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ECONOMIC PROBLEMS OF REPRODUCTION OF FERTILITY OF SOILS

The purpose. To study contemporary state of fertility of soils in Ukraine, to determine basic problems of reproduction of effective fertility and to offer ways of their solution. **Methods.** Dialectic method of scientific knowledge, analysis and synthesis, system generalization. **Results.** Contemporary state of fertility of soils as to the content of humus and basic nutrients is analyzed. The causes of level recession of fertility of soils of plowlands are specified, ways of raising economic efficiency of measures on its preservation and reproduction are offered. **Conclusions.** For preservation and increase of fertility of soils which provides high and stable yields of crops it is necessary to optimize entering of all nutrients of plants in order not only to compensate their removal with crop, but to fill up the content of humus and mobile forms of nutrients in soil.

Key words: fertility of soils, organic fertilizers, fertilizers, chalking, gypsuming, green manure crops, erosion of soils, efficiency.

Rational use of agricultural lands, preservation and increase of soil fertility occupy an important place among the problems of modern agriculture. The state of land resources is becoming increasingly worrisome due to the decline in soil fertility: the content of humus is reduced, nutrient reserves are decreasing, the area of acid and saline soils is increasing, which causes the soil to degrade. The effective use of organic and mineral fertilizers, chemical meliorants, scientifically based crop rotation, anti-erosion measures are necessary conditions for further enhancement of the efficiency of agricultural production.

Analysis of recent research and publications. Problems of the theory and practice of increasing soil fertility and the effective use of land were reflected in the scientific works of famous scientists: P.P. Borshchevskyy, A.S. Baliuk, V.S. Bullo, V.A. Velikchko, H.A. Korchinska, M.V. Lisovyy, G.A. Mazur, V.V. Medvedev,

A.M. Moskalenko, M.M. Fedorov [1–11] and others. However, most of the components of this problem remain relevant at the current stage of development of agricultural production.

The purpose of the research is to investigate the current state of soil fertility in Ukraine, to identify the main problems of reproduction of effective fertility and to propose ways to solve them.

Research methods. The dialectical method of scientific knowledge, analysis and synthesis, systemic generalization was applied.

Research results. Losses of humus are: in Polissya – 1.42 tons/ha, in the Forest-steppe – 1.81, in the Steppe – 0.92, and in general, in Ukraine – 1.08 tons per hectare per year in recent years [11]. The content of humus is 3.14% according to the data of the ninth round of agrochemical soil survey (2006–2010) against 3.19% compared with the seventh tour (1995–2000). The problem was aggravated by the balance of nutrients (NPK). Loss of nutrients from the soil exceeds 100 kg/ha annually during the last ten years. An increase in the area of acid and saline soils is observed. Up to 500 million tons of soil is lost. from erosion annually. Up to 11 million tons of humus, 0.5 million tons of nitrogen, 0.4 million tons of phosphorus, 0.7 million tons of potassium is carried out with products of erosion. Growth of eroded lands reaches 80-90 thousand hectares annually [12].

Decrease of the level of fertility of soils of arable land is a consequence of reduction of volumes of introduction of organic, mineral and limy fertilizers, non-compliance with scientifically grounded crop rotation, ignoring the law of returning to the soil of the main elements of nutrition, etc.

Organic fertilizers use.

One of the important components of reproduction and increase of soil fertility is organic fertilizers, due to which 35–40% of nutrients are fed into the soil. 340 million tons of organic fertilizers are recommended to be introduced annually to ensure a hygienic balance of humus, in particular in Polissya – 16 tons/ha, in the Forest-steppe – 11 and in the steppe – 8 tons/ha [12].

The introduction of organic fertilizers decreased by 17.2 times from 8.6 tons/ha in 1990 to 0.5 tons/ha in 2016 over the past twenty-five years (Table 1).

1. Dynamics of the introduction of organic fertilizers in Ukraine

Indexes	Years						
	1990	1996	2000	2005	2010	2015	2016
The introduction of organic fertilizers, of all a million tons	257,1	80,6	28,4	13,2	9,9	9,6	9,1
incl. per 1 hectare, tons	8,6	3,2	1,3	0,8	0,5	0,5	0,5

Source: According to the State Statistics Service of Ukraine.

One of the alternative sources of replenishment of organic material stocks in the soil is sideration. About 60 different cultures are used for seeding. Leguminous crops are sown more often: sainfoin, alfalfa, vicia, melilotus, lupine. Not leguminous siderates are used quite often too – radish oil, mustard, buckwheat, phacelia, etc. Climbing 20-30 t/ha of green mass of siderates provides an effect equivalent to the introduction of a similar amount of manure according to scientific research data. Calculations of the economic efficiency of using green fertilizers indicate that for each unit of funds spent we get 2–2.5 units of conditional net profit.

The plowing of the plow-root residues is a significant reserve for increasing soil fertility in conditions of reduced manure. The plowing of the non-commodity part of the crop (straw, corn and sunflower stalks, beet pulp, etc.) is a significant reserve for improving soil fertility in conditions of reduced manure inputs as well.

Straw plays an important role in regulating the balance of organic matter entering the soil. 1 ton of straw is equivalent to 3-5 tons of manure. One ton of straw forms about 0.2 tons of humus. Straw is burned in the fields after harvesting very often. About 1.5–2.0 tons of organic matter is lost from one hectare when burning straw. Soil microflora is also violated [2].

Straw has a higher efficiency of using as organic fertilizer when crushed by a combine. Thus, the results of the research show that each 1 UAH spent on its use brings 0.41–2.27 UAH of conditional net income depending on the culture.

Mineral fertilizers use.

The world experience of agriculture convincingly proves that 30-40% of the growth of agricultural products in the USA and Western Europe are due to the use of mineral fertilizers. However, in Ukraine, the volume of their input to crops in recent years does not meet the requirements of modern agriculture: the need for crops in nutrients for the production of crops is not provided, as well as for the increased reproduction of soil fertility (Table 2).

2. Dynamics of introduction of mineral fertilizers in agriculture of Ukraine

Indexes	Years					
	1990	2000	2005	2010	2015	2016
Introduction of mineral fertilizers - total, thousand tons	4242,0	279,0	557,9	1060,6	1410,0	1724,4
including per 1 hectare of crops, kg	141	13	32	58	79	96
Percentage of fertilized area, %	83,0	22,0	44,9	69,5	80,8	87,0
Nitrogen - total, ths. tons	1784,0	223,0	376,9	774,6	981,7	1195,0
including per 1 hectare of crops, kg	59,0	10,0	22,0	42,5	55,1	66,4
Phosphorus - total, ths. tons	1280,0	38,0	101,6	157,4	222,2	286,1
including per 1 hectare of crops, kg	43,0	2,0	6,0	8,5	12,5	15,9
Potassium - total, thousand tons	1178,0	18,0	79,4	128,6	206,1	243,3
including per 1 hectare of crops, kg	39,0	1,0	4,0	7,0	11,5	13,5

Source: calculated according to the State Statistics Service of Ukraine.

The high rate of growth of the cost of mineral fertilizers prevents the expansion of their use. Thus, over the past ten years, the cost of 1 t of ammonium nitrate has increased by 8.9 times, urea – at 6.8, ammophos – by 5.6, superphosphate – by 8.8 times (Fig. 1). A further rise in prices for mineral fertilizers may hold back the increase in agricultural production and the increased fertility reproduction of soils.

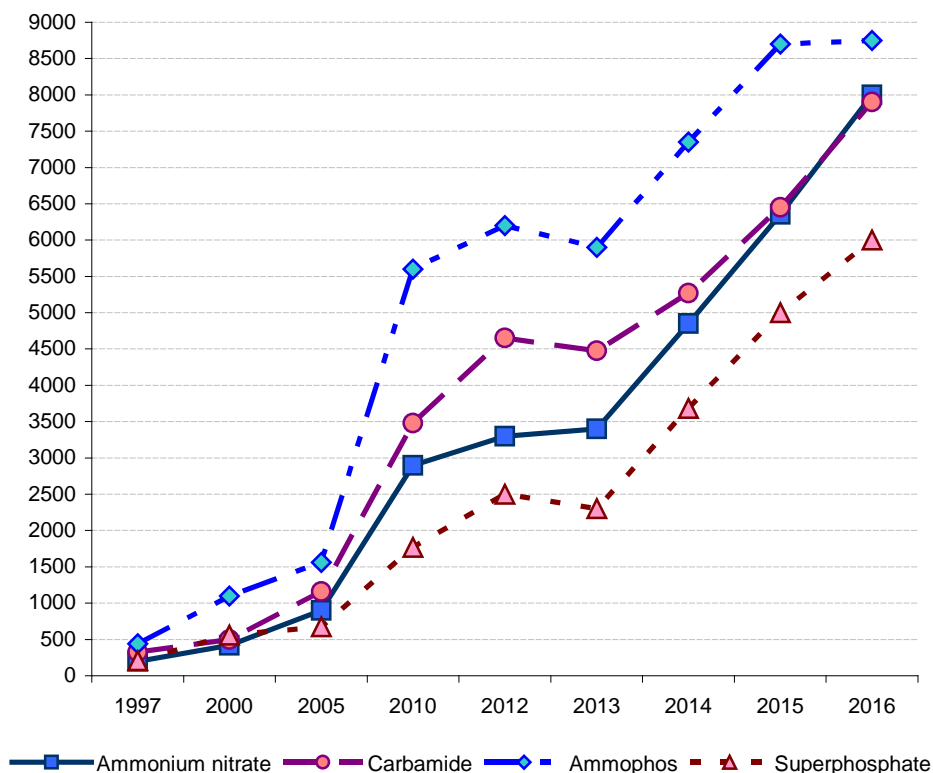


Fig. 1. Dynamics of prices for certain types of mineral fertilizers coming to the agriculture of Ukraine, UAH per 1 ton (physical)

Source: Research Institute of Agrarian Economics.

One of the ways to reduce the cost of using mineral fertilizers is the use in agricultural practice of liquid forms of nitrogen fertilizers, in particular ammonia water and urea ammonia mixture (UAM). Their use is rather widespread in developed countries of the world, since it has a noticeable economic effect. So, in the US agriculture, up to 50% of nitrogen fertilizers are used in liquid form, in some states anhydrous (liquid) ammonia is the most popular nitrogen fertilizer.

The calculation of the economic efficiency of the use of ammonium nitrate, anhydrous (liquid) ammonia, ammonia water and urea ammonia mixture (UAM) in 2015 on the basis of the costs of their use, the norms of the increase in yields and selling prices for agricultural products shows that the most effective is the use of anhydrous (liquid) ammonia. So, every 1 UAH spent on its application gives, depending on the culture, 1.05-4.37 of the conditional net income.

Chemical melioration of soil.

9 million hectares are acid soils in the arable land of Ukraine. More than 2.8 million hectares of soils are saline. Chemical melioration is an important step in increasing the fertility of acidic and saline soils. At present, the volumes of liming and gypsum are much lower than the need, but since 2005, their gradual growth has been observed (Table 3). A scientifically grounded chemical soil reclamation cycle should be conducted to preserve and reproduce soil fertility. The volume of liming will increase to 1200 thousand hectares annually, and the volume of gypsum will increase to 300 thousand hectares.

3. Dynamics of volumes of works on chemical soil reclamation in Ukraine

Indexes	1990	1995	2000	2005	2010	2015	2016
Liming area, thousand hectares	1439,2	267,8	23,9	41,6	73,2	88,1	103,7
Lime input, thousand tons	7371,6	1423,5	169,8	243,1	340,8	454,1	374,6
Gypsum area, thousand hectares	304,7	16,7	5,0	2,7	4,4	7,1	11,1
Depositing of gypsum, thousand tons	1343,9	75,0	27,0	12,1	23,4	16,0	32,4

Source: According to the State Statistics Service of Ukraine.

Crop rotation.

The crop rotation plays an important role in the conservation and reproduction of soil fertility, especially with a significant percentage in the structure of perennial grassland (35–40%) and legume crops (about 60%). This allows you to reduce the dependence of plant growing on industrial fertilizers. During the two-year cultivation of perennial grasses in the soil, there are 4–5 tons of root and post-crop residues, which is equivalent to a single application of 15 tons per hectare of manure. However, the sown area of perennial herbs decreases with each passing year. Thus, in 2005, it amounted to 1553.6 thousand hectares or 6.0% in the structure of sown areas, and in 2016 it decreased to 995.0 thousand hectares, which is only 3.7% of the total area of crops.

Anti-erosion measures.

The development of erosion processes is one of the factors that lead to a decrease in soil fertility. About 13 million hectares of agricultural land undergo water erosion in Ukraine. More than 50% of arable land is deflationary. The development of erosion processes causes tangible damage to agricultural production. Therefore, an

important direction for the preservation and reproduction of soil fertility is the use of organizational and economic, agricultural, forestry, anti-erosion measures and the construction of hydro-technical structures. The volume of anti-erosion measures has decreased significantly during the last years due to the reduction of funding for soil protection works and the lack of programs for the use and protection of land.

Conclusions.

The long-term results of studies on soil fertility monitoring indicate a decrease in its main indicators and an increase in the area of acid and saline lands. The formation of a crop is due to humus and nutrients contained in the soil, since the current level of mineral and organic fertilizer does not fully meet their needs. Therefore, it is necessary to optimize the introduction into the soil of all necessary elements of plant nutrition, so as not only to compensate for their withdrawal from the crop, but also to increase the content of humus and to replenish the stocks of moving nutrients in the soil.

Reducing soil fertility is a national problem, not just owners and land users. Therefore, the state should play a leading role in preserving and reproducing soil fertility. The state should create conditions that would stimulate rational, ecologically safe use of agricultural land and the application of measures to preserve and reproduce soil fertility through regulations and economic levers of influence. It is the basis of stable agriculture, which is intended to provide food security to the country.

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