THE USE OF DIGESTATE FOR THE DEVELOPMENT OF ORGANIC AGRICULTURAL PRODUCTION

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Abstract. Global climate changes and their impact on agricultural production are studied. The state of the humus content in the soils of Ukraine, the situation with land degradation, and the degree of plowing of agricultural land today were studied. A comparative analysis of the ratio of plowed agricultural land and the share of agro-industrial complex in the world GDP is given. The use of animal manure, plant residues and food waste as raw materials for biogas production was analyzed. The scientific aspects of the development of waste-free agricultural production for an important contribution to the fight against climate change through sustainable production and protection of natural resources are revealed. The scientific work is *aimed* research of agrochemical analysis of digestate as an organic fertilizer and it is proposed to use it for the development of organic agricultural production. *Methodology*. The conducted studies are substantiated on experimental studies of scientific topics on the topic: "Development of bio-organic technologies for growing agricultural crops for the production of biofuels and ensuring the energy independence of the agricultural sector". The expected *results* of the research are aimed at achieving complex ecological, economic, energy and social effects. The authors have considerable experience in research related to rational nature management, the development of land reclamation measures taking into account the concepts of rational nature management, which ensure the optimization of land use, as well as the biologicalization of agriculture. The scientific research of the authors has been commercialized, in particular, contracts have been concluded for the performance of research within the

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framework of farm contract and state topics. It was established that in order to ensure a deficit-free balance of humus in soils and their deoxidation, an urgent task is to change the fertilizer application system with a reorientation to increase the share of organic fertilizers. *Practical implications.* The problems of land degradation and desertification are exacerbated by crop rotation violations, an imbalance in the production of livestock and crop production, a significant decrease in the number of cattle, the concentration of export-oriented agricultural crops in vertically integrated agricultural structures, which leads to soil mineralization, and also due to the rapid pace of climate change; which are accompanied. *Value/originality.* Based on the data analysis, it was proven that the use of digestate ensures the energy independence of enterprises and the industry in general, ecological capacity, leads to an increase in the yield of agricultural crops, an increase in soil fertility, a decrease in soil acidity, a decrease in the cost of applying mineral fertilizers due to the introduction of digestate, and an increase in the yield of agricultural crops. enterprises. The agrochemical analysis of digestate as an organic fertilizer was studied and it was proposed to use it for the development of organic agricultural production.

1. Introduction

Land resources play an important role in the development of Ukraine's productive forces. The modern land use system is a complex object, characterized by various forms of ownership, targeted use, dynamic development (change in the composition of land, economic objects), as well as obtaining the maximum economic profit in the process of use. This, in turn, deepens the problems of anthropogenic load on land resources, irrational land use, land structure, etc. The economic model, according to which agricultural production is developing in Ukraine, causes extremely high risks for society. Reckless use of natural capital – soil, water, air pollution leads to irreversible changes in ecosystems. Limited or insufficient implementation of measures aimed at preserving this capital inevitably lead to an increase in costs for its replacement. It is also important that as a result of the imbalance in ecosystems, their ability to support growth is reduced, which inevitably leads to a decline in the current level of consumption.

At the current stage, there is a need to change the paradigm economic growth both in the economy in general and in the industry agricultural

production in particular. New models of production and consumption are needed, as well as a fundamentally different approach to defining the concept of "growth" and measuring its results, where the ecological component of development is the main one.

For intensive agricultural production and full restoration of humus reserves in Ukraine requires the annual application of 320-340 million tons of organic fertilizers. Previously, this balance was maintained mainly at the expense of domestic livestock. However, today the livestock population in the UK rainini is nullified. Thus, on 1 ha of arable land in Ukraine, there are ten times fewer cattle than in the countries of Western Europe [1, p. 45–47].

In recent years, an average of 17 times less organic fertilizers than necessary have been applied to crops. Therefore, the soil without organic substances is greatly depleted and yields are reduced. It is known that the loss of 0.1% of humus in the soil reduces grain yield by 0.5 t/ha. If the trend continues, then in the near future Ukraine may be on the verge of humus starvation – a serious ecological disaster. And then no agrotechnical, reclamation, nature protection and organizational and economic measures will be able to restore the agrotechnical potential of the land [2; 3].

In modern conditions of agriculture in Ukraine, the real source of organic matter is straw, stubble, stalks and other post-harvest residues, siderates, therefore it is very important to justify the price of these wastes [4].

Soil organic matter, as an integrated indicator of its fertility, takes an active part in plant nutrition, creation of favorable physico-chemical properties, migration of various chemical elements in it, because the most important soil processes are primarily related to organic compounds [5; 6]. Despite the fact that Ukraine has a large export potential of agricultural products, the agricultural sector of our country still cannot be called ecological.

The production of agricultural products leads to the emission of three greenhouse gases: carbon dioxide, methane and nitrous oxide. Agriculture accounts for almost half of the global emissions of the two most powerful greenhouse gases, after carbon dioxide, nitrous oxide and methane. Nitric oxide is formed during microbiological and chemical transformations of organic matter, both in oxidation (nitrification) and reduction reactions (denitrification). The volume of emissions depends on the type of soil,

humidity, temperature and soil cultivation system. So, the expected results of the research are aimed at achieving complex ecological, economic, energy and social effects.

2. Analysis of recent research and publications

Hryhoriy Kaletnik carried out calculations of the needs for land resources to solve the outlined problems.

Victor Mazur singled out the main sources of pollution of the agricultural sector – the use of fossil fuels, burning of plant residues in the fields, non-compliance with the norms of waste disposal of plant and animal products, food waste, principles of land use, etc.

Inna Honcharuk comprehensively considered the concept of energy independence from the standpoint of ensuring the country's food and environmental security. And also revealed the role of the agro-industrial complex of Ukraine in solving the problems of energy and environmental security of the state.

Hanna Pantsyreva determined that the agricultural sector suffers from changes the most out of all branches of the country's economy climate, however, it is also not ecological and affects climate change.

Lina Bronnikova examined the state of humus content in the soils of Ukraine, the actual situation with land degradation, the degree of plowing of agricultural lands in the Vinnytsia region.

Oleksiy Alieksieiev carried out a comparative analysis of the ratio of plowed agricultural land and the share of agriculture in the GDP of the countries of the world.

A number of foreign researchers claim that the use of fermented sludge stimulates the growth of soil microorganisms and their metabolic activity [19]. As a result, faster ammonia oxidation is observed, general nitrogen mineralization and denitrification processes increase. Phosphorus in aerated sludge is mainly in the form of phosphates and nucleoproteins, and potassium is contained in the form of digestible salts, which ensures their better consumption by plants. Moreover, during the fermentation process in the biogas plant, the potassium content practically does not change increases, however, the amount of absorbed phosphorus doubles. Of the other macroelements, calcium (1.0-2.3%), magnesium (0.3-0.7%) and sulfur (0.2-0.4%) are also present in the carbonated sludge [20].

Many scientists in their writings proposed the concept of development of rural areas with the introduction of complex environmentally safe technologies for the production and use of biofuels [10–11]. However, issues regarding the prospects of using digestate in the agricultural sector as a source (way) of increasing energy independence and soil fertility remain insufficiently clarified.

3. Literature review

The main chemical elements, thanks to the presence of which in the fertile layer of the soil increase the yield of grain, leguminous and industrial crops, are nitrogen, phosphorus, potassium, and for some plants – magnesium. Data on the cost of nutrients in widely used inorganic fertilizers – urea, ammonium nitrate, ammonium sulfate, ammophos, diamofoska, nitroamofoska, superphosphate, KAS-32, potassium chloride – were selected from scientific and reference literature, summarized and analyzed. In these fertilizers, such nutrients as nitrogen, phosphorus, potassium and magnesium are in the form of salts – nitrates, phosphates, potassium and magnesium. Taking into account the chemical formulas of fertilizer salts, the share of each of the elements was determined, and based on the price of the mineral fertilizer and the share of each of the constituent nutrients, the cost of each element was calculated.

Digestate is organic substrates after fermentation in biogas plants, saturated with nutrients and excellent for soil fertilization [12]. Re-fermented sludge (digestate) is a highly effective disinfected fertilizer that returns nutrients and lignin to the soil as the basis of humus formation and ensures the production of ecologically clean products [12–14; 37–38]. Any organic waste of plant and animal origin can be used to obtain digestate [25; 26]. The source of organic nitrogen is the microorganisms of the alimentary tract of animals.

Biofertilizer is applied to agricultural, decorative and vegetable crops in a water-diluted form, by fertilizing, surface watering the soil or spraying the leaf surface of plants [30]. Having a slightly alkaline environment (pH 7.6-8.2), reduces the acidity of the soil. It is used in in all climatic zones, for all types of soils, increasing their fertility and improving their ecological condition, increases the resistance of plants to adverse environmental conditions, especially during late frosts, microbiological processes in the root zone of plants occur with the release of heat necessary for the protection

of seedlings. Fertilizer application improves survival of transplanted fruit crops both in spring and autumn. One to three tons of liquid fertilizer is equivalent to 50-100 tons of manure in terms of effectiveness [31; 36].

There is global experience in the use of biofertilizers (digestate), in particular, they are widely used in Holland, Germany, England, Finland, Italy, China, India and other countries. In the conditions of Ukraine, very good results of fertilizer application are obtained when growing vegetable and berry crops, as well as cereals, fodder and lawn grasses, ornamental plants [19; 35].

The production of digestate and the stability of anaerobic digestion processes strongly depend on the composition of waste, process conditions, and the activity of microbial colonies in the system. In this sense, certain ratios of mixing, co-digestion can also lead to antagonistic interactions that reduce the productivity of the biogas plant [8; 19; 34].

Ukraine has a fairly powerful raw material potential for the production of biogas and digestate [14; 33]. Livestock complexes and poultry farms can be considered primarily as producers of waste, since the volumes of manure and droppings are hundreds and thousands of times greater than the volumes of the main products, and this is ecological problem [6; 15; 32]. Evaluation of the yield of manure, litter, biogas and digestate depends significantly on specific conditions and technology. In particular, the yield of manure (and, to a lesser extent, litter) depends on the age of the animals, as well as on local framework conditions and conditions of maintenance (feed) [35]. The amount of waste from the agro-industrial complex of Ukraine today reaches 290 million tons per year (108 million tons of dry matter) [4]. In Ukraine, about 50% of livestock farms are industrial [2; 14; 31].

The concept of development of rural areas with the introduction of complex eco-safe technologies for the production and use of biofuels has been developed in the world, the implementation of which will ensure the restoration of soil fertility by establishing a balance between the fields of plant and animal husbandry, will allow increasing the employment of the rural population by installing biogas complexes directly at the enterprises of the agro-industrial complex, and will ensure the energy independence of farms and rural communities through the introduction of complex eco-safe technologies for the production and use of biofuels in agricultural formations from existing resources [22–30; 40–44].

4. Conditions, objective and methods of research

The scientific work is aimed research of agrochemical analysis of digestate as an organic fertilizer and it is proposed to use it for the development of organic agricultural production. Methodology. The conducted studies are substantiated on experimental studies of scientific topics on the topic: "Development of bio-organic technologies for growing agricultural crops for the production of biofuels and ensuring the energy independence of the agricultural sector". When conducting observations, accounting and analysis, generally recognized methods were used, in particular "Fundamentals of scientific research in agronomy") [19].

5. Prospects for the use of digestate in Ukraine and the world

The by-product of fermentation – digestate – is usually used in agriculture in two forms: liquid and solid. Due to the content of readily available forms of nitrogen, phosphorus, potassium, sulfur and trace elements, digestate is a complete fertilizer, which, thanks to its properties, can replace mineral fertilizers [18]. The content of nitrogen compounds in the digestate is preserved on average by 70%, the content of potassium and phosphorus – by 100%. The estimated nitrogen content is 4.3-5.4 kg, phosphorus – 2-2.5 kg, and potassium – 8.8-13.1 kg per ton of re-fermented manure [15].

From the point of view of the legislation of Ukraine (Law of Ukraine "On Pesticides and Agrochemicals"), agrochemicals are organic, mineral and bacterial fertilizers, chemical meliorants, plant growth regulators and other substances used to increase soil fertility, yield of agricultural crops and improve the quality of plant products [11; 29].

Therefore, having fertilizing properties when applied to the soil, digestate formally falls under the concept of agrochemicals. In addition, digestate is a special type of organic fertilizer because it has a variable composition throughout the year and from year to year. This is due to the difficulty of maintaining stable technological regimes during the operation of biogas plants. Due to the variability of digestate composition, its state registration as conventional fertilizers is a practical nonsense [15].

Organic fertilizers are traditionally considered to be manure or droppings from animal husbandry, sapropel, composts. But with the development of biogas production technologies in Ukraine from by-products and raw

materials of agricultural origin, more and more digestate is formed – mass re-fermented in anoxic conditions [23].

Such digestate is also a valuable resource for restoring soil fertility, as it contains a complex of nutrients and microelements in forms available to soil biota, allows for deacidification and moistening of soils, and is a source of soil-beneficial bacteria. As an organic fertilizer or soil improver, digestate at almost all active biogas plants in Ukraine is only a by-product of the biogas production process. And the most rational way to use it is to apply it to the soil [17].

Regular application of fertilizers in them helps to maintain the health of the soil. The use of mineral fertilizers made it possible to intensify agricultural production, make it more predictable and, accordingly, economically feasible [10].

But one of the main factors in restoring the fertility of Ukrainian lands is organic fertilizers: plant residues, by-products, siderates, etc. The introduction of organic matter improves the agrochemical, physical and water-air properties of soils [17].

6. Research of raw materials for the production of digestate

Digestate is a highly effective organic fertilizer that passes through stages of fermentation, destruction of harmful substances, has useful elements for plants and soil.

Currently using modern technologies to obtain biofertilizers can be used to process various types of organic waste.

Main types of waste:

1. Cattle manure (cattle).
2. Chicken droppings.
3. Pig manure.
4. Sugar beet tops.
5. Straw and grass.
6. Forestry waste.
7. Sediment and wastewater.
8. Dairy waste (lactose, whey).

Wastes of animal and bird origin are the most valuable organic fertilizers, which include liquid and solid excretions of animals. They contain important elements for the growth and nutrition of plants.

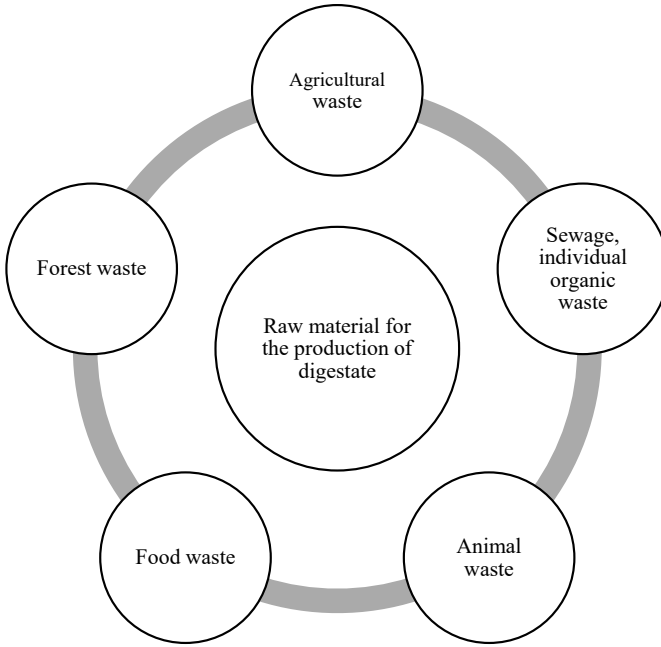

Figure 1. Raw materials that can be used to produce digestate

Source: the figure was created by the author based on the data of the State Statistics Service of Ukraine and the Institute of Soil Science and Agrochemistry

For example, waste from agricultural enterprises, livestock complexes, poultry farms, food and processing industries, and generally various types of plant and animal waste are used for biogas production. First of all, this applies to waste prone to the process of biodegradation. Today, biogas is mainly produced by from by-products of vegetable and animal origin: silage mass, beet pulp, liquid manure, chicken droppings with litter, etc.

Biogas obtained from biomass is used as a fuel that is not harmful to the environment, as it does not cause additional emissions of the greenhouse gas CO_2 and reduces the amount of organic waste. Unlike wind energy and solar radiation, biogas can be obtained regardless of climatic and weather conditions.Manure is the main organic fertilizer in all regions of Ukraine. It is a mixture of solid and liquid secretions of agricultural animals (chicken

droppings, manure of cattle and pigs), with bedding (solid fraction) and without it (liquid manure). Straw, sawdust, etc. serve as litter. Manure has all the useful elements that plants need.

The quality of manure may depend on the species of animals, the composition of feed, the amount and quality of litter, the method of accumulation and storage conditions (Table 1).

Table 1

Chemical composition of litter-free manure of different types animals, %

Indexes medium content	Cattle	Pigs	Chickens
Dry matter	10,00	10,00	20,00
Organic substances	6,80	7,70	14,90
N	0,40	0,65	1,52
P	0,06	0,14	0,61
K	0,46	0,27	0,50
Ca	0,21	0,25	1,04
Mg	0,05	0,07	0,11
Na	0,06	0,08	0,12
pH	7,8	6,7	6,8

The collection and storage of organic fertilizers (bedding manure, manure, bird droppings) takes place in special places: manure storage, storage for bird droppings, sites to prevent the infiltration of biogenic elements and toxic substances to the groundwater level. If the dry fraction of manure contains more than 30%, it is stored in the sides, and to prevent the evaporation of nutrients, they are covered with a film or a layer of straw. Litter-free manure is collected in large quantities on farms and livestock complexes.

7. Characteristic features of digestate obtained after anaerobic fermentation of manure

Organic matter serves as a powerful energy material for soil microorganisms, which is why its application in the soil activates nitrogen-fixing and other microbiological processes. Tables 2 and 3 show the chemical composition of biological fertilizers [30; 31; 32].

Table 2

Chemical composition of biofertilizers from the biogas plant. Solid fraction 75% moisture*, kg/t

Biofertilizer (fermented mass)	Chemical composition				
	N	NH_4-N	P_2O_5	K_2O	MgO
Pig manure	6,3	1,8	5,5	6,2	1,7
Bird droppings	17,1	3,4	10,5	8,6	4,3
Grass silage	3,2	1,1	1,5	4,4	0,7
Corn silage	3,1	1,2	1,2	4,1	0,9
Sugar beet tops	2,1	1,2	1,1	3,6	0,8
Grain waste	8,7	2,1	5,7	5,6	1,2
Rapeseed meal	5,3	-	3,5	5,4	3,2

The value of biological fertilizer also lies in the fact that when the manure ripens, it gets rid of some of the nitrites and nitrates that are excessively contained in the manure of birds and domestic animals. In the fermentation process, they are fermented to ammonia and methane. Useful phosphorus, potassium and nitrogen contained in the fermented mass remain completely in biological fertilizers.

Table 3

Chemical composition of biofertilizers from a biogas plant. Liquid fraction 95% humidity

Biofertilizer (fermented mass)	Chemical composition				
	N	NH_4-N	P_2O_5	K_2O	MgO
Pig manure	3,3	2,3	2,4	2,3	0,9
Bird droppings	8,7	3,4	5,6	7,6	2,1
Grass silage	2,2	0,6	0,8	2,1	1,0

With traditional methods of preparation of organic fertilizers (composting) nitrogen losses reach 30-40%. Fourfold processing of anaerobic manure – compared to unfermented manure – increases the content of ammonium nitrogen (20-40% of nitrogen is converted into ammonium). As a result, compared to ordinary manure, in equivalent doses, the yield increases by 10-20%. The high profitability of biogas technologies is ensured by the simultaneous production of highly effective organic fertilizers, 1 ton (due to the impact on agricultural crops)

corresponds to 70-80 tons of natural waste from livestock and poultry farming. Biosludge can be divided into two fractions: liquid and solid with the help of screw separators. Both are fertilizers.

After processing by a biogas plant, biofertilizers have the following advantages:

1. Absence of pathogenic microflora.
2. Maximum accumulation and preservation of nitrogen-containing compounds.
3. Absence of weed seeds.
4. Lack of storage period.
5. Ecologically effective impact on the soil.
6. Resistance to leaching of useful elements from the soil.

Fermented materials improve the physical properties of the soil.

Mineral components are a source of energy and nutrition for underground microorganisms, improve the assimilation of nutrients by plants. This biological fertilizer contains many organic substances that contribute to increasing the permeability of the soil and its hygroscopicity, improve the general condition of the soil and prevent the occurrence of erosion.

Biofertilizers are also the basis for the development of microorganisms. With their help, nutrients are transformed into a form that is easily absorbed by plants. Digestate accelerates seed germination, rapid plant survival, and reduces stress during transplanting.

8. Effectiveness of using digestate in increasing soil fertility

Due to increased anthropogenic impact on soils, they acquire the relevance of methods that make it possible to detect signs in time anthropogenically caused soil degradation of natural ecosystems and agroecosystems. Recently, the active use of microbiological and biochemical methods of biodiagnosis of anthropogenic disturbances in soils is associated with the rapid reaction of microorganisms to any deviations from the norm in the environment. Degradation phenomena in soils primarily affect biological objects, in particular microorganisms, which leads to a decrease in biological activity and, as a result, soil fertility. In addition, the physical, physico-chemical and chemical characteristics on which soil diagnostics are based are quite conservative and reflect changes in soil properties under

the intense or prolonged action of negative anthropogenic factors, when they become noticeable and even sometimes irreversible.

The most important role in maintaining the ecological balance in the soil is played by the supply of humus, which is a nutrient medium for microorganisms that stimulate plant nutrition and their growth processes.

The basis of natural humus is the remains of organic plant substances: fractions that have decomposed the least, fractions that are still decomposing, complex substances obtained as a result of hydrolysis and oxidation of organic substances, which are the result of the viable activity of microorganisms.

Humus includes humic acids, fulvic acids and salts of these acids, as well as humin. Humic has a significant specific surface (600-1000 m^2/g) with a high adsorption capacity. After adding a small amount of humus to the soil, compared to other fertilizers, not only the chemical composition and qualitative physical and chemical characteristics of the soil changes, but also the composition and structure of the microflora, which, in turn, leads to a change microbiological regime in the soil, activating the processes of transformation of matter and energy. As a result, metabolic processes accelerate, new cycles of microflora development are included, in particular, the activity of nitrogen-fixing bacteria increases.

Humic substances resulting from the decomposition of organic substances actively participate in all important processes of soil formation and form its fertility. The main indicator of soil humus is the content of organic matter, as it significantly improves the physical, chemical and biological properties of the soil, and contributes to fertility. The humic materials produced during fermentation in the methane tank improve the physical properties of the soil: aeration, water retention and soil infiltration, as well as the rate of cation exchange (Table 4).

When using humus, a significant increase can be achieved yield and its quality. Wheat yields 15-20% more, corn – 20-30%, potatoes up to 30%, sugar beet up to 20%.

Biohumus has many advantages:

1. Increases moisture resistance and moisture capacity.
2. Mechanical strength of granules.
3. Does not contain weed seeds.
4. Contributes to the development of a large number of various useful microorganisms, the formation of antibiotics, enzymes.
5. Does not have a harmful effect on the soil.

Table 4

Normative indicators of humus for various organic of waste (kg of humus in 1 ton of substrate)

Substrate	Dry matter content, % (in fresh mass)	Humus content, kg (in 1 t of fresh mass)
Fermented mass (liquid fraction)	4–10	6–12
Fermented mass (solid fraction)	25–35	36–54
Filtration sludge	10–20	10–15

Source: [42]

In Ukraine and in Western countries, biohumus is divided into three fractions. Each of them has its own function: the smallest is used for "treatment" of plants, because it is easily absorbed by plants, promotes the development of small roots; small – for feeding greenhouse and garden crops (flowers, vegetables), large – in horticulture and crop production. In many countries (Denmark, Germany, India, China) since the 1990s, a number of tests have been conducted, the results of which show a significant increase in yield when using digestate as fertilizer.

It was calculated that the use of biogas technology for the processing of organic substances allows not only to completely eliminate the threat to the environment, but also to obtain an additional 95 million tons of standard fuel annually (about 60 billion m^3 of burning methane or biogas, 190 billion kWh). and more than 140 million tons of highly effective fertilizers, which would significantly reduce the extremely energy-intensive production of mineral fertilizers (about 30% of all electricity consumed by agriculture) and help avoid secondary soil acidification, which is often caused by excessive application of nitrogen and phosphorus fertilizers.

9. Practical value

Our research confirms the real benefit and effectiveness of using digestate from biogas plants in agriculture as a highly effective organic fertilizer. After all, during the use of digestate, it was found that it is universal and suitable for all soils, as well as for feeding all types of plants; increases the content of organic matter (humus); improves the water and air conditions of the soil; it can be made at any time; has neutral acidity and deacidifies the soil; absence of pathogenic organisms; allows you to increase the

yield, as it contains a complete set of necessary macro and microelements, organic compounds that improve the soil structure, and humic acids; creates prerequisites for the development of organic agricultural production and increased income from the sale of products.

10. Conclusions

The process of complex processing of manure simultaneously has three advantages: obtaining energy from biogas, improving the ecological situation around livestock farms, obtaining environmentally friendly and agronomically effective fertilizers. The role of manure in agriculture is well known, and its role as the main element of a proper fertilization system did not decrease even when relatively large doses of mineral fertilizers were applied. Thanks to them, traditionally, from 30 to 50% of the plants' nutritional needs were met. An example of this is the developed countries of Europe – Germany, Great Britain, and the Netherlands, which, along with applying a significant amount of mineral fertilizers (350-800 kg/ha per year), apply high rates of organic fertilizers of 26-75 tons per hectare of arable land.

It should be noted that the use of biogas plants can reduce the anthropogenic impact on the environment due to the processing of agricultural waste and waste from other industries. As a raw material for obtaining digestate, not only pig or cattle manure is used, but also straw, dairy and forestry waste.

Currently, soils in Ukraine are subject to unjustified land reclamation, improper and irrational use of chemical fertilizers and pesticides. The greatest damage to land is caused by salinization, soil acidification, waste pollution, wind and water erosion, drying, waterlogging, non-renewable losses of humus.

To improve the condition of the soil and increase its fertility, the use of fermented sludge is suggested. In its composition, digestate contains many useful substances, such as calcium (1.0-2.3%), magnesium (0.3-0.7%), sulfur (0.2-0.4%). Biofertilizer also contains trace elements, as well as amino acids, hydrolysis enzymes, nucleic, humic and organic acids (fulvic acids), monosaccharides, phytohormones (gibberillin, auxin, cytokenins), B vitamins, some antibiotics and other biologically active substances. Nitrogen is stored in ammonia (up to 50-75%) and organic form. Phosphorus

occurs in the form of phosphates and nucleoproteins, and potassium in the form of digestible salts (which ensures their better absorption by plants). After the process of anaerobic fermentation, there is a much smaller number of pathogens, larvae and worm eggs.

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