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PECULIARITIES OF MARKETING ACTIVITIES OF AGRARIAN ENTERPRISES IN THE CONDITIONS OF MARTIAL LAW

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ABSTRACT

The agro-industrial sector is one of the locomotives of the national economy of Ukraine: the industry was growing steadily until the beginning of the full-scale war, the annual growth was 5-6%, the share of agricultural production in the GDP was 10%, and together with the processing of agricultural products – 16%. Agriculture was one of the leaders in world production of some types of food, providing trade volumes equivalent to 6% of global calorie consumption. Ukraine was the leader in international trade in sunflower oil (first place in the world), rapeseed and barley (third and fourth places, respectively) and other products. Trade in agricultural products and foodstuffs brought Ukraine about 22 billion dollars annually. USA and accounted for 41% of all exports. However, the invasion of the Russian Federation into Ukraine led to corresponding negative changes in the functioning of enterprises in the agrarian sector of the economy.

It should be noted that there have been significant changes in the economic relations between agricultural producers and processing enterprises, suppliers, and intermediaries: the system of stable relations with the processing sphere was destroyed, and the state order for agricultural products was canceled. Agricultural enterprises faced serious problems during the sale of produced products and the purchase of the necessary means of production. They were forced to independently engage in planning, pricing, study of external and internal markets, tastes and preferences of consumers, evaluation of competitors' advantages, etc. That is, there is an urgent need to introduce a new management concept that will help adapt to market conditions and ensure the competitiveness of their products on the domestic and foreign markets.

In modern enterprises, one of the most effective tools for influencing the result is the management of marketing activities. Considering the current situation in the country, it becomes necessary to improve the activities of enterprises, and in particular the marketing component to increase the competitive characteristics of their goods or services.

Despite the war and large-scale destruction, agriculture is unlikely to lose its status as one of the leading branches of the Ukrainian economy. However, today's conditions require agrarian enterprises to direct their development to the future with an orientation towards meeting the needs of consumers by more effective means than competitors. It is due to successful marketing that the necessary conditions for the sustainable development of an enterprise in the agrarian sector are created.

The results of the presented research in the monograph are made within the initiative of the Department of Agrarian Management and Marketing of Vinnytsia National Agrarian University "Development of the concept of marketing management of agricultural enterprises" state registration number: 0122U002111 for 2022–2024.

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2. Development of ecological marketing in the sphere of production of biofertilizers

Agriculture in modern conditions has demonstrated the dynamics of accelerated development in recent years. Such industries as animal husbandry and poultry are developing especially intensively. The intensification of these directions also leads to an increase in the volume of organic waste, which often accumulates near livestock and poultry farms and creates an ecological threat to the natural ecosystem. At the same time, organic waste is a valuable raw material for the production of organic fertilizers, which is of great importance in the biologization of agriculture and the production of ecologically clean agricultural products.

The introduction of high-quality organic fertilizers during the cultivation of agricultural crops in optimal doses shows high agronomic efficiency. Not only the yield of crops increases, but also their quality indicators improve.

The problematic issue in this study is the high cost of organic fertilizers, for the production of which sources of traditional electron carriers are used. These alternatives must be inexpensive, accessible, reproducible and effective in order to compete with traditional inorganic fertilizers and at the same time reduce any potential negative impact on the environment. We aim to evaluate the effectiveness of digestate application in an agricultural system over a period of time. Digestate based on livestock waste, namely pig manure digestate, chicken manure digestate and cow manure digestate, was used in the study.

Theoretical, methodological and practical aspects of the production and use of biogas plants in the cultivation of agricultural crops were studied by such domestic scientists as Kaletnik G.M., Honcharuk I.V., Lutkovska S.M., Logosha R.V. However, the analysis of scientific literature shows that today there are no unified statements regarding the use of these processes. However, the issue is relevant and needs further development.

Object of research: agricultural enterprises of Vinnytsia region.

The subject of the research is the waste of biogas plants in the form of digestate fertilizer and its effect on the fertility of agricultural lands.

The purpose of the work is to determine the theoretical and practical principles of production of organic fertilizers in the form of digestate from biogas plants.

In accordance with the set goal, the following tasks were solved:

- to determine the theoretical basis of the production and use of biogas plants for extracting organic fertilizers from them;
- research and analyze the raw material base for the production of digestate;
- determine the role of digestate in increasing soil fertility.

The theoretical and methodological basis of the research is generally accepted methods: observation, comparison, analysis and synthesis, modeling of economic phenomena, fundamental works of domestic and foreign scientists in the field.

The practical significance and scientific novelty of the work lies in the fact that the theoretical conclusions and developments made in it can be used in the process of development and improvement of the cultivation of agricultural crops at agricultural enterprises of the Vinnytsia region.

The agricultural market is a complex system of relations aimed at ensuring the combination of resources of the agrarian sphere, labor, and infrastructure in order to functionally support the process of production and sale of agricultural products.

Marketing research is one of the main functions of marketing, which connects marketers with markets, competitors, consumers and a set of elements of the external marketing environment, serves as systematization and analysis of data from various levels of marketing activity. Any enterprise operating on the market operates in a marketing environment, namely in a combination of forces and factors that have an impact on its management. Monitoring of the marketing micro-environment and adaptation of the macro-environment to it require a continuous study of the nature and intensity of this influence. Therefore, marketing research provides decision-making in all areas of marketing activity. With the help of marketing research, the level of uncertainty and risk regarding any product in a specific market is reduced.

The greatest influence on the level of competition in the industry is exerted by the number and capacity of enterprises producing agricultural products. Modern agro-food markets are characterized by a situation where producers offer conventionally homogeneous products intended for a wide range of potential consumers, and therefore competition between these producers is fierce.

To increase the efficiency of the innovative activity of agricultural enterprises with the help of marketing tools, it is advisable to implement a set of measures, which are conditionally systematized into 8 groups:

– prompt response: daily statuses and monitoring of changes; regular anti-crisis programs; short-term planning; conducting marketing research of the agricultural market and consumers;

– optimization of budgets: savings and budget reduction; suspension and cancellation of innovative projects; optimization of production processes, reduction of production and logistics costs;

– remote mode and taking care of the team: remote work, changing the work schedule; strengthening the protection of employees who cannot work remotely; informing employees, strengthening employee safety; online trainings and webinars;

– assistance to agrarian business: growth of corporate social responsibility, implementation of social initiatives, charity; support of partners, compatible projects;

– adjustment of the marketing strategy: transition to situational marketing; formation of a new strategy for brands; adaptation of communication strategy; change of the plan of innovative activity; revision of the pricing policy;

– change of the communication mix: strengthening of digital communication channels; increase in the number of SMM activities;

– transformation of the portfolio of innovative products: creation of new products.

In this regard, the management of the competitive environment in the agrarian sphere becomes important to ensure the process of extended reproduction and development of enterprises in a harmonious combination with the social needs of society.

Increasing the efficiency of the competitive environment is connected with the improvement of the functions of the competitive policy in the agrarian sphere. From today's point of view, demonopolization of the agrarian complex of Ukraine is considered as a kind of organizational anti-innovation. Most of the developed countries of the world see the development of the economy in the creation of territorial production systems of small and medium-sized enterprises, i.e. clusters.

The marketing strategy of the industry should also be based on the study of the competitive situation in one or another market. To determine the intensity of competition, a list of indicators is used - four- and eight-part indicators of market concentration, Gini (G), Hirschman-Herfindahl (HHI) and Rosenbluth (I) indices.

One of the central links of export agricultural marketing is the system of information and analytical support for the activities of marketing services at enterprises, which covers sorting and certification of products, the field of agricultural products procurement, international advertising activities, transportation of products, standards and technical requirements. When developing a foreign economic strategy, information is considered as the most important resource of the enterprise, and information technologies as means by which strategic goals are realized.

For agro-industrial complex enterprises, it is not important to separate and isolate information flows of foreign economic activity into a separate system or software product, but their integration into the general information system of the enterprise and effective interaction with this system.

Despite the positive dynamics of foreign trade of agribusiness enterprises in 2021, the main areas of ensuring its further development remain:

- improvement of the mechanisms of customs procedures and taxation when carrying out export-import operations, as well as transit transportation through the territory of Ukraine;

- dissemination of information regarding the holding of specialized international exhibition events among enterprises engaged in foreign economic activity.

The adjustment of the functioning mechanism of marketing information systems should be carried out through a complex of state institutions - at the Ministry of Agrarian Policy and Agro-Food through the national department, in regional and district administrations of agriculture thanks to regional offices.

The domestic system of agro-industrial export marketing should cover all enterprises and organizations, that is, the subjects of marketing activity should be producers of agricultural products, procurement, transport, processing, intermediary, service and trade enterprises.

At large agro-industrial complex enterprises, it is expedient to create special management structures - export marketing services. Smaller enterprises, for example, peasant farms, including farm-type ones, intermediary and service firms can combine their financial resources and carry out relevant activities through industry marketing centers or use the services of consultants and firms that specialize in international marketing activities on a contract basis. contractual principles.

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Recently, the demand for agricultural systems has increased significantly, which is connected with the needs of a constantly growing population against the background of limited land resources. These demands precede, but are not limited to, these three challenges – food security, income for farmers and ensuring a safer environment. To meet these requirements, agricultural practices such as organic farming, agro-ecological practices, and green practices are used to meet and exceed these goals in the short and long term. One of the researched and encouraged methods of agricultural management is the application of digestates to agricultural soils [23].

About 180 million tons of anaerobic digestate are produced annually in the EU, most of which is used as organic fertilizer. Treated anaerobic wastes are products from various sources of organic raw materials, which include sewage treatment, plant sludge (primary and secondary sludge), agro-industrial complex waste (part of solid household waste, including fruit and vegetable by-products, canteen waste, kitchen waste), green waste (waste from mowing grass, leaves), animal husbandry waste (pig, cow manure) and food waste (animal fats, used cooking oils, waste from restaurant degreasing tanks) [25].

Digestate is one of the products formed in biogas systems and is rich in nutrients. Digestate has the ability to compete favorably with inorganic fertilizers to increase crop productivity, yield, and improve soil health [23, 24]. One of the advantages of using digestate is that it has a higher nutrient content than any other raw material. Although the anaerobic digestion process releases a significant amount of nitrogen (N) in ammonium form from the resulting digestate, while carbon (C) is also removed in the form of methane and carbon dioxide. However, much of the nutrients such as N, phosphorus (P) and potassium (K) are retained. The content of mineral substances and the characteristics of the digestate mostly depend on the characteristics of the substrate and the method of fermentation. These determined characteristics, such as organic matter content, NH4, C/N ratio and nitrogen content, present in different substrates or feedstocks forming the digestate, will show differences in the efficiency and productivity of plants and soils, making it the main source for this study.

There are usually three types of digestate:

- whole: similar in appearance to livestock manure, with usually less than 5% dry matter.

- solution: this is a complete digestate from which most or all of the solid matter has been separated.

– fiber: similar to compost, it is a solid material separated from the whole digestate [26].

Studies have shown that digestate obtained from a biogas plant can significantly improve the yield of agricultural crops in comparison with manure - by 10-30%. The tests showed that after the introduction of digestate from the biogas plant, the production of potatoes increased by 30%, the production of perennial grasses – by three times, cabbage and tomato seedlings - by 12-15%, and the total biomass of plants increased by 30-50%.

Digestate has several advantages over traditional chemical fertilizers. First, digestate contains a number of essential plant nutrients, including nitrogen, phosphorus and potassium, as well as trace elements such as copper, zinc and boron. These nutrients are slowly released over a long period of time, providing a constant source of nutrition for crops. Second, digestate is a renewable resource that can help reduce reliance on non-renewable fertilizers that are often derived from fossil fuels. In addition, digestate can help improve soil structure and fertility, stimulate plant growth and yield, and reduce greenhouse gas emissions [27].

Therefore, the use of digestate has several advantages for agriculture, such as improving soil quality and yield, reducing waste, and improving the environmental sustainability of the farm.

An additional advantage of using digestate is its relative availability and cost-effectiveness. Compared to commercial fertilizers, which are often quite expensive, digestate can be produced on site using organic waste, which reduces the cost of its purchase and transportation.

In addition, the use of digestate can be beneficial for agricultural enterprises that raise animals. Organic waste from animals can be processed into digestate, which can be used as a fertilizer for growing plants. This helps to reduce waste and increase the efficiency of resource use.

Annually, in order to ensure intensive agricultural production and full reproduction of humus reserves in Ukraine, it is necessary to apply about 350 million tons of organic fertilizers. Previously, this balance was ensured mainly thanks to domestic animal husbandry. However, over the past 30 years, the number of cattle in Ukraine has decreased by more than 4.5 times. Under today's conditions, there are more than 10 times less cattle per hectare of arable land in Ukraine than in the countries of Western Europe. Recently, on average, 20 times less organic fertilizers are applied than is necessary to achieve high yields of agricultural and vegetable crops.

The microbiological composition of litter-free pig manure used to obtain bioorganic fertilizer "Effluent" based on digestate [28] is given in table. 1.

Table 1

Quantitative composition of microorganisms in samples of liquid pig manure (as of February 25, 2022)

№	A type of pig manure	In total, thousand/year	including				Mushrooms-antagonists Toxin-producing species of fungi		Mushrooms-antagonists Toxin-producing species of fungi	
			pathogenic species saprotrophic species		pathogenic species saprotrophic species					
			thousand/year	%	thousand/year	%	thousand/year	%	thousand/year	%
1	Unfermented	118,8	79,2	66,7	39,6	33,3	11,3	9,5	101,8	85,7
2	Reborn	193,8	12,6	6,4	181,2	93,6	6,2	3,2	31,2	16,1

Source: formed on the basis of research [29, c.5].

Organic fertilizers of various origins, which contain different amounts of nutrients, are used in agricultural enterprises of the Tyvriv district of the Vinnytsia region. For our research, we took organic fertilizer based on pig manure, which is produced at the Subekon LLC pig complex, where more than 12,000 pigs are kept for fattening, as well as organic fertilizer, which is made from organic residues from the cultivation of corn, carrots and table beets. in the village of Sutysky, Tyvriv district.

The passage of pig manure through a biogas plant leads to a decrease in the number of pathogenic microorganisms and an increase in the number of saprophytic organisms. This contributes to the improvement of the microbiological composition of the obtained organic fertilizer, which is called "Effluent" and is made on the basis of digestate.

When analyzing the composition of pathogenic fungi in fermented and unfermented manure (according to Table 2), it was found that in fermented manure the number of pathogenic fungi from the genus Fusarium decreased to 3.2%, while in unfermented manure it was 9.5%. In addition, no fungi of the genus Aspergillus were found in fermented manure, while their number in unfermented manure was 57.2%.

Table 2

General ratio of pathogenic mycoflora in samples of pig manure (as of February 25, 2022)

№	Version	All pathogenic fungi		including from genera, %		
		thousand/year	%	*Fusarium*	*Alternaria*	*Aspergillus*
1	Unfermented	79,2	66,7	9,5	0	57,2
2	Reborn	12,6	6,4	3,2	3,2	0

Source: formed on the basis of research [29, c.5].

Production of bio-organic fertilizer "Effluent" based on pig manure digestate passed through a biogas plant leads to a decrease in the number of pathogenic microorganisms and an increase in the number of saprophytic organisms, which positively affects the microbiological composition of the obtained fertilizer.

We will present data on the agrochemical composition and value indicators of organic fertilizers obtained from different types of animals (Table 3).

Studies have shown that pig manure contains more nitrogen, phosphorus and magnesium, both in liquid and thick consistency, than cattle manure. However, cow manure has more potassium than pig manure. Therefore, to increase the yield of grain crops, it is better to use biofertilizer based on pig manure, and for root crops, it is more appropriate to use biofertilizer based on cow manure, which should be applied to the soil in the fall. In addition, Table 1 shows that biofertilizers with a thick consistency have a higher cost.

Table 3

Calculation of the cost of biofertilizer from cow and pig manure with different contents of dry matter

Main nutrients Content of nutrients in bio-fertilizer (kg/t)	Main nutrients Content of nutrients in bio-fertilizer (kg/t)	The cost of nutrients in 1 ton of organic fertilizer UAH/t		
		€/t	$/t	UAH/t
Biofertilizer from pig manure (25% dry matter)				
Nitrogen	4,5	4,73	5,16	120,06
Phosphorus	5,6	5,21	5,67	132,33

Continuation of table 3

Potassium	6,2	4,46	4,87	113,46
Magnesium	1,7	0,54	0,59	13,82
In total	18,0	24,88	16,29	379,67
Biofertilizer from cow manure (25% dry matter)				
Nitrogen	3,6	5,4	5,9	96,05
Phosphorus	2,8	2,6	2,84	66,16
Potassium	7,7	5,54	6,04	140,91
Magnesium	1,4	0,45	0,49	11,38
In total	15,5	13,99	15,27	314,50
Biofertilizer from pig manure (25% dry matter)				
Nitrogen	1,8	1,89	2,06	48,02
Phosphorus	2,4	2,23	2,43	56,71
Potassium	2,3	1,66	1,81	42,09
Magnesium	0,7	0,22	0,24	5,69
In total	7,2	6,0	6,54	152,51
Biofertilizer from cow manure (5% dry matter)				
Nitrogen	0,9	0,95	1,03	24,01
Phosphorus	1,2	1,12	1,22	28,36
Potassium	2,5	1,80	1,96	45,75
Magnesium	0,5	0,16	0,17	4,07
In total	5,1	4,03	4,38	102,19

Source: [30]

The use of organic fertilizers is an effective method of increasing the yield of corn for grain and vegetables in open ground. The most optimal economic effect was obtained when using bioorganic fertilizer "Effluent" obtained from digestate, in the amount of 55.0 tons per hectare when growing various types of grain crops.

For the effective introduction of new crops or growing technologies, it is necessary not only to evaluate their yield and product quality, but also to carry out an economic analysis. It will help determine the efficiency of resource use and the optimal technology option, which will be the most profitable from an economic point of view. This, in turn, can lead to an improvement in the quality of products, an increase in their volume, and a reduction in production costs. Evaluation of research results and analysis of technological process elements is an important stage in increasing production efficiency [30].

The effectiveness of measures aimed at increasing the yield and quality of products can be confirmed only by the results of their economic evaluation. Today, no manufacturer will start using new technologies without analyzing energy consumption and assessing their economic feasibility [31,32].

Resource prices are constantly fluctuating due to market leverage, and therefore the economic evaluation of cultivation technologies does not always provide an objective picture of their effectiveness. The assessment needs to take into account all types of energy consumption, including gross and exchangeable energy. To determine the efficiency of cultivation technology, it is necessary to compare the energy profit accumulated in fertility with the total energy spent on cultivation and harvesting [34].

To solve the problem described in the article and to fulfill the tasks, calculations of the economic efficiency of growing corn for grain and vegetables in the open ground were carried out. These calculations were based on technological maps of cultivation of each crop. The cost of fuels and lubricants, seeds, plant protection products, mineral fertilizers and bio-organic fertilizer "Effluent" based on digestate was calculated for November 2022. At the time of the research, the selling price of 1 ton of corn at the stock market was UAH 5,000, carrots – UAH 7,000, and table beets – UAH 8,000.

The conducted economic analysis of technologies for growing corn and vegetables in the open ground (sowing carrots and table beets) showed that fertilizer significantly affects the economic efficiency of the production of marketable products – grain and root crops. When applying fertilizers, the following pattern was revealed: with an increase in nutrition rates, the amount and value of additional products increases, the conditional net profit from each hectare and the level of profitability increase accordingly (Table 4).

Table 4

Economic assessment of technologies for growing corn for grain and table roots depending on fertilizer
(on average for 2020-2022)

Culture Fertilizer	Culture Fertilizer	Productivity, t/ha	Cost of production, hryvnias/ha	Production costs, hryvnias/ha	Conditionally net profit,	Cost of 1 ton of products,	Rate of return, %
Corn Camponi KS	1*	6,78	33900	19841	14059	2930	71
	2	7,65	38267	20086	18181	2620	91
	3	9,65	48233	22969	25264	2380	110
	4	10,28	51417	24133	27284	2350	113

Continuation of table 4

	5	10,46	52318	25266	27052	2410	107
	6	11,55	57733	26459	31274	2290	118
	7	12,86	64300	33604	30696	2610	91
	8	12,06	60283	29254	31029	2430	106
Carrot seed Bolivar F1	1*	28,81	201670	96665	105004	3360	109
	2	34,22	239540	97084	142456	2840	147
	3	40,85	285950	98903	187047	2420	189
	4	44,24	309680	100902	208778	2280	207
	5	47,07	329490	102776	226714	2180	221
	6	50,82	355740	104681	251059	2060	240
	7	58,05	406350	118057	288293	2030	244
	8	51,45	360150	110138	250012	2140	227
Table beet Kestrel F1	1*	37,12	296960	89466	207494	2410	232
	2	40,34	322720	89978	232742	2230	259
	3	45,80	366400	92669	273731	2020	295
	4	53,22	425760	94946	330814	1780	348
	5	62,12	496960	97037	399923	1560	412
	6	72,52	580160	99287	480873	1370	484
	7	86,23	689840	113048	576792	1310	510
	8	73,01	584080	105869	478210	1450	452

Note: 1 − without fertilizers (control); 2 – application of water (45.0 m3/ha); 3 - biofertilizer "Effluent" (25.0 t/ha); 4 – "Effluent" (35.0 t/ha); 5 – "Effluent" (45.0 t/ha); 6 – "Effluent" (55.0 t/ha); 7 – "Effluent" (55.0 t/ha) + N90P90K90; 8 - N90P90K90.*

Source: formed on the basis of research 7

The conducted studies showed that there was a decrease in economic efficiency indicators on the options for growing crops without applying fertilizers. More specifically, the lowest values of net profit and profitability were recorded on the control variants. For example, the costs of growing corn, carrots, and beets were UAH 19,841.0/ha, UAH 96,665.0/ha, and UAH 89,466.0/ha, respectively. At the same time, the net profit was UAH 14,059.0/ha, UAH 105,004.0/ha, and UAH 207,494.0/ha, and the profitability level was 71%, 106%, and 232%. These results suggest emphasizing the importance of applying fertilizers to achieve higher economic efficiency of growing agricultural products.

Calculations of the economic efficiency of growing seed carrots and table beets with the use of different rates of fertilizers showed that among the studied options, the most profitable are those that use the bioorganic fertilizer "Effluent" at the rate of 55.0 t/ha and the full application of bioorganic-mineral fertilizer at the rate of 55.0 t/ha of digestate + N90P90K90.

Bioenergetic analysis is an important tool for determining the efficiency of growing corn for grain. Traditional methods of economic assessment, which are based on natural or cost indicators, do not provide sufficient information about the energy costs of mechanized work and the costs of human labor. Bioenergetic analysis allows you to determine the efficiency of energy consumption that accumulates in the crop and to reveal the level of energy intensity of the obtained products. All labor and process inputs are measured in energy units such as kilocalories or joules. This allows comparison of technologies in crop production and agriculture and provides a more complete assessment of cultivation efficiency. Bioenergy analysis does not depend on fluctuations in the prices of energy carriers, fertilizers and the cost of final products, so it provides a more accurate assessment of individual elements of cultivation technology.

The analysis of energy consumption per hectare of corn sowing for grain showed that the lowest consumption was observed in the control variant without fertilizer application – 47.3 GJ/ha. The highest consumption of total energy of 61.2 GJ/ha was noted in the variant where mineral fertilizer in the norm N90P90K90 and bio-organic fertilizer "Effluent" based on digestate (55.0 t/ha) were applied in a complex manner, which exceeded the control by 29.4% for this indicator (Table 5).

Similar results were obtained when growing vegetables. An increase in the level of fertilizers in the soil led to a proportional increase in energy consumption. For example, the energy consumption for sowing carrots was the highest in the areas where mineral fertilizers were applied at the rate of N90P90K90 (70.4 GJ/ha) and their combination with digestate (rate of 55.0 t/ha) (77.3 GJ/ha) . This is 12.1-18.9 GJ/ha more than in the control plots (58.3 GJ/ha). The highest energy consumption was observed when growing table beets. On unfertilized plots, energy consumption was 75.7-78.6 GJ/ha, and increasing the level of fertilizers led to an increase in energy consumption by 9.7-32.0 GJ/ha, depending on the form and rates of fertilizers.

Table 5

Energy efficiency of growing corn for grain and table roots depending on fertilizer (average for 2020-2022)

Culture Fertilizer	Culture Fertilizer	Received energy with harvest, GJ/ha, Ev	Energy consumption, GJ/ha, Eo	Energy gain, GJ/ha, E	Coefficient of energy efficiency, Kee
Corn Camponi KS	1*	99,12	47,29	51,83	2,10
	2	111,89	51,01	60,88	2,19
	3	146,01	54,03	91,98	2,70
	4	155,65	54,81	100,84	2,84
	5	158,37	55,12	103,25	2,87
	6	174,77	56,35	118,42	3,10
	7	188,01	61,21	126,81	3,07
	8	176,27	57,89	118,38	3,05
Carrot seed Bolivar F1	1*	70,98	58,34	12,64	1,22
	2	75,90	60,72	15,18	1,25
	3	85,63	62,48	23,15	1,37
	4	89,87	64,08	25,79	1,40
	5	92,32	65,59	26,73	1,41
	6	98,48	67,16	31,32	1,47
	7	108,59	77,27	31,32	1,41
	8	101,88	70,43	31,45	1,45
Table beet Kestrel F1	1*	125,71	75,71	49,99	1,66
	2	133,27	78,62	54,65	1,70
	3	145,30	81,60	63,70	1,78
	4	157,39	83,07	74,32	1,89
	5	165,73	85,26	80,47	1,94
	6	178,54	87,49	91,05	2,04
	7	199,43	99,96	99,47	2,00
	8	183,98	93,60	90,39	1,97

Note: 1 − without fertilizers (control); 2 – application of water (45.0 m3/ha); 3 - biofertilizer "Effluent" (25.0 t/ha); 4 – "Effluent" (35.0 t/ha); 5 – "Effluent" (45.0 t/ha); 6 – "Effluent" (55.0 t/ha); 7 – "Effluent" (55.0 t/ha) + N90P90K90; 8 - N90P90K90.*

Source: formed on the basis of research 7

Based on the results of the analysis, it can be concluded that the use of fertilizers during the cultivation of cereals and root crops increases energy consumption. However, this agrotechnical method allows you to significantly increase the accumulation of energy in the crop, increase the gross energy and increase the energy efficiency ratio.

Therefore, the efficiency of fertilizer application from biogas plants can be determined based on several criteria. First of all, it is necessary to take into account the composition and content of nutrients in fertilizers. Next, it is important to find out exactly which crops or plants will be grown using these fertilizers and how they respond to specific nutrients. The cost of fertilizers and their transportation, storage and application in the fields for further application should also be taken into account.

Another important criterion is the environmental friendliness of fertilizers. If the fertilizers obtained from biogas plants contain harmful substances that can harm the environment or the health of people and animals, then this can negatively affect the effectiveness of their use.

The level of technical equipment of the biogas plant and the processes used to produce fertilizers should also be taken into account. If the technical equipment is not efficient or the production processes are not optimized, it can lead to the loss of nutrients and a decrease in the quality of fertilizers.

For the effective use of fertilizers from biogas plants, it is necessary to take into account the climatic conditions and the type of soil in the field where the fertilizers will be applied. For example, in an area with high humidity, certain types of fertilizers may be less effective than in an area with a drier climate.

In addition, it is necessary to take into account local legislative requirements regarding the use of fertilizers. For example, some countries may have restrictions on the amount of fertilizer that can be applied to a certain area of land.

The supply of humus plays the most important role in maintaining the ecological balance in the soil, as it is a source of nutrients for microorganisms that stimulate plant nutrition and growth. Natural humus consists of the remains of organic plant substances, which contain fractions that have decomposed the least, fractions that are still decomposing, complex substances formed during the hydrolysis and oxidation of organic substances formed as a result of the vital activity of microorganisms.

The use of humus can significantly increase the quality and quantity of the harvest. For example, the use of humus when growing wheat can increase the yield by 15-20%, corn – by 20-30%, potatoes – up to 30%, and sugar beet – up to 20%.

Since the early 1990s, several studies have been conducted in countries such as Denmark, Germany, India, and China, which have shown a significant increase in yield when using digestate as fertilizer [34].

The conducted studies show that the use of biogas technology for the processing of organic materials has several advantages. It allows you to completely eliminate the threat to the environment and ensures the annual production of an additional 95 million tons of standard fuel (about 60 billion m3 of methane or biogas, 190 billion kWh) and more than 140 million tons of highly effective fertilizers. This can significantly reduce energy costs associated with the production of mineral fertilizers, which agriculture uses in large volumes, consuming about 30% of all electricity. In addition, the use of biogas technology can help avoid secondary soil acidification, which often occurs as a result of excessive application of nitrogen and phosphorus fertilizers.

The use of different types of digestate, manure and litter in different soil and climatic conditions was studied. The objects of the study were 5 types of digestate from biogas plants operating on agricultural farms, in particular, 3 pig farms, 1 cattle complex and 1 poultry farm [35].

Studies were conducted on the use of different types of digestate, which were obtained from agricultural biogas plants of various livestock farms and poultry farms. The research involved 5 types of digestate obtained by processing different initial media (semi-liquid cattle manure, liquid pig manure, liquid bird droppings and liquid pig manure effluents) under different fermentation modes (thermophilic or mesophilic) lasting from 7 to 15 days.

In the area where biogas plants are located, various crops are usually grown using traditional local methods. Harvesting was carried out in accordance with standards and regulatory requirements for product quality.

The effectiveness of the use of digestate depends on its effect on the microbial composition of the soil, in particular, an increase in the specific weight of bacteria that promote plant growth and a decrease in the share of fungal microflora and actinomycetes. Studies of plant production products grown on soils treated with digestate have shown an increase in the content of nutrients, elements, proteins, fiber, fats and vitamins. In different countries of the world, biofertilizers are used in both solid and liquid form. The solid form is obtained by drying the liquid fraction, while the liquid form is obtained directly from bioreactors [36].

Applying liquid biofertilizers to the soil requires a different approach compared to solid forms. Before field application, liquid biofertilizers are usually diluted with water in a 1:1 ratio, as high concentrations of ammonia and phosphorus can adversely affect plant cover.

To ensure basal and foliar nutrition of plants, the liquid fraction is dispersed on the fields with the help of special agricultural equipment. However, this method of introduction can create problems with parallel soil cultivation.

Undiluted digestate has high electrical conductivity and cannot be applied directly, as it can cause negative consequences for the soil. To avoid these problems, the solid fraction should be diluted in water in a ratio of 1:4 to 1:8 (digestate to water ratio).

Therefore, the use of biofertilizers leads to the improvement of the biological, physical and chemical properties of the soil, as well as to the improvement of the water and air regime. The peculiarity of the digestate is that it enriches the soil with organic substances, which can later turn into humus, which increases the absorbing complex of the soil. This ensures greater stability of crops during adverse weather conditions.

1. The study studied the theoretical foundations for the development of the use of biogas waste in the form of digestate and analyzed the possibility of application for various processes of fertilization of agricultural land.

The results showed that this approach can ensure the high quality of agricultural and vegetable crops, as well as increase productivity due to the effective use of bioorganic fertilizers, which is especially important in modern conditions, when mineral fertilizers have become significantly more expensive.

2. The evaluation of technologies for growing different types of crops depending on the fertilization system made it possible to find out the energy efficiency of growing crops in the absence of an increase in fertilizer costs.

The main feature of digestate is its ability to enrich the soil with organic substances. Undecomposed organic substances of the digestate can turn into humus in the soil, which contributes to the increase of the absorbing complex. This ensures greater stability of crops in adverse weather conditions.

Natural biofertilizers have many beneficial properties, one of which is their ability to balance the acid-base balance of the soil, which helps prevent soil depletion. In addition, they do not harm soil microorganisms, which is of great importance for soil health, do not contain pathogens, so they are safe for use in agriculture.

Biological fertilizers have an important advantage over mineral fertilizers - they are absorbed by almost 100%, compared to mineral fertilizers, which are absorbed by only 35-50%. Biofertilizers do not increase the amount of nitrates in products and soil, which allows for high yields.

3. The role of increasing soil fertility with the help of digestate was determined and it was proven that natural biofertilizers have many useful properties, one of which is their ability to balance the acid-alkaline balance of the soil, which helps prevent its depletion. In addition, they do not harm soil microorganisms, which is of great importance for soil health, do not contain pathogens, so they are safe for use in agriculture.

Biological fertilizers have an important advantage over mineral fertilizers - they are absorbed by almost 100%, compared to mineral fertilizers, which are absorbed by only 35-50%. Biofertilizers do not increase the amount of nitrates in products and soil, which allows for high yields.

In addition, the use of biological fertilizers helps to increase the biological activity of the soil and improve its structure. Biofertilizers provide plants not only with nutrients, but also with useful microorganisms that contribute to increasing soil fertility and provide protection against diseases and pests.

Biofertilizers are also a more environmentally friendly option, compared to mineral fertilizers, because they do not contain harmful substances and do not harm the environment. The use of biofertilizers allows you to reduce the amount of chemicals that enter the environment and pollute the soil, air and water.

The development of ecological marketing in biotechnological production depends on consciousness at all levels: state, production, consumer. The main problem in the development of ecological marketing is unscrupulous producers and weak legal control by the state. Governmental institutions need to prioritize the issues of resource conservation, public health, and comprehensive development of ecologically oriented business. In turn, there will be an increase in consumer demand and the creation of added value for producers, because the consumer will have confidence in the quality of the products he uses, which meets his own ecological needs, on the one hand, and on the other – the producer of food products. It should also be emphasized that the most relevant marketing model for the functioning of environmental marketing in biotechnological production is the "5P" model, since an important element of successful economic activity is people, namely the target audience, which has a clear awareness of their own and collective environmental needs and an understanding of how biotechnological production can solve the issue of safe nutrition and improve the quality and general condition of natural resources of agriculture.

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