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ЕКОНОМІКА ПРИРОДОКОРИСТУВАННЯ І ОХОРОНИ НАВКОЛИШНЬОГО СЕРЕДОВИЩА

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СУЧАСНІ АСПЕКТИ ВНЕСЕННЯ ДОБРИВ У РОСЛИННИЦТВІ ТА ДОСЛІДЖЕННЯ НАСЛІДКІВ ЇХ НЕРАЦІОНАЛЬНОГО ЗАСТОСУВАННЯ ©

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У статті розглянуто основні аспекти сучасних тенденцій внесення добрив. Ключовою особливістю визначено невідповідність сучасної системності удобрення науково обґрунтованим нормам.

Проаналізовано наслідки нераціональності внесення поживних речовин у галузі рослинництва. Визначено, що ці тенденції спричинили низку проблем, серед яких має місце хронічний дефіцит основних поживних елементів, ґрунтова ерозія, зростання площ земель з високою кислотністю, мінералізація запасів гумусу.

Систематизовано показники внесення органічних та мінеральних добрив та поголів'я сільськогосподарських тварин, що дозволило унаочнити тенденції удобрення сільськогосподарських угідь та виявити причинно-наслідкові зв'язки між цими показниками. Виявлено, що негативний темп приросту поголів'я тварин прямо пропорційно впливає на обсяги внесення органічних добрив та вміст гумусу у верхньому родючому шарі ґрунту.

Розраховано, що домінантна ситуація у сфері виробництва, постачання та використання мінеральних добрив в Україні не відповідає ні потребам ринку, ні умовам наявної в країні культури землеробства, що зумовлено, передусім, дефіцитом калійних та фосфорних складових, високою вартістю та значною часткою імпорту. Наслідками цієї ситуації є неповноцінність забезпечення необхідними елементами живлення рослин. Критичність цієї дилеми доведено авторськими розрахунками екологічного збитку, що проведено на прикладі найбільш поширених у сівозміні сільськогосподарських культур: кукурудзи та озимої пшениці.

Напрямки вирішення виявленого спектру проблем консолідовано у вигляді концепції економіко-екологічної збалансованості сучасного землекористування.

Ключові слова: ґрунт, гумус, удобрення, мінеральні добрива, органічні добрива, раціональне землекористування, урожайність.

Рис.: 6. Табл.: 5. Літ.: 17.

MODERN ASPECTS OF FERTILIZER USING IN CROP PRODUCTION AND RESEARCH OF THEIR IRRATIONAL USE CONSEQUENCES

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The article discusses key aspects of current trends in fertilizer application. A key feature is the inconsistency of the existing fertilizer system with scientifically sound standards.

The consequences of the irrationality of nutrient input in the field of crop production are analyzed. It is determined that these trends have caused a number of problems, among which there is a chronic shortage of basic nutrients, soil erosion, growth of areas of land with high acidity, mineralization of humus reserves.

Organic and mineral fertilizers and livestock rates have been systematized, which has made it possible to identify trends in farmland fertilization and to identify causal relationships between these indicators. It was found that the negative rate of increase in the livestock population directly affects the volume of fertilizer application and humus content in the upper fertile soil layer.

It is estimated that the dominant situation in the field of production, supply and use of mineral fertilizers in Ukraine does not meet either the needs of the market or the conditions of agriculture in the country, which is due, first of all, to the shortage of potassium and phosphorus components, high cost and a significant share of imports. The consequences of this situation are the inferiority of providing the necessary nutrients for plants, the criticality of this dilemma is proved by the author's calculations of ecological damage, which was carried out on the example of prevailing agricultural plants in the crop rotation: corn and winter wheat.

The directions of solving the identified range of problems are consolidated in the form of the concept of economic and ecological balance of modern land use.

Key words: soil, humus, fertilizer, mineral fertilizers, organic fertilizers, rational land use, yield.

Fig.: 6. Tabl.: 5. Ref.: 17.

СОВРЕМЕННЫЕ АСПЕКТЫ ПРИМЕНЕНИЯ УДОБРЕНИЙ В РАСТЕНИЕВОДСТВЕ И ИССЛЕДОВАНИЕ СЛЕДСТВИЙ ИХ НЕРАЦИОНАЛЬНОГО УПОТРЕБЛЕНИЯ

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В статье рассмотрены ключевые проблемы восстановления плодородия почв, детерминирующих нарастающий дефицит основных элементов питания, прогрессирование почвенной эрозии, окисление земель, процессы потери гумуса.

Проанализированы особенности внесения минеральных и органических удобрений на основе чего определено, что тенденции удобрения сельскохозяйственных угодий в Украине имеют негативный характер. Продемонстрировано статистические данные численности поголовья сельскохозяйственных животных, которая прямо пропорционально влияет на объемы получения органических удобрений. Оценены тенденции внесения последних и баланс гумуса, в результате чего выявлена прямая зависимость.

Оценен соответствие объемов внесения питательных веществ научно обоснованным нормам. Обосновано, что объемы внесенных минеральных удобрений не отвечают потребностям интенсивного земледелия и не обеспечивают полноценную потребность растений в элементах питания. Проведено сравнение уровня использования минеральных удобрений в сельском хозяйстве Украины и мировых стран. Определено, что отечественная система удобрения значительно отстает от зарубежной.

Проанализировано современное состояние рынка минеральных удобрений в Украине, характеризующееся дефицитом калийных и фосфорных составляющих, высокой стоимостью, значительной долей импорта и недостаточным объемом удобрений отечественного производства. Рассчитано стоимость утраченных питательных веществ, при хроническом дефиците питательных элементов и минерализации гумуса, что превышает половину полученной выручки от продажи данной продукции. Консолидировано ключевые проблемы современной системы использования удобрений в растениеводстве и предложены концептуальные направления их решения.

Ключевые слова: почва, гумус, удобрения, минеральные удобрения, органические удобрения, рациональное землепользование, урожайность.

Рис.: 6. Табл.: 5. Лит.: 17.

Formation of the problem. Addressing urgent problems in the agricultural sector requires a comprehensive approach, taking into account the requirements of sustainable development and sustainable land use. The priority of agricultural policy should be considered to ensure environmental and economic efficiency in the context of balancing the system of fertilizer use and the development of scientific recommendations in order to optimize nutrient input in accordance with the European standards.

Leading domestic scientists are actively discussing the array of problems that accompany modern agricultural production. Among the main ones are irrational land use, unreasonably high plowing of agricultural land, non-compliance with the requirements of contour-reclamation organization of the territory and crop rotation, lack of adequate state support for measures aimed at improving the agrochemical and ecological status of soil, which has reduced the soil's ability to bear fruit and decreased agrophysical and agrochemical soil properties. All this fosters reduction of the potential yields and gross yields of crops. The scientifically sound use of organic and mineral fertilizers is a necessary prerequisite to further improve the efficiency of agricultural production. Therefore, an urgent task for scientific research is to analyze the current state of nutrient input and justify the prospects for the latest technologies in agriculture.

Analysis of recent research and publications. Problems of increasing the rational use of organic and mineral fertilizers were studied in the works by domestic scientists, such as O.V. Khodakovskaya [15], S.G. Korchinskaya [16], G.M. Kaletnik [3], V.A. Mazur [4] , J.G. Tsitsyura [17] and others.

Formulating the goals of the article. The purpose of the article is to investigate the current peculiarities in the field of production, supply and use of mineral and organic fertilizers in Ukraine. Based on the investigation, we highlight the main environmental and economic problems in this segment and offer conceptual directions to solve these problems.

Presenting main material. It is well-known that agriculture has a significant contribution to the development of the domestic economy. Therefore, the growth of domestic GDP is directly related to the improvement of modern systems of agriculture, reproduction and increase of soil fertility and rational use of bioclimatic potential (Fig. 1).

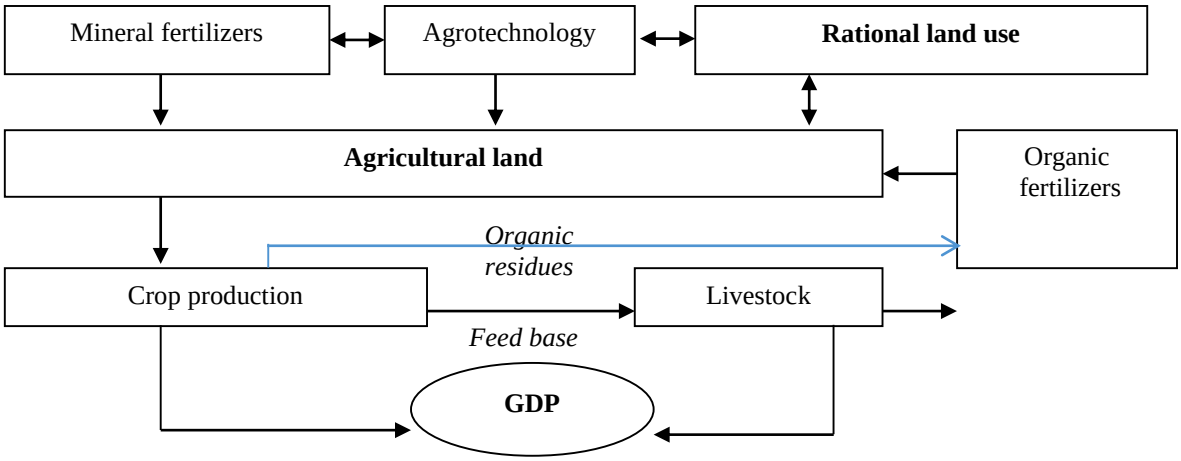


Fig. 1. **Scheme for ensuring rational land use**

Source: provided by the authors of the article

The problem of soil fertility reproduction in Ukraine is exacerbated as there is an increasing shortage of basic nutrients of plants, the development of erosion processes, and an increase in soil acidity. In other words, the soil suffers the loss of humus stocks. H.M. Kaletnik also emphasizes on this problem, recapping that "the suspension of degradation processes in the soils of Ukraine and the increase of their effective fertility is the most important issue of our time" [3]. Fertilizer trends of agricultural land in Ukraine have a negative perception. It should be noted that over the period of 1990-2017, the area of agricultural land increased by 2.4%, amounting to 41.5 million hectares in 2017. In spite of this, the volumes of mineral fertilizer use in the given period decreased by 54%, which amounted to 48.9 kg/ha in 2017, whereas in 1990 this indicator was at the level of 105.1 kg/ha. The lowest amount of fertilizer was introduced in 2000, which was 6.7 kg/ha and 11.2% of the fertilized area. It should be noted that the area of agricultural land fertilized with mineral fertilizers in the period under review has decreased almost twice (Table 1).

Table 1

Fertilizer trends in agricultural land in Ukraine

Indicator	Years							2017 to 1990, ±
	1990	1995	2000	2005	2010	2015	2017	
Area of agricultural land, million hectares	40,2	41,8	41,8	41,8	41,6	41,5	41,5	1,3
Fertilizers total, thousand tons	4414,2	529,9	281,9	560,5	1064,2	1415	2028	-2386,2
Including per 1 ha of agricultural land. land, kg	105,1	12,7	6,7	13,4	25,6	34,1	48,9	-56,2
The share of fertilized area,%	62,9	19,6	11,2	18,7	30,5	34,9	39,8	-23,1
Made organic fertilizers, total million tons	260,7	81,2	28,9	13,8	9,9	9,6	9,2	-251,5
Including per 1 ha of agricultural land. please, t	6,2	1,9	0,7	0,3	0,2	0,2	0,2	-6
The share of fertilized area, %	13,1	4,5	1,7	1,2	1,0	1,0	1,2	-11,9

Source: concluded by the authors using [7]

Among the important measures of soil reproduction and soil fertility increase is the introduction of organic fertilizers due to which 35-40% of nutrients enter the soil. In order to ensure a deficient humus balance, 340 million tons of organic fertilizers are required each year (including 16 tons/ha in Polissia, 8 tone's/ha in the forest-steppe), whereas in 2017 only 9.2 million tons were introduced, which is only 2.7% of the need itself [15].

H.M. Kaletnik focuses on the problem of organic fertilizers. "Due to the decline of animal husbandry in agriculture there is a remarkable shortage of organic fertilizers. The shortage leads to intensive dehumidification and deterioration of the agrophysical soil properties" [3].

The share of agricultural land fertilized with organic fertilizers in 2017 was 1.2%, compared to 13.1% in 1990. Reduction of organic fertilizers per 1 ha by 96% is caused by organic deficiency due to the negative rate of livestock change in Ukraine (Fig. 2).

Agrarian Economics NNC scientists are focusing on the escalation of nutrient loss (NPK) problems, which, according to their research, have exceeded 100 kg/ha in the last ten years, with areas of acidic, saline and eroded land increasing, leading to losses of about 500 million tons of soil annually. Erosion destroys up to 11 million tons of humus, 0.5 million tons of nitrogen, 0.4 million tons of phosphorus, and 0.7 million tons of potassium. Annual growth of eroded lands reaches 80-90 thousand hectares [16].

Statistical evaluation of the results of the various rounds as far as the agrochemical survey goes showed that the average weighted humus content in Vinnitsya region soils was 2.62% as of 2016 and is characterized by a negative dynamics with respect to other indicators of land quality [1].

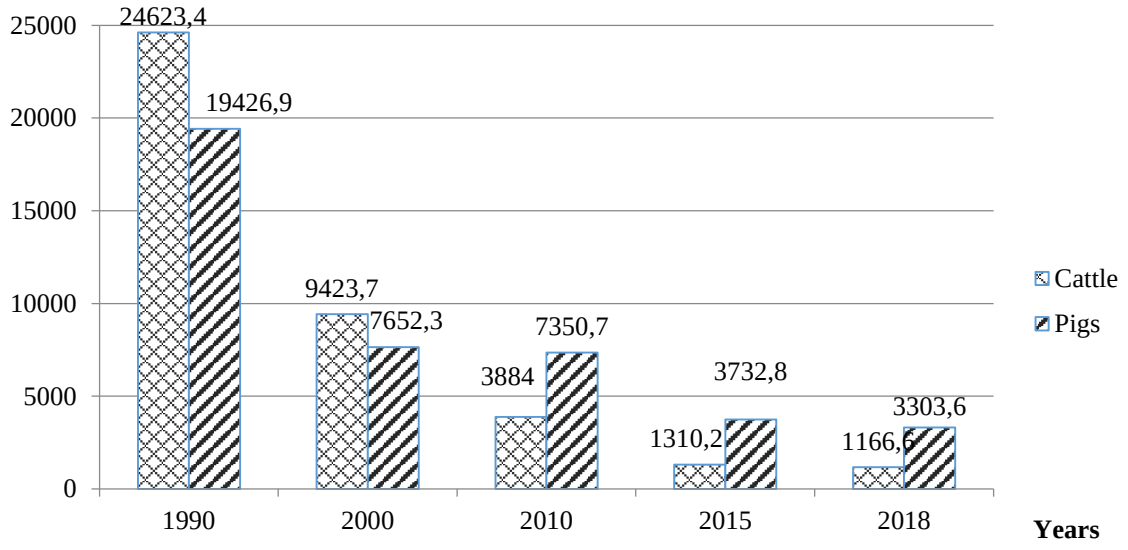
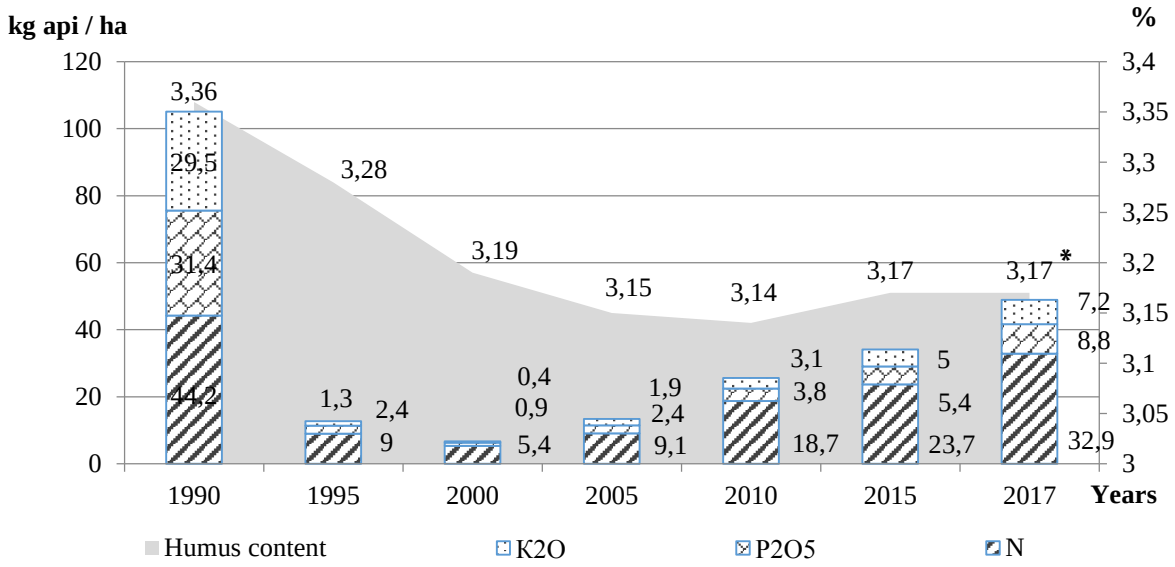


Fig. 2. **Dynamics of changes in the number of animals in Ukraine over the period 1990-2018**
Source: concluded by the authors using [7]

According to the research done by the Vinnitsya National Agrarian University scientists, in the territory of both Vinnytsia and all Ukraine, a negative balance of humus in soils was found, which is most pronounced in the areas of intensive agriculture. As a result of degenerative soil processes, scientists estimate the annual loss of humus in Polissia amounting to 1.42 t/ha. In the forest-steppe the loss amounts to 1.81 and in the Steppe it is 0.92. On the whole, in Ukraine the loss amounts to 1.08 t of humus per hectare [4]. The key cause of land degradation is the insufficient amount of fertilizer usage, the reduction of which is comparable with the negative dynamics of the weighted average humus content (Fig. 3).

Analyzing the structure of the introduced mineral fertilizers per 1 ha, it should be noted that it differs significantly in dynamics and does not meet the scientifically substantiated norms of NPK application (1.0: 0.8: 0.7) [4]. Particularly, in 1990, with the application of mineral fertilizers per hectare of arable land of 105.1 kg, the share of NPK was N 44.2%, P2O5 - 31.4%, K2O - 29.5% (1: 0.7: 0.6), and that is, almost in a rational ratio. However, in 2017, the NPK structure was substantially unbalanced, accounting for N 32.9%, P2O5 - 8.8%, K2O - 7.2% (1: 0.2: 0.2). Based on the above data, it is safe to say that the volumes of mineral fertilizers introduced do not meet the needs of intensive agriculture and do not meet the full needs of plants in the nutrients. This structure of fertilizers has a negative impact on the soil fertility as plants receive an insignificant amount of nutrients as a result of humus mineralization, which balance, respectively, decreased from 3.36 in 1990 of the analyzed period to 3.17 in 2017. The predominant and unjustified application of nitrogen fertilizers (ammonium nitrate) leads to acidification of soils and the so-called "nitrate problem". That is excessive accumulation of nitrates in the products grown.



* - *prediction*

Fig. 3. **Structure of mineral fertilizers introduced and humus balance in Ukraine for the period of 1990-2017**

Source: concluded by the authors using [7], [8]

According to the UN FAO, the actual level of mineral fertilizers in Ukraine is much lower (49 kg) than in the developed countries (Fig.). In particular, in the Netherlands, mineral fertilizers are 5.2 times larger, which on average per hectare of agricultural land is 258 kg of mineral fertilizers per active substance, while in the UK it is 247 kg, Israel - 240 kg, Germany - 202 kg, Belarus - 194 kg, Poland - 176 kg, France - 169 kg, Czech Republic - 153 kg, USA - 137 kg, Italy - 129 kg, Hungary - 118 kg and Turkey - 107 kg (Fig. 4).

Considering the fact that the current level of mineral fertilizers use in agriculture is not only significantly behind the agrarian indicator of the developed countries and also does not ensure simple nutrient balance in the agro-sphere, it can be expected to further increase the balance as an important strategic factor for maintaining the competitiveness of the industry. In many respects, it depends on the preservation possibilities and increase of domestic chemical industry capacities.

A significant portion of nitrogen fertilizers in Ukraine are produced at the enterprises of the holding company called Ostchem Holding AG. The company brings together Azot PJSC, Rivneazot PJSC, Severodonetsk Azot Union PJSC and other chemical industry enterprises. Also, the production of nitrogen fertilizers is carried out by OJSC "Odessa Port Plant". The efficiency of these enterprises' activity depends on the supply of imported gas and its price, which significantly increases the competitiveness of mineral fertilizers production and price increase [12].

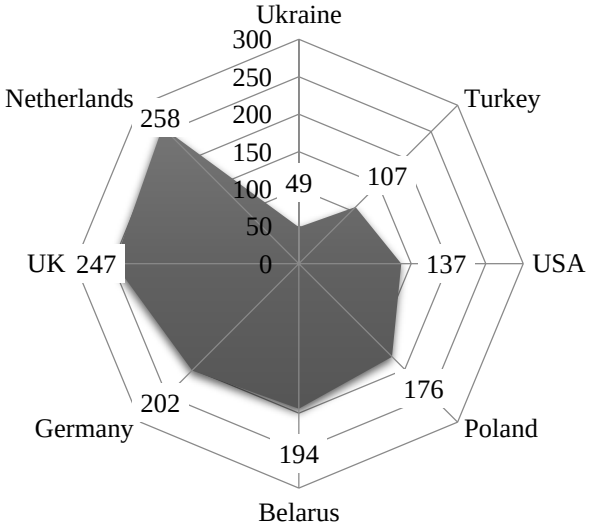


Fig. 4. **Fertilizer application by world countries compared to Ukraine, kg ape / ha**

Source: concluded by the authors using [8], [11]

During 2017-2018, the geography of mineral fertilizer imports to Ukraine changed significantly (Fig. 4). In particular, there have been significant changes in the volume of imports of various types of mineral fertilizers from the Russian Federation. According to the Resolution of the Cabinet of Ministers of Ukraine No. 1147 dated December 30, 2015 and No. 1022 dated December 20, 2017 [13], measures of state protectionism were taken, banning imports of plant protection products and minerals, fertilizers and their components from the Russian Federation (RF) into Ukraine [10].

In 2018, the supply of nitrogen fertilizers as of October amounted to 2,867 thousand tons due to a 33% drop in imports, which is 11% less than in the same period last year. Imports of potassium phosphate fertilizers also fell by 35%, which in turn affected the final balance of this group of fertilizers as domestic production almost did not produce fertilizers in this group. As of October 2018, the supply amounted to 953 thousand tons, which is 35% less than last year.

Overall, we see a 20% drop in market supply for all fertilizers compared to 2017. While in 2017, 64.9% of imports came from the Russian Federation. In 2018, deliveries were differentiated mainly between six importing countries, where Russia's share declined more than three times (19.5%) (Fig. 5). This affected the volumes of imports accordingly, which tend to decline. The phosphate fertilizers from Serbia and Egypt have started to be delivered to Ukraine, and volumes from Belarus have also increased.

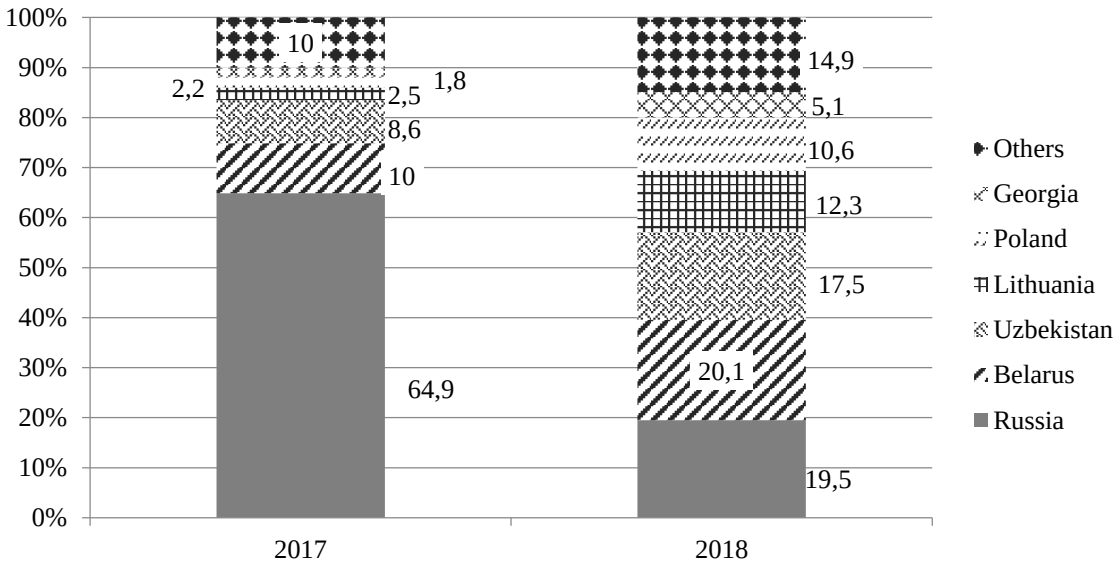
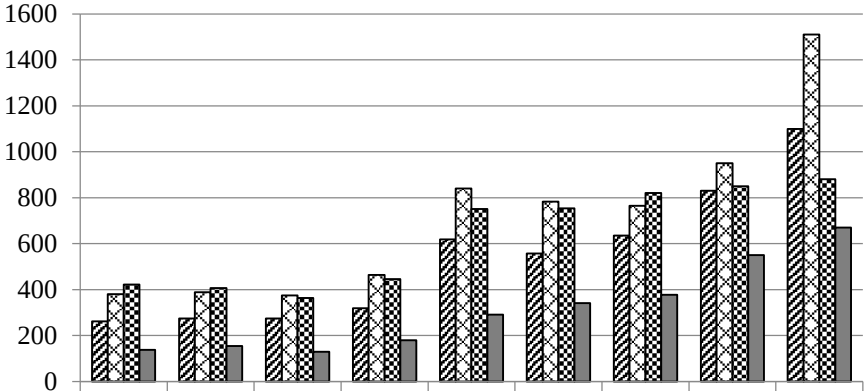


Fig. 5. **Import of nitrogen fertilizers to Ukraine**

Source: concluded by the authors using [7], [12]

The expansion of the mineral fertilizers usage is hampered by the high growth rate of their value. Restrictions on the supply of fertilizers from the Russian Federation have led to their shortage in the market of potassium phosphate fertilizers, which we estimate is about 50%. This can be considered one of the reasons for their rise in price (Fig. 6). The rise contributed to the deepening of the disparity of prices for agricultural and industrial products, and as a consequence, led to a decrease in the amount of mineral fertilizers.



	2011	2012	2013	2014	2015	2016	2017	2018	2019
Nitrogen (Ammonium nitrate)	262	274,9	274,4	319,1	618,6	557,2	635,7	830	1100
Phosphorus (superphosphate)	381	388	375,2	463,4	840,5	783	764,6	950	1510
Potassium (colimagus)	421,8	406,5	363,5	445,9	751,2	754,4	820,2	850	880
Cereals and legumes	137,4	154,7	129,9	180,1	291,2	341,4	377,1	550	670

Fig. 6. **Dynamics of purchase prices for mineral fertilizers, UAH / d**

Source: concluded by the authors using [7]

The low volume of fertilizer use is also associated with a high proportion of other components of the cost of agricultural products: high credit rates, volatility of the national currency and the dependence of agricultural prices on the situation in world markets. Thus, for the period from 2011 to 2019, nitrogen fertilizers went up 4.9 times, phosphorous - 3.96, potassium - 2.08 times. The cost of cereals and legumes has increased almost three times over the studied period; however, the price ratio of the value of mineral fertilizers and cereals is on average 1:2, which automatically leads to "leaching" of funds from agrarians. The price disparity can be considered in table. 2

Table 2

Price disparity for agricultural products

Indicator	Years					
	1990	2000	2005	2010	2015	2019
The average price of wheat (2 cells) UAH/t	118,4	443,8	417,8	1374,2	2380	4800
For the production of grain						
1 t of diesel fuel	0,2	14	16,75	6	7,2	7,4
1 t of petroleum	0,7	9,6	11,5	8,2	8,3	7,7
1 t ammonium nitrate	1,1	2,5	3,2	1,9	2,6	2,3
1 t of superphosphate	0,9	1,7	2,2	2,8	3,5	3,2

Source: concluded by the authors using [2], [9]

To buy ammonium nitrate in 1990, it was necessary to allocate 1.1 tons of wheat crop and 900 kg of superphosphate. In 2019, there are already 2.3 tones and 3.2 tons respectively. This indicates a more progressive rate of increase in prices for fertilizers than for grain, respectively, and an increase in their share among the cost components [16].

Scientists [5] today focus on the paradoxical situation where Ukraine, having a number of competitive advantages in the development of the agro industrial complex (favorable natural and climatic conditions, cheap labor and raw materials, convenient location in relation to other world markets), does not receive from it the proper "dividends" . Having significant potential for exporting crop products due to the non-compliance of agricultural business entities, we are in fact irreversibly "exporting" nutrients as well. Let us illustrate this trend by the example of the calculations performed (Table 3).

Table 3

Effect of yields and fertilizer volumes on nutrient balance for the period 1990-2017.

Years	Wheat										Corn									
	Yield, kg / ha	Nutrient removal, kg ai/ ha			Contributed nutrients, kg / ha			Nutrient balance, kg / ha			Yield, kg / ha	Nutrient removal, kg / ha			Contributed nutrients, kg / ha			Nutrient balance, kg / ha		
		N	P	K	N	P	K	N	P	K		N	P	K	N	P	K	N	P	K
1990	40,2	121	121	314	60	32	30	-61	-89	-284	38,7	93	84	217	68	46	39	-25	-38	-178
2000	19,8	59	59	154	13	2	1	-46	-57	-153	30,1	72	65	169	15	3	1	-57	-62	-168
2010	26,8	80	80	209	45	6	5	-35	-74	-204	45,1	108	97	253	53	10	8	-55	-87	-245
2015	38,8	116	116	303	52	8,6	7	-64	-107	-296	57,1	137	123	321	63	11	11	-74	-112	-310
2017	37,3	112	112	291	66	14	11	-46	-98	-280	78,4	188	169	440	77	20	15	-111	-149	-425

Source: concluded by the authors using [7]

According to the table, it can be noted that the increase in yield is accompanied by an increasing imbalance between the amount of NPK introduction and the removal of their plants. Thus, in the case of maize in 1990, at a yield of 38.7 c/ha and NPK application in the ratio of 1: 0.5: 0.5 kg ai/ha, the imbalance was -25: -38: -178 kg dp/ha respectively. In 2017, the imbalance was -111: -149: -425 at a yield level of 78.4 c/ha and NPK introduction in the ratio of 1: 0.3: 0.2. That is, when corn was grown for grain, NPK yields were 7 times higher than their incomes, 5.7 times for wheat cultivation.

According to the estimates of domestic scientists [15], the cost of the basic components of soil fertility is: 1 kg of humus - 2700 UAH, 1 kg of nitrogen - 29 UAH/kg, 1 kg of phosphorus - 39 UAH, 1 kg of potassium - 18 UAH. Thus, in 2017, due to a gross corn harvest of 24.67 million tons and 26.16 million tons of wheat, given the shortage of nutrients, Ukraine lost NPK reserves amounting to 173.4 billion UAH, which is about 78% of export earnings according to these cultures (table 4). As economists position land as the main means of agricultural production, these nutrient losses should be characterized as depreciation of land resources, i.e. depreciation, which leads to a deterioration of its agrochemical properties and production potential as a whole. At the legislative level, there is no provision for fixing these costs and taking them into account in the cost of production, which does not allow proper control over the proper financing of soil regeneration measures.

Table 4

Damage caused in 2017, UAH billion

Crop	Cost of nutrients lost, billion UAH				Gross collection, thousand tons	Product Cost, billion UAH	Export, thousand tons	Export revenue, billion UAH	Export revenue based on nutrients lost
	N	P	K	Total					
Corn	14,42	26,04	34,28	74,74	24668,8	106,57	18151,4	108,00	33,26
Wheat	32,84	31,26	34,58	98,67	26158,0	115,46	15274,6	99,72	1,05
Total	47,26	57,30	68,86	173,41	50826,8	222,03	33426,0	207,72	34,31

Source: concluded by the authors using [7], [12]

According to the table, net export revenue, taking into account the value of nutrients lost in 2017 for winter wheat, is actually absent, and for corn it is three times less than actual. The problem with low profitability is that domestic exporters sell raw materials with low value added in most cases. In this situation, in our opinion, it is right to refer to the book "How Rich Countries Have Become Rich ... and Why Poor Countries Remain Poor", where its author E.S. Reinert condemns the export of raw materials abroad and proposes the introduction of a "death penalty for such merchants" [14]. This quotation is appropriate for Ukraine, because in the context of the financial and economic crisis, the export of raw materials, the state loses a significant share of value added, which is formed precisely in the processing industry. Accordingly, Ukraine becomes poorer relative to the importing countries of our raw materials, on the basis of which they develop their own production of final consumption products, some of which returns to our own markets. Thus, the economy of Ukraine also receives significant losses from the existing "raw material policy" and makes us dependent on so-called imports.

Based on our research, we consolidate key problems in the use of mineral and organic fertilizers and offer conceptual directions for solving them (Table 5).

Solving consolidated problems requires systematization of certain institutional measures. Let us identify the key solutions for stabilizing the ecological and economic situation in the agricultural sector of Ukraine. Increasing control over the observance of the elementary units of crop rotation, creation of plowed territories, preservation of field-protected forest plantations are decisive [17].

Table 5

The concept of economic and ecological balance of modern land use

	Problem	Conceptual solution
Economic component	1. The high cost of fertilizers and its significant share in the production cost. 2. Ignoring the damage caused by cultivation of crops as a result of destructive processes in soils. 3. The dominance of raw materials in the commodity structure of exports.	– state support for the development of the domestic fertilizer market, reduction of imports; – control of crop rotation through the development of technological maps and plans and the introduction of the necessary nutrients; – strengthening of state control, establishment of regional offices of State Institution "Soil Protection Institute"; –strengthening of the control over the exploitation of the lands in accordance with their purpose and scientifically grounded agrotechnics; –diversification of production by deepening the processing of products and taking into account natural and climatic conditions, which will maximize value added.
Ecologigal component	4. Failure to comply with agricultural measures. 5. Low level and unbalance of fertilizer structure. 6. Organic deficiency and negative humus balance.	– Scientific consulting centers for the development of integrated fertilizer systems; – coordination of activities of environmental services to monitor the regularity of soil analysis and agrochemical certification; – implementation of measures to encourage livestock development; – formalization of the obligation to keep livestock (at least 0.5 head per 1 ha).
Social component	7. Destabilization of social institutions of land use.	– systematic development and implementation of rational land-use planning schemes taking into account social preferences.
	8. Leveling of social responsibilities of People concerning dealing with the land.	–improving the level of knowledge about the importance and role of land and land resources; environmental education, promoting the ideology of sustainable land usage and environmentally friendly land usage.
	9. Lack of social responsibility of land users.	– involving the public in the process of sustainable land use planning and control; – support and implementation of initiatives by nature conservation organizations in land management.

Source: Generalized by authors using [15], [16], [17]

One way to reduce the cost of using mineral fertilizers is to consider the use of liquid forms of nitrogen fertilizers, in particular ammonia water and CAS, the effectiveness of which is confirmed by the practice of developed countries, for example in the United States, up to 50% of nitrogen fertilizers are used in liquid form.

Given the insolvent demand for mineral fertilizers and organic deficiency, we support the view of scientists about the need for plowing root crops and siderite crops. This will provide the necessary balance of organic matter, since 1 ton of straw forms about 0.2 tons of humus, and for 2 years of growing perennial grasses there are 4–5 tons of root and post-residual residues in the soil, equivalent to a single application of 15 tons/ha of manure [16].

Conclusions. According to the results of the conducted research, it should be noted that the growth of domestic GDP is directly related to the improvement of modern systems of agriculture, reproduction and increase of soil fertility and rational use of bioclimatic potential. The domestic agro-sector is characterized by an increasing shortage of basic nutrients of plants, the development of erosion processes, increasing the acidity of soils, that is, progressing processes of soil loss of humus reserves. We consider these problems as a derivative of reducing the volume of organic, mineral fertilizers, non-observance of scientifically justified crop rotations, ignoring the law of returning the basic nutrients to the soil, etc. These arguments are confirmed by analytical results that show a decrease in the volume of organic even by 96% relative to 1990. Organic deficiency is due, first of all, to the negative rate of change in the livestock population.

The analysis of the structure of the introduced minerals made it possible to reveal a significant inconsistency with the scientifically substantiated application standards due to the shift towards nitrogen-containing substances. This trend does not meet the conditions of intensive agriculture and does not provide the full need of plants for nutrients, which, accordingly, adversely affects the fertility of the soil, as plants receive deficient nutrients as a result of the mineralization of humus.

Comparison of the dynamics of fertilizers input by Ukrainian farms with foreign practice demonstrates many times lower nutrient input in our country in relation to the indicators of world farmers, which determines the decrease in the competitiveness of domestic agricultural products in world markets. The reasons for the lack of nutrients in agrotechnics of domestic farms are seen in the high cost of fertilizers, as a consequence of a large share of imports in their structure and insufficient production of domestic ones. Particularly acute is the increase in the disparity of prices for agricultural products and components of its cost.

An analysis of yield trends showed an increasing imbalance between the volume of NPK introduction and the removal of their plants. It has been calculated that when corn is grown for grain, NPK yields are 7 times higher than their incomes and 5.7 times for wheat cultivation. Based on the calculations, it was proved that due to the shortage of nutrients while growing only two of the studied crops - corn and wheat, the state lost NPK reserves in the amount of 173.4 billion UAH, which is about 78% of the export earnings for these crops.

It is proposed to solve the identified problems by strengthening state control through the establishment of regional representative offices and scientific consulting centers on the development of integrated fertilizer systems, intensification of state support for the production of domestic fertilizers and reduction of their import, introduction of measures to stimulate the development of animal husbandry, strengthen the control of their operation in accordance with the land purpose and science-based agrotechnics, diversification of production due to deepening product processing and consideration of climatic conditions.

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