UDC 631.43.539.16.332

Disturbance of ecology in zone of techogenic load of modern swine-growing complex

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The purpose. To make local assessment of vulnerability of sod-podzolic soil village settlement terrains in the area of modern swine-growing complex, and to justify methods of rehabilitation of terrain with disturbed ecology. **Methods.** Agrochemical, physical, spectrometric, biometrical (determination of mean values, their lapses, etc.). **Results.** Agrochemical research is carried out of coverless dung and soils in the terrain which are in catchment area swine-growing complex. Arable soils in catchment area of swine-growing complex are characterized by close to neutral response of environment, heightened content of mobile potassium, and also very high content of flexible joints of phosphorus. The content of flexible joints of phosphorus on gross stores varies within the limits of 33 – 7650% and exceeds analogous index for sod-podzolic soils of Zhytomyr region — up to 15% in loamy and 4 – 12% — in sandy-loam soils. Variability of this index is great: for sandy loam soils — 25 – 27%, for sandy-loam soils — approach to 50%. In sod-podzolic soils after long manuring, as a rule, amount of organophosphates augmented in 3 – 4 times in comparison with soil without fertilization. Dynamics of the content of biogenic elements on years testifies to steady lowering the content of potassium in different fractions of coverless dung and stable increase in them of phosphorus. It is the cause of existing unbalance of nutrients in soils within the limits of terrain of economic activities of swine-growing complex where they use coverless pig manure as fertilizer. **Conclusions**. Information basis is formed of ecological-agrochemical indexes of sod-podzolic soil in zone of technogenic load of modern swine-growing complex. On the basis of the gained data scientifically justified methods will be developed, which will lower technogenic load on environment of modern swine-growing complex in conditions of scouring regimen of sod-podzolic soil of zone of Polissia.

Key words: *soil, settlement terrain, mobile potassium, mobile phosphorus, heavy metals, tolerance levels.*

DOI: https://doi.org/20.31073/agrovisnyk201910-10

The transition of agriculture to an intensive way of development has led to the emergence of powerful livestock complexes with a stable high output. The main feature of such companies is the high concentration of animals in restricted areas, which inevitably generates a number of environmental problems in these areas. The territories that are in the zone of influence of such companies are subject to intense action connected with pollution of natural environments due to the emission of pollutants into the atmosphere, dumping them into water sources and the formation of a large amount of organic waste, which are located mainly on the arable land of these farms [1].

Despite the considerable amount of work done over this problem, a number of issues remains to be resolved, which require further research. The issues of the uncontrolled introduction of non-sprinkler manure in rural settlements in the soils with a high infiltration rate and high levels of soil contamination and contamination of surface waters due to uncontrolled storage of livestock effluent are not adequately covered for today. Ignoring the environmental principles of agricultural production inevitably accelerates the ecological destruction of land resources, reduces the ecological and economic efficiency of agrarian production [2]. Purpose of researches. Conducting an effective local assessment of the vulnerability of sod-podzolic soils of rural residential areas in the zone of influence of modern pig farms and to substantiate ways of rehabilitation of the territory with a violation of the ecological balance.

Material and methods of research. The information base for research serves modern pig farms with a production capacity of 6.0 and 25.0 thousand units, located on the territory of Grozyno village, Korosten district of Zhytomyr region. The total area of the first complex is approximately 5.5 hectares. On the eastern side of the complex there are experimental fields of the Institute of Agriculture Polissya of the National Academy of Agricultural Sciences, from other sides - limited byy agricultural lands and buildings of economic use. From the western side of the pig farm there is a river of local significance Siniavka. The distance to the nearest residential buildings is 440 m. The second complex occupies 16 hectares and is located at a distance of 1000 m from residential buildings.

For research, samples of soil are selected on the territory located in the zone of influence of pig farms. Selected plots are in the same geomorphological and hydrological conditions. Samples were selected in May-early June 2017. For the agrochemical characteristics of the soils, mixed samples were taken at the depth of the arable layer. The points for the sampling of individual samples were at a different distance from the location of the pig farms, in fields where non-sprinkler pus was introduced directly as fertilizer (sites No. 1-30) [3].

The following indicators were determined in the soil: exchange acidity - at pH - meter; mobile compounds of phosphorus and potassium - according to Kirsanov (National Standard of Ukraine 4115-2002); alkaline hydrolyzed nitrogen - by the Cornfield method, nitrate nitrogen (N-NO3) - using Griss reagent. The sum of the absorbed bases (S), the absorption capacity of the soil (T), the degree of soil saturation with the bases (V%), and the hydrolytic acidity (Ng) [4] were determined.

The group composition of phosphates was determined by the method of F.V. Chirikova (1947) (variant Shkonda, 1952). The method is based on repeated soil treatment with appropriate solvents and obtaining selective extracts [5].

In order to determine the content of heavy metals in soil, the method of atomic absorption spectrometry on “Quantum - 2A” spectrometer was used.

Digital material is processed by the methods of variation statistics [3].

Results of research.

Pork manure includes all the necessary biogenic elements for plant development. This organic fertilizer contains 0.35-0.66% total nitrogen, 0.15-0.76% phosphorus, 0.14-0.21% potassium. The nitrogen in the pus at 50-70% is represented by ammonia and ammonium carbonate, as well as the nitrate form, which accounts for from 3 to 8%. These forms are well absorbed by plants in the first year. In addition, litterless manure contains (in terms of 10% dry matter content) trace elements: boron – 3.6 mg / kg, manganese – 27.3 mg / kg, molybdenum – 0.2 mg / kg, copper – 6 , 9 mg / kg, zinc – 36.8 mg / kg.

By 2018, the total accumulations of non-litter manure and soil saturation increased 1.6 times compared to 2016 and 1.2 times compared to 2017 due to the increase in the number of pigs. At the same time, against the background of constant amount of solid pig manure (5% of the total weight of organic fertilizers), the proportion of liquid pig manure increased from 43% to 85%.

Table 1 shows the dynamics of the content of biogenic elements by years shows a steady decrease in the content of potassium in all types of organic fertilizers and a steady increase in their phosphorus.

1. Content of basic biogenic elements in pig manure,%

Selection year sample	On natural humidity				On dry matter			
	Pb	Cd	Zn	Ni	Pb	Cd	Zn	Ni
2016	1,4	0,01	5,6	1,3	27,5	0,19	109,8	25,5
2017	1,7	0,01	5,6	1,3	30,9	0,18	101,8	23,6
2018	1,8	0,02	6,3	1,5	27,3	0,30	95,5	22,7
DSTU 10-118-96 (for RSG)					*130*	*2,0*	*220*	-
MPC in soil					*32*	*0,5*	*55*	*20*

Ultimately, this fact, along with the redistribution of particles of the participation of different types of organic fertilizers in their total mass (the final ratio of nutrients was N: P205: K20 as 1: 1,1: 0,4), is the cause of the existing imbalance of nutrients in soils within the territory of the holding of the pig farms where the non-litter pig pig manure is used as fertilizer.

Comparing the industry standard for unleaded liquid pig manure with the available data, it can be noted that the amount of nitrogen in the fertilizer can be compared with the given standard, the potassium content in the already mentioned fertilizer is lower by 3.7 times, and phosphorus - higher by 1.6 times. that low potassium content will inevitably affect the productivity of the crops grown on the land.

Ecological safety of the use of organic fertilizers is determined by the content of xenobiotics (including heavy metals), the content of which should not exceed the norms of their content in the soil (Ponomareva LV et al., 1996; Reference book ..., 2001) [10]. Data on the content of heavy metals in pig manure are presented in table 2.

2. Content of heavy metals in liquid pig manure, mg / kg

Selection year sample	On natural humidity				On dry matter			
	Pb	Cd	Zn	Ni	Pb	Cd	Zn	Ni
2016	1,4	0,01	5,6	1,3	27,5	0,19	109,8	25,5
2017	1,7	0,01	5,6	1,3	30,9	0,18	101,8	23,6
2018	1,8	0,02	6,3	1,5	27,3	0,30	95,5	22,7
DSTU 10-118-96 (for RSG)					*130*	*2,0*	*220*	-
MPC in soil					*32*	*0,5*	*55*	*20*

Zinc is the only element that exceeds the MPC level by almost 2 times. A possible explanation for this fact lies in the particular formation of the diet of pigs in the holding. Various trace element additives are actively used for the preparation of feed in pig complexes - premixes that increase the conservation of animals, reduce feed consumption and increase gains. In the finished feed using such additives, the zinc content ranges from 0.3 to 0.8 mg / kg, depending on the age structure of the livestock. Due to the low absorption of heavy metals by the body of animals, in the excrement can be detected up to 90% of the total number of pollutants that came with feed.

However, if we consider the content of heavy metals in pig manure in relation to the data proposed by the industry standard, where the MPC for zinc is 4 times higher than the soil standard, we can speak about the safety of this type of organic fertilizer in relation to the proposed indicators.

No less significant indicator of the safety assessment of the use of pig manure in agricultural production is the determination of the total amount of heavy metals entering the soil when it is disposed of in Table 3.

3. Heavy metals input to soil with average annual rate of pig manure

Indicators	Pb	Cd	Zn	Ni
Contributed with the average annual rate of 200t / ha, g	340	3,0	1160	280
Receipts in the amount of 10 years, mg per kg of soil	1,13	0,01	3,87	0,93

They testify that over the 10 years of operation of the pig manure complex, 57% of the gross lead form, 41% of the gross zinc content, 54% of nickel and about 60% of the cadmium content have been provided.

Thus, the fact of the active use of premixes in pig production can contribute to the anthropogenic introduction into the environment of heavy metals, which will ultimately lead to an increase in environmental load in the area. This should be taken into account and, wherever possible, efforts should

be made to reduce the amount of heavy metals introduced into the ecosystem, not only during the development of measures to reduce the content of ecotoxicants in soil and plant products,

The investigated arable soils are characterized by a near neutral reaction of the medium, an average degree of content of organic matter (2.1%) and high - moving potassium, as well as a very high concentration of mobile phosphorus compounds. According to the latest data, the share of such soils (with a very high level of P2O5) in the structure of arable areas is 12%, and 49% - soil with high and high content of phosphorus. 51% of investigated areas (51.4 hectares), including 42% (42.0 hectares), and 9% (9.4 hectares) of arable soils, are in particular need of liming Introduction of limestone materials (Table 4, 5).

4. Agrarian and chemical characteristics of sod-podzolic sandy soils

Lot No	Organic substance, %	pH_{KCl}	P_2O_5	K_2O	S	Hr	T	V, %
			by Kirsanov, mg/kg		mg-eq/100 g			
1	1,1	4,9	700	22	22,2	2,2	24,4	91,0
2	2,8	5,2	1 805	110	29,9	5,3	35,2	84,9
3	2,1	6,0	2 427	120	24,4	1,9	26,3	92,8
4	2,6	5,8	4 720	137	28,0	4,1	32,1	87,2
6	2,3	5,7	2 340	200	29,2	2,9	32,1	91,0
13	2,0	5,7	720	39	7,6	2,0	9,6	79,2
14	1,8	6,4	1 975	45	29,0	1,0	30,0	96,7
15	1,5	5,3	1 257	306	8,0	2,3	10,3	77,7
16	1,6	5,7	1 137	46	8,2	1,3	9,5	86,3
17	1,1	4,9	1 390	72	7,2	2,2	9,4	76,6
18	1,5	5,4	762	120	26,2	1,8	28,0	93,6
19	1,5	5,0	1 375	51	8,2	2,7	10,9	75,2
20	1,7	5,4	2 360	28	10,2	2,4	12,6	81,0
21	1,4	5,7	860	44	8,6	1,5	10,1	85,1
22	1,6	5,3	1 077	82	23,4	1,9	25,3	92,5
23	2,2	5,1	1 840	52	20,6	2,5	23,1	89,2
27	2,2	5,3	1 750	48	11,8	2,8	14,6	80,8
28	1,4	5,4	407	134	8,6	1,5	10,1	85,1
29	1,0	5,4	613	289	9,0	1,5	10,5	85,7
30	1,5	5,2	530	180	4,4	2,4	6,8	64,7

A small amount of mobile potassium in soils is associated with the high removal of this element by cultivated crops and its low content in used organic fertilizers. On the contrary, the accumulation of phosphorus in the studied soils is due to the relatively low demand for plants in it at sufficiently high levels in pork manure.

Analyzing the presented results, first of all, it should be noted that very high level of soil saturation with mobile forms of phosphorus, determined in 0,2n HCl, exceeds the established concepts of high level of soil P2O5 in 5-10 times. The content of mobile forms of phosphorus in relation to gross reserves varies within 33-50% and exceeds the similar indicator for sod-podzolic soils of Zhytomyr region to 15% in loamy

and 4-12% in sandy loam. The variability of this indicator is quite high: on the soils of lightloamy it is 25-27%, and on sandy soils is approaching 50%.

5. Agrochemical characteristics of sod-podzolic loamy soils

Lot No	Organic substance, %	pH_{KCl}	P_2O_5	K_2O	S	Hr	T	V, %
			by Kirsanov, mg/kg		mg-eq/100 g			
5	2,3	5,5	2 137	52	16,8	3,1	19,9	84,4
7	2,3	5,3	937	84	6,9	2,9	9,8	70,4
8	2,1	5,9	2 443	165	13,1	2,3	15,4	85,1
9	2,8	5,4	3 015	181	4,5	3,7	8,2	54,9
10	1,8	5,4	2 230	449	30,8	2,4	33,2	92,8
11	1,7	5,2	1 008	58	5,0	2,8	7,8	64,1
12	1,6	5,0	810	84	5,4	2,9	8,3	65,1
24	1,7	6,0	1 851	62	10,1	1,4	11,5	87,8
25	1,1	-	-	-	22,2	2,2	24,4	91,0
26	1,6	5,2	1 585	118	15,8	4,3	20,1	78,6

The sod-podzolic soils responded to the prolonged introduction of organic fertilizers, usually by increasing the amount of organophosphates – 3-4 times in comparison with the soil without fertilizing (Table 3). In sandy soils with less pronounced buffering force and the ability to accumulate mineral forms of phosphorus, the relative content of organophosphates for the introduction of organic fertilizers increases to 35% of gross reserves. The fact that sorption of phosphorus in sod-podzolic soils occurs mainly due to the phosphates of iron and aluminum, according to A.I. Kalinin (1975, 1985), A.Yu. Kudeiarova (1995), I.M. Khmelinin (1984), etc. [6]. In our studies, we have obtained similar results: the content of phosphorus semi-oxide is about 70% of the amount of mineral phosphorus. At the same time for the fraction of alumina and ironphosphates marked minimum variability of the characteristic, which is expressed by coefficients of variation in 5-20%. Soil nutrition with liquid pork pus contributed to a decrease in the fraction fraction Al-P and Fe-P (Table 6).

6. Fraction composition of soil phosphates by systematic application of pig manure

Soil	Saturation with fertilizers, t/ha	Indsces	P_2O_5 by Kirsanov, mg/kg	$P_{min.}$ mg/kg	Fractions P_2O_5, mg/kg			
					Loosebound	Al - P	Fe - P	Ca - P
Sandi	0	M ± m	203 ± 72	871	41	204	460	164
		n	7	5	5	5	5	5
		lim	741 ÷ 1800	1345 ÷ 2605	62 ÷ 340	445 ÷ 460	665 ÷ 20	162 ÷ 760
	200	M ± m	1216 ± 420	1975 ± 410	206 ± 108	465 ± 17	824 ± 122	465 ± 232
		V, %	44,5	23,4	65,2	5,2	20,6	62,4
Loamy	0	M ± m	216 ± 42	822	33	170	365	233
		n	14	6	6	6	6	6
		lim	950 ÷ 1460	1825 ÷ 2460	97 ÷ 301	275 ÷ 460	760 ÷ 940	533 ÷ 872
	200	M ± m	1139 ± 279	2088 ± 275	210 ± 62	345 ± 65	835 ± 45	675 ± 122
		V, %	21,5	14,6	46,2	24,0	9,2	23,3

7. Phosphate condition of soil with a systematic application of organic fertilizers

Type fertslszer	Saturation with fertilizers, t/ha	$P_{val.}$, mg/kg	$P_{opr.}$		$P_{min.}$		Al-P + Fe-P				Ca – P	
			mg/kg	% к $P_{val.}$	mg/kg	% к $P_{val.}$	mg/kg	% к $P_{val.}$	% к P_{min}	mg/kg	% к $P_{val.}$	% к P_{min}
			Sod – podzolic loamy									
Pig manure	0	1 365	345	25,4	821	58,0	545	40,2	66,7	269	19,8	33,1
	200	3 370	963	26,1	2 075	63,8	1 225	35,6	57,3	891	26,2	42,4
			Sod – podzolic sandi									
Pig manure	0	1 225	326	25,7	630	52,7	444	35,6	67,6	211	17,1	32,1
	200	3 885	1 342	34,2	1 845	50,6	1 275	33,0	65,3	696	17,5	34,5

The proportion of calcium phosphates as a result of the long-term application of pumice manure to light-loamy sod-podzolic soils increased up to 42%, and up to 35% of the amount of mineral phosphates in the sandy loam. The reason for such a phenomenon may be temporary excessive moisture conditions, which are formed on loose-loamy soils with a binomial profile enriched with a mule in combination with sand particles. As a result, in these soils, along with the elemental soil processes of pseudosuppression, signs of malting appear, which stimulate the formation of iron phosphates to the detriment of calcium phosphates. The content of organophosphates for the systematic introduction of liquid pork manure increases slightly and mainly on the sandy soils.

The most important problem that accompanies the operation of such large enterprises is the recycling and utilization of livestock effluent, which is often solved by their use as meliorants.

At the moment, it should be kept in mind that in the recycled waste, impurity elements (heavy metals) may be present at elevated concentrations as compared with their presence in the soil. Consequently, the monitoring of the content of heavy metals in the environment is a prerequisite for the existence of these territories.

Comparison of the data of the level of heavy metals in the studied soils with the norms (maximum permissible concentration) showed that the content of gross forms of investigated elements below the MPC, except for cadmium and zinc. Excess of cadmium content is noted at 9 sites (2, 7, 8, 9, 11, 12, 13, 14, 26) and varies from 0.51 to 0.64 mg/kg (greater than PC by 2-28%) Zinc content above the normative requirements is observed only in the seventh section and is 61.14 mg/kg. The total area of land disadvantaged by these elements was 19.8 hectares, or 19.7% of the total area of arable land.

The maximum content of lead in the soil is only 6.92 mg/kg (22% of PC), copper – 15.98 (65% of PC), cadmium 13.79 mg/kg (14% of PC).

The content of the moving forms of heavy metals in the studied soils as a whole is also within the norms of the maximum permissible concentration, with the exception of zinc – the excess of PC is observed at the 4th site and is 27.84 mg/kg (the area of the contaminated surface is 1.1% of the total area arable land).

Agroecological survey data were processed using nonparametric statistics, resulting in a correlation between the total content of certain ecotoxicants. This fact is another confirmation that all of the listed pollutants have one source of origin - organic meliorants widely used in the surveyed area.

It is believed that in non contaminated soils, the share of moving forms of heavy metals from their gross content is 5-20% [7], and in the turf podzolic we studied it was 6-30%. The results of calculations show that zinc is prone to the greatest variability, the coefficient of variation of the share of moving forms of which amounted to an average of 83%, which is the result of unpredictable level of pollution for this element. At the same time, the share of rolling forms of zinc increased in comparison with the background value of 6,3 times on sandy soils and 9,6 times on light-loamy soils.

Conclusions

The dynamics of the content of biogenic elements over the years indicates a steady decrease in the content of potassium in different fractions of baseless manure and a steady increase in their phosphorus. The final ratio of biogenic elements was: N: P205: K20 as 1: 1,1: 0,4, and is the reason for the existing imbalance of nutrients in soils within the territory of the farms of pig farms, which uses litterless pig manure as fertilizer. The utilization of large volumes of unleaded manure on land adjacent to pig farms has led to a change in the agrochemical parameters of arable soils. At the same time marked violation of the ratio of batteries in the direction of a clear increase in the proportion of mobile phosphorus. Utilization of large volumes of manure drains on the land adjacent to pig farms has led to changes in agro-chemical parameters of arable soils. At the same time, there is a violation of the ratio of nutrients in the direction of explicit increase in the proportion of mobile phosphorus.

Prolonged application of organic fertilizers leads to a general increase in the content of mobile phosphorus compounds, while the relative content of organic and mineral phosphate groups does not increase or increases slightly, fluctuating within the limits of 27-35% and 50-62%, according to the gross

reserves of phosphorus. The replenishment of rifle-bound phosphates on soddy-podzolic light-loamy soils occurs mainly due to the fraction of calcium phosphates, on sandy soils - at the expense of phosphates of aluminum or iron.

The agro-ecological state of the investigated soils on the content of heavy metals should be assessed as satisfactory, since the concentration of pollutants in general does not exceed PC. However, the indicator of total pollution indicates negative trends in the accumulation of heavy metals in the soil.

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