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IMPROVING THE EFFICIENCY OF AGRICULTURAL ENTREPRENEURSHIP BY PROCESSING RAPESEED TO BIODIESEL

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Abstract

The expediency of rapeseed processing and biodiesel production is investigated in the article. Potential opportunities for biodiesel production at completed mini-plants have been identified and the costs for the creation of production facilities have been calculated. A comparative evaluation of the efficiency of biodiesel production from rapeseed and sale of its seeds has been carried out. Higher economic efficiency from rapeseed processing than mass export of this raw material is substantiated, which will increase the profitability of agricultural enterprises. The key guidelines for the location of production facilities for the processing of rapeseed for biodiesel on a cooperative basis at the regional level have been formed. The paper uses general and special research methods, in particular the calculation and design method to substantiate the estimated cost of production facilities for processing rapeseed into biodiesel. The results of interviews with key stakeholders, producers of rapeseed, prove the feasibility of practical application of these proposals in enterprises.

Key words: *agricultural enterprises, biodiesel, rapeseed processing.*

INTRODUCTION

Ukraine is an important producer of vegetable oils. The main oilseeds that agricultural enterprises specialize in growing are sunflower, soybean and rapeseed. At the same time, the capacities of the oil and fat industry are mainly used for soybean and sunflower processing. Rapeseed is still systematically excluded from this list, as the main vector of its export is seeds, and rapeseed oil is almost never used in the diet.

Declining opportunities for rapeseed exports due to the epidemiological situation and a very low share of its processing, lead to a decrease in the volume of cultivation and loss of rapeseed in some areas. Accordingly, in the medium term it is advisable to diversify the sectors of domestic consumption of rapeseed. In the future, it is advisable to focus on the processing of rapeseed into biodiesel. This issue is especially relevant in the context of current administrative and territorial transformations.

Today in Ukraine it is necessary to develop capacities for own production of biodiesel from renewable resources. The growth of environmental pollution, the scarcity of traditional energy sources encourage scientific organizations and business structures to search for new environmentally friendly fuels. One of these areas is the production of diesel fuel from rapeseed oil.

Analyzing scientific sources on the problem of processing rapeseed into biodiesel, it should be noted that research has been conducted in several areas. Scientists of the first direction focused on the efficiency of rapeseed processing, in particular: ensuring the efficiency of agricultural production by using production facilities for processing rapeseed into biodiesel [5, 7, 9, 11]; assessing the profitability of agricultural enterprises [1]; studying the impact of factors on the

profitability of the US biodiesel industry [6]; study of energy viability of rapeseed biofuel production [8]. Scientists of the second direction of the research studied the trends of rapeseed processing into biodiesel as one of the directions of development of renewable energy sources in Ukraine and the world [3, 2, 4, 19, 22]. Scientists of the third direction, for example, Yurchuk N.P. and Yurchuk S.S. [23], Matvieieva I. et al. [10], in their work focus on the environmental friendliness of biodiesel, ie less harmful impact on the environment compared to diesel fuel. Despite the significant amount of research on this topic, more in-depth study requires questions about the feasibility of processing rapeseed into biodiesel, justification of its economic efficiency for agricultural enterprises, the location of processing facilities in some regions of Ukraine.

The object of the study are agricultural enterprises of Ivano-Frankivsk region. The choice of the object of study is due to the fact that the level of profitability of rapeseed production in Ivano-Frankivsk region in 2019 was – 4%, and in 2020 – 0 %. At that time, the average level of profitability in Ukraine during this time was 9.4 % and 17.2 %, respectively, and in some areas reached 28 % and 37 % [15]. The subject of the study is the level of efficiency of agricultural enterprises, which is formed in the process of selling rapeseed and processing it into biodiesel.

The urgency of this issue has led to the direction of our study, which aims to assess the feasibility of processing rapeseed into biodiesel and identify prospects for regional location of production facilities for processing.

MATERIALS AND METHODS

The methodological basis of the study were general and special methods. In particular, the calculation and design method was used to substantiate the estimated cost of production capacity of the mini-plant for processing rapeseed into biodiesel and to calculate the total cost of processing 1 ton of rapeseed for biodiesel. Theoretical methods of analysis and synthesis were used to assess and justify the feasibility of further processing of rapeseed, abstract-logical - to form theoretical generalizations, assumptions and conclusions. The general scientific method of comparison was used to substantiate a better alternative to rapeseed processing compared to its implementation. General scientific empirical methods of observation and description made it possible to substantiate the territorial location in the Ivano-Frankivsk region of production facilities for processing rapeseed into biodiesel.

The study used data from the Main Department of Statistics of Ukraine in Ivano-Frankivsk region and the official websites of enterprises that sell equipment for processing and sell biodiesel.

RESULTS AND DISCUSSIONS

Ukraine is a country dependent on energy imports, so the development of rapeseed fuel production can become one of the priorities of state agricultural policy. The study of economic efficiency of biodiesel production today is gaining considerable relevance as an effective mechanism for stimulating the development of the agro-industrial complex.

In EU countries, rapeseed oil is mainly used for biofuel production. This type of oil ranks third in world production and is produced mainly by the United States, Malaysia and China [3]. Biodiesel is most often produced from rapeseed oil (84 %). Vegetable oil is a mixture of triglycerides, esters combined with a molecule of glycerin. The main task in obtaining biodiesel is to remove glycerin, replacing it with alcohol.

According to the Research Institute of Alternative Fuels, Ukraine has the capacity to produce at least 0,5 million tons of biodiesel and bioethanol per year. However, today even a small amount of biodiesel consumed in Ukraine is imported from EU countries. The paradox is that this biofuel is produced from products exported by Ukrainian companies [12].

Today in Ukraine there is no plant of European level for the production of biofuels. Foreign investors offer to build in Ukraine quite large plants for the production of

biodiesel with a capacity of 50-100 thousand tons per year, this requires processing about 300 thousand tons of rapeseed, and the cost of such a plant is quite high. Insufficient raw material base and lack of guarantees for its stable supply, as well as undercapacity of similar plants abroad block the development of construction projects for such plants, with the participation of foreign investors [18].

Construction in Ukraine of mini-plants for the production of biodiesel with a capacity of 2.7 thousand tons per year or the creation of production facilities directly on the territory of agricultural enterprises that grow rapeseed, has good economic prospects. The yield of biodiesel from one ton of rapeseed is 40 %, ie under the above capacity we get 1.1 thousand tons of biodiesel per year. Taking into account the cost of the premises and other technical means to ensure the extraction of oil and its processing into biodiesel, the cost of production capacity was determined. According to our calculations, the cost of one mini-plant for processing 2.7 thousand tons of rapeseed per year is 2,856.8 thousand UAH (Table 1).

Table 1. Calculation of the plant cost for the production of biodiesel from rapeseed

General characteristics of the plant	
The territory of the plant, ha	0.5
Rapeseed processing: per day, tons	10.8
per year thousand tons	2.7
Biodiesel production: per day, tons	4.3
per year thousand tons	1.1
Number of working days	250
The total cost of the plant, thousand UAH, including:	2,856.8
Buildings and structures, thousand UAH	850.0
Equipment, thousand UAH, including:	2,006.8
equipment for oil production, thousand UAH, including:	784.9
oil press screw MMSh-450, productivity is 420-450 kg/h. (3 pieces at the price of 210 thousand UAH)*	630
filter line LF-4, capacity 200 l / h (3 pieces at the price of 38.4 thousand UAH)*	115.2
capacity for oil (2 pieces with a capacity of 3,000 l at the price of 9.8 thousand UAH)	19.6
capacity for meal (3 pieces with a capacity of 700 kg at a price of 6.7 thousand UAH)	20.1
equipment for the production of biodiesel (EXON-250 complex, capacity 6,000. l), thousand UAH *	1,221.9
Machine-tractor park, thousand UAH	350.0

Source: authors' own calculations.

* The cost of equipment according to official websites: GG "TT Group"[16], PP "LAVRIN"[17].

It should be noted that today the biggest problem of technical equipment of mini-plants in Ukraine is the purchase of biodiesel plants. Back in January 2007. Chernivtsi enamel factory "Karpaty" presented plants for the production of biodiesel with a capacity of 10 to 200 liters per hour, but serial production was not established. Accordingly, there is a need to purchase this equipment abroad. However, in our opinion, Ukrainian industry has the potential to produce the above facilities.

A significant advantage of rapeseed processing is that once in the air, biodiesel does not harm plants or animals and there is a complete biological decomposition of this substance. Biodiesel is mainly used to form a mixture with diesel fuel. The most commonly used mixture of biodiesel with a share of 20 % in diesel fuel (B20), are popular and mixtures with a lower share. Pure biodiesel (B100) is also in high demand in many countries, especially in Germany [12]. For example, Gbf german biofuels gmbh has an annual production capacity of over 130,000 tons of high quality biodiesel [15].

The production of 1,000 liters of biodiesel requires 1,000 liters of purified rapeseed oil, as well as 186 methyl alcohol, 5 kg of catalyst and other excipients. Taking into account all the conditions of the technological process of biodiesel production, it is determined that the cost of processing 1 ton of rapeseed for biodiesel is 618.2 UAH (Table 2).

The environmental component of rapeseed processing efficiency is important, but the most important is the economic component. The economic feasibility of processing rapeseed into biodiesel is justified by its higher efficiency compared to the sale of rapeseed seeds in domestic and foreign markets. Gross rapeseed harvest in Ivano-Frankivsk region has been increasing dynamically in recent years. The cost of 1 ton of rapeseed produced in 2020 was UAH 9,802, and the cost of 1 ton of rapeseed sold was UAH 10,620. The selling price of 1 ton was UAH 10,630.3, respectively, the level of profitability of sales – 0.0 % [21].

Thus, the cultivation of this type of product in 2020 in the region was neither unprofitable nor profitable. Although the situation regarding the level of profitability in 2020 has slightly improved (in 2019 there was a loss of 4.0%), but high competition in the rapeseed market for the sale of its seeds and the

presence of traders, contribute to the shortfall of agricultural enterprises.

Table 2. Calculation of the total cost of processing 1 ton of rapeseed for biodiesel

№	Expense items	Calculation	Amount, thousand UAH
1.	Amortization		451.3
	including depreciation of buildings and structures (4%)	(850-40)/30	27
	depreciation of oil production equipment (12%)	(784.9-78.4)/5	141.3
	depreciation of biodiesel production equipment (12%)	(1,221.9-122)/5	220
	depreciation of machine and tractor park (12%)	(350-35)/5	63
2.	Expenses for repair of fixed assets (1%)	2,856.8*0.01	28.6
3.	Remuneration with accruals		597.6
	including administrative staff (2 people)	(6,900*2)*12	165.6
	service staff (6 people)	(6,000*6)*12	432
4.	Electricity (total capacity 146 kV / h)		490.6
	including biodiesel plant (80 kV / h)	160 thousand kV *1.68 UAH	268.8
	three oil presses (22 kV/ h)	132 thousand kV *1.68 UAH	221.8
5.	Heating and lighting costs	3,6 thousand kV *1.68 UAH 1 thousand cubic meters *7.99 UAH	14
6.	The cost of methanol, catalyst		87
Total costs			1,669.1
Costs per ton at a capacity of 2.7 thousand tons, UAH			618.2

Source: authors' own calculations.

At the same time, the sale of products obtained as a result of processing according to the technological process (biodiesel, rapeseed meal, crude glycerin) can provide higher profitability.

If we make economic calculations, taking into account the current conditions for the production and sale of rapeseed by agricultural enterprises of Ivano-Frankivsk region in 2020, their results will indicate the feasibility of processing rapeseed into biodiesel (Table 3).

The introduction, along with the cultivation of rapeseed, of the technology of its processing into biodiesel, will promote better use of the production potential of agricultural enterprises, which are more profitable to convert rapeseed into biodiesel fuel than to sell rapeseed seeds on the foreign market. When processing 1 ton of rapeseed for biodiesel, you can get 4,339.8 UAH of profit, while when selling rapeseed - only 10.3 UAH, with a level of profitability of 41.7% and 0.0 %, respectively. In total, when selling 2.7 thousand tons of rape, agricultural producers received 27.8 thousand UAH, and when processing into biodiesel could receive 11,716.9 thousand UAH.

Table 3. Efficiency of rapeseed processing into biodiesel on the example of Ivano-Frankivsk region

Indicator name		Indicator value
Rapeseed processing on biodiesel	Product yield as a result of processing 1 ton of rapeseed	400
	incl. biodiesel yield, l	550
	cake yield, kg	68
	yield of technical glycerin, kg	14,760
	The cost of the received production from 1 t of rape - all, UAH	11,200
	incl. cost of biodiesel, UAH (28 UAH per 1 liter *)	2,200
	the cost of cake, UAH (4 UAH per 1 kg *)	1,360
	cost of technical glycerin, UAH (20 UAH per 1 kg)	9,802.0
	The cost of 1 ton of grown rapeseed, UAH	618.2
	The cost of processing 1 ton of rapeseed, UAH	10,420.2
	Total costs for production and processing of 1 ton of rape, UAH	4,339.8
	Profit from 1 ton of rapeseed as a result of processing, UAH	41.7
	The level of profitability of processing 1 ton of rape,%	11,716.9
Implementation of rapeseed	The cost of 1 ton of rape sold, UAH	10,620
	Sales price of 1 ton of rape, UAH	10,630.3
	Profit from the sale of 1 ton of rapeseed, UAH	10.3
	The level of profitability of sales of 1 ton of rape,%	0.0
	Profit from the sale of 2.7 thousand tons of rapeseed, thousand UAH	27.8
Economic effect (increase in profit as a result of rapeseed processing compared to sales) thousand UAH		11,689.1

Source: authors' own calculations.

* The price is set according to the official sites: Ecoist [14], Agrovektor [13].

Therefore, according to Table 3, it can be concluded that in general from the construction of one plant we get an increase in profit by 11,689.1 thousand UAH. Comparing the additional profit with the cost of the required production capacity, we can conclude that investment in construction will pay off in the first year of operation. In addition, companies will be able to save working capital by providing their own needs with biodiesel. Also, during processing, they will receive cake (a valuable feed additive), which enterprises engaged in animal husbandry can use for their own needs. The obtained glycerin is also widely used in the pharmaceutical and

perfume industries, so it is constantly in demand.

If agricultural enterprises are not integrated into a single organizational and technological chain, it is important to establish economic partnerships between rapeseed producers and enterprises that process rapeseed into biodiesel on mutually beneficial terms. In our opinion, agricultural enterprises need to create production facilities for rapeseed processing on a cooperative basis. Such a mini-plant is able to meet the needs of agricultural producers in one or three territorial communities of the region, depending on the volume of raw material production. 69 large and medium-sized enterprises are engaged in the production of this type of product in the Ivano-Frankivsk region, and the total sales volume is 92.6 thousand tons [20]. At the beginning of 2021, a new regional administration came into force due to administrative-territorial decentralization. Rapeseed was sold in 2020 by enterprises Horodenka (16.6 thousand tons), Kolomyia (5.1 thousand tons), Sniatyn (2.8 thousand tons) districts, which in 2021 as a result of administrative decentralization were merged into Kolomyia district. Rapeseed was also sold by enterprises of Halych (2.8 thousand tons), Rohatyn (22.1 thousand tons), Tysmenetsia (2.7 thousand tons), Tlumats (3.2 thousand tons) districts and t. Frankivsk (32.6 thousand tons), which are united in Ivano-Frankivsk district. In Kaluh district, with the same name of the newly created district in 2021, 4.5 thousand tons of rapeseed were sold. If we implement the above measures for processing rapeseed into biodiesel and offer to process at least half of the sold rapeseed, then the sale of 49.4 thousand tons of the remaining 43.2 thousand tons of rapeseed could provide capacity for 16 similar processing plants.

Hawing consideed the distribution of rapeseed sales in Ivano-Frankivsk region by district, taking into account the territorial proximity of communities and transport, which is focused on the administrative centers of reorganized districts, we can make the following proposals for the location of mini-rapeseed processing plants (Fig. 1):

(1). 1 plant can be located on the territory of Tlumach territorial community, the volume of rapeseed sales in the reorganized district of the same name, which also included Olesha and Obertyn territorial communities, amounted to 3.2 thousand tons. That is, a small part of the rapeseed 0.5 thousand tons may not be sent for processing, but be sold.

(2). 1 plant Tysmenytsia territorial community with a capacity of 2.7 thousand tons, as the volume of rapeseed sales by agricultural enterprises of the reorganized district of the same name, which also included the lands of the other five created territorial communities located around Ivano-Frankivsk, amounted to 2.7 thousand tons.

(3). 1 plant can be located in Halych territorial community with a capacity of 2.7 thousand tons, as the volume of sales in the reorganized district of the same name, which also included Bilshivtsi and Dubovets communities amounted to 2.8 thousand tons.

(4). 4 plants in the communities reorganized in 2021 by joining Rohatyn district to Ivano-Frankivsk. We also recommend to place one plant at a time in Burshtyn and Bukachivtsi communities, as well as two factories in Rohatyn community, which is larger in area of agricultural land. The new production capacity will process 10.8 thousand tons, the total sales of rapeseed by agricultural enterprises in 2020 amounted to 22.1 thousand tons.

(5). 1 plant in Ivano-Frankivsk territorial community of Ivano-Frankivsk district. It should be noted that the largest volume of rapeseed sales according to statistics is indicated by enterprises registered in the administrative center of the region, district and territorial community – t. Ivano-Frankivsk.

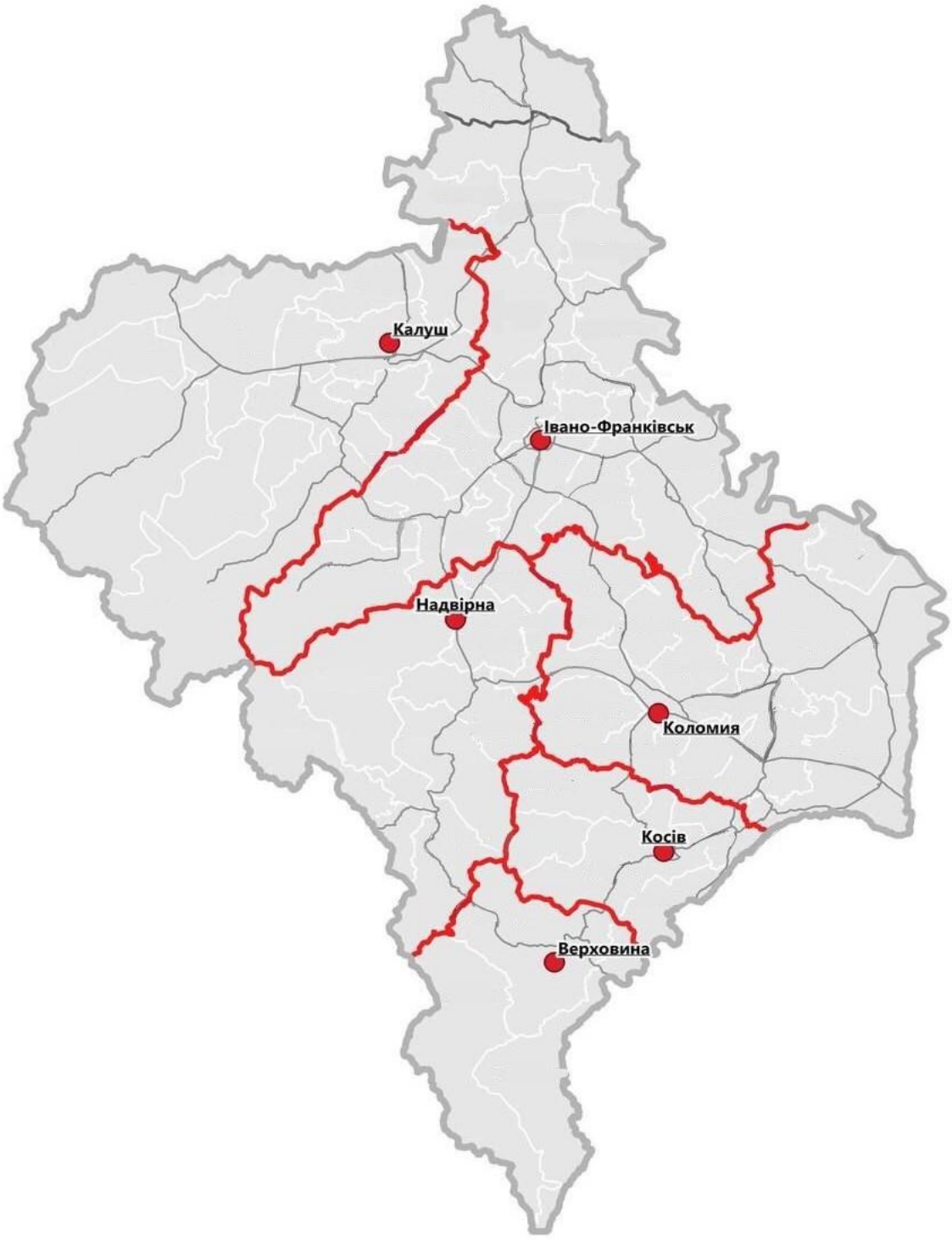

Fig. 1. Proposals for the territorial location of rapeseed processing plants in Ivano-Frankivsk region.
Source: authors' own research.
▲ – production facilities for rapeseed processing into biodiesel.

In total, these agricultural enterprises sold 32.6 thousand tons of rapeseed. Accordingly, these enterprises, wishing to carry out processing, can transport rapeseed to neighboring local communities.

(6). 2 plants can be located in the newly created Kalush area, which remained the administrative center and was created by joining two more neighboring areas. New production facilities located in Kalush and Verkhnia territorial communities, will process 5.4 thousand tons per year, and the total sales of rapeseed in 2020 amounted to 4.5 thousand tons. Therefore, suppliers of raw materials for

capacity reloading Verkhnia communities in the amount of 0.9 thousand tons may be enterprises from neighboring Burshtyn and Bukachivtsi communities of Ivano-Frankivsk district.

(7). 2 plants – in the newly created Kolomyia district, which remained the administrative center and was created by joining the neighboring Sniatyn and Horodenka districts. The volume of rapeseed sales in the reorganized area in 2020 amounted to 5.1 thousand tons. One of such plants should be located on the territory of FE "Prometei" of Matiivtsi territorial community, which in 2020 sold only 52.9 % of the produced rapeseed, and the total production amounted to 1,551 tons, which is enough to ensure the capacity of the plant for six months. The second plant located on the territory of Korshiv territorial Community in the amount of 0.3 thousand tons can be supplied with raw materials by the enterprises of the neighboring Obertyn community of Ivano-Frankivsk district where there is a surplus of rapeseed of 0.5 thousand tons.

(8). 1 plant of processing rapessed in Zabolotiv territorial community, which together with the Sniatyn territorial community were previously merged into, now attached to Kolomyia, Sniatyn district. Sales amounted to 2.8 thousand tons.

(9). 2 plants in the Horodenka territorial community and 1 plant in the Chernelytsia community, which were previously merged into the Kolomyia, Horodenka district, now attached to Kolomyia. The total sales of rapeseed in 2020 amounted to 16.6 thousand tons. These production facilities will process 8.1 thousand tons per year. One of these plants should be located on the territory of "SVC named after T.H. Shevchenka.

In addition, rapeseed production is higher than sales, ie the potential number of processing plants may be higher.

If in 2020 year 92.6 thousand tons of rapeseed were sold and 1 ton of UAH 2,831.3 profit was received from the sale (a total of UAH 262,178 thousand), then according to our proposals it would be expedient to sell 49.4 thousand tons and make a profit 139,866 thousand UAH. The remaining 43.2 thousand tons of rapeseed would be appropriate to process for biodiesel and other products with a profit of a ton of 4,855.1 UAH, and only 209,740 thousand UAH. As a result, from the sale of 49.4 thousand tons of rapeseed and processed products from 43.2 thousand tons it will be possible to get 349,606 thousand UAH of profit or 33.3 % more than in 2020 year.

We believe that the implementation of these measures can also increase the efficiency of small agricultural enterprises in the region. That is, it is advisable to operate small businesses that will specialize mainly in the cultivation of rapeseed, and ancillary production will be husbandry. Having obtained state support in the process of obtaining credit resources, such small agricultural enterprises can place on their territory equipment for processing rapeseed into biodiesel. As a result, we will increase the efficiency of small agricultural entrepreneurship and additional filling of rural and settlement budgets.

CONCLUSIONS

Quite often, agricultural enterprises are forced to sell rapeseed on their own, seeking to obtain better conditions for the sale of products than they are offered by intermediaries. At the same time, the construction of small processing plants by direct producers of rapeseed or mini-plants by representatives of the processing industry requires insignificant capital investments and pays off quickly. The possibility of processing will reduce the loss of raw materials by farmers during storage.

Conducted research confirms the economic and environmental feasibility of processing rapeseed into biodiesel. On the one hand, the selected approaches are the basis for the systematic development of crop production and processing industry, on the other hand, contribute to the optimization of rapeseed production by activating cooperative principles. Approbation of the obtained results showed a significant interest of producers and processors in the relevant analytical and forecasting products. It is advisable to create production facilities for processing rapeseed

into biodiesel considered FE "Prometei", "APC named T.H. Shevchenko", Precarpathian State Agricultural Research Station ISH of the Carpathian region of NAAS, which are engaged in rapeseed cultivation.

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