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## RECYCLING OF POULTRY WASTE TO OBTAIN ALTERNATIVE ENERGY AND FERTILIZERS

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Poultry farming in Ukraine and in the world is a highly intensive branch of agriculture with a short production period for final products [1]. Recently, in our country, there has been a tendency to a decrease in the number of farm animals, however, according to the statistical data of the Research Institute «Ukragroprodromproduktivnist», the poultry population is still 207, 836 million heads (as of 01.05.2020) [2]. One of the main derivatives of poultry farms is manure, which is formed daily in huge quantities. Waste in this category usually accumulates quickly if it is not recycled on time. For a long time, experts have considered poultry manure to be the most valuable organic fertilizer in terms of its chemical composition. The accumulation of droppings on poultry farms not only negatively affects the health of people working and living in the production area, but also the ecological situation associated with environmental pollution. Development of new and improvement of existing technologies for recycling (disposal) of poultry waste in such cases is always relevant [2].

After processing the statistical data of the State Statistics Service of Ukraine for 2019, table 1 calculates the percentage of the main agricultural waste generated.

Table 1 – The amount of agricultural waste generated in 2019 in Ukraine

Waste categories	Waste generated, t	Percentage,%
Agricultural waste	5782438,72	100
Excrement, urea and manure from cattle	2551993,57	44
Grain straw	277967,62	5
Straw of other cereals	405314,43	7
Dry corn stalks	826682,18	14
Feed is spoiled, contaminated and its remains	402383,80	7
Dead animals and birds (including substandard)	23463,10	1
Bird droppings	1041399,13	18
Other wastes	253234,90	4

Considering table 1, it can be seen that poultry droppings account for 18% or 1041.3 thousand tons of the total amount of waste generated in agriculture 5782.4 thousand tons. This fact has not received due attention.

The problems associated with the accumulation of waste can already be solved

by applying a strategic approach by directing efforts to identify ways to reduce the burden on the environment, by considering and justifying technical methods for handling poultry droppings (Fig. 1), until they are fully recycling and used.

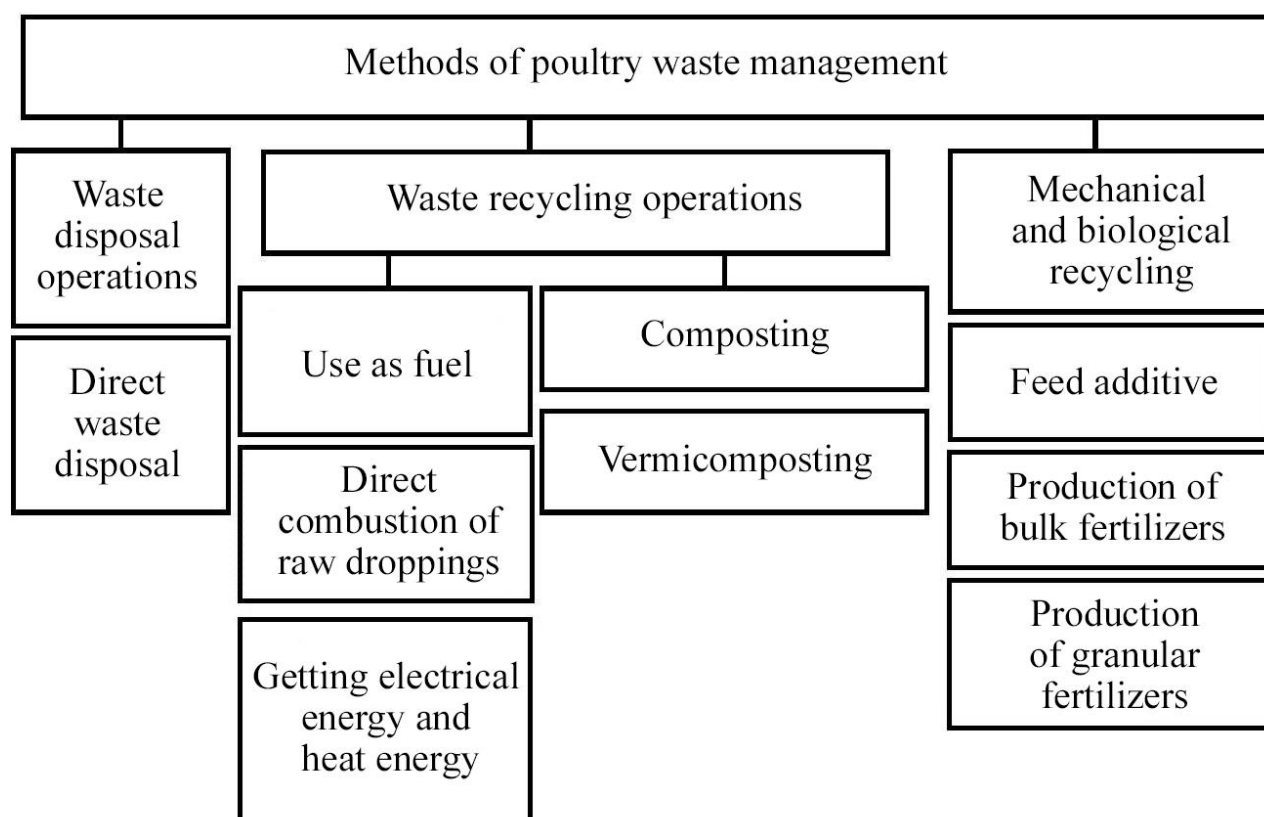


Figure 1 – Main methods of poultry waste management

The use of the method of direct burial of the placenta in the soil without its preliminary recycling is prohibited by the legislation of Ukraine. The state supervises unauthorized waste emissions, imposes significant fines, or applies legal liability for disregard of these prohibitions by poultry farms.

Technologies for using dung as fuel are twofold (positive and negative). If direct combustion is insufficiently substantiated and rational, then the production of heat energy and electrical energy is on the way of improvement [3], and their use is already practiced in small poultry farms.

Composting is perhaps the most popular technology for the disposal of animal waste. It provides for nitrogen emissions and has significant negative consequences for the environment. Companies not using composting must necessarily monitor and correct nitrogen emissions to the air to prevent environmental disaster.

Technologies of mechanical and biological processing [4], due to the need for high-quality fertilizers, have a good potential for implementation, since the market for organic products in Ukraine is only gaining popularity, while abroad it is already working.

We propose a symbiosis of waste recycling: technologies for using manure in the form of alternative fuel and mechanical and biological processing, taking into account a significant rise in the price of electrical energy [5] in Ukraine. The method

of recycling poultry droppings with the production of electrical energy, heat energy and organo-mineral fertilizers has been optimized. This method provides for the separation of manure, which is removed from the poultry farm into smaller and larger parts. For the purpose of disinfecting and fixing nutrients, a smaller part is treated with a stabilizer, followed by holding for the stabilization time. Most of the droppings are recycled by pyrolysis to generate electricity, heat energy and ash. About 15% of electrical energy is directed to ensure the operation of the technological line, and for other on-farm needs - the remaining 85%. It is assumed that a certain part of the thermal energy will be used to dry the manure before its recycling and the granules of the manufactured fertilizer [6]. The rest of the heat energy can be used to heat the production and residential premises of the poultry farm. Ashes that are formed after pyrolysis of droppings contain nutrients available to plants in a concentrated form and can be used as fertilizer [7]. There is also an option for the preparation of granular organo-mineral fertilizers by mixing in a percentage ratio of ash with droppings treated with a stabilizer. The implementation of this method is reflected in the technological scheme of the recycling poultry droppings complex (Fig. 2).

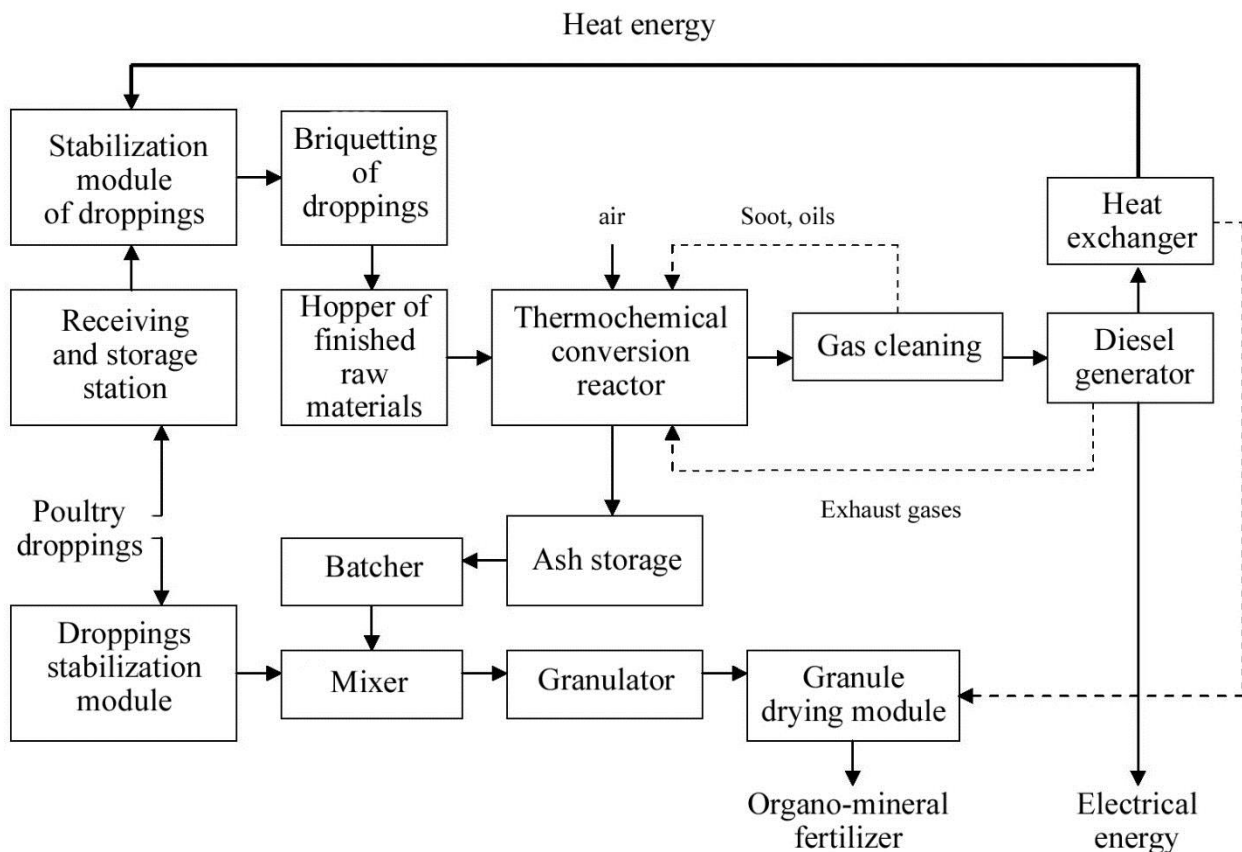


Figure 2 – Flow diagram of poultry droppings recycling complex

The production line assumes the use of serial production equipment and (or) developed non-standard equipment. To generate electrical and thermal energy from manure in production conditions, it is advisable to use the local energy complex LEK-4500.

The modular units of the complex operate in an autonomous mode, and the

gasification technology produces zero emissions when recycling organic material. Fully autonomous complex, requires only timely delivery of raw materials, operates on its own energy balance and does not require external connections. With the increase in waste, the modular design allows increasing the capacity of the complex and is easily transported to the place of production.

The complex provides that when recycling 1 ton of droppings (moisture content up to 70%), we will receive about 0.4 MW of electrical energy and about 0.5 MW of thermal energy. For the initial material, the reactor capacity will be about 1.2 t / h. The high energy conversion efficiency of up to 95% is ensured by the recycling poultry droppings by the pyrolysis method to obtain cheaper electrical and thermal energy and ash, which is a component for the preparation of organo-mineral fertilizers.

Setting up this technology eliminates the need for poultry farms to store droppings, significantly reduces transportation costs, and the environment does not suffer from poultry pollution. Implementation of the idea of recycling poultry droppings with energy supply for residential and industrial premises and obtaining fertilizer for this is an ideal solution.

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