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ENVIRONMENTAL CRITERIA AND INDICATORS FOR ASSESSING THE OPTIMALITY OF THE PARAMETERS OF THE AGRICULTURAL LAND USE SYSTEM

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Abstract. *The article analyzes the current state of the regulatory framework in the field of land use and protection, which is the basis for assessing the optimality of the ecological parameters of the agricultural land use system. It was established that the vast majority of standards (optimal parameters) in the researched field are of a recommendatory nature, and therefore need to be systematized and consolidated in the relevant legal acts.*

The need for the structuring of ecological criteria and indicators for assessing the optimality of the parameters of the agricultural land use system, taking into account the norms of the Law of Ukraine "On Land Protection" regarding regulations in the field of land protection and reproduction of soil fertility, is substantiated. Taking into account the Law of Ukraine "On Land Protection", the

division of criteria and indicators for assessing the ratio of land plots is given; criteria and indicators for assessing man-made soil pollution; criteria and indicators of soil quality assessment; criteria and indicators of land and soil degradation assessment.

The optimal parameters of the ratio of land areas and the norms of assessments of the ecological state of lands caused by man-made pollution are highlighted. Optimum parameters of the volume mass of soils are indicated on the example of sod-podzolic sandy soil. Optimum parameters of the qualitative state of soils and diagnostic criteria and indicators of agrophysical and agrochemical degradation of soils are indicated.

Keywords: *agricultural land use, system, optimality of land use, ecological criteria and indicators.*

Problem statement. The actual state of use of land resources in the agricultural sector of the economy does not correspond to the principles of rational nature management, and therefore requires optimization, the main difficulty of which is the need to overcome the contradiction between the socio-economic needs of the population and the requirements of environmental safety. That is why an adequate assessment of the optimality of the parameters of the system of rational agricultural land use is necessary for making weighted scientifically based management decisions in the field of land use and protection.

Since land resources are considered, at the same time, as a natural habitat, a production resource and a social category, the term "optimality of land use" has a threefold formula and implies a harmonious combination of ecological, economic and social directions of optimization. At the same time, the optimality of the socio-economic component of the agricultural land use system should be considered only in the context of ensuring the normative state of the environment, that is, the optimal parameters of the ecological component of the studied system.

The assessment of the optimality of the actual indicators of the ecological component of the agricultural land use system should be carried out by comparing

them with the optimal parameters established on the basis of the generalization of the results of research by domestic research institutions and established by the relevant legal acts. Information about the actual indicators of the ecological component of the agricultural land use system at the regional and national levels can be obtained on the basis of the data of the "large-scale soil survey, the State Land Cadastre and agrochemical certification of agricultural lands, the results of which are reflected in the properly issued: technical passport of the land plot; soil passport; agrochemical passport of agricultural lands" [1].

In connection with the above, the development and substantiation of the criterion basis for assessing the optimality of ecological parameters of the agricultural land use system are relevant.

Analysis of recent research and publications. The works of such scientists are devoted to the issue of optimizing agricultural land use, in particular to its ecological aspects, in the context of reforming land relations Dobriak D., Bulyhin S., Kryvov V., Medvediev V., Saiko V., Sokhnych A., Tarariko O., Tretiak A., Kanash O., and other.

However, the need to make balanced management decisions under conditions of accelerated dynamics of transformational processes in the agrarian sphere determines the urgent need to justify criteria and determine standards for assessing the optimality of ecological parameters of the agricultural land use system.

The purpose of the article – to substantiate the criterion basis for assessing the optimality of ecological parameters of the agricultural land use system.

Materials and methods. During the study of issues related to the determination of ecological criteria and indicators of assessment of the optimal system of agricultural use, methods of scientific knowledge were used: monographic, analysis, generalization. Thanks to the monographic method and the method of analysis, scientific studies and a legal framework were developed regarding the criteria and indicators of the optimality of the parameters of the agricultural land use system. Using the method of generalization, criteria and indicators for assessing the

optimality of ecological parameters of the system of agricultural land use are proposed.

Main Material. The analysis of legal acts and literary sources in the field of land use and protection made it possible to identify (taking into account the composition and content of currently valid agrochemical passports of fields and land plots) ecological criteria and indicators for assessing the optimality of the parameters of the agricultural land use system, which, taking into account the norms of the Law of Ukraine About land protection" is divided into 4 groups: 1) criteria and indicators for assessing the ratio of land plots; 2) criteria and indicators for assessing man-made soil pollution; 3) criteria and indicators of soil quality assessment; 4) criteria and indicators of land and soil degradation assessment.

1) Criteria and indicators for evaluating the ratio of land plots

According to Article 33 of the Law of Ukraine "On Land Protection" "standards for the optimal ratio of land plots include" [2]:

"optimal ratio of agricultural, nature reserve and other nature protection, health, historical and cultural, recreational lands, as well as forest and water fund lands (criterion A)" [2];

"optimal ratio of arable land and perennial crops, hayfields, pastures, as well as land under field protection forest strips in agricultural landscapes" (criterion B)" [2].

To assess the optimality of criterion A), the following indicators are offered: the level of agricultural development of the territory, %; the level of plowing of the territory, %; the level of forest cover in the territory, %; level of territory protection, %; coefficient of ecological stability of the territory.

The optimal parameters of the listed indicators, which are obtained based on the generalization of the data of scientific institutions, are given in Table 1.

For the first time, the problem of optimizing the structure of land was highlighted in the writings of V. Dokuchaiev, who emphasized the need to observe certain norms of the relationship between arable land and natural objects (meadows, marshes, water bodies, forests) in relation to specific soil and climatic conditions and

the nature of cultivated plant products, and argued that the violation of these norms intensifies the degradation processes [5].

Table 1

Optimal parameters of the ratio of land plots

The name of the criterion, indicator	Optimal (normative) the value of indicators
A) ratio of agricultural, nature reserve and other nature protection, health, historical and cultural, recreational lands, as well as lands of forest and water funds	
level of agricultural development of the territory, %	≤65
the level of plowing of the territory, %	≤40**
the level of forest cover of the territory, %:	
Polissia zone	36-37*
Forest Steppe zone	17-18*
Northern and Central Steppe zone	10-11*
Southern Steppe zone	8-9*
Ukraine	20-22
protected area level, %	10-12
coefficient of ecological stability of the territory	≥0,67
B) the ratio of arable land and perennial crops, hayfields, pastures, as well as lands under field protection forest strips in agricultural landscapes	
the level of plowing of agricultural land, %:	
Polissia zone	40-50*
Forest Steppe zone	45-55*
Northern and Central Steppe zone	55-60*
Southern Steppe zone	60-65*
Ukraine	≤50**
the ratio of arable land and ecologically stable agricultural land	≤1
coefficient of ecological stability of agricultural land	≥0,67

Reference: *[3]; **[4]

The beginning of the solution to this problem in Ukraine was the establishment of standards for optimal forest coverage of territories, which were determined by modeling forest systems in key areas located in all natural and climatic zones of the country. At the national level, according to S. Hensiruk and V. Bondar (1973), the optimal forest cover should have been 20-25% [6], and in terms of natural and climatic zones: "for the Steppe zone - 5-10%, for the Forest-Steppe zone - 16-20%, Polissia zones - 40%" [3].

Currently, the indicator of the optimal forest cover of the territory of Ukraine is fixed by the Order of the Ministry of Environmental Protection and Natural

Resources of Ukraine "On approval of the indicators of regional standards of the optimal forest coverage of the territory and the minimum necessary protective forest cover of the agro-landscapes of Ukraine" dated July 22, 2021 No. 494, and is 20%, and at the regional level it can range from 5% in Zaporizhia Oblast to 55% in Zakarpattia Oblast [7].

It should be noted that in the process of reforming land relations, favorable conditions were created for increasing the area of nature reserve and other nature conservation lands to 10-12%, which is connected, in particular, with the removal of eroded arable land from intensive use; establishment of water protection zones and coastal protective strips around/along rivers and other water bodies; by increasing the area of forest plantations around industrial and residential zones; the need for Ukraine to fulfill its international obligations in the field of environmental protection.

The withdrawal from agricultural circulation of "9-12 million hectares of degraded arable land will allow to reduce the plowing of the territory at the national level to 40% and increase the total forest cover to 20%, and the protective field cover - to 4%, which will create a foundation for conducting full-fledged soil water protection agriculture in Ukraine and increase its productivity" [8]. At the same time, optimization of the structure of land at the regional level should be carried out exclusively by developing an appropriate land management scheme, and at the local level - an appropriate land management project.

The result of optimizing the ratio of agricultural, nature reserve and other nature conservation, historical and cultural, health and recreational purposes, as well as water and forest fund lands at the national level should be ensuring the ecological stability of the country's territory, which is characterized by a corresponding coefficient at a level not lower than 0. 67.

The following indicators are offered to evaluate criterion B): level of plowed agricultural land, %; the ratio of arable land and ecologically stable agricultural land; coefficient of ecological stability of agricultural land.

A scientifically unfounded approach to the organization of the use of land resources in the agricultural sphere has led to the formation of an inferior system of

agricultural land use in all regions of Ukraine, which is characterized by low economic efficiency, environmental threats and social unattractiveness. Considering this, the main task of optimizing agricultural land use at the regional level is the formation of an effective market-type system that will ensure not only high economic indicators, but also environmental safety of the region. This process should take place taking into account the natural and economic, climatic, historical and geographical features of the region [8]. When forming a model of agricultural land use for a specific region, it is also necessary to take into account a number of limiting factors: insufficient amount of highly productive agricultural land; ecological factor of the territory, which is subject to preservation and reproduction; the unsatisfactory state of land resources, caused by various reasons, mainly excessive anthropogenic load on the soil cover and as a result - a significant spread of degradation processes.

Scientists of the O. Sokolovskoho NAAS of Ukraine National scientific center institute of soil science and agrochemistry proposed a solution to the problem of land structure optimization through the concept of entropy. At the same time, "in the agricultural landscape as a self-organized system, the share of chaos, which is directly related to the percentage of destabilizing land: arable land, should not exceed 38%, and therefore, the level of plowed territory should be lower than 40%, and agricultural land should be lower than 50% %" [4]. Considering this, it is proposed to reduce the area of arable land by 10 million hectares.

The result of optimizing the ratio of arable land and perennial crops, pastures, hayfields, lands under field protection forest strips in agrolandscapes at the national level should be the provision of ecological stability of agricultural lands, characterized by a corresponding coefficient at a level not lower than 0.67.

2) Criteria and indicators for assessing man-made soil pollution

According to the norm of Article 31 of the Law of Ukraine "On Land Protection" "the norms of maximum allowable soil pollution include:

maximum permissible concentrations in soil of chemical substances, residual amounts of pesticides and agrochemicals, heavy metals, etc.;

maximum permissible levels of soil contamination with radioactive substances" [2].

Soil contamination with pesticides, heavy metals, and radionuclides is the most dangerous for the environment, so the assessment of the ecological state of the land should be carried out using the following criteria: 1) the content of the residual amount of pesticides in the soil and plant mass, mg/kg; 2) content of gross forms of heavy metals in soils and plant mass, mg/kg; 3) content of mobile forms of heavy metals in soils, mg/kg; 4) density of soil contamination with cesium-137 and strontium-90, Ki/km2.

It should be taken into account that it is quite difficult to assess the ecological condition of soils caused by technogenic influence. It is especially difficult to establish the beginning of man-made degradation, because its consequences in most cases are not visually observed, therefore, for the diagnosis of such a process, it is necessary to use mainly quantitative indicators, and to combine soil research with the analysis of the chemical composition of plants grown in the studied territories. In this case, these plants act as test cultures.

The modern system of regulation of technogenic impact on the environment takes into account only the sanitary and hygienic standards of individual indicators, which is why it is ineffective in terms of diagnosing the productive functions of the soil. In addition, the multi-component composition of production emissions reduces the effectiveness of monitoring compliance with regulations for each individual element, since it is not possible to predict the effect of the cumulative effect of pollutants on ecosystems in different natural and agricultural zones.

Taking into account the above, for the correct formation of the regulatory framework necessary for the assessment of the ecological state of the land, information is needed on: 1) critical levels of pesticide load and MPC of pesticides; 2) clarics and MPCs of heavy metals; 3) standards of radiation background levels.

According to clause 5.3.3 of DSTU 4362:2004 "Soil quality. Indicators of soil fertility" "The benchmark for soil contamination with radionuclides is soil whose radioactive contamination does not exceed the normal natural background. For

mineral soils, the pollution density should not exceed 1.0 Ki/km2 for cesium - 137 and 0.02 Ki/km2 for strontium - 90. The content of gross forms of heavy metals in the reference soil should not exceed 1 clark or 0.5 MPC, and the content of pesticide residues is less than 0.5 MPC" [1].

Table 2 summarizes the data on standards for assessing the ecological state of lands caused by man-made pollution.

Table 2

Norms for assessing the ecological state of lands caused by man-made pollution

Type of ecological situation	**Pesticides**			**Heavy metals**				**Density of soil contamination with radionuclides, Ki/km²**	
	load, kg/ha d.r. in a year	Residual quantity (relative to GDC)		Gross forms			Moving forms		
				in the soil		in plants	in the soil		
		in the soil	in plants	clark	relative to the GDC			Cs-137	Sr-90
1. Favorable	<3	are not detected	are not detected	<1	<0,5	<1	<1	at the level of the natural background	at the level of the natural background
2. Satisfactory	3-4	<1	<1	1-2	0,5-1,5	<1	<1	<1,0	<0,02
3. Pre-crisis	4-5	<1	<1	3-4	1,6-2	<1	1,0-2,0	1-5	0,02-1,0
4. Crisis	5-7	1,0-1,5	1,0-1,5	5-6	2,1-2,5	1,1-1,5	2,1-10	6-15	1,1-3
5. Catastrophic	>7	>1,5	>1,5	>6	>2,5	>1,5	>10	>15	>3

Reference: [9]

3) Criteria and indicators for assessing the quality of justifications

According to Article 32 of the Law of Ukraine "On Land Protection" "Standards for the qualitative condition of soils determine the level of pollution, optimal content of nutrients, physical and chemical properties, etc." [2].

Considering this, the quality condition of the soil should be assessed using the following indicators: humus content%; the content of mobile compounds of nitrogen, phosphorus, potassium, mg/kg soil; soil density, g/cm3; pH of water and salt extract; sum of absorbed bases (Ca+Mg), mg-eq/100 g of soil.

According to clause 5.3.1 of DSTU 4362:2004 "Soil quality. Indicators of soil fertility" "The standard (standard) is the optimal value of the diagnostic indicator within a specific type of soil formation according to the granulometry (physical clay content)" [1]. Therefore, the optimal values of the indicators mentioned above are differentiated depending on the specific type of soil-forming process and granulometry (physical clay content) (Table 3).

Table 3

Optimal parameters of soil quality (soil layer 0-25 cm)

Indicators	**Parameters depending on granulometry (physical clay content, %)**						
	sandy <5	generally sandy 6 – 10	Sandy 11 – 20	light-loamy 21 – 30	medium-loamy 31 – 45	heavy loamy 46 – 55	easily - clayey 56 – 65
1	2	3	4	5	6	7	8
Polish zone. Sod-podzolic unglazed soils							
Humus, %	-	0,5-0,6	0,6-1,3	1,2-2,0	-	-	-
Available forms of nitrogen (N-NO3+N-NH4)	-	30 – 40	35 – 45	35 – 45	-	-	-
Mobile phosphorus according to Kirsanov	-	120 – 170	150-200	150 – 200	-	-	-
Mobile potassium according to Kirsanov	-	150 – 200	170-220	170 – 220	-	-	-
Density, g/ cm ^{3}	-	1,5-1,6	1,4-1,5	1,3-1,4	-	-	-
pH salt extractor	-	4,6-5,4	4,6-5,4	5,0-6,0	-	-	-
The amount of absorbed bases (Ca+Mg), mg-екв/100 g	-	3,0-4,0	4,0-6,0	6,0-8,0	-	-	-
Forest-steppe zone. Black soils are typical							
Humus, %	-	-	-	2,5 – 4,0	3,5 – 5,0	4,5 – 5,7	5,5 – 6,3
Available forms of nitrogen (N-NO3+N-NH4)	-	-	-	35 – 45	35 – 45	35 – 45	35 – 45
Mobile phosphorus according to Kirsanov	-	-	-	45 – 60	45 – 60	45 – 60	45 – 60
Mobile potassium according to Kirsanov	-	-	-	250 – 300	300 – 400	300 – 400	300- 400
Density, g/ cm ^{3}	-	-	-	1,1 – 1,3	1,1 – 1,3	1,1 – 1,3	1,1 – 1,3
pH salt extractor	-	-	-	5,8 – 6,4	6,0 – 6,8	6,3 – 7,0	6,5 – 7,0
The amount of absorbed bases (Ca+Mg), mg-екв/100 g	-	-	-	14,0 – 27,0	21,0 – 36,0	32,0 – 44,0	39,0-55,0
Step zone. Black soils are southern							
Humus, %	-	-	-	-	-	2,5 – 3,6	3,1 – 4,3

Available forms of nitrogen (N-NO3+N-NH4)	-	-	-	-	-	35 – 45	35 – 45
Mobile phosphorus according to Kirsanov	-	-	-	-	-	45 – 60	45 – 60
Mobile potassium according to Kirsanov	-	-	-	-	-	300 – 400	300-400
Density, g/ cm ^{3}	-	-	-	-	-	1,2 – 1,3	1,2 – 1,4
pH salt extractor	-	-	-	-	-	7,0 – 7,7	7,0 – 7,7
The amount of absorbed bases (Ca+Mg), mg-екв/100 g	-	-	-	-	-	30 – 42	39 – 50

Reference: [1]

However, according to V. Patyka and O. Tarariko (2002), for soils that are light in terms of granulometric composition, the optimal indicators of equilibrium density (bulk mass) are in the range of 1.30-1.50 g/cm3, and an excess of these parameters indicates degradation soil and indicates the need to apply preventive measures (introduction of increased doses of organic fertilizers, use of lightweight equipment, etc.) [10]. This approach does not agree with the optimal parameters of the density of sod-podzolic cohesive-sandy soils given in DSTU 4362:2004, since the bulk density in the range of 1.50-1.60 g/cm3 (Table 3) indicates the presence degradation processes on these soils. But this is nonsense, because degraded soil by definition cannot have optimal fertility parameters.

The analysis of the experimental data obtained by us in the stationary experiment laid out in Kyiv Polissia allowed us to establish that for an adequate assessment of the qualitative state of the soils on the cultivated lands by the value of the equilibrium density (volumetric mass), in addition to the granulometric composition of the soils, which is provided for by the existing methodical recommendations, it is necessary to take into account the type of agricultural crop grown, the agrobiological features of which are associated with a set of certain technological operations related to soil cultivation and the introduction of agrochemicals [11].

Based on this, table 4 shows the optimal indicators of the volumetric mass of the studied soil, taking into account the cultivated crops.

Table 4

Optimum indicators of bulk mass (g/cm3) of sod-podzolic sandy soil

Agricultural culture	Optimal bulk mass parameters *
Lupine	1,47-1,58
Winter rye	1,48-1,58
Potato	1,39-1,45
Barley	1,50-1,57
Clover	1,41-1,49
Winter wheat	1,44-1,50
Corn	1,42-1,49

* the given parameters are conditionally optimal, as they ensured the maximum yield of agricultural crops under the specific weather and climate conditions of this experiment

4) Criteria and indicators of land and soil degradation assessment

According to Article 34 of the Law of Ukraine "On Land Protection" "the standards of land degradation indicators include indicators of the maximum permissible deterioration of the condition and properties of land resources as a result of anthropogenic influence and negative natural phenomena …» [2].

The evaluation of land and soil erosion under the influence of water erosion is proposed to be carried out using the following indicators: the intensity of actual water-erosion soil losses, t/ha per year; the actual erosion occurring in a certain area, %.

The following indicators should be used for normalization of water erosion hazard parameters: 1) Erosion rate n=0.1%H, where H is the thickness of the upper humus horizon of the full-profile soil (in cm), t/ha; 2) Erodibility coefficient (K), which is: for weakly eroded soils -1.2, moderately eroded -1.4, strongly eroded -1.6; and for a specific territory is defined as a weighted average value; 3) Indicator of soil erosion manifestation (PPEG, %); 4) Volume of potential liquid flow (PS), mm.

The neutral level of land degradation under the influence of water erosion processes is characterized by the following indicators: annual soil erosion losses do not exceed the erosion rate; the weighted average coefficient of erosion does not exceed 1.05; PPEG<5%; d) PS <5.0 mm.

It is proposed to evaluate the deflation of lands and soils under the influence of wind erosion using such an indicator as the intensity of wind-erosion soil losses, t/ha

per year. At the same time, deflation is considered absent if the average annual wind-erosion losses of the soil do not exceed the rate of erosion.

Agrophysical soil degradation is diagnosed according to the following criteria and indicators: structural-aggregate composition: content of air-dry aggregates 0.25-10 mm in size, %; the content of water-resistant aggregates over 0.25 mm in size, %; equilibrium density, g/cm3; water permeability, mm/h; agrochemical degradation (depletion of soils for nutrients) - nitrogen content of easily hydrolyzable compounds, mg/kg of soil; content of mobile phosphates, mg/100 g of soil; content of exchangeable potassium, mg/100 g of soil (Table 5).

Table 5

Diagnostic criteria and indicators of agrophysical and agrochemical soil degradation

Indicators	**Degree of soil degradation, lack of harvest,%**			
	weak, to 10	average, 10-50	strong, 50-90	full, 90-100
Agrophysical degradation				
Structural and aggregate composition, %:				
air-dry aggregates 0.25-10 mm in size	75-60	60-50	50-30	<30
water-resistant units over 0.25 mm in size	45-35	35-25	25-15	<15
Equilibrium density, g/cm^3				
sandy and loamy	1,3	1,3-1,5	1,5-1,7	>1,7
loamy and clayey	1,4	1,4-1,6	1,6-1,8	>1,8
Water permeability, mm/h.	100-50	50-30	30-10	<10
Agrochemical degradation				
Nitrogen compounds that are easy are hydrolyzed, (mg/kg of soil) per:				
Kornfildom	150-100	100-50	50-25	<25
Mobile phosphates (mg/100 g of soil) according to:				
Kirsanovym	50-25	25-15	15-5	<5
Chyrykovym	50-20	20-10	10-5	<5
Exchangeable potassium (mg/100 g of soil) by:				
Kirsanovym	80-40	40-20	20-10	<10
Chyrykovym	40-20	20-10	10-5	<5

Reference: summarized data of scientific institutions of Ukraine

Conclusions. Taking into account the norms of the Law of Ukraine "On Land Protection", the criterion base for assessing the optimality of ecological parameters of the agricultural land use system includes 4 groups of criteria and indicators: I) criteria and indicators for assessing the ratio of land plots; II) criteria and indicators of

assessment of man-made soil pollution; III) criteria and indicators of soil quality assessment; IY) criteria and indicators of land and soil degradation assessment.

Norms (optimal parameters) of environmental indicators of groups I, II and IY are formed on the basis of the generalization of data from scientific institutions, and group III - on the basis of the provisions of DSTU 4362:2004 "Soil quality. Indicators of soil fertility".

The comprehensive application of the specified regulations will make it possible to correctly assess the optimality of the environmental parameters of the agricultural land use system and justify the appropriate measures to ensure environmental safety in the process of economic use of land in the agrarian sector of the economy.

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ЕКОЛОГІЧНІ КРИТЕРІЇ ТА ПОКАЗНИКИ ДЛЯ ОЦІНКИ ОПТИМАЛЬНОСТІ ПАРАМЕТРІВ СИСТЕМИ СІЛЬСЬКОГОСПОДАРСЬКОГО ЗЕМЛЕКОРИСТУВАННЯ

У статті проаналізовано сучасний стан нормативної бази в сфері використання та охорони земель, яка є основою для оцінки оптимальності екологічних параметрів системи сільськогосподарського землекористування. Встановлено, що переважна більшість нормативів (оптимальних параметрів)

в досліджуваній сфері носить рекомендаційний характер, а тому потребує систематизації і закріплення у відповідних нормативно-правових актах.

Обґрунтована необхідність структуризації екологічних критеріїв та показників для оцінки оптимальності параметрів системи сільськогосподарського землекористування з врахуванням норм Закону України «Про охорону земель» щодо нормативів в галузі охорони земель та відтворення родючості ґрунтів. Враховуючи Закон України «Про охорону земель» наведено поділ критеріїв та показників оцінки співвідношення земельних угідь; критерії та показники оцінки техногенного забруднення ґрунтів; критерії та показники оцінки якісного стану ґрунтів; критерії та показники оцінки деградованості земель та ґрунтів.

Висвітлено оптимальні параметри співвідношення земельних угідь та нормативи оцінок екологічного стану земель, зумовленого техногенним забрудненням. Вказано на оптимальні показники об'ємної маси ґрунтів на прикладі дерново-підзолистого супіщаного ґрунту Наведено оптимальні параметри якісного стану ґрунтів та діагностичні критерії і показники агрофізичної і агрохімічної деградації ґрунтів.

Ключові слова: *сільськогосподарське землекористування, система, оптимальність землекористування, екологічні критерії та показники.*