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REPRODUCTION OF SOIL RESOURCES IN THE SYSTEM OF SUSTAINABLE AGRICULTURAL LAND USE

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Abstract. *The current state of the use of soil resources in the agricultural sector of the country is analyzed. It has been established that the soil cover, which is the basis of agricultural landscapes, is characterized by a high agricultural potential, which allows, depending on the climatic conditions of a particular region and the genetic characteristics of the crops grown, to obtain a yield of 30-35 centners / ha of grain units and higher. However, due to a significant excess of the limit of ecological stability of soils, as evidenced by the practice of agricultural production, various destructive processes are accelerating, which now almost completely covered the country's land, which are under intensive cultivation. In this context, the soil resources of Polesie are especially vulnerable due to their predominantly light grain size distribution and, accordingly, a low ability to withstand the negative impact of external factors.*

It has been proved that an effective measure of ensuring the preservation and reproduction of soil resources is land management, which ensures the improvement of land relations, planning and organizing the rational use and protection of lands at all levels from national to economic. In particular, in the Polesie zone, this role should be fulfilled by working projects of land management to protect land from acidification, which determine the procedure for carrying out work on the chemical reclamation of acidic soils in relation to specific socio-economic and environmental conditions of economic entities on the ground.

Keywords: *agricultural land use, working draft of land management, soil resources, degradation processes.*

Formulation of the problem. The non-alternative condition for the harmonious development of rural areas, highly efficient functioning of the agricultural sector of the economy is the reproduction of soil resources, which should be carried out in the system of sustainable agricultural land use through the development and implementation of relevant land management projects. According

to V.V.Dokuchaiev, such a system of land use should prevent “loss of organic matter, soil impoverishment, development of erosion processes”, and ensure the improvement of the quality of agricultural landscapes [1].

In general, the strong soil resource potential of the country, due to the dominance of the soil cover of chernozems, provides, depending on the climatic conditions of a region, the yield of crops in grain equivalent at the level of 30-35 kg / ha [2]. But this can be achieved only in the conditions of sustainable functioning of the soil cover, which does not allow exceeding the external, in particular anthropogenic, influence of the permissible level at which soils lose the ability to self-restore their modal characteristics after such influence.

However, the practice of commodity agricultural production indicates frequent exceeding of the buffer capacity of soils, as a result of which in the structure of modern agricultural landscapes there is an intensification of various degradation processes, which now cover almost one hundred percent arable land [3]. The main reasons for this are the excessively high share of arable land in the structure of agricultural lands (over 80%) and high-intensity industrial crops in the structure of sown areas (about 33%) [4]. Issues related to the conservation and reproduction of soil resources of the Polissya zone are especially relevant at the current stage of land relations development, as they are characterized by very high environmental vulnerability due to light particle size distribution of soils and, consequently, their low buffer capacity.

Analysis of recent research and publications. The research of S.A.Baliuk, D.K.Volovnenko, T.O.Hrinchenko, V.I.Kunovskyi, H.A.Mazur, Z.M.Tomashivskyi, R.S.Truskavetskyi, Yu.L.Tsapko is devoted to the solution of the problem of reproduction of soil resources in the agrarian sphere of the Polissya natural and agricultural zone. The works of these scientists clearly outline the theoretical and practical aspects of improving the quality characteristics of acid soils of light particle size distribution, but the transformation processes of today, the formation of a competitive market environment require modernization of fertile soil fertility

technologies in the context of improving their environmental and economic efficiency. sustainable land use.

The methodological basis for solving this problem is a systemic approach that combines on the one hand - reducing the level of anthropogenic, including technological, pressure on the soil, on the other - increasing its environmental sustainability. In order to reduce the level of anthropogenic pressure on the soil cover it is necessary to reduce the share of arable land in the structure of agricultural landscapes to 50% [5], technological - to reduce the number of high-intensity crops of the technical group in crop rotations to 10-15%. For example, in the Kyiv region it is planned to withdraw from the intensive use of more than 340 hectares of unproductive and degraded lands [6], which will reduce the level of plowing in the region by 11.8%, agricultural land - by 20.3%. The increase in the ecological stability of the soil cover will be facilitated by the optimization of the content of humic substances and the structure of metabolic cations in its surface layer, in which calcium plays a decisive role in the regulation of key soil processes and regimes [7]. An alternative source of increasing organic matter to the soil under modern conditions is to reduce the volume of organic fertilizers due to a significant reduction in cattle and pigs should be used as fertilizer by-products of crop production, including straw after harvesting cereals from its obligations. tongue grinding for better earnings in the soil.

The purpose of the article is to analyze the current state of use of soil resources in agricultural production and justify measures for their reproduction in the system of sustainable agricultural land use in relation to soil and climatic conditions of the Polissya region of Ukraine.

Presentation of the main research material. A characteristic feature of soil resources of Polissya of Ukraine is “spatial mosaic, contrast and heterogeneity of soil structures, high specific weight in these structures of gley and acid soils with unsatisfactory water-physical, physico-chemical and biological properties” [8]. In particular, sod-podzolic soils, which dominate the soil cover of this natural agricultural zone, due to the genetically inherited light particle size distribution have

a low content of humus and metabolic bases, including calcium and magnesium. Involvement of such soils in intensive use in agricultural production intensifies the podzolization processes, which are accompanied by an increase in the level of acidity of their environment and a decrease in the degree of saturation of the soil absorption complex (GVC) with calcium and magnesium. According to the results of our experimental studies, with the use of synthetic mineral fertilizers hydrolytic acidity increased by 13.8%, and the degree of saturation of GVK Ca2 + and Mg2 + decreased by 6.4% compared to unfertilized land (Table 1). These factors, in turn, cause constant losses of humus (up to 3 relative% per year compared to baseline to the bookmark of the experiment), deterioration of agrophysical properties of soils: reducing the content of silty fraction by 0.5 absolute%, particle size index - by 2.7 %, which confirms the activation of destructive processes in relation to the aluminosilicate part of soils and the reduction of their aggregative capacity on a mineral background.

Table 1.

Parameters of potential fertility of sod-podzolic sandy soils depending on the application of fertilizers and ameliorants

№ pp	Indexes of soil properties	Without fertilizers	Fertilizers and ameliorants		
			$N_{47}P_{50}K_{54}$	$N_{47}P_{50}K_{54}$ + manure	$N_{47}P_{50}K_{54}$ + manure +$CaCO_3$
1	Humus content,%	0,57	0,84	1,10	1,32
2	Hydrolytic acidity, mg-eq per 100 g of soil	2,9	3,3	2,9	1,4
3	The content of Ca2 + and Mg2 +,mg-eq per 100 g of soil	1,50	1,53	2,54	3,58
4	Saturation of bases,%	34,1	31,9	46,7	71,7
5	Particle size distribution index (P),%	15,4	12,7	16,0	16,5
6	The content of the silty fraction,%	4,9	4,4	5,1	5,6
7	Water resistance criterion,%	41,7	23,7	27,4	64,4

Source: [9]

That is why, in the agricultural landscapes of Polissya, ensuring high ecological stability of soils, expanded reproduction of their fertility requires scientifically sound application of fertilizers on limed land plots. Thus, the integrated use of fertilizers and lime, by increasing the content of exchange bases in sod-podzolic soils to 3.6 mg-eq / 100 g of soil, humus content to 1.3%, provided an increase in particle size index of their structure by 7.1%, criterion of water resistance of soil structure by 54.4%, which confirms the strengthening of the potential ability of the studied soils to form water-resistant microaggregates in particular and their environmental stability in general.

Positive changes in the main fertility parameters of sod-podzolic sandy soils under the influence of joint use of fertilizers and lime led to annual production of additional crop production at 22.1 kg / ha of grain units, which is higher than the mineral and organo-mineral background by 40.2 and 9.3% (table 2). At the same time, the yield of winter wheat and barley increased by 111.2 and 83.0%, respectively, and of winter rye, a culture tolerant to the weakly acid reaction of the soil environment - by 48.6%.

Table 2.

Yields of cereals and potatoes depending on the use of agrochemicals on sod-podzolic sandy soils

Agrochemicals	Harvest, c/ha of grain units			
	grains winter wheat	bulbs potatoes	grains barley	grains winter wheat
No fertilizers	24,3	22,1	17,1	22,4
$N_{47}P_{50}K_{54}$	33,2	37,4	22,6	31,4
$N_{47}P_{50}K_{54}$ + гній	34,5	52,0	28,8	44,5
$N_{47}P_{50}K_{54}$ + гній +$CaCO_3$	36,1	59,6	31,3	47,3
HIP_{05}	3,1	6,9	2,1	3,1
S_x,%	2,6	4,2	3,5	3,7

Source: [9]

Although the use of calcium-containing compounds on soils with high acidity is accompanied by a high environmental effect (expanded reproduction of soil fertility, maintaining the ecological functions of soils at the regulatory level, etc.), the volume of this reclamation measure on acidic soils has decreased more than 14 times over the past three decades. reform processes in the agricultural sector and low financial capacity of the vast majority of land entities (Table 3).

Table 3.

Dynamics of application of agrochemicals in agriculture

Indicator	Years					
	1990	2000	2005	2010	2015	2020*
Mineral fertilizers were applied: total, kg / ha of sown area	141,0	13,0	32,0	58,0	79,1	125,0
incl. nitrogen	59,0	10,0	22,0	42,5	55,1	85,0
phosphorus	39,0	1,0	4,0	8,5	12,5	22,0
potassium	43,0	2,0	6,0	7,0	11,5	18,0
Introduced organic fertilizers, t / ha of sown area	8,6	1,3	0,8	0,5	0,5	0,6
Liming area, million hectares	1,439	0,024	0,042	0,073	0,088	0,105
Limestone materials were introduced, t / ha	5,1	5,3	5,8	4,7	5,1	5,0

Source: [4], *forecast values

According to the State Statistics Service of Ukraine, the implementation of agro-ameliorative measures on acid soils is characterized by different intensity and scale both over the years and in specific regions [4]. The maximum area of limestone lands at the national level (1.4 million hectares) falls on 1990. In the next ten years, the area of limed agricultural land decreased to 24 thousand hectares, and in the period from 2005 to 2015 - fluctuated at 42-88 thousand hectares. The average application rate of limestone reclamation was 5.2 t / ha.

Significant increase in the area of acid arable land in recent years, currently reaching 5.5 million hectares [8], due primarily to the lack of chemical reclamation combined with deterioration as the ratio of organic and mineral fertilizers (from 16.4

kg of active substance NPK per 1 tons of manure in 1990 to 208.3 kg / t in 2020), and the ratio of nitrogen, phosphorus and potassium fertilizers (from 1: 0.66: 0.73 in 1990 to 1: 0, 26: 0.21 in 2020). The growing load of physiologically acidic synthetic mineral fertilizers with a predominance in their structure of nitrogen, in particular ammonia water and ammonium nitrate, against the background of a shortage of organic fertilizers contributes to the intensification of secondary acidification of the soil.

In the pre-reform period, due to the systematic use of limestone materials on acidic soils on a national scale annually received additional crop production at the level of 650 thousand tons of grain equivalent [10]. The latter was undoubtedly assessed as a positive phenomenon at the economic level, as the financing of costs for the practical implementation of reclamation measures was carried out at public expense. However, nationwide, these reclamation measures have been economically inefficient, due to: the importation of chemical reclamation agents from remote regions instead of more intensive development of local deposits of calcium-containing compounds; often low quality limestone materials, in particular a low percentage of calcium carbonate; neglect of phytobiological reclamation as the cheapest means of reproduction of soil fertility on acid soils; exceeding the recommended rates of application of limestone flour (“liming”), which on Polissya soils of light granulometry led to leaching into groundwater of almost a third of the introduced calcium and magnesium, and as a consequence - to a sharp increase in water hardness in nearby reservoirs and wells of rural settlements; etc.

At the present stage of development of land relations, the expansion of the use of limestone materials in agricultural production is hampered by the disproportion of prices for products of the chemical industry and agriculture. Sales prices for crop products, which are formed in market conditions, do not provide the agricultural producer with an adequate economic effect from the use of fertilizers and ameliorants. With the increase in the cost of the latter increases the cost of crop production, and in case of failure to provide this increase with a corresponding increase in crop yields decreases the competitiveness of cultivated products.

According to the calculations of energy efficiency of reclamation measures on acid soils, conducted by scientists of NSC Institute of Soil Science and Agrochemistry. O.N.Sokolovskyi, “at the rate of liming 5 t / ha to maintain the profitability of this agricultural measure it is necessary to obtain yield increments 30-50% higher than existing” [10]. Therefore, at present, given the limited financial capacity of agricultural enterprises and the urgent need for reclamation measures, it is necessary to provide partial compensation of at least 40-50% of their value from the budget, as to solve this problem only through their own working capital of agricultural producers without proper state support is impossible.

A key role in solving these problems should be played by land management, which provides a harmonious combination of legal, organizational, economic and technological measures aimed, inter alia, at the reproduction and increase of soil fertility, and which in practice are implemented “in accordance with land management schemes and technology. -economic justification of land use and protection of administrative-territorial units, working land management projects” [11]. In particular, chemical reclamation aimed at radical improvement of acid sod-podzolic soils should be carried out in accordance with a scientifically sound land management project on land protection from acidification, which is regulated by the relevant articles of the Laws of Ukraine “On Land Protection” (Article 36) [11] and “On land management” (Article 54) [12]. Development of this type of land management documentation is carried out taking into account the provisions of DSTU 4768: 2007 “Soil quality. The procedure for chemical reclamation of acid soils”.

The peculiarity of such projects should be the alternative of their development with the possibility of choosing the most optimal design solutions for land reclamation activities on the ground, taking into account natural and economic conditions, resource, logistical and financial support of an agricultural enterprise. In view of this, when preparing the design and estimate documentation it is necessary to take into account the data of the last round of agrochemical survey of land plots (fields), the wishes of the customer of land management documentation and its

logistical and financial capabilities. This documentation, in addition to the algorithm of reclamation works, should provide for control over the quality and efficiency of their implementation, ie: establishing the need for soil liming for each field (or land); determining the form and rate of application of limestone materials, technology and frequency of their re-use, the cost of applying calcium-containing compounds and technical and economic calculations.

The need of soils in liming is established for each separate field (or land plot) depending on the value of hydrolytic acidity according to the data of agrochemical certification. The need of soils for liming is primary in the Polissya zone, if the value of hydrolytic acidity exceeds 3.0 mg-eq per 100 g of soil; medium - if the hydrolytic acidity fluctuates at the level of 2.9-2.0; weak - 1.9-1.5 mg-eq per 100 g of soil. If the value of hydrolytic acidity does not exceed 1.4 mg-eq per 100 g of soil, liming of soils is not carried out [13].

For reclamation activities on acid soils use mainly carbonate salts of calcium, calcium and magnesium, which are part of various industrial wastes: limestone and dolomite flour, marl, limestone tuffs, defecate, flotation tails and more. The effectiveness of various forms of chemical ameliorants depends on many factors, in particular: the presence in their composition of certain chemical compounds; the density of the raw materials from which they are made; degree of fragmentation; solubility, impurity content, etc. The application rates of limestone materials depend on the degree of acidity of soils and their particle size distribution: from 2-4 t / ha on sandy and loamy soils to 3.5-6 t / ha on medium and heavy loam soils. The simplest and most reliable method of calculating the norms of lime is their determination by the value of hydrolytic acidity [13].

In the conditions of Polissya, when crops tolerant to the weakly acid reaction of the soil environment (for example, potatoes, flax, lupins) are grown on large areas, the application of lime in crop rotation is of great importance. Due to the fact that potatoes grow best at pH 5.0-5.5, lupines -4.5-6.0, and flax - 5.5-6.5, liming should be carried out so as not to change these intervals. Because of this, in grain-flax-potato crop rotations all forms of limestone materials in scientifically substantiated norms

are applied directly under potatoes - during fallow plowing or in spring for cultivation, under flax or lupine - before furrow plowing.

In general, in order to increase the economic efficiency of reclamation measures on acid soils, limestone materials should be applied in such a way that their maximum reclamation effect falls on crops that respond to this with the highest yield growth. In Polissya agrolandscapes such crops are: winter wheat, barley, fodder roots and perennial legumes. Given that the cost structure for chemical reclamation accounts for 70-75% of the cost of limestone materials and their transportation, ensuring its high economic efficiency is impossible without the widespread involvement of local raw materials. According to the NSC Institute of Soil Science and Agrochemistry. O.N.Sokolovskyi, “in Ukraine there are 5 deposits of dolomite, with estimated reserves of about 424 million tons and 30 deposits of limestone (respectively more than 83 million tons)” [8].

Conclusions. Reproduction of soil resources, which is a key prerequisite for food security, is possible only in the system of sustainable agricultural land use, in which due to the optimization of land and sown areas is not allowed to exceed the normative level of anthropogenic pressure on the soil, and due to erosion processes in them. A set of measures for the expanded reproduction of soil fertility should be carried out through the implementation of appropriate land management projects, developed on an alternative basis, taking into account the socio-economic and environmental conditions of a particular land entity.

In the natural-agricultural zone of Polissya, where the soil structure is dominated by acid soils of light granulometric composition, the algorithm of agro-ameliorative measures should be determined on the basis of working land management projects to protect lands from acidification. These projects should provide for the establishment of the need for soil liming within each individual land plot; determination of the form, norm, technology and frequency of application of chemical ameliorants, carrying out technical and economic calculations, including expenses for carrying out reclamation actions. To increase the economic efficiency of chemical reclamation of acid soils, which is to increase crop yields and ensure rapid

payback of reclamation measures, it is necessary to make extensive use of local deposits of limestone materials and give preference to their priority crops on lands with moderately acidic soil response.

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ВІДТВОРЕННЯ ГРУНТОВИХ РЕСУРСІВ В СИСТЕМІ СТАЛОГОСІЛЬСЬКОГОСПОДАРСЬКОГО ЗЕМЛЕКОРИСТУВАННЯ

Проаналізовано сучасний стан використання грунтових ресурсів в аграрній сфері країни. Встановлено, що грунтовий покрив, який є основою сільськогосподарських ландшафтів, характеризується високим агропотенціалом, який дозволяє залежно від кліматичних умов певного регіону та генетичних особливостей вирощуваних культур отримувати урожай на рівні 30-35 ц/га зернових одиниць і вище. Проте, через істотне перевищення межі екологічної стійкості грунтів, про що свідчить практика аграрного виробництва, прискорюються різноманітні деструктивні процеси, які зараз майже повністю охопили земельні угіддя країни, що перебувають в інтенсивному обробітку. Особливо вразливими в цьому контексті є грунтові

ресурси Полісся через переважно легкий гранулометричний склад і відповідно низьку здатність протистояти негативному впливу зовнішніх факторів.

Доведено, що дієвим заходом забезпечення збереження і відтворення грунтових ресурсів є землеустрій, який забезпечує вдосконалення земельних відносин, планування і організацію раціонального використання та охорони земель на всіх рівнях від національного до господарського. Зокрема, в зоні Полісся цю роль мають виконувати робочі проекти землеустрою щодо захисту земель від закислення, якими визначається порядок проведення робіт з хімічної меліорації кислих ґрунтів стосовно конкретних соціально-економічних та екологічних умов суб'єктів господарювання на землі.

Ключові слова: *сільськогосподарське землекористування, робочий проект землеустрою, грунтові ресурси, деградаційні процеси.*

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ВОСПРОИЗВОДСТВО ПОЧВЕННЫХ РЕСУРСОВ В СИСТЕМЕ УСТОЙЧИВОГО СЕЛЬСКОХОЗЯЙСТВЕННОГО ЗЕМЛЕПОЛЬЗОВАНИЯ

Проанализировано современное состояние использования почвенных ресурсов в аграрной сфере страны. Установлено, что почвенный покров, который является основой сельскохозяйственных ландшафтов, характеризуется высоким агропотенциалом, который позволяет в зависимости от климатических условий определенного региона и генетических особенностей выращиваемых культур получать урожай на уровне 30-35 ц/га зерновых единиц и выше. Однако, из-за существенного превышения предела экологической устойчивости почв, о чем свидетельствует практика аграрного производства, ускоряются различные деструктивные процессы, которые сейчас почти полностью охватили земельные угодья страны, что находятся в интенсивной обработке. Особенно уязвимыми в этом контексте являются почвенные ресурсы Полесья из-за преимущественно легкого гранулометрического состава и соответственно низкой способности противостоять негативному воздействию внешних факторов.

Доказано, что действенной мерой обеспечения сохранности и воспроизводства почвенных ресурсов является землеустройство, которое обеспечивает усовершенствование земельных отношений, планирование и организацию рационального использования и охраны земель на всех уровнях от национального до хозяйственного. В частности, в зоне Полесья эту роль должны выполнять рабочие проекты землеустройства по защите земель от закисления, которыми определяется порядок проведения работ по химической мелиорации кислых почв относительно конкретных социально-экономических и экологических условий субъектов хозяйствования на земле.

Ключевые слова: *сельскохозяйственное землепользование, рабочий проект землеустройства, почвенные ресурсы, деградационные процессы.*