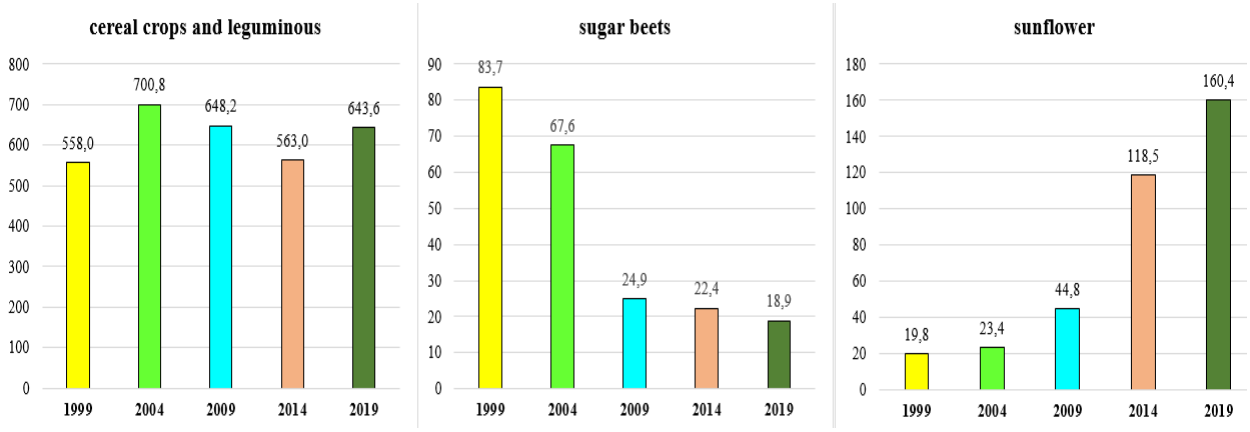

Fig. 1. Sown area of crops in the Kiev region, thousand hectares
Source: Main department of statistics in Kyiv region - Crop Production (1995-2019).

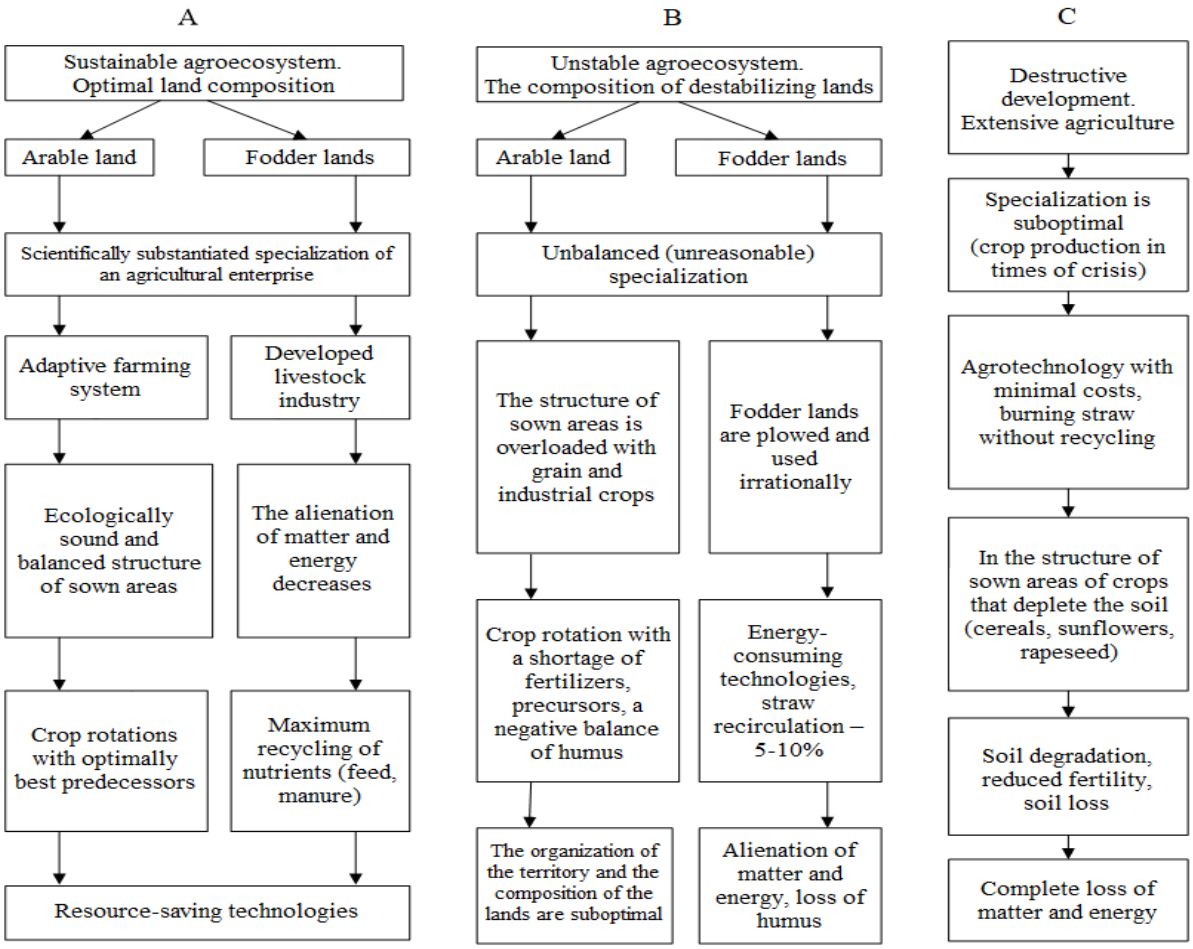

Fig. 2. Scenarios of functioning of modern agroecosystems
Source: Own research.

Destructive development of the agroecosystem is based on extensive agriculture, where crop rotations are not observed, rational organization of the territory, structure of sown areas, which causes a certain degradation of the agroecosystem and reduction of total humus reserves [20]. Such destructive development of the agroecosystem is characteristic of modern agriculture in the newly formed agro-formations on a lease basis [2].

Scenarios for the functioning of modern agroecosystems are shown in Figure 2.

Based on the above scenarios, we can talk about the need for land management in certain areas (agricultural enterprises), where the environmental situation is catastrophic (or close to it). In such cases development of the corresponding projects of the land management with such organization of the territory and system of agriculture which normalize an ecological situation is necessary [6]. At the same time we must not forget the axioms – «environmentally acceptable land use is environmentally sound» and, conversely, negative environmental phenomena lead to significant economic losses.

Ukraine has accumulated extensive experience in developing and implementing various land management projects for the organization of land use, including the soil protection system of agriculture [2].

The need for such capital-intensive measures can be explained by the desire to counteract the numerous erosion processes on unjustifiably plowed slopes with intensive use of such lands [20].

For Ukraine, where the level of plowed land exceeds the ecological norms almost twice, such approaches are unfounded, as most of its territory has enough space for growing major crops (in particular, arable land on slopes up to 3°) [1].

Therefore, when conducting land management in such agricultural enterprises, mainly organizational and economic measures are implemented, which consist in involving only suitable lands (soils) for use [7].

Modern adaptive systems in agriculture should take into account not only the peculiarities of natural conditions (climate, relief, soils), but also individual elements of the existing landscape, choosing the most suitable land for growing major crops [6, 17].

CONCLUSIONS

In the conditions of development of soil degradation due to increase of anthropogenic load, disturbance of ecological stability of agrolandscapes it is important to optimize the ratio of natural ecosystems, to apply anti-erosion organization of the territory both at local and regional levels.

To ensure an effective transition to an adaptive system of ecological and economic agriculture in modern conditions it is necessary:

–to develop (improve) landscape farming systems;

–actively apply economic influence on land use entities (ecologically dangerous land use should be economically unprofitable);

–to withdraw according to the established criteria from intensive cultivation of unproductive lands and introduction of a complex of reclamation measures on arable lands. This will increase the productivity of agroecosystems and preserve soil fertility

–to optimize the composition of land of agricultural enterprises, applying environmental standards in the formation of spatial organization of the territory;

–constant provision in crop rotations of deficit-free balance of humus due to fertilizer application and maximum recirculation of nutrients;

–to improve the structure of sown areas by introducing dynamic (flexible) crop rotations by reducing the share of row crops and increasing the area of perennial grasses.

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