

N₄₅₋₅₄P₄₂₋₄₆K₅₅₋₆₂ + 10 т гною. Подальше підвищення насиченості сівозмін добривами зумовлює інтенсифікацію радіального переміщення нутрієнтів, що своєю чергою спричиняє їх непродуктивні втрати.

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ASSESSMENT OF SNOW COVER IN SANITARY PROTECTION ZONE OF PIG COMPLEXES OF DIFFERENT CAPACITIES

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Досліджено стан снігового покриву на різній віддаленості від свинокомплексів (свиноферм) різної потужності та різних систем утримання тварин і утилізації відходів. Встановлено відмінності у варіантах досліді в межах кожного господарства за рівнем окислювання, наявності біогенних елементів та іонів мінеральних сполук, а також мікроорганізмів. Проаналізовано вплив виробничо-технологічних особливостей господарств на можливу віддаленість віднесення та осідання цих речовин на сніговий покрив. Перераховано кількість кожного компонента досліджуваного снігу на одну тварину. Розраховано індекси навантаження вказаних елементів на екосистему санітарно-захисних зон свинокомплексів.

Ключові слова: свинокомплекси, довкілля, сніговий покрив, органічні речовини, біогенні елементи, мінеральні сполуки, гетеротрофні бактерії.

It is commonly known that pig growing and fattening farms with all their technological and production processes and animal husbandry serve as an important source of various pollutant emissions in the atmosphere both organic and mineral origin [1, 2].

It is suggested that precipitation, including snow, in some extent characterizes air-space composition of certain territory, because

the formation of precipitation chemical composition occurs of water droplets or crystals passage through certain atmosphere layers and aerosols absorption by them which are available there, especially in the surface layers of the atmosphere [3–5].

There is no established background value for substances or MAC for snow and other precipitation in Ukraine. It is known only approximate chemical composition of precipitation (rain, snow, frost, hail, dew) for cer-

tain regions of Ukraine according to the data of Ukrainian Hydrometeorological Center long-term observations of 11 meteorological stations [5]: Ca^{2+} – 5.9 mg/dm³, Mg^{2+} – 0.40, Na^+ – 1.6, K^+ – 0.6, HCO_3^- – 11.3, Cl^- – 1.4, SO_4^{2-} – 14.4; NH_4^+ – 0.70 mg/dm³ (in Kyiv region). The chemical composition of water clouds in Kyiv region is also known according to the Main Geophysical Observatory data in Ukraine [5]: Ca^{2+} – 0.30 mg/dm³, Mg^{2+} – 0.14, Na^+ – 0.37, K^+ – 0.33, Cl^- – 0.99, SO_4^{2-} – 1.0; NH_4^+ – 0.08, HCO_3^- – 0.08 mg/dm³.

In addition, snow cover that lies directly near the source of pollution for a long time is a kind of screen absorption of harmful substances existing in the atmosphere. Therefore, due to the quantity and quality composition of snow on the certain territory we could characterize the emission of certain components from contamination objects to its airspace. Snow also could be considered as a unique indicator of environment pollution, when speaking not only about atmosphere condition, but about ecosystem as a whole, as after snowmelt all available components in it fall into the soil and groundwater, and then – into natural water bodies, plants and perhaps continue their migration through the trophic food chain.

Environmental studies are conducted, as a rule, in a favourable period for sample selection of environmental objects and profitable for vital function of living organisms – spring-autumn. Much less attention is given to winter season. In our research we attempted to estimate pollutant emissions from pig farms to the environment exactly in winter period with using snow cover as a research object.

The research purpose was to explore and describe the state of snow cover at various distances from the pig complexes of different capacities.

MATERIALS AND RESEARCH METHODS

As objects of environment pollution we studied four pig farms in Ternopil and Poltava regions with different average annual wild-life population and various systems of pig husbandry and waste management – State

Enterprise Research Farm (SERF) «Stepne», SERF «n.a. Dekabrystiv», Limited Liability Corporation (LLC) «Medobory» and Private Agricultural Enterprise (PAE) «Agroprod-servis». The selection of snow samples was carried out within the sanitary protection zones (SPZ) of pig complexes at a distance of 0 m, 250 m and 500 m from the farm territories in the direction of prevailing winds for these regions by five-spot method, with the size of each plot 5×5 m.

Laboratory, hydrochemical and bacteriological examinations were carried out according to specified methods for water objects evaluation of state and governing regulatory documents for each of measured components. Statistical analysis of the obtained results is conducted using Fisher and Student criterion by dispersion analysis with the determination of the least significant difference (LSD_{05}) at the 5% significance level. Load Index of snow components on ecosystem is calculated in consideration of quantitative meanings of the corresponding components, and also the number of accumulated snow on the investigated territory and period of continual snow cover [7].

RESULTS AND DISCUSSION

According to the research objective in meltwater of selected snow samples such biogenic elements (BE) and oxidation level as permanganate (PO) and bichromate (BO), major ion content and mineralization level and also heterotrophic bacteria were fixed. The research results showed that some indicators don't practically change in selected snow samples taken within the same farm, and evidently characterize only the chemical composition of snow – pH, absolute water hardness, a number of mineral elements: Ca^{2+} , Mg^{2+} , HCO_3^- , Cl^- . Others have significant differences depending on sample location within the same farm. We assume that these components are not only the obvious component of snow composition, but falling into it in result of activities of investigated pig complexes (Table 1).

The pH – value in all selected samples varied from 4.9 to 5.9 (SERF «Stepne» –

Table 1

Condition of snow cover at various distances from the pig complexes of different capacities

Sampling place	PO, mg O/l	BO, mg O/l	BE			Ions of mineral compounds		Heterotrophic microorganisms, cells/ml
			NH ₄ ⁺ , mg N/l	NO ₂ ⁻ , mg N/l	NO ₃ ⁻ , mg N/l	Na ⁺ + K ⁺ , mg/l	SO ₄ ²⁻ , mg/l	
<i>SERF «Stepne» Poltava region</i>								
0 m	4.8	12.1	0.80	0.03	0.32	1.5	9.5	1480
250 m	2.6	6.6	0.63	0.03	0.13	0.7	7.8	890
500 m	2.6	6.6	0.60	0.03	0.10	0.5	6.2	180
LSD ₀₅			0.03	–	0.03	0.12	0.37	88.88
<i>SERF «n.a. Dekabrystiv» Poltava region</i>								
0 m	8.0	18.9	0.66	0.03	0.25	1.4	6.9	1580
250 m	3.3	7.7	0.90	0.04	0.33	1.9	9.8	1370
500 m	3.3	7.7	0.61	0.03	0.20	1.3	8.1	250
LSD ₀₅			0.06	–	0.03	0.15	0.63	114.62
<i>LLC «Medobory» Ternopil region</i>								
0 m	7.5	18.7	0.62	0.04	0.24	3.5	2.9	1540
250 m	3.2	8.1	0.88	0.06	0.29	5.5	6.6	1330
500 m	3.2	8.1	0.59	0.04	0.16	4.0	4.9	200
LSD ₀₅			0.04	0.01	0.02	0.41	0.32	91.74
<i>PAE «Agroprodservis» Ternopil region</i>								
0 m	5.2	13.0	0.60	0.03	0.18	4.0	2.1	320
250 m	1.3	3.2	0.51	0.04	0.22	4.8	3.3	240
500 m	1.3	3.2	0.69	0.05	0.13	5.3	4.1	180
LSD ₀₅			0.05	0.01	0.02	0.31	0.24	57.12

4.9–5.5; SERF «n.a. Dekabrystiv» – 4.9–5.5; LLC «Medobory» – 5.0–5.4; PAE «Agroprodservis» – 5.2–5.9). This can be considered as the norm, because for atmosphere precipitation pH – value of 5.0–6.0 is considered a neutral reaction, about 5.5 due to the CO₂ presence of in the atmosphere [5].

Oxidizability level describes the presence of organic matter in exanimated water. It has been established that PO and BO of selected snow samples has the highest value only in the close distance to farm and at a distance of 250 m and more a significant decrease of it is observed. Evidently, the pig farms are the source of organic compounds emissions in atmosphere which in the main quantity deposit on territory surrounding farm. Moreover,

organic matter quantity in the snow cover and distance of dissemination also depends on the number of pigs and technological characteristics of the household. So in the farm with an average pig population of 43 thousand annual units and the advanced technologies of livestock hardling (PAE «Agroprodservis») oxidizability level of meltwater is slightly lower than in separate farms with a relatively small number of animals, but with traditional systems of pig raising and waste management: PO – 5.2 mg O/l and 7.5–8.0 mg O/l, BO – 13.0 mg O/l and 18.7–18.9 mg O/l, respectively. At the same time, the percentage of organic matter deposited on the land surface (snow) in the close distance to farm in SERF «Stepne» is 46%, in SERF «n.a. Dekabrystiv» –

59, LLC «Medobory» – 57, PAE «Agroprod-servis» – 75%.

There were also some differences in the number of BE, but they manifested the most in ammonium and nitrate forms of nitrogen. Their number and dissemination distance from pollution source is not homogeneous. So on the farm with the least pig population (SERF «Stepne») at a distance of 0 m the highest content of nitrogen ions is observed and with distance it gradually decreases. And on the farm with the highest pig population (PAE «Agroprodservis») conversely, at a distance of 0 m it is the lowest and slightly increases with distance from the farm. On the other two farms (SERF «n.a. Dekabrystiv» and LLC «Medobory») the highest ions number of different forms nitrogen is observed in the middle of the sanitary protection zone at a distance of 250 m. These differences within one farm for ammonium ions and nitrate forms of nitrogen are statistically reliable as they exceed $LSD_{0.5}$ -value, and in nitrite forms of nitrogen no significant differences were found.

A similar situation toward dissemination distance was observed in the range of scatter and in determining the major ions of mineral compounds, including statistically reliable differences depending on sampling places of snow within one farm were only for Na^+ + K^+ and SO_4^{2-} .

As livestock objects are favourable place for vital function and reproduction of various living organisms and an important source of microorganisms emission to the atmosphere, in the researched samples of meltwater a number of heterotrophic bacteria was determined, which are indicators of readily available organic matter presence in water. Most of their quantity was found on territory close to the farm in all enterprises. However, their total number varied considerably depending on the household. If the PAE «Agroprod-servis» according to the ecological sanitary classification of the of surface waters [6] the state of the meltwater of all snow samples belongs to the class «pure», category 2a «very clean», β -oligosaprobic zone, and on the other three farms that greatly inferior in pig popu-

lation but use traditional systems of animal husbandry and waste management situation is somewhat worse. Thus in SERF «Stepne» the state of snow samples meltwater selected at a distance of 0 m, and in SERF «n.a. Dekabrystiv» and LLC «Medobory» at a distance of 0 m and 250 m, we refer to the class «satisfactory clean», category 3a «clean enough» β -mezasaprobic zone.

Researched farms significantly differ from each other in the pig population that is simultaneously held and in the level of technological support of all production processes and waste management that makes it difficult to compare them according to pollutant emissions into the environment. Therefore, as one of comparison criteria we used an indicator of the number of each defined component calculated to one animal unit (Table 2).

The amount of emissions on animal unit is highest on the farm with the least capacity, and vice versa, the lowest – on the farm with the greatest capacity. Therefore it is inappropriate to consider separately only one factor of influence on emissions level – a namely a number of livestock. It is important only at about the same maintenance systems and animals husbandry and their waste. In this case, an increase in the number of pigs, respectively, and the amount of harmful emissions increases. If the engineering and manufacturing processes are completely different (in our case, the PAE «Agroprodservis») therefore animal population does not have priority on level emissions. Our research shows that modern high-tech enterprise, even with a large number of farmed pigs, emits slightly fewer pollutants into the air (in winter season) than farms with traditional technological and production processes.

To assess the level of environmental impact of contaminated snow cover near possible hazardous objects (in our research – pig farm), we have designed and calculated indicator – the load index of each individual component on the ecosystem [7].

Index values are proportional to the weight of emissions of similar substances within each farm and depend on the same household characteristics of pig complexes.

Table 2

**Available substance content in the snow cover of sanitary protection zone
of researched farms in terms of animal unit**

Sampling place	PO, mg O/l	BO, mg O/l	Ions of chemical compounds, mg/l	Heterotrophic microorganisms, cells/l
<i>SERF «Stepne» Poltava region</i>				
0 m	0.00438	0.01104	0.01109	1350
250 m	0.00237	0.00602	0.00848	812
500 m	0.00237	0.00602	0.00678	164
<i>SERF «n.a. Dekabrystiv» Poltava region</i>				
0 m	0.00369	0.00871	0.00426	728
250 m	0.00152	0.00355	0.00598	632
500 m	0.00152	0.00355	0.00343	115
<i>LLC «Medobory» Ternopil region</i>				
0 m	0.00476	0.01187	0.00463	977
250 m	0.00203	0.00514	0.00846	844
500 m	0.00203	0.00514	0.00615	127
<i>PAE «Agroprodservis» Ternopil region</i>				
0 m	0.00012	0.00031	0.00016	8
250 m	0.00003	0.00008	0.00021	6
500 m	0.00003	0.00008	0.00024	4

Table 3

**Load Index of substances presented in snow cover on the ecosystem
of sanitary protection zones of researched farms**

Sampling place	PO, mg/m ²	BO, mg/m ²	Ions of chemical compounds mg/m ²	Heterotrophic microorganisms, thousand cells/m ²
<i>SERF «Stepne» Poltava region</i>				
0 m	32.0	80.7	81.0	9861
250 m	17.3	44.0	62.0	5935
500 m	17.3	44.0	49.5	1200
<i>SERF «n.a. Dekabrystiv» Poltava region</i>				
0 m	60.0	141.8	69.3	11850
250 m	24.8	57.8	97.3	10270
500 m	24.8	57.8	76.8	1875
<i>LLC «Medobory» Ternopil region</i>				
0 m	62.5	155.9	60.8	12836
250 m	26.7	67.5	111.1	11086
500 m	26.7	67.5	80.8	1667
<i>PAE «Agroprodservis» Ternopil region</i>				
0 m	38.1	95.4	50.7	2347
250 m	9.5	23.5	65.1	1760
500 m	9.5	23.5	75.3	1320

However, they take into account the specific climatic features of the research territory and show the conditional load of snow component per 1 m² of the land surface. So, LLC «Medobory» that is located in Ternopil region has certain specified indicators (0 m: PO – 7.5 mg O/l, BO – 18.7 mg O/l, heterotrophic bacteria – 1540 cells/ml) is slightly inferior to SERF «n.a. Dekabrystiv» located in Poltava region (0 m: PO – 8.0 mg O/l, BO – 18.9 mg O/l, heterotrophic bacteria – 1580 cells/ml), but the load indexes of corresponding components on the contrary are higher on LLC «Medobory» (0 m: PO – 62.5 mg/m², BO – 155.9 mg/m², heterotrophic bacteria – 12836 thousand cells/m²) than in SERF «n.a. Dekabrystiv» (0 m: PO – 60.0 mg/m², BO – 141.8 mg/m², heterotrophic bacteria – 11850 thousand cells/m²), and thus LLC «Medobory» has a greater impact on the environment in the area of its activities. This is due to the fact that this farm is located in region where at the time of sampling there was the most amount of snow falls.

CONCLUSIONS

Conducted research shows that environment state depends on the farm capacity and economic and technological conditions of animal husbandry and waste management used by them.

The possibility to use snow cover for environmental condition assessment on the territory of pig farm activities is proved. The indicators characterizing the state of the environment are the presence of organic matter

(oxidizability level), a number of bacteria and ion content NH₄⁺, NO₃⁻, Na⁺ + K⁺, SO₄²⁻.

Assessment of sanitary protection zones of pollution object (pig farm) impact on the ecosystem should be carried out according to the integrated index – load index of snow cover on ecosystem, which shows the conditional load of component on 1 m² of the land surface in a specific distance from the source of contamination.

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