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Analysis of Economic Indicators for Oil Flax Processing

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Abstract. Oil flax grows in many countries of the world. Fibre production on its basis can significantly increase the profitability of flax-growing farms. At the present stage, taking into account the real possibilities of the national economy, for its effective development it is necessary to introduce advanced technologies. Cur-rently, processing enterprises may choose among different technological equipment lines to process oil flax into fibre and thus get additional profit. (*Research purpose*) The determination of a technologically and economical-ly effective line for oil flax processing. (*Materials and methods*) The main materials for calculation were represent-ed by the indicators of production capacity, the average annual value of fixed as-sets, the amount of money spent on salaries and wages, etc. The main research method is the balance method that allows making a plan in the form of a balance sheet that takes into account the sources of inputs and the requirements for these inputs. (*Results and discussions*) The authors have considered low-cost lines for oil flax processing into short fibre on the basis of disintegrators of various brands (from domestic and foreign producers), offered characteristics of the fibre obtained in the lines, and analyzed technical and economic indicators of various technologi-cal lines under different conditions, and the payback period of capital expenditures for different oil flax acreages. (*Conclusions*) The authors have determined that the most effective is the pro-cessing of oil flax from an area of at least 1000 hectares, with a throughput capaci-ty of raw materials of at least 1000 kg/h and a distance of the transportation of straw rolls to a processing site of 50 km. They have also obtained technological and economic data that can be used in the organization of oil flax processing into marketable fibre.

Keywords: oil flax, fibre, acreage, profitability, production lines, payback, production cost, efficiency.

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Oil flax is cultivated both in the southern and northern regions in many countries of the world [1]. Both fibre and seeds can be obtained from it simultane-ously [2]. The use of fibre from oil flax straw or retted stalks can significantly in-crease the profitability of a flax-growing farm, increase employment in rural areas, and expand the range of manufacturing enterprises for the processing of fibrous raw materials [3, 4].

In 2017, the flax acreage in the Russian Federation amounted to 565.2 thou-sand hectares, which, with a yield of 1000 kg per hectare, results in a gross yield of 565.2 thousand tons of flax straw (stalk mass), which can be processed into fibre. Additional profit from the sale of stalk fibre may amount to 2 thousand rubles/ha [5]. As a rule, not traditional flax factories, but small private enterprises in coopera-tion with research centers are interested in flax straw processing. For example, the All-Russian Research Institute of Flax Cultivation Mechanization and Kostroma State University are developing resource-saving technologies for oil flax straw pro-cessing into fibre of wide industrial use.

Among the most famous foreign companies and organizations involved in the development and sale of processing equipment for oil flax are *Charle & Co* (Belgium), *Laroche* (France), *DiloTemafa* (Germany) and the *Roman Research Center IPZS* (Italy)). These firms offer equipment and technologies for processing flax stalks into paper, and German manufacturers - for the production of geotex-tiles, nonwoven and composite materials, but this is a kind of deep processing [6]. At the initial stage, the primary processing is carried out, the purpose of which is the isolation of short fibre from the stalk mass of oil flax. As a rule, foreign techno-logical lines for primary processing are metal- and energy-intensive and expensive, and it is difficult to predict whether they will be profitable in Russia.

In Russia today, a significant problem is the considerable wear and tear of the material and technical facilities [7]. At the present stage, taking into account the real capabilities of the domestic economy, it is necessary to introduce progressive technologies for effective development [8]. Earlier, in the works of the All-Russian Research Institute of Flax Cultivation Mechanization, equipment for primary pro-cessing of oil flax based on a disintegrator was described [9, 10]. At present, one of the lines based on the disintegrator is the simplest, low-cost and efficient option. It consists of a straw roll cutter, two disintegrators (D) and two shakers (T), which can be presented as a straw roll cutter + Д + Д + Т + Т [10]. This equipment is produced in Russia and Belarus. For example, at present, several types of disinte-grators are produced: ДЛВ-2М and ОКВ-1 (Russia), МДТ-1000 (Belarus) and ТН-112 (Russia), ТГВ-14 (Belarus). Obviously, processing enterprises may choose among the lines of technological equipment to process oil flax straw or ret-ted stalks into fibre and thereby gain additional profit.

The purpose of this research is to determine the technologically and eco-nomically efficient line for the processing of oil flax.

Materials and methods – the main materials for calculation were represent-ed by the indicators of production capacity, the average annual value of fixed as-sets, the output and quality of fibre from retted stalks, the average annual number of industrial and production personnel (the number of employees), and the amount of money spent on salaries and wages. The main research method is the balance method that allows drawing a plan in the form of a balance sheet that takes into ac-count the sources of inputs and the requirements for these inputs.

To calculate specific values of technical and economic indicators, use has been made of direct calculation methods, factor-based calculation, and mathemati-cal modeling.

Results and discussion. Some enterprises employ the following technologi-cal lines:

- *Line 1* (from Russian manufacturers): straw roll unwinding machine РЛР-1500 + disintegrator ДЛВ-2М + fibre unloader ВУЛ + shaking machine ТН-112 (2 pcs.) + fibre separating machine ВОМ-2;
- *Line 2* (from Belarus manufacturers): straw roll unwinding machine МР-1400 + retted stalk crushing machine МДТ-1000 (disintegrator) + fibre unloader КНИИЛП + shaking machine ТГВ-14 (2 pcs.) + ВОМ-2;
- Combined *Line 3* (joint production of Belarus + Russia): carver of rolls KUHN (or similar) + MDT-1000 (2 pcs.) + unloader KNIILP + TGV-14 (2 pcs.) + VOM-2;
- Combined *Line 4* (joint production of Russia + Belarus + Belgium): МР-1400 + breaking machine М-110Л1 + МДТ-1000 + fibre unloader КНИИЛП + ТГВ14 + shaking machine (*Charle & Co*, Belgium) + scutching drum «*Charle & Co*», Belgium) + shaking machine (2 pcs., «*Charle & Co*», Belgium) + ВОМ-2.

Our previous production experiments have shown the following fibre quality on the lines (*Tab. 1*).

Table 1

Characteristics of the fibre of retted flax stalks obtained from different lines for primary processing*

Indicator	Line			
	1	2	3	4
Mass share of chaff and weed, %	35-45	35-45	25-30	20-25
Average mass-length of fibre, mm	70-90	70-90	60-80	50-70
Average linear density of fibre, tex	6-8	6-8	6-7	6-7
Breaking load, kgs	0-11			

*Throughput capacity of the lines is almost the same and depending on the feedstock amounts to 500 and 1000 kg/h

Since the price of the Belarusian МДТ-1000 disintegrator is much lower than that of its Russian analogue ДЛВ-2М, it is possible to assemble a relatively inex-pensive line from machines produced in these two countries, for example, *Line 3*. Of interest is also the Combined *Line 4*, which can produce a higher quality fibre.

The authors have carried out a comparative analysis of the technical and eco-nomic indicators (hereinafter referred to as TEI) of the flax plant, which processes the oil flax straw (retted stalks) into short fibre on the four considered lines.

The TEI of these lines for oil flax have been calculated for flax acreage of 700, 1000 and 1500 hectares, with a distance of straw roll transportation to the processing site of 50 and 100 km, the capacity of equipment of 500 and 1000 kg/h. The calculation includes the cost of

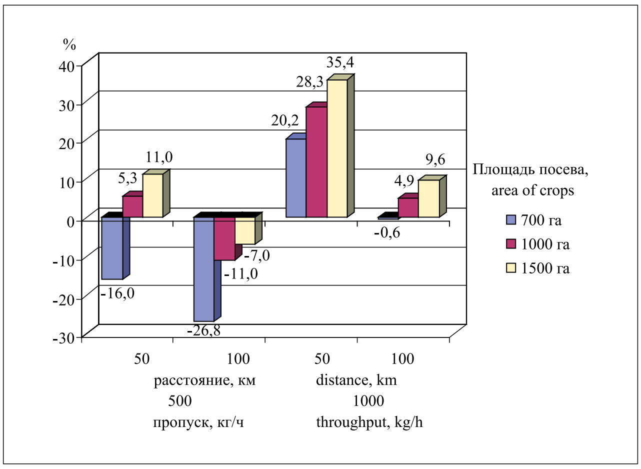

Fig. 1. The profitability of oilseed flax processing with Line 1

Table 2

Initial data for the calculation of TEI of processing lines

Indicator	Line 1	Line 2	Line 3	Line 4
Throughput capacity of the line for raw material, kg/h	500 и 1000	500 и 1000	500 и 1000	500 и 1000
Fibre output, %	30	30	28	25
Sale price of fibre, rub/kg	29	29	31	33
Electric power of equipment, kW	70	68,4	103	83,6
Capital expenditures*, thousand rubles	14411,4	11025,6	11441,4	17240,9

* the price of new equipment

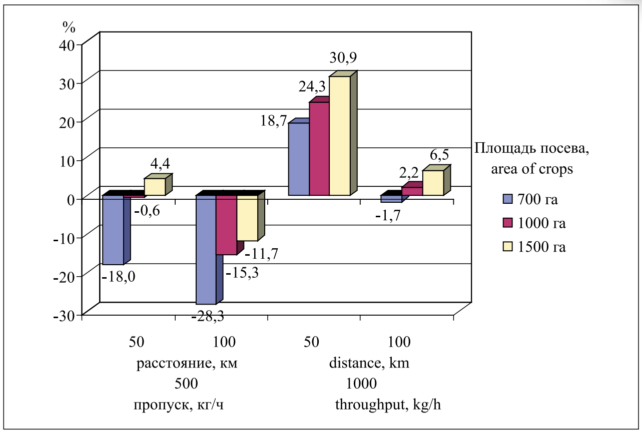

Fig. 3. The profitability of oilseed flax processing with Line 3

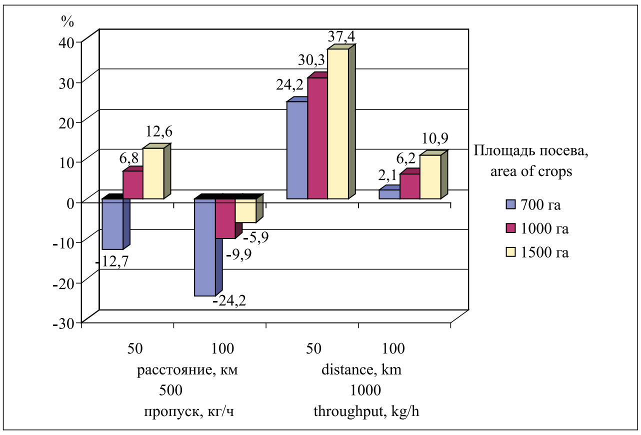

Fig. 2. The profitability of oilseed flax processing with Line 2

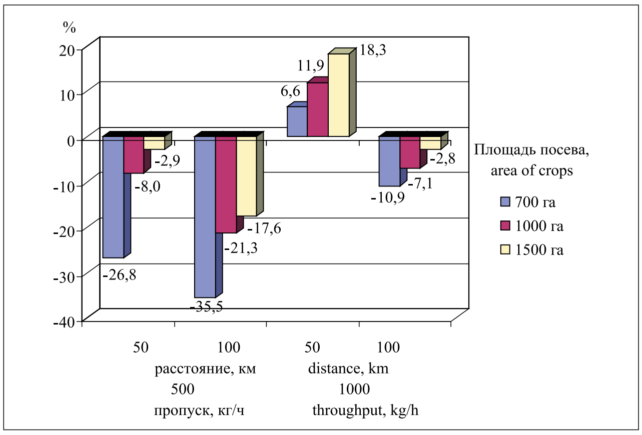

Рис. 4. Рентабельность переработки масличного льна на линии 4

Fig. 4. The profitability of oilseed flax processing with Line 4

buildings, structures, vehicles and other fixed assets. Other initial data for the calculation are presented in *Table 2*.

The results of calculating the TEI of these lines are shown in *Figures 1-4* and *Table 3*.

The processing of oil flax with the throughput capacity of lines of 1000 kg/h and the distance of straw roll transportation to the processing site of 50 km is effec-tive for all areas under consideration. The production profitability in this case will range from 6.6 to 37.4% (*Fig. 1-4*), and the payback period of capital expenditures ranges from 48.5 to 3.1 years (*Table 3*). With an increase in the straw roll transpor-tation distance to 100 km, only oil flax processing with *Line 2* will be effective, but it is impossible to obtain fibre with a low content of chaff. This results in a limited sale of fibre or its sale at a lower price.

Oil flax processing at a capacity of 500 kg/h and with a distance of straw roll transportation to the

Table 3

Payback period of capital expenditures, years

Line												
	Crop acreage, ha											
	700				1000				1500			
	Distance, km											
	50		100		50		100		50		100	
	Capacity of equipment, kg/h											
	500	1000	500	1000	500	1000	500	1000	500	1000	500	1000
1	-	12,8	-	-	27,1	6,2	-	29,3	9,2	3,5	-	10,5
2	-	9,3	-	87,0	19,8	5,4	-	21,7	7,6	3,1	-	8,6
3	-	12,0	-	-	-	6,7	-	62,4	20,9	3,7	-	14,3
4	-	48,5	-	-	-	19,6	-	-	-	9,0	-	-

processing site of 50 and 100 km is not effective for all lines, regardless of the amount of processed raw materials, as it causes a loss or provides a high payback period (*Table 3*), which is associated with a significant rise in the cost of raw materials due to the greater distance of its transportation, and with a low throughput capacity because of an increase in costs per unit of finished products (*Fig. 1-4*).

The costs for organizing the processing of raw materials with *Line 2* (*Table 3*) will be recovered most quickly due to the optimal ratio of the fibre price, its yield and low capital expenditures (*Table 2*).

Line 3 deserves attention, as it, like *Line 4*, allows to obtain fibre with a low content of chaff (*Table 3*), hence, fibre will be sold better.

Line 4 is recommended to be used at a flax acreage of 1000 hectares and above and throughput capacity of lines of at least 1000 kg/h, and straw roll transporting to the processing site over a distance of not more than 50 km (*Fig. 4*).

Conclusions

Processing of oil flax grown on an area of 500 hectares, at a throughput ca-pacity of 500 kg/h, on small-sized equipment and equipment of normal size is inef-fective and often unprofitable.

The processing of oil flax grown on an area of at least 1000 hectares is most effective, with a throughput capacity of at least 1000 kg/h for raw materials and for straw roll transporting to the processing site over a distance of 50 km.

The research has provided technological and economic data that can be used to organize oil flax processing into marketable fibre.

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