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UDC 658.567:636:504.06

УДК 658.567:636:504.06

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ASSESSMENT OF WASTE FORMATION AND PROSPECTS OF IMPLEMENTING ENVIRONMENTALLY FRIENDLY WASTELESS TECHNOLOGIES IN LIVESTOCK INDUSTRY

ОЦІНКА ФОРМУВАННЯ ВІДХОДІВ ТА ПЕРСПЕКТИВИ ВПРОВАДЖЕННЯ ЕКОЛОГІЧНО ЧИСТИХ БЕЗВІДХОДНИХ ТЕХНОЛОГІЙ В ГАЛУЗІ ТВАРИННИЦТВА

Urgency of the research. The main objective of functioning livestock enterprises is to provide population with food (meat, milk, eggs, and other) and to provide food industry with raw materials (meat, milk, eggs, leather, wool, feathers, and other). During the vital activities of animals and poultry get, there is a big quantity of waste (manure), which is the main pollutant for the environment together with sewage. Most of disposing facilities that are in operation of agricultural enterprises are technologically obsolete, physically overused, and do not comply with sanitary standards.

Target setting. Emissions from livestock farms pollute the air, ponds, reservoirs, groundwater, rivers with biologically active bacteria, which affects not only the ecological situation around the enterprise, but also adversely affects the health of the population of the adjacent areas. Thus, the specified problems must be solved comprehensively taking into account all the aspects directly or indirectly involved in this process.

Analysis of actual scientific researches and issues. The problems of livestock industry waste attract the attention of many researchers. The research of environmental problems of livestock industry is carried out by M. S. Malovanyi, V. M. Bogoliubov, T. P. Shanina, V. F. Funtiov, I. L. Starykh, O. N. Starykh, A. M. Suzdalieva, R. G. Gladyr, and other scientists.

Uninvestigated parts of the general matter. In the current economic conditions, entrepreneurs focus their attention mainly on getting high economic outcomes (revenue growth, gross and net profit growth). The problems of using the waste, generated as a result of animal keeping, are not always solved properly, leading to pollution of the environment.

The research objective is to assess the formation of waste and prospects of implementing environmentally friendly wasteless technologies in livestock industry.

The statement of basic material. The problems of formation, storage and use of animal waste are investigated. The quantitative composition and dynamics of the number of animals and poultry are analyzed. The amounts of the formed manure and the used process water in livestock and poultry industry are calculated.

Conclusions. The main directions of manure use in order to reduce the burden on the environment are determined.

Актуальність теми дослідження. Головною метою функціонування тваринницьких підприємств є забезпечення населення продуктами харчування (м'ясом, молоком, яйцями, іншими), а харчову промисловість сировиною (м'ясом, молоком, яйцями, шкірою, вовною, пухо-пір'яною та іншою). В процесі життєдіяльності тварин та птиці отримують велику кількість відходів (гній), які разом із стічними водами є основними забруднювачами навколишнього природного середовища. Більшість очисних споруд, що знаходяться в експлуатації сільськогосподарських підприємств, технологічно застарілі, фізично зношені та не відповідають санітарно-гігієнічним нормам.

Постановка проблеми. Викиди тваринницьких ферм забруднюють атмосферне повітря, ставки, водоймища, підземні води, річки біологічно активними бактеріями, що погіршує не тільки екологічну ситуацію у зоні функціонування підприємств, а й негативно впливає на стан здоров'я населення прилеглих територій. Таким чином, указані проблеми повинні вирішуватися комплексно з урахуванням усіх сторін, які безпосередньо або непрямо приймають участь у даному процесі.

Аналіз останніх досліджень і публікацій. Проблеми відходів галузі тваринництва привертають увагу багатьох науковців. Дослідженням екологічних проблем галузі тваринництва займаються М. С. Мальований, В. М. Боголюбов, Т. П. Шаніна, В. Ф. Фунтіов, І. Л. Старих, О. Н. Старих, А. М. Суздальова, Р. Г. Гладир та інші науковці.

Виділення недосліджених частин загальної проблеми. У сучасних умовах господарювання суб'єкти підприємницької діяльності зосереджують свою увагу, в основному, на отриманні високих економічних результатів (зростанні доходу, валового та чистого прибутку). Питання поводження з відходами, що утворюються у результаті утримання тварин, не завжди вирішуються належним чином, що призводить до забруднення екології.

Постановка завдання. Завданням дослідження є оцінка формування відходів та перспективи впровадження екологічно чистих безвідходних технологій в галузі тваринництва

Виклад основного матеріалу. Досліджено проблеми формування, зберігання та використання відходів життєдіяльності тварин. Проаналізовано кількісний склад та динаміку поголів'я тварин та птиці. Розраховано обсяги утвореного гною та використаної технічної води у тваринництві та птахівництві.

Висновки. Визначено основні напрямки використання гною з метою зниження навантаження на навколишнє природне середовище.

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Keywords: livestock; poultry breeding; animal wastes; manure; organic fertilizer; biogas; ecology.

Ключові слова: тваринництво; птахівництво; відходи життєдіяльності тварин; гній; органічні добрива; біогаз; екологія

DOI: 10.25140/2410-9576-2017-2-3(11)-82-88

Urgency of the research. The main objective of functioning livestock enterprises is to provide population with food (meat, milk, eggs, and other) and to provide food industry with raw materials (meat, milk, eggs, leather, wool, feathers, and other). During the vital activities of animals and poultry get, there is a big quantity of waste (manure), which is the main pollutant for the environment together with sewage. Most of disposing facilities that are in operation of agricultural enterprises are technologically obsolete, physically overused, and do not comply with sanitary standards.

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Analysis of actual scientific researches and issues. The problems of livestock industry waste attract the attention of many researchers. The research of environmental problems of livestock industry is carried out by M. S. Malovanyi, V. M. Bogoliubov, T. P. Shanina [10], V. F. Funtiov, I. L. Starykh, O. N. Starykh, A. M. Suzdalieva [12], R. G. Gladyr [1], and other scientists.

M. S. Malovanyi, V. M. Bogoliubov, T. P. Shanina emphasize on the fact that environmental pollution is largely determined by the composition of the manure effluents, and that depends on such major factors as: the type of farm animals, their quantity, quality and quantity of feeding-stuffs, height, gender and weight of animals, direction of livestock industry, keeping mode and methods of manure removal. Liquid manure contains a large number of pathogenic organisms, its anaerobic decomposition causes harmful gases formed (hydrogen sulfide, ammonia, etc.), as well as fatty acids, amines and other compounds with an unpleasant smell [10].

In modern conditions, using intensive livestock technologies leads to a certain number of environmental problems. The following are of primary importance: eutrophication of reservoirs, accumulation of pathogenic organisms and air pollution with hydrogen sulfide, ammonia, molecular nitrogen [2].

V. F. Funtiov, I. L. Starykh, O. N. Starykh and A. M. Suzdalieva note that raw animal sewage, manure poorly kept, and raw droppings, create a great threat to the environment and public safety. Despite this, the construction of new disposal facilities and the renovation of old ones are not carried out due to lack of financing [12, p. 130].

V. Martsynkevych and N. Kolomiets [4], V. O. Melnyk [5] and other researchers devoted their works to the issues of solving the problems related to using animal waste.

One of the perspective directions for Ukraine, according to V. Martsynkevych and N. Kolomiets, is the processing of the biomass of animal waste, namely - animal manure and poultry droppings - by anaerobic digestion with the formation of biogas, which is then used to produce energy or fuel [4, p. 3].

V. O. Melnyk notes that poultry droppings are known as a highly concentrated easily digestible organic fertilizer. The need in such fertilizers is particularly high, when mineral fertilizers are expensive, and soils in Ukraine lost largely their natural fertility potential due to the rapid removal of humus. Poultry droppings, prepared properly, can also be used as a feed ingredient, and were recently used as an energy resource.

Thus, the theoretical foundations and methodological tools are laid for complex research and solving the problems of using the animal waste.

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The statement of basic material. Livestock industry and those industries that process agricultural raw materials create the greatest problem in agriculture - the problem of waste disposal, which occupy large areas of land and is a major source of pollution. The presence of pathogens in these wastes can cause viral and parasitic diseases. In soil, the pathogens of various infectious diseases can spread (anthrax, gas gangrene, tetanus, botulism). Among the pathogenic microorganisms, which temporarily live in soil, pathogens of intestinal infections dominate (paratyphoid, typhoid, dysentery, cholera, salmonellosis, amebiasis, brucellosis, leptospirosis, tularemia, plague, pertussis). Some of these bacteria can persist in soil for a long time: causative agents of cholera, typhoid and paratyphoid - up to 4 months, tularemia - up to 3 months, brucellosis - up to 6 months. Mycobacterium of tuberculosis, fungal infections, diphtheria and leprosy remain viable from 3-4 weeks to 16 months [6].

Poultry droppings are often a source of polluting the air, soil, water and groundwater with toxic substances, spreading pathogens, weed seeds, eggs and larvae of worms and flies. Large areas of farmland are seized for its handling and storage [5].

To solve these negative phenomena, there is a need in a special technology of manure processing that would make it possible to increase the concentration of nutrients per unit of manure volume and also to eliminate the smells, to inhibit or destroy the pathogens, to reduce the content of toxic substances and harmful emissions into the atmosphere [1].

The biggest environmental polluters are industrial livestock complexes, their share, by different types of animals and poultry, ranges from 14.1% of sheep and goats held to 54.9% of poultry of all types (Table 1).

Table 1

Dynamics of the Number of Livestock and Poultry, thousand heads*

Years	Cattle		Pigs	Sheep and goats		Horses	Poultry of all kinds
	total	including the cows		total	including the sheep		
1990	21083,3	6191,6	14071,2	7165,5	7164,1	700,9	132966,6
2000	5037,3	1851,0	2414,4	413,3	412,4	249,8	25352,9
2010	1526,4	589,1	3625,2	298,4	294,9	41,6	110561,3
2013	1417,6	560,3	3792,7	233,0	228,3	28,7	127240,0
2014	1310,2	529,2	3732,8	205,5	200,8	23,8	122077,8
2015	1270,5	505,1	3704,0	186,9	181,4	21,2	112008,7

*Source: [9, p. 12]

The presented data demonstrate a trend (1990-2015) to reduce the number of livestock and poultry in agricultural enterprises of Ukraine. For example, in 2015 cattle was 6.0% out of the index in 1990, including cows – 8.2%, pigs - 26.3%, sheep and goats - 2.6%, horses - 3%, and poultry - 84.2%.

On one side, the given data may be the evidence of reducing the negative pressure on the environment that is caused by animal waste, on the other - the decline in profitability and funding of animal waste disposal.

Livestock industry is a consumer of large amount of water for technical purposes (Table 2). The largest share of industrial water, according to our calculations, is used for keeping pigs and cattle (52.3% and 34.9%) for the following: technology needs while milking cows, washing specialized equipment, hydraulic cleaning of manure in the premises and fields, washing animals, etc. Similar requirements encourage the breeding of other animals and poultry, but in a smaller scale.

Table 2

Water Consumption for Technical Purposes in Livestock Industry in 2015*

Species of animals and poultry	Number of enterprises	Number of animals and poultry, thousands head	Water consumption for technical purposes, m ³
1	2	3	4
Cattle - total	2826	1270,5	29344,5

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including cow	2614	505,1	15153,0
Pigs - total	2480	3704,0	43985,0
including main sows		325,4	7408,0
Sheep and goats	863	186,9	93,5
Horses – total		21,2	318,0
Poultry of all kinds	515	112008,7	2853,6
chickens and cocks		110013	2750,3
geese		239,9	28,8
ducks		400,6	50,1
turkeys		813,2	24,4
Total			84002,5

*Source: [9]

On average, one enterprise that is engaged in growing cattle spent 10.4 m³ of water, one that keeps pigs - 17,7 m³, sheep and goats - 0,1 m³, and poultry - 5.5 m³ of water. In general, according to our calculations, the farms spent 84 thousand m³ of water for technical purposes.

In livestock complexes, manure removal from the place of its formation is carried out by a dry method, hand method or water-washing. Dry removing requires considerable expenses of manual labor, but the total amount of waste is 3-4 times less than the hydro-removal. Dry livestock waste is transported to the places of composting, and in 6-8 months they are suitable for using as organic fertilizer. While hydro removing, for flushing manure by means of water jets, up to 3 m³ of water is spent per 1 m³ of excrement. Liquid livestock waste, formed in this way, through pipes or gutters fall into settling tanks, where they are divided into solid and liquid phases. Liquid phase, as wastewater, enters the disposal facilities. While dry manure forming, wastewater is generated only during wet cleaning of livestock buildings, and their volume is half less [3].

The number of livestock waste, given in Table 3, is formed by feeding cattle with mixed corn fodder [3].

Table 3

Formation of Wastewater in Livestock Complexes

Species and number of animals in the complex	Number of animals of simultaneous keeping	Yield of livestock wastes, thousand m ³ /year	Costs of wastewater from the complex, thousand m ³ / year	
			dry removal of manure	hydro-flushing of manure
Pork production				
12 thousand pigs	12000	36,0	52,4	101,0
24 thousand pigs	24000	70,5	96,8	195,5
54 thousand pigs	37000	114,0	181,0	332,5
Beef production				
600 cows	600	12,0	14,2	20,8
10 thousand cows	9883	94,8	113,0	-
Milk production				
800 cows	800	16,0	18,9	30,6
1200 cows	1200	24,0	28,5	46,0

*Source: [3]

The negative impact of the undisposed wastewater, formed at hydro-washings, on the environment is essential because it pollutes the sources of drinking water that causes local problems and the spread of infectious diseases in villages and entire regions.

Another important issue to be studied is to assess the release of pollutants contained in manure of livestock complexes.

M. S. Maliovanyi, V. M. Bogoliubov, T. P. Shanina [10] reveal the data of biogenic composition of cattle and pigs manure; the work of V. O. Melnyk [5] reveals the data on chickens, turkeys, ducks

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and geese. We perform the relevant calculations of the formed manure and the content of pollutants (Table 3 and Table 4).

Table 4
Volume of Generated Waste in Livestock and Poultry Industries in 2015*

Species of animals and poultry	Number of animals and poultry, thousand heads	Yield of manure	
		t / day	thousand t / year
Cattle - total	1270,5	52486,6	19157,6
including cows	505,1	27780,5	10139,9
Pigs - total	3704,0	22015,6	8035,7
including main sows	325,4	4230,2	1544,0
Chickens	110013,0	15841,9	5782,3
Turkeys	813,2	264,3	96,5
Ducks	400,6	139,0	50,7
Geese	239,9	113,7	41,5
Total yield of manure		90861,1	33164,3

* **Source:** [5; 10] and own calculations

The calculations showed that in 2015 more than 33 million tons of manure were formed on livestock farms and poultry houses. The largest share of manure was obtained from keeping cattle - 57.8%, pigs - 24.2%, and chickens - 17.4%.

According to the research of O. A. Khomiak, 90% of agricultural enterprises are lack of facilities for storage, decontamination, disposal, processing the manure, and preparing it for use. The main ways of contamination of soil, water and atmosphere with manure from livestock farms can be the following: the exceeded dose of manure as fertilizer per unit of area, washing the manure drains by means of precipitation from the areas of livestock farms, disordered places of storage of manure, breaching hygiene requirements during transportation and storage of manure, placing livestock farms near water sources and settlements, poor disposal and disinfection of manure before using it [13].

Our calculations show that in 2015 the received manure contained 1.1 million tons of nitrogen, 0.6 million tons of phosphorus, and 0.8 million tons of potassium (Table 5).

Table 5
Content of Biogenic Substances in Manure of Livestock and Poultry in 2015*

Species of livestock	Number of livestock and poultry, thousand heads	Yield of manure, thousand tons / year	Biogenic composition (% of dry matter of fresh manure)			Content of biogenic substances in manure - total, thousand tons / year		
			N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Pigs	3704,0	8035,7	5,0	2,1	2,5	401,8	168,7	200,9
Cattle	1270,5	19157,6	3,2	2,0	3,1	613,0	383,2	593,9
Chickens	110013,0	5782,3	1,7	0,9	0,8	98,3	52,0	46,3
Turkeys	813,2	96,5	1,7	0,6	0,4	1,6	0,6	0,4
Ducks	400,6	50,7	1,0	1,1	0,5	0,5	0,6	0,3
Geese	239,9	41,5	1,4	0,6	0,5	0,6	0,2	0,2
Total		33164,3				1115,9	605,3	841,9

* **Source:** [5; 9; 10] and own calculations

Experts say that the problem of a lack of modern sewage disposal facilities on farms is very serious. Over the past few years the situation of implementing modern technologies did not budge from the spot. There are new technologies and materials on the market (such as the lagoon from the film with complete waterproofing instead of unreliable concrete buildings), but due to the high cost of conversion of enterprises they are almost not used. Currently, there are almost no farms, which use disposal facilities for processing the waste. In most cases, the so-called lagoons are applied - pits, which discharge manure. After filling a lagoon, its contents is taken out on the field without any

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processing. The experience of Europe can be compared with, where for about 10 years there is the law that prohibits throwing non-recycled organic waste on the field [8].

What purposes should the manure obtained in livestock industry be used for? There are the following options for using the manure: in the form of organic fertilizers, feed additives, raw materials for the production of biogas, burning dried manure for heat.

The obtained waste in the livestock industry or biogas production can be used as organic fertilizer. However, in the first case two methods are used: 1) fresh (diluted with water), and 2) rotted (in piles within one year). For the purpose of enriching the manure the following technologies are applied: composting (adding to fresh manure the last year's substrate and organic waste (grass, food waste, etc.)), vermacomposting (processing the manure with the help of earthworms), accelerated fermentation using humates (using bio-additives to accelerate the fermentation of manure substrate at its composting).

One of the ways to dispose the manure and to return the part of its nutrients to livestock is to obtain protein foods - protein flour and bio-humus. The method of biological processing makes it possible to transform complex organic compounds found in manure and litter, and to develop the accompanying flora that is rich in protein, fat, amino acids and trace elements into the zoo-feed biomass which, after disinfection, is used for animal feed. After disposing poultry droppings, the fly larvae for 5 days at 20°C process the viscous substrate at the humidity of 80% into a loose mass at the humidity of 40% and pH 9.5. So, except protein feed, fertilizers can be produced. After the processing of manure, the larvae separate from the substrate, dry and prepare flour, which is a protein supplement to the basic diet of birds. 1 kg of the product contains 340-430 grams of protein, lysine - 33-40 g, methionin - 10-15 g, calcium - 6-8 g, phosphorus - 10-12 g, that is rich in vital trace elements [11].

One of the ways to use efficiently the energy of liquid manure of livestock farms is its methane fermentation in which the waste water is neutralized, biogas (methane) is generated, and manure is stored as an organic fertilizer. Now it is estimated that each cow can provide electric lighting of a small room for 10 thousand hours. This trend of manure disposal, in conditions of gradual depletion of traditional energy resources (oil, gas, coal, etc.), is particularly important [7]. Another way is the burning of dried manure for heat.

Conclusions. Researching the generated waste of livestock and poultry activities can have both negative and positive effects. If the wastes of livestock industry are not properly stored (in piles, lagoons, etc.), throwing biogenic substances into the soil and water resources causes the worsening of sanitary-epidemiological situation in the area of the enterprise.

Storing fresh manure in an open place (ground) leads to air pollution with ammonia, nitrogen compounds and other hazardous substances. Livestock farms can also throw carbon dioxide and methane, feed dust, and other microorganisms into the atmosphere.

To reduce the negative pressures on the environment from the livestock industry it is possible to use manure as a feedstock for biogas facilities or complexes. These examples already exist in Ukraine, but not many (Myronivskiy Khliboproduct, Astarta-Kyiv, LLC "Danosha", etc.). The spread of this practice in other enterprises enhances energy availability of enterprises, reduces emissions of pollutants into the atmosphere and hydrosphere. In addition, biogas production causes generating fertilizers that can be applied into the soil or sold on the market, although biomarket in Ukraine is not developed and is in its infancy.

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Received for publication 15.05.2017

Бібліографічний опис для цитування :

Zakharchenko, O. V. Assessment of waste formation and prospects of implementing environmentally friendly wasteless technologies in livestock industry / O. V. Zakharchenko // Науковий вісник Полісся. – 2017. – № 3 (11). Ч. 2. – С. 82-88.