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Improving the Efficiency of Biogas Production in Agricultural Sector of the Republic of Belarus

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Agricultural production in the Republic of Belarus is one of the most important fields of economics. The leading spots in terms is to provide the country with food products and to export it. At the same time, Belarusian active development is associated with large-scale environmental problems. Production of organic waste at agricultural and processing plants is accompanied by contamination of the atmospheric air, soil, underground and surface waters. Environmental problems are further complicated by the fact that Belarusian agricultural production is growing in time. Today, the country has 668 bovine breeding complexes, 112 pig complexes and 55 poultry plants, which annually generate about 75 million tons of organic waste per year. Environmental problems of animal maintenance will become even more relevant in the future. According to the State Program for Development of Agricultural Business in the Republic of Belarus for 2016-2020 years, animal production volumes will increase till 18.3% by 2020, increasing the volume of the waste and affecting the environment. A big part of the above environmental problems could be eliminated by using biogas technologies for waste treatment and consequently biogas producing. One of the main advantages of biogas production is the ability to transform organic waste material into a valuable resource, by using as a

substrate for anaerobic digestion. Many European countries, including R. Belarus, are facing enormous problems associated with overproduction of organic wastes from industry, agriculture and household sectors. Biogas production is an excellent way to comply with increasingly restrictive national and European regulations in this area and to utilise organic wastes for energy production, followed by recycling of the digested substrate as fertilizer [1]. Anaerobic digestion can also contribute to reduce the volume of waste and costs for waste disposal. Other advantage of using anaerobic digestion is the possibility to cover for a plant's own requirements for electrical and heat power (for example, green houses heating). It is possible to achieve growth in the yield capacity of agricultural crops by using higher quality fertilizers, reducing loads on mineral treatment facilities, decreasing of greenhouse gases emissions and the volume of herbicides applied to the cultivated lands. It is clear that the evaluation of economic effects of using biogas technologies need to reflect the environmental and agricultural factors.

The agricultural biogas plants are considered those plants, which are processing feedstock of agricultural origin. The most common feedstock types for this kind of plants are listed in Table 1.

Availability of sufficient volume of feedstock plays a key part in the efficient operation of a biogas plant function. The advantage of Belarusian agricultural enterprises lies in the combination of animal keeping and plant production process. This means that the substrate (feedstock) is available at the place of operation of a biogas plants function, which helps to eliminate significant transportation costs. Its fertilizing characteristics can be improved by fermentation, which has been proven by a number of scientific studies [3, 4]. One of the products of biogas waste treatment is the digestate, which has a number of advantages over untreated organics.

Table 1 – The common feedstock types of agricultural origin and their main characteristics [2]

Substrate	Dry solids, DS (%)	Organic dry solids %	Biogas output, m^3/t	CH_4 m^3 / 1 tone of DS
Bovine manure slurry	10	80	25	210
Pig manure slurry	6	80	28	250
Bovine manure	25	80	80	250
Poultry manure	40	75	140	280
Corn silage	33	95	200	340
Crop straw	33	95	200	329
Grass silage	35	90	180	310
Rape cake	92	87	660	396
Potato pulp	13	90	80	336
Sugar-beet pulp	24	95	68	218
Fruit marc	35	88	148	453

It contains nitrogen in a form that is more accessible for plants consumption and is free from weed seeds and pathogenic organisms. Biogas treatment of bovine manure helps increase the average yield capacity of the cultivated crops by 5-7%. In this case, the quality of digestate becomes nearly identical to the quality of nitrogen-based fertilizers. Even better effect can be achieved by means of treatment of pig manure: the use of pig digestate helps increase the yield capacity by about 15% as compared to untreated manure. Process stages of agricultural biogas plants are shown in Figure 1 [5].

The first process stage (storage, conditioning, transport and insertion of feedstock) includes the storage tank for manure, the collection bins, the sanitation tank, the drive-in storage tanks and the solid feedstock feeding system. The second process stage includes the biogas production in the biogas reactor also referred to as the digester. The third process stage is represented by the storage tank for digestate and the utilization of digestate as fertilizer on the fields.

The fourth process stage (biogas storage, conditioning and utilization) consists of the gas storage tank and the CHP-unit (combined heat and power generation).

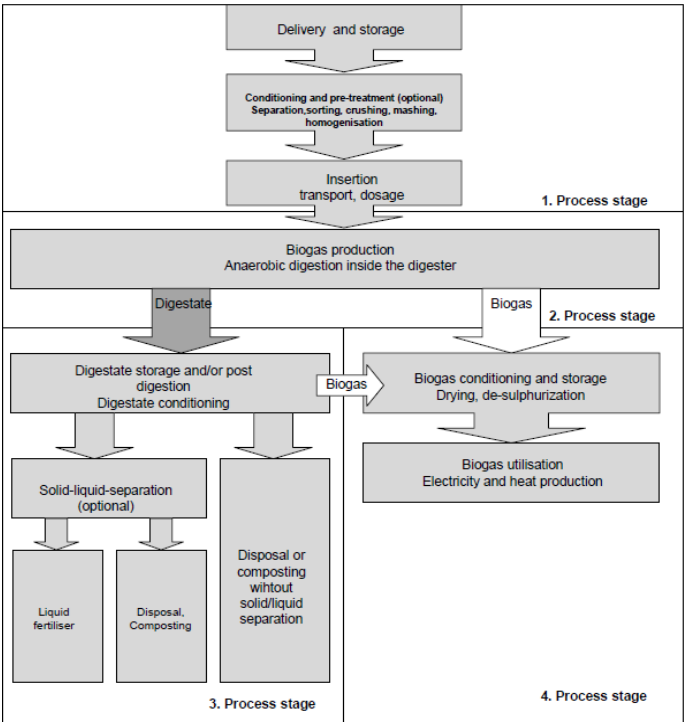

Figure 1 – Process stages of agricultural biogas plants

In order to ensure the efficiency of biogas plants, it is necessary to examine the entire system, from the availability of the substrate to design of the biogas plant itself and energy supply to consumers.

In practice, investors usually only estimate the income from sales of electrical energy. In some cases, the possibility of heat utilization is taken into account. On the other hand, a complete assessment of environmental and agrotechnical factors is difficult. Moreover, some of the above-mentioned

factors (Table 2) are external (i.e. influence third parties) and cannot be directly accounted for by the owner of the plant.

Table 2 – Stages of planning biogas plants

1. Substrate provision	2. Biogas plant	3. Energy sales	4. Estimation of environmental factors
- Determining types and volumes of the available feedstock -Who supplies the feedstock? -What substrate treatment is required?	-Selecting biogas production technology -Determining the plant capacity -Calculating the costs of energy generation	-Technical concept of distribution of energy (electrical and heat) -Costs of energy distribution	-Sales of fertilizers -Increasing yield capacity -Reducing loads on treatment facilities -Reducing environmental tax

However, according to the calculations, sales of electrical energy, which is currently considered as the main income factor in biogas technologies, ensures only up to 55% of the total income. In planning and construction of biogas complexes, it is necessary to account for the possibility of utilization of heat energy or its sales to third parties, as well as the possibility to gain income due to environmental factors. Their share in the total income volume can amount to about 25% (Figure 2).

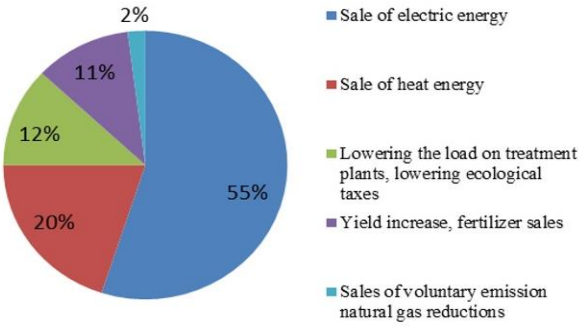

Figure 2 – Structure of possible incomes from the operation of a biogas complex

Regardless of the wide range of advantages, expansion of biogas technologies in Belarus faces a number of problems. Serious issues are indicated by the implementation of the National Program of development of local and renewable power sources and the Program of construction of biogas-powered sources. Of the 52 biogas projects planned within these programs, only 7 were implemented. Below is an overview of the main problems of the field:

i. In the conditions of state dotation of agriculture, the main problem for the development of bioenergetics lies in the absence of the country's own agricultural plants for initial investments. Credit rates are too high, which complicates the attraction of borrowed funds. Planning of state programs suggests a search for foreign investors and their participation in the funding of projects. At the same time, a search of investors has to start with developing authentic and full-scale business plans capable of attracting foreign financial institutions. These works have to be done by the Belarusian initiator of biogas.
ii. Certain functioning bioenergetics facilities create a negative image for the entire industry. This is due to insufficient planning of logistic chains of feedstock delivery, non-compliance with the requirements for its composition and quality and incomplete utilization of heat energy. All this resulted in an almost complete absence of initiative from heads of agricultural organizations and local executive authorities.
iii. A significant barrier to the entry of foreign investors to the market of bioenergetics is caused by multiple changes in the regulatory base of this sphere. The most important of the latest changes of legislation in the field of bioenergetics became fixing up quotas for the creation of

new biogas capacities and their unreasonably low numbers.

Accordingly, adjustment of the state policy and utilization of a complex approach to planning will help make bioenergetics a promising field for the attraction of investments and solve a number of problems of the Belarusian agricultural complex. Biogas production in the Republic of Belarus is based on the renewable agricultural waste materials and consequently, it reduces the negative impact on the environment. However, the biorefinery concept has to be utilized for a biogas production system in order to obtain more value-added products that could additionally enlarge the environmental and economic sustainability of this bioprocess.

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