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SCENARIOS FOR ORGANIZATION OF BIOFUELS PRODUCTION BY AGRICULTURAL ENTERPRISES OF UKRAINE[1]

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The importance of using the bioenergy potential of agricultural enterprises for the production of biofuels while preventing food shortages and increasing its cost is substantiated. Scenarios for managing bioenergy potential are developed using the example of a small agricultural enterprise: an optimistic scenario (own production of biofuels, in particular pellets, biodiesel and biogas), a realistic one (participation in bioenergy cooperatives, sale of bioenergy crops to biofuel producers on a contractual basis) and a pessimistic one – sale of bioenergy crops exclusively on the food market. In order to assess the probability of the first scenario, the potential for own production of briquettes, biodiesel and biogas is calculated. For own production of briquettes, the obstacle is the high cost of the technological line, for biodiesel production – the high demand for sunflower as a food crop; for biogas – limited resource potential and high cost of equipment. It is substantiated that the probability of the first scenario is low. When assessing the realistic scenario, options for different types of bioenergy cooperatives, of which the studied enterprise may become a member, were considered. It was determined that a solid biofuel production cooperative is the optimal option that will provide the cooperative members with energy resources of its own production at low cost. Within the framework of the second scenario, stages of interaction between the studied enterprise and the biofuel production enterprise as a supplier of raw materials were developed, which creates an opportunity for sustainable development of the both parties. The probability of the realistic scenario is medium. The pessimistic scenario will predict that the bioenergy potential of the agricultural enterprise will remain unused. Unfortunately, its probability is quite high given the low awareness of enterprise managers about the advantages of organizing biofuel production and the complexity of organizing such production from the economic, financial and technical side.

Keywords: biofuels, scenarios, biodiesel biogas, solid biofuels, pellets, energy cooperatives, biofuel production enterprises.

Table: 4. Fig.: 2. Ref.: 13.

СЦЕНАРІЇ ОРГАНІЗАЦІЙ ВИРОБНИЦТВА БІОПАЛИВ АГРАРНИМИ ПІДПРИЄМСТВАМИ УКРАЇНИ

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Обґрунтовано важливість використання біоенергетичного потенціалу аграрних підприємств для виробництва біопалив за одночасного недопущення дефіциту продовольства й зростання його вартості. Розроблено сценарії управління біоенергетичним потенціалом на прикладі малого аграрного підприємства: оптимістичний сценарій (власне виробництво біопалив, зокрема пелет, біодизелю та біогазу), реалістичний (участь у біоенергетичних кооперативах, реалізація біоенергетичних культур виробникам біопалив на договірних засадах) і песимістичний – реалізація біоенергетичних культур лише на продовольчому ринку. Для оцінки ймовірності першого сценарію розраховано потенціал власного виробництва брикетів, біодизелю та біогазу. Для власного виробництва брикетів перешкодою є висока вартість технологічної лінії, для виробництва біодизелю – високий попит на соняшник як продовольчу культуру; біогазу – обмежений ресурсний потенціал і висока вартість обладнання. Обґрунтовано, що ймовірність першого сценарію є низькою. За оцінки реалістичного сценарію розглянуті варіанти різних видів біоенергетичних кооперативів, учасником яких може стати досліджуване підприємство. Визначено, що кооператив із виробництва твердих біопалив є оптимальним варіантом, який забезпечить учасників кооперативу енергетичними ресурсами власного виробництва за невисокою собівартістю. У межах другого сценарію розроблено етапи взаємодії досліджуваного підприємства з підприємством-виробником біопалив як постачальника сировини, що створює можливість для сталого розвитку обох сторін. Ймовірність реалістичного сценарію є середньою. Песимістичний сценарій передбачатиме, що біоенергетичний потенціал аграрного підприємства залишиться невикористаним. На жаль, його ймовірність є досить високою з огляду на низьку обізнаність керівників підприємств про переваги організації виробництва біопалив і складність організації такого виробництва з економічної, фінансової та технічної сторони.

Ключові слова: біопалива, сценарії, біодизель біогаз, тверді біопалива, пелети, енергетичні кооперативи, підприємства-виробники біопалив.

Табл.: 4. Рис.: 2. Літ. 13.

Formulation of the problem. The efficiency and competitiveness of agricultural enterprises can be ensured only if they flexibly adapt to modern trends in innovative development of the agricultural sector. One of the key areas is an activity in the field of renewable energy, which involves the formation and use of bioenergy resources. The specificity of this area is that bioenergy belongs to the energy sector, the basis of which is biofuels, produced from biomass of plant and animal origin [1, p. 230].

The motivating factor for the organization of fuel production and consumption in the agricultural sector of the economy of Ukraine is the high cost of traditional energy resources. This became especially noticeable with the beginning of the full-scale invasion of the russian federation, when energy infrastructure was destroyed and damaged as a result of missile and drone attacks, domestic oil refineries, oil depots

were under fire, and the energy sector as a whole was being systematically destroyed.

Thus, the agricultural sector of the economy can not only be a guarantor of food security, but also contribute to the formation of energy security by acting as a producer of biofuels and consuming them for its own needs and energy autonomy of the sector.

Analysis of recent research and publications. Key aspects and problematic issues of organizing biofuel production in Ukraine were studied by a number of scientists, including H.M. Kaletnik [2], Ya.V. Hontaruk, I.V. Honcharuk, T.V. Yemchyk [3], D.V. Yeremenko [1], T.V. Kolomiiets [4], N.V. Pryshliak [5], I.V. Furman [6], S.V. Shcherbyna [7] and others.

In particular, H.M. Kaletnik investigated the technical, technological, economic and environmental aspects of the production of certain types of biofuels, such as bioethanol, biodiesel, biogas, solid biofuels [2]. Scientists I.V. Honcharuk, Ya.V. Hontaruk, T.V. Yemchyk [3] assessed the potential of agrobiomass of the agro-industrial complex of Ukraine for the production of biofuels. The emphasis on farms in the development of conceptual principles for the development of bioenergy potential was made by D.V. Yeremenko [1]. The current status of the development of biofuel production in Ukraine during martial law was studied by T.V. Kolomiiets [4]. N.V. Pryshliak and others studied the potential of hangar production waste as raw materials for biofuel production [5]. I.V. Furman and D.O. Ksenchyn considered the theoretical foundations and methodological principles for the formation of bioenergy potential [6]. S.V. Shcherbyna summarized the directions of modernization of the agricultural sector of our country for the development of biofuels' production [7]. Despite the contribution of the above-mentioned scientists, the capabilities of individual agricultural enterprises in the production of biofuels remain insufficiently studied and there is a need to develop appropriate scenarios of their production.

Formulation of the goals of the article. The purpose of the study is to determine the main scenarios for organizing of biofuels' production, based on the existing bioenergy potential of the enterprises, their financial condition and development prospects.

Presentation of the main research materials. Agricultural enterprises are producers of bioenergy raw materials, which can be used to produce various types of biofuels (solid, liquid, gaseous).

The potential of agricultural enterprise for the production of biofuels depends on many factors: the size of the enterprise, the range of the products grown, the financial condition of the enterprise, the innovative potential, the readiness of management to diversify activities, etc. Using the example of the private agricultural enterprise (hereafter – PAE) «Ukraine» in the village of Kynashiv, Vinnytsia region, we will develop various scenarios for organizing of the production of biofuels using the expert method (Table 1). The enterprise is engaged in the cultivation of winter wheat, corn for grain, sunflower and was engaged in sheep breeding; it is small in size and is profitable.

Table 1

Scenarios for organizing the production of biofuels by agricultural enterprises

Scenario type	Scenario	Use of bioenergy potential
Optimistic scenario	1. Management of bioenergy potential with organization of own production of biofuels from own raw materials.	1.1. Own production of solid biofuels; 1.2. Own production of biodiesel; 1.3. Own production of biogas.
Realistic scenario	2. Management of bioenergy potential with participation in a biofuel production cooperative.	2.1. Participation in a pellet/briquette production cooperative; 2.2. Participation in a biodiesel production cooperative.
	3. Management of bioenergy potential with sale of raw materials for biofuel production to specialized enterprises.	3.1. Sale of grain to bioethanol production enterprises; 3.2. Sale of rapeseed to biodiesel production enterprises; 3.3. Sale of crop residues to solid biofuel production enterprises.
Pessimistic scenario	4. Management of bioenergy potential without obtaining energy products.	4.1. Sale of products on food markets; 4.2. Use of waste for soil fertilization.

Source: generated by the authors

Optimistic scenario – management of bioenergy potential with organization of own production of biofuels from own raw materials.

The relevance of development of bioenergy production in agricultural enterprises for development of bioenergy in the country as a whole is determined by the following factors:

1. Ensuring energy independence of Ukraine at all levels (enterprise, region, state) is an urgent need of today. Formation of regional energy centers that will stimulate development of bioenergy, especially in agricultural sector, will be an important step in this direction. The effectiveness of such centers will largely depend on the state and development of domestic agricultural entrepreneurship, which can act as both supplier of raw materials and producer of various types of biofuels.

2. The economic activity of Ukrainian agricultural enterprises, especially small ones, in particular engaged in grain and sunflower production, is mainly aimed at exports, which is due to the predominance of traders. This may carry risks for agricultural enterprises due to possible negative changes in world markets or difficulties in the work of trading companies. One of the solutions is to expand the opportunities for farmers to meet the solvent demand of local consumers. Among such needs is ensuring a stable energy supply, in particular using bioenergy resources.

3. The introduction of regional energy centers based on the activities of small agricultural enterprises can significantly contribute to improving socio-economic conditions in rural areas. First of all, the reorientation of the sphere of activity to new directions and the introduction of science-intensive technologies will contribute to the growth of the number of jobs in specific communities. This will also increase the demand for qualified labor, which implies a higher level of wages and will help to attract specialists with high professional training. This will contribute to raising the standard of living at the local level.

According to the Law of Ukraine «On Licensing of Types of Economic Activities» dated March 2, 2015 [8], the activity of producing biofuels is not a subject to licensing in Ukraine. Accordingly, any business entities can engage in its production. The exception is the activity of producing bioethanol, which, accordingly, is licensed according to the Law of Ukraine «On State Regulation of the Production and Circulation of Ethyl Alcohol, Alcohol Distillates, Alcoholic Beverages, Tobacco

Products, Liquids Used in Electronic Cigarettes, and Fuel» dated October 5, 2024 [9].

Thus, the studied enterprise can organize its own production of such types of biofuels as: solid (briquettes or pellets), biodiesel and biogas.

1.1. Own production of solid biofuels.

From the standpoint of economic efficiency, the production of biomass briquettes is considered a more profitable option compared to the production of pellets. This is explained by the fact that capital investments in briquetting equipment and subsequent operating costs are significantly lower than in the case of organizing a pelletizing line with similar productivity indicators [4].

Advantages of using fuel briquettes from agrobiomass:

- are produced from agricultural waste (straw, husks, plant stems), which reduces the amount of waste burning in the fields. Being burned, fewer harmful emissions are released into the air compared to traditional fuels, such as coal or firewood;

- fuel briquettes have a high combustion coefficient and higher calorific value compared to raw biomass. Due to their dense pressed structure, they burn longer and provide more heat, which is economically advantageous to use for heating premises;

- agrobiomass is a renewable resource, unlike fossil fuels, which reserves are limited. The use of fuel briquettes allows to reduce dependence on natural gas, coal and the other imported fuels;

- briquettes from agrowaste are cheaper to produce, since the raw materials for them are available, especially in regions with developed agriculture. Briquette production can be organized even on local farms;

- fuel briquettes are convenient to transport, stack and store due to their compact form. They take up less space than, for example, firewood or straw, and their density allows them to retain heat during combustion for a longer time;

- the production of briquettes based on agrobiomass can become an additional source of income for farmers and agrarians, stimulating the development of small agricultural businesses and promoting employment in rural areas;

- the use of agrobiomass for heating reduces the need for firewood and preserves forests, contributing to environmental stability. Also, organic ash formed after burning briquettes can be used as a fertilizer for the soil.

Technological operations for the production of fuel briquettes are shown in Fig. 1.

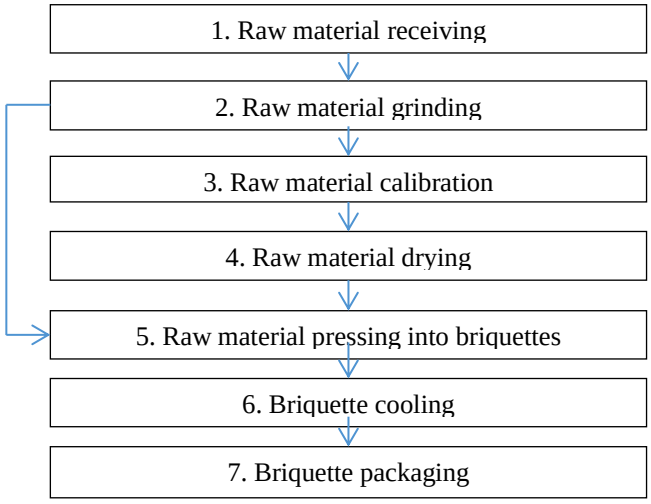

Fig. 1. **Technological operations for the production of fuel briquettes**
Source: [10]

Let us reflect the prospects for using the bioenergy potential of crop waste for the production of briquettes using the example of PAE «Ukraine» (Table 2).

Table 2

Theoretical volume of briquettes from crop waste in PAE «Ukraine», 2020-2024 and forecast for 2026

Indicators	2020	2021	2022	2023	2024	On average over 5 years	Forecast for 2026
	Winter wheat						
Theoretical waste potential (waste generation volume), quintals	22574	34789	16486	39400	26746	27999	32199
Recommended percentage of energy use, %	30	30	30	30	30	30	30
Economically feasible waste potential for energy use, quintals	6772.2	10436.7	4945.8	11820.0	8023.8	8399.7	9659.7
	Corn for grain						
Theoretical waste potential (waste generation volume), quintals	38163	92996	36009	65126	22909	51041	66353
Recommended percentage of energy use, %	40	40	40	40	40	40	40
Economically feasible waste potential for energy use, quintals	15265.2	37198.4	14403.6	26050.4	9163.4	20416.2	26541.1
	Sunflower						
Theoretical waste potential (waste generation volume), quintals	21366	33313	30128	32342	24607	28351	31186
Recommended percentage of energy use, %	40	40	40	40	40	40	40
Economically feasible waste potential for energy use, quintals	8546.2	13325.1	12051.3	12936.7	9842.8	11340.4	12474.5
	Total						
Economically feasible waste potential for energy use, quintals	30583.6	60960.2	31400.7	50807.1	27030.0	40156.3	48675.2
Theoretical volume of briquettes, quintals	6728.4	13411.2	6908.2	11177.6	5946.6	8834.4	10708.5

Source: calculated by the authors based on data from the PAE «Ukraine»

As part of their research, specialists from the Bioenergy Association of Ukraine [11] assessed the energy potential of plant residues. They took into account all possible areas of their use: as an organic fertilizer for the soil, as an ingredient for the production of livestock feed, for silage and as bedding for animals, as an energy carrier. According to the results of the assessment, it was determined that 30-40% of the theoretically available biomass of plant origin (i.e., the total volume of waste generated during crop cultivation) is suitable for energy production. In the context of agricultural waste, it was noted that the disposal of up to 30% of cereal plant residues (straw) involves its removal from the field once every three years, while in the other years the straw remains on the field and is plowed in as fertilizer. The alienation of up to 40% of residual corn and sunflower production means that these residues are removed from the field every two to three years, with only a portion of the waste, such as corn stalks or sunflower baskets, being removed for each agricultural crop, while the rest remains in the field.

These recommendations were taken into account in our calculations. They showed that theoretically PAE «Ukraine» can receive from 6728.4 to 13411.2 tons of briquettes (according to the forecast in 2026 – 10708.5 tons), using 30-40% of the

waste of grown crops, leaving the rest for plowing into the soil in order to preserve its fertility.

It is worth emphasizing that obtaining briquettes of proper quality is possible only under the condition of strict adherence to the technological process and the use of modern equipment. Therefore, when designing and building production facilities, it is advisable to provide for high-tech production lines equipped with the latest units, in particular equipment from such companies as «KALN» and «SRM» [12]. However, the cost of such equipment is quite high, and the volume of waste generated at the enterprise is insignificant. Therefore, independent organization of briquette production at the enterprise is unlikely.

1.2. Biodiesel production at the enterprise.

Biodiesel is an environmentally friendly type of fuel made from renewable resources – vegetable oils or animal fats. The technology of its production is based on the transesterification process, during which a liquid fuel is formed that can fully or partially replace traditional diesel fuel by using it in its pure form or by mixing [2, p. 145]. Biodiesel is biodegradable, less toxic and reduces greenhouse gas emissions, so its use contributes to reducing environmental pollution. The use of biodiesel is not only a step towards preserving nature, but also a profitable economic solution for our country, and especially for its agricultural sector of the economy. Studies confirm that the use of biological fuel in standard diesel engines significantly reduces the level of emissions of substances such as hydrocarbons, carbon monoxide, sulfates, aromatic hydrocarbons, particulate matter, as well as carcinogens and toxins. Combining conventional diesel fuel with biodiesel for agricultural machinery helps to significantly save money and increases engine life due to the high lubricating properties of biofuel, which contains a lot of oxygen. Due to improved lubrication of moving parts, the engine's service life without repair increases by approximately 50%. In conditions where resources are limited and not always enough to update equipment or meet current needs, this makes biodiesel particularly attractive.

The raw materials for biodiesel production are oilseeds: rapeseed, sunflower, soybean, etc. The use of rapeseed is the most economically profitable option. According to scientific sources, if the cost of one ton of rapeseed biodiesel is about 28 thousand UAH, and the wholesale price of oil-based diesel fuel reaches 52 thousand UAH/t, then the mixed fuel in the ratio of 70:30 (traditional diesel fuel and biodiesel, respectively), which is used in Ukraine, will have a final cost of 36–38 UAH per 1 liter [13].

Small installations and mini-factories for the production of biodiesel are mostly introduced in the agricultural sector of Ukraine's economy. They are designed to meet the own needs of enterprises, with an annual productivity of 100–300 tons. Mobile mini-plants (about a third the size of a truck trailer) are widely used to provide fuel for agricultural machinery during field work. Such mini-plants produce an average of up to 2 tons of biofuel per day, or about 730 tons per year, and thanks to domestic innovative equipment, the cost of biodiesel is lower compared to small plants.

Along with significant prospects for the development of biodiesel production in Ukraine, there are a number of problematic aspects that require detailed research,

systematic analysis and making informed management decisions. This is primarily about the imperfection of regulatory policy in the field of growing raw materials, manufacturing main and by-products, as well as the organization of mechanisms for biofuel consumption. Special attention is required by the issues of mandatory state support and the use of fiscal instruments, as well as the issues of standardization and certification of biodiesel [7, p. 155].

Let us analyze the theoretical volumes of biodiesel production in the PAE «Ukraine» (Table 3).

Table 3

Theoretical volumes of biodiesel production at PAE «Ukraine», 2020-2024 and forecast for 2026

Indicators	2020	2021	2022	2023	2024	On average over 5 years	Forecast for 2026
Gross sunflower production, quintals	11245	17533	15857	17022	12951	14922	16414
Oil content (oil yield from 1 quintal), %	50	50	50	50	50	50	50
Theoretical oil production, quintals	5622.5	8766.5	7928.5	8511.0	6475.5	7460.8	8206.9
Biodiesel yield from 1 quintal of oil, %	95	95	95	95	95	95	95
Theoretical biodiesel production, quintals	5341.4	8328.2	7532.1	8085.5	6151.5	7087.8	7796.5

Source: calculated by the authors based on data from the PAE «Ukraine»

From the agricultural crops, suitable for processing into biodiesel, only sunflower is grown in the studied company. But this crop is in second place after cereals in terms of revenue from sales of products, the enterprise has reliable channels for its sale, the production of sunflower seeds is quite profitable for the enterprise. In turn, the organization of biodiesel production will require significant financial investments, which, at present, the enterprise cannot afford.

Based on the raw material supply for biodiesel production, the volumes of its production at enterprises will theoretically be small and will amount to 7532.1-8328.2 tons, and the organization of production is quite complicated, in particular, due to the need to use methyl alcohol.

Also, given the current situation in Ukraine's market conditions, sunflower is considered more promising for food use, while its energy use as a raw material for biodiesel production is practically not practiced.

1.3. Biogas production at the enterprise.

Biogas is a gaseous fuel formed during the anaerobic decomposition of organic materials, in particular agricultural residues, manure or food waste. Its main components are methane (CH_4) and carbon dioxide (CO_2). Biogas is used in the production of electricity and heat, it can serve as fuel for vehicles, its use also contributes to the reduction of waste volumes and greenhouse gas emissions.

The raw materials for biogas production are various wastes of organic origin, for agricultural enterprises it is mainly livestock waste – manure of cattle, pigs, goats, sheep, as well as bird droppings. In PAE «Ukraine» for biogas production, it was theoretically possible to use sheep manure in 2021-2023 (the company ceased sheep breeding activities in 2024), the theoretical biogas yield from it is calculated in Table 4.

Table 4

Theoretical biogas yield from sheep farming waste in PAE «Ukraine» 2020-2024 and forecast for 2026

Indicators	2020	2021	2022	2023	2024	On average over 5 years	Forecast for 2026
Average annual manure yield from sheep, tons	24	24	20	20	0	18	20
Biogas yield from 1 ton of sheep manure, cubic meters	108	108	108	108	108	108	108
Theoretical biogas yield using livestock waste, cubic meters/year	2592.0	2592.0	2160.0	2150.0	0	1900.8	2150.0

Source: calculated by the authors based on data from the PAE «Ukraine»

The sheep population at the enterprise was small, and in 2024 the livestock industry was abandoned altogether. Therefore, the probability of implementing a project to produce biogas from animal products at the enterprise, provided that the sheep industry is restored, is small. Even if the sheep population that existed in the previous years is restored, the biogas yield will be insignificant, and the cost of the project will be high, which will result in a long payback period.

Realistic scenario – involves the participation of the enterprise in bioenergy cooperative or in the production of biofuels as a supplier of raw materials. Let's consider possible options for such cooperation.

Membership in a cooperative, engaged in the production and sale of biofuels provides a number of advantages:

- preservation and rational use of its own raw materials;
- obtaining additional profit for its farm;
- the ability to sell not only raw materials, but also products of its processing;
- access to modern technologies, professional management and new market opportunities;
- the ability to bypass unnecessary intermediaries;
- the ability to compete with other biofuel producers;
- production of biofuels for its own consumption;
- partnership support and cooperation between agricultural producers.

2.1. Participation of the enterprise in a cooperative for the production of pellets/briquettes (solid biofuels).

Since there are currently no cooperatives for the production of pellets/briquettes in the Tulchyn district, where the enterprise under study is located, it is necessary to initiate its creation. PAE «Ukraine» can act as a supplier of raw materials for the production of solid biofuels and take a financial part in the purchase of a technological line for the production of pellets/briquettes. In return, it will receive solid biofuels, which it can use for its own energy needs. We consider this option for managing the bioenergy potential of the enterprise under study to be optimal.

2.2. Participation of the enterprise in a cooperative for the production of biodiesel / biogas.

A common feature of the participation of PAE «Ukraine» in a cooperative for the production of both biodiesel and biogas is that the raw material base of the

enterprise for the production of these types of biofuels is quite limited. The geographical location and distance to the other producers-potential participants of the cooperative are significant, which will lead to large logistical costs. The organization of the production of biodiesel and biogas requires significant capital investments, even being a member of the cooperative, these costs for the studied enterprise can become quite significant or even unaffordable. Thus, we can conclude that this scenario of managing the bioenergy potential is inefficient and unlikely for PAE «Ukraine».

3. Management of the bioenergy potential for the sale of raw materials for the production of biofuels to specialized enterprises.

The process of interaction between the studied enterprise, which will grow raw materials for biofuels, and the biofuel production enterprise occurs through the consistent coordination of the supply, processing and processing of raw materials. This process includes several key stages, each of which contributes to the effective functioning of the both parties and the maximization of the economic effect of their interaction (Fig. 2).

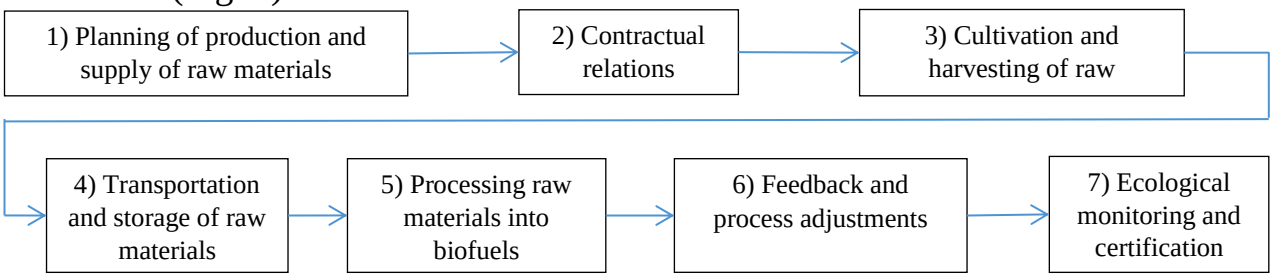

Fig 2. **Stages of interaction between a raw material producer and a biofuel producer**

Source: generated by the authors

1) Planning the production and supply of raw materials. The agricultural enterprise determines the type and volume of raw materials (for example, rapeseed, corn or sunflower) that will be grown in its fields. The cultivation of raw materials is planned taking into account the needs of the biofuels production enterprise, which helps to ensure stable supplies. The biofuels production enterprise determines in advance the needs for raw materials, their required volume, delivery times and quality requirements. This data is provided to the agricultural enterprise to coordinate the volumes and time of harvest.

2) Contractual relations. The parties conclude contracts (preferably long-term ones) that determine the terms of supply of raw materials: volumes, price, delivery periods, quality standards and the methods of transportation. The contract may also provide for obligations regarding the environmental responsibility of both enterprises, which is especially important for biofuel production.

3) Cultivation and collection of raw materials. The agricultural enterprise grows raw materials, adhering to agrotechnical requirements and standards to ensure high product quality. After the harvest is ripe, the raw materials are collected and initially processed (dried, cleaned). In order to ensure uninterrupted supply of raw materials, enterprises can agree on the necessary agrotechnical measures that will help to improve the yield and quality of products.

4) Transportation and storage of raw materials. The collected raw materials are transported to the biofuels production enterprise. In some cases, the agricultural enterprise can temporarily store the raw materials on its territory before processing begins. It is important to comply with the transportation conditions in order to preserve the quality of the raw materials and reduce losses during delivery.

5) Processing of raw materials into biofuels. The biofuels production enterprise receives the raw materials, checks their quality and subjects them to further processing: grinding, fermentation, distillation or another technological process to obtain finished biofuels (for example, biodiesel or bioethanol). The processing process may produce by-products, such as rapeseed cake or other residues, which are often returned to the agricultural enterprise for use in animal husbandry or as organic fertilizer.

6) Feedback and process adjustment. After each cycle of raw material supply and processing, the parties analyze the results of cooperation, identify possible problems or shortcomings, and make adjustments to subsequent supplies or production processes. Enterprises can discuss improvements in cultivation or processing technologies to increase efficiency and reduce costs.

7) Environmental control and certification. The interaction of both enterprises may include environmental control measures to confirm the environmental friendliness of products. In particular, they may undergo certification confirming the compliance of products with the standards of the «green» economy, which contributes to improving the reputation of enterprises and increasing the competitiveness of biofuels in the market.

Based on the raw bioenergy potential, the studied enterprise may cooperate with bioethanol producers, supplying them with wheat and corn for grain as raw materials, as well as with the enterprises for the production of pellets/briquettes, supplying plant residues. The sale of sunflower to biodiesel producers, as well as sheep manure to biogas producers, is irrational.

Pessimistic scenario – management of bioenergy potential without obtaining energy products. According to the pessimistic scenario, the enterprise under study will not realize its bioenergy potential. It will continue to sell on the market the agricultural crops it grows, receiving sales proceeds that will form a profit. However, given the decline in profitability and profitability of the agricultural activities of PAE «Ukraine» in recent years, the enterprise should change its approaches to its activities and begin to realize its bioenergy potential.

The pessimistic scenario also assumes that the enterprise's organic waste will remain unused in the energy sector, and will be used only as soil fertilizers. Given the increasing cost of energy carriers, the loss of the bioenergy potential of waste can have a significant negative impact on the enterprise's activities.

Conclusions. Agricultural enterprises can act not only as food producers today, but also become players in the energy market. Given the long-term state of war in Ukraine and the high cost of energy resources, the energy direction of using part of the products produced by agricultural enterprises is extremely relevant. Various scenarios for using bioenergy potential for biofuels production are possible: organizing their own production, participating in cooperatives, being a supplier of

raw materials to biofuel production enterprises, etc. Currently the most likely option for small agricultural enterprises is to participate in energy cooperatives, which will combine the resource and financial potential of several enterprises to organize biofuel production.

The organization of the production and use of biofuels by agricultural enterprises today is an important step towards their energy autonomy. At the same time, it is necessary to take into account that the primary task of the agricultural sector is to provide the population with food at affordable prices, that is, to guarantee food security. Therefore, a balance between the energy and food use of agricultural products is needed.

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РОЗРАХУНКИ З НАЙМАНИМИ ПРАЦІВНИКАМИ АГРАРНИХ ПІДПРИЄМСТВ: СУТНІСТЬ, ОБЛІК, ОПОДАТКУВАННЯ ТА ЗВІТНІСТЬ

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У роботі зазначено про ситуацію, коли аграрні підприємства змушені працювати з обмеженим людським ресурсом. Відзначено, що трудовий потенціал є складником ресурсного потенціалу суб'єктів господарювання. Охарактеризовано поняття «кадри», «робоча сила», «трудові ресурси», «персонал», «трудовий та інтелектуальний потенціал». Проаналізовано законодавчі документи й досліджено нормативне трактування сутності категорії «наймані працівники» і з'ясовано, як відбувається оформлення відносин із ними. Запропоновано власне визначення сутності досліджуваної категорії «наймані працівники». Представлено основи нормативно-правових відносин суб'єкта господарювання з найманими працівниками й державними органами. Проаналізовано розмір мінімальної заробітної плати та прожиткового мінімуму за 2018–2025 роки в Україні. Розкрито підходи визначення прожиткового мінімуму. Відзначено про суттєвий розрив між низьким рівнем заробітної плати й високою вартістю життя. Досліджено законодавчу базу щодо організації та розрахунків із сезонними й тимчасовими працівниками, які залучаються до виконання певних видів робіт у сільському господарстві. Окреслено базу оподаткування доходів найманих працівників у сільському господарстві, зокрема оплату праці в натуральній формі. Охарактеризовано облікові аспекти за розрахунками з найманими працівниками. Розглянуто основні форми звітності для відображення інформації про розрахунки за виплатами найманим працівникам. Зазначено про необхідність деталізації інформації у розрізі аналітичних рахунків. Відзначено про необхідність формування внутрішньої звітності задля аналізу й оцінки продуктивності праці. Внесено пропозиції щодо обліку й оподаткування винагороди найманим працівникам за цивільно-правовими договорами, які не є штатними працівниками підприємства й сезонними, а також тимчасовими працівниками.

Ключові слова: наймані працівники, оплата праці, заробітна плата, винагорода, облік, оподаткування, звітність, аграрні підприємства.

Табл.: 3. Рис.: 3. Літ.: 26.

SETTLEMENTS WITH EMPLOYEES OF AGRICULTURAL ENTERPRISES: ESSENCE, ACCOUNTING, TAXATION AND REPORTING

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