# PROFITABILITY OF SUGAR BEET PRODUCTION IN 2023/2024 CAMPAIGN ON EXAMPLE OF LUBLIN VOIVODESHIP

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**Abstract.** The work presents a complex analysis and cost accounting of sugar beet cultivation in the 2023/2024 campaign for individual farms of the Lublin region. The economic results obtained by the producers are mainly affected by indirect cost accounting. Within this group of costs, the major components are sowing service, harvest and soil liming operations. Sugar beet production in the analysed years was profitable, with the profitability index about 1.26 and the production cost was 48.64 EUR·t$^{-1}$. Sugar beet growing is considered one of the most profit-making activities in agricultural production, even though it is characterized by the high overall production costs. However, the incomes are different in particular years. The main factor affecting the income from sugar beet cultivation was the price for the raw material, which increased by only 9.5 EUR in the considered marketing year compared to the previous season. The limitation of the presented analysis of the costs of cultivation and profitability of sugar beet production is its preparation for a model farm with specific criteria. Further research should be carried out taking into account the classification of the analysed farms into groups with different criteria. This will allow for a better approximation of the performed analyses of cultivation costs to the actual conditions. A good direction for the development of individual farms is to combine science with practice in the pursuit of cooperation between growers and scientists indicating the economics of sugar beet production.

**Keywords:** sugar beet, costs, profitability, profitability of production.

## Introduction

Sugar production in Europe has for years been based on the profitable production of sugar from sugar beets grown in many countries [1; 2]. This traditional crop is widespread among farmers because it is a good crop rotation for intensive cultivation of other crops, such as wheat [3]. The use of crop rotation is the basis of good agricultural practice and contributes to the sustainable development of agriculture [4]. Such agriculture requires sustainable cultivation of sugar beets for the needs of sugar producers. Providing the right amount is crucial for the competitiveness of the produced white sugar on the world market. In Europe, sugar beets are the main raw material for sugar production. In the world, sugar beets are also used to produce bioethanol, and the pulp produced during sugar production can be burned similarly to other typical energy plants [5-8]. The development of the diversity of the use of sugar beets, just like other raw materials, depends on good organization of production processes [9].

Sugar production from sugar beets ranks first in terms of environmental sustainability. The yield of sugar from fermentable processes is higher for sugar beets than for other crops used to produce sugar. Hence, there has always been great interest in growing this plant from both, producers and growers. For many years, it has been one of many plants cultivated by farmers, providing them with significant income compared to other plants [10-13]. Many researchers analyze income from sugar beet cultivation, using various methods to assess their profitability [14-17].

Sugar beets as a raw material for sugar production are a very efficient plant in terms of the use of agricultural land. This is very important due to the changes introduced in the agricultural policy of the European Union. The development prospects of EU agricultural markets for 2023-2035 indicate that the current climate protection policy will be maintained. Yields are also expected to decline due to weather problems and limited availability of plant protection products. Sugar consumption is expected to decline by 7% by 2035 as consumers adopt lower sugar diets [18]. Additives are introduced into consumed products that change their taste [19; 22]. Consumer preferences are different and variable, but they are shifting towards healthy organic products [23; 24]. Agricultural and food production is expected to ensure food security for EU countries, with net exports of food so that there is no food waste [25-27]. The estimated change in sugar consumption will also reduce sugar beet production.

The analysis of the profitability of sugar beet cultivation concerns the contract area of the Krasnystaw sugar factory, which is part of the National Sugar Company, transformed in 2022 into the "Krajowa Grupa Spożywcza Spółka Akcyjna" (KGS S.A.), whose sole owners are the state treasury, growers and employees. Period of membership in KGS S.A is a time of extremely dynamic development, just like the other six sugar plants of this national concern.

During this period, the Krasnystaw sugar factory increased its beet processing from 4.5 thousand per day to approximately 12 thousand [28; 29]. Obtaining such efficiency was possible by implementing planned investments, modernization and replacing most of the devices with new ones. Such devices require various tests before their implementation into production and use in a sugar factory [30-32]. When designing and operating machines (devices, new construction materials, improving material properties), risk analysis is indispensable, which enables the identification (forecasting) of threats [33-36].

The presented calculation of sugar beet production costs is comprehensive, with particular emphasis on own workload and general economic costs. In similar calculations, other costs of engaging production factors, e.g. interest costs on capital, are often omitted. This has been taken into account in the calculation provided.

The aim of the work is to analyze the income and costs of sugar beet production in the 2023/2024 campaign on the example of the Lublin region. The main value and originality of the work is its detailed, meticulous and insightful analysis of the costs of sugar beet production in relation to the Lublin macroregion under the jurisdiction of the Krasnystaw sugar factory. When reading an article in these categories, it should be considered as a case study.

The presented calculation, like the others presented by the author for many years, contains a comprehensive analysis of the costs of sugar beet production [37] for individual farms in the Lublin region. Currently, approximately 3,908 growers from this region supply sugar beets to the KGS "Cukrownia Krasnystaw" branch.

**Methodology and results of the analysis**

**1. Methodological assumptions adopted for calculating the costs of growing sugar beets**

Individual farms focused on sugar beet production, having equipment for this type of production, but also partially using services were selected for the cost analysis.

After analyzing 92 farms out of 3,908 supplying sugar beets to the Krasnystaw sugar factory, a model farm reflecting regional specificity was adopted for further analysis.

Most of the data contained in the work are the author's own observations or obtained directly from growers and from the "Cukrownia Krasnystaw" sugar plant in Siennica Nadolna. By assumption, wherever possible, attempts were made to assume actual costs instead of estimated costs.

The individual categories for calculating costs and income are defined below.
1. Production value.
2. Direct costs.
3. Gross surplus.
4. Indirect costs.
5. Income.
6. Total costs.
7. Production costs 1 dt [9; 10].

**1.1. Own labour costs**

The cost of own work was estimated at the parity rate for 1 hour. The parity rate was calculated on the basis of the average annual net salary in the entire national economy (according to the Central Statistical Office data), assuming that the nominal working time of one full-time employee in individual agriculture is 2,200 hours per year, the rate was adopted for 2023 – 5.88 EUR [11; 12].

**1.2. Cost of tractor and agricultural machinery work**

The cost of tractor operation was determined based on the methodology for calculating the operating costs of agricultural machinery according to the literature [34; 35] and data obtained from the Lublin Agricultural Advisory Center in Końskowola. This is a comprehensive summary including the costs of: depreciation, fuel, oils and lubricants, repairs, garage parking, insurance, technical inspection, and interest on capital. The operating time of the tractor (with a power of 48.5 kW) was set at 400 operating hours per year (300 mth for year), giving the operating time cost of one hour of the tractor – 27.18 EUR.

The cost values of individual tillage treatments take into account the total operating cost of the tractor in combination with the agricultural machine. The number of hours devoted to individual treatments are determined based on literature data [38; 39] and the author's own experiences.

It was assumed that the model farm had used agricultural equipment (50%) – a plow, a disc and toothed harrow, a sprayer and an agricultural trailer, as well as new equipment in the form of an agricultural tractor, a tillage set and a fertilizer spreader.

### 1.3. Other assumptions

Characteristics of data for calculating the costs of growing sugar beets:

- sugar beet cultivation area 2-10 ha,
- medium intensive cultivation on good wheat and very good rye complex soils, with a pH of 6 - 6.5,
- beetroot leaves remain in the field, fertilizing the soil,
- farm has mostly its own equipment for agricultural production,
- selling price of beets to a sugar producer – 45 EUR per ton (for standard polarization 16%),
- the price of wet pulp (7.05 EUR·t$^{-1}$) assumed at the level of the price applicable at "Cukrownia Krasnystaw" in the 2023/2024 campaign,
- prices of plant protection products and artificial fertilizers current for the 2023/2024 campaign,
- farm grows sugar beets without manure,
- farm uses the services of liming, sowing and harvesting sugar beets.

The calculation also estimated the quantities and values of by-products obtained from the cultivation of sugar beets (pulp), as well as additional factors involved in the production process, i.e. partial costs of: using a passenger car, telephone, electricity and water consumption (included in general economic costs).

The calculation assumes that the raw material will be taken from the plantation by the sugar producer's transport (so-called "collection from the field").

The transport of by-products: pulp and saturating lime to the grower are also carried out by means organized by the sugar factory to the farm as part of a comprehensive service, borne by the grower and they have been included in the cost calculation (Table 1).

Transport organized by the sugar factory is mainly based, as in other industries, on road transport. These vehicles must be adapted to transport sugar beets and are subject to general road safety regulations [40]. Transport in the sugar industry should meet general and specific safety rules applicable to the transport of various products [41; 42].

### 2. Cost calculation

The analysis of sugar beet production costs taking into account all the previously presented assumptions is presented in Table 1.

Table 1

**Calculation of the production costs of 1 ha of sugar beets in the 2020/2024 season**

| Content | U.m. | Unit price | Quantity | Value in EUR | Share in percent |
|---|---|---|---|---|---|
| **Production - sugar beet roots** | **ton** | **45.00** | **50** | **2250.00** | |
| Refund of pulp sum tax VAT | | 7.00 | 2250.00 | 157.50 | |
| By-product – beet pulp | ton | 7.05 | 25.00 | 176.32 | |
| Area direct payment | ha | 165.73 | 1.00 | 165.73 | |
| Sugar payment per 1 ha from 2015 | ha | 303.00 | 1.00 | 303.00 | |
| **Total revenue from production** | | | | **3052.55** | |
| **Direct costs** | | | | | |
| **Seeds:** | | | | | |
| Cultivar – Jampol Rh Cr(KHBc) | box | 166.91 | 1.25 | 208.64 | 8.58 |

Table 1 (continued)

| Content | U.m. | Unit price | Quantity | Value in EUR | Share in percent |
|---|---|---|---|---|---|
| **Plant protection products** | | | | | |
| Herbicides: | | | | | |
| Powertwin 400 SC | l | 28.12 | 2.00 | 56.23 | 2.31 |
| Goltrix Titan 565 SC | l | 27.41 | 3.00 | 82.24 | 3.38 |
| Targa Super 0.5 EC | l | 13.70 | 1.50 | 20.56 | 0.85 |
| Fungicidal products: | | | | | |
| Syrale 475 EC | l | 35.43 | 1.00 | 35.43 | 1.46 |
| Porter 250 EC | l | 25.60 | 0.40 | 10.24 | 0.42 |
| **Total plant protection product expenses** | | | | **194.46** | **8.00** |
| **Fertilizer needs :** | | | | | |
| N-ammonium nitrate | ton | 394.95 | 0.35 | 139.42 | 5.73 |
| P- 40 SuperFosDar | ton | 642.97 | 0.22 | 141.45 | 5.82 |
| K- 60 potassium salt | ton | 825.16 | 0.28 | 233.52 | 9.60 |
| CaO saturation lime (every 4th year) | ton | 7.53 | 4.00 | 7.53 | 0.31 |
| **Total fertilizer expenses** | - | | - | **521.92** | **21.46** |
| **Total direct costs** | - | | - | **925.02** | **38.04** |
| **Direct superplus** | - | | - | **2127.52** | |
| **Indirect costs** | | | | | |
| **Complex service cost (transportation from field)** | **ton** | **0.94** | **50.00** | **47.02** | 1.93 |
| **Production levy** | **ton** | **0.00** | **50.00** | **0.00** | 0.00 |
| **Services:** | | | | | |
| Seed sowing | | 86.14 | 0.70 | 60.30 | 2.48 |
| Beet root harvest (Holmer harvester) | | 293.86 | 1.00 | 293.86 | 12.08 |
| Liming operation (every 4th year) | | 121.82 | 0.50 | 15.23 | 0.63 |
| **Total services costs** | | | | **369.39** | **15.19** |
| **Cultivation and protection** | | | | | |
| Disking operation | h | 30.58 | 2.00 | 61.15 | 2.51 |
| Harrowing(2 x 0.7h) | h | 28.86 | 1.40 | 40.41 | 1.66 |
| Deep plowing | h | 30.21 | 2.50 | 75.53 | 3.11 |
| PK fertilizer application (2 x 0.7h) | h | 31.81 | 1.40 | 44.53 | 1.83 |
| Pre-sowing tillage (soil tillage unit 2 x 0.7h) | h | 37.35 | 1.40 | 52.29 | 2.15 |
| N top dressing (2 x 0.7h) | h | 31.81 | 1.40 | 44.53 | 1.83 |
| Sprays (5 x 0.5h) | h | 31.84 | 2.50 | 79.61 | 3.27 |
| Collection of beetroots from harvester | h | 33.70 | 2.00 | 67.39 | 2.77 |
| **Total cultivation and protection costs** | | | | **465.44** | **19.14** |
| **Farm overhead expenses** | | | | | |
| Property tax | | | | 37.00 | 1.52 |
| Liability insurance | | | | 6.53 | 0.27 |
| Building structure depreciation | | ` | | 85.81 | 3.53 |
| Other overheads | | | | 213.38 | 8.77 |
| **Total overhead costs** | | | | **342.72** | **14.09** |
| **Owner/operator labour cost** | **h** | **5.88** | **48.00** | **282.42** | **11.61** |
| **Total indirect costs** | | | | 1506.99 | **61.96** |
| **Agricultural income** | | | | 620.54 | |
| **Total costs** | | | | 2432.01 | |

### 3. Profitability of sugar beet production

Production profitability was determined on the basis of the production profitability index defined below: placement of complex formulae in text should be avoided.

$$W = P/K, \tag{1}$$

where    $W$ – profitability index;
$P$ – value of production in EUR;
$K$ – production cost in EUR.

The index value greater than 1 indicates profitability of production, whereas less than one – unprofitable. An index calculated in this way can also determine the profit percentage generated from the production. The values of the production profitability index and unit production cost are shown in Table 2.

Table 2

**Values of production profitability index and unit production cost; source: own study**

| Type of production | Profitability index (W)* | Unit production cost (1 ton in EUR) |
|---|---|---|
| Sugar beet | 1.26 | 48.64 |

\* The values calculated include the values of the by-product beet pulp and area payment (SAP + greening + redistribution), and sugar payment.

The profitability index is greater than one, so the sugar beet production in the 2023/2024 campaign was profitable.

### Discussion of the results

The economics of sugar beet production vary in different regions as well as in different parts of the world [11-17]. It depends on many factors related to the size of the farm, climatic and soil conditions.

Conducting a comparative analysis of the economics of sugar beet production is difficult and problematic because there is enormous variation in sugar beet cultivation conditions even between macroregions and countries. For this reason, researchers do not attempt to compare in detail the profitability of sugar beet production. Currently, there is a lack of detailed scientific works that would enable comparative analyses.

However, in any economic analysis, direct, indirect costs and production revenue are always taken into account. Fig. 1 shows the direct costs.
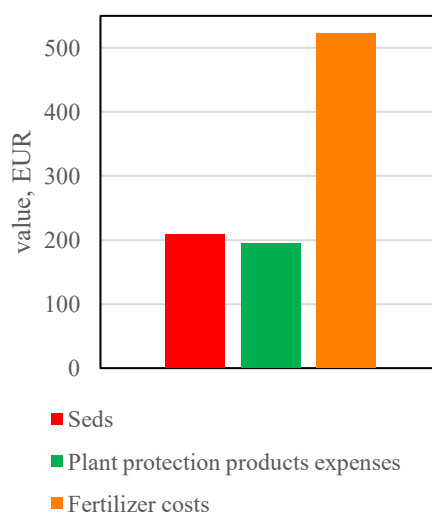


Fig. 1. **Direct costs; source: own study**

Direct costs also had a significant impact with a share of 38.04%, including: fertilizer costs – a share of 21.46%, seed costs – a share of 8.58%, costs of plant protection products – a share of 8.00%. The analysis shows that in the 2023/2024 campaign, as in the previous campaign, the costs of mineral fertilizers had the greatest impact on the value of income. This is the result of the increased price (from 2022) of mineral fertilizers due to the increase in their production costs. The increase in energy costs in the production of mineral fertilizers was caused by the dysregulation of the gas and fuel market after Russia's aggression against Ukraine. In this campaign, the share of seed costs was 0.53%. The costs of seeds and their type have a significant impact on the income obtained from sugar beet cultivation [43]. The number of seeds sown per one hectare of plantation is crucial here - the recommended dose is about 90,000 seeds. Sowing such a number of seeds requires precise seeders [44]. Precise sowing of sugar beet seeds, as well as other seeds, requires many tests of the sowing quality [45-48].
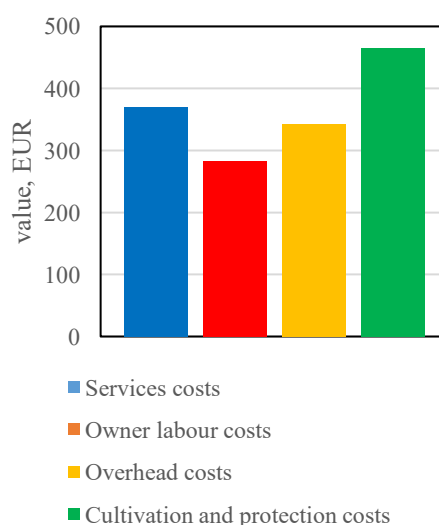
Fig. 2 shows the indirect costs.



Fig. 2. **Indirect costs; source: own study**

According to the analysis carried out, the greatest share in the cultivation of sugar beets (Table 1) had the indirect costs with a share in all costs amounting to 61.96%, and among them the greatest influence on their share had: the costs of sowing and harvesting services of sugar beets and liming the field – share 15.19%, costs of cultivation and plant protection – share 19.14%, general economic costs – share 14.0%, own labour costs – share 11.61%.

A detailed cost analysis allows to determine the income from sugar beet cultivation. Figure 3 shows the division of income from sugar beet production.
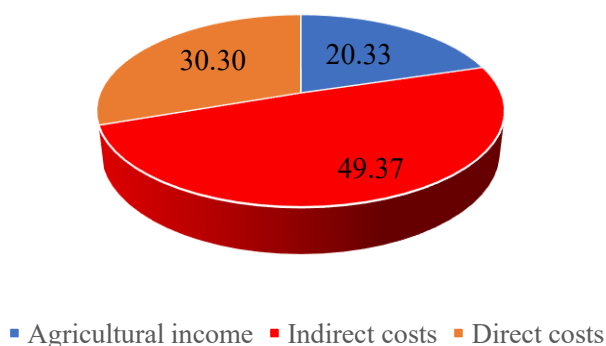


Fig. 3. **Breakdown revenue from sugar beet production; source: own study**

The analysis of income from sugar beet production shows that 79.67% are production costs, and only 20.33% are agricultural income (Table 1, Fig. 3). The profitability of sugar beet production in the

analysed 2023/2024 campaign increased by 147.09 EUR in relation to the 2022/2023 campaign. This was mainly due to a decrease in the share of the direct costs by 10.19% and the share of the indirect costs by 2.46%, as well as an increase in the price of sugar beet by 6.90 *EUR*.

Such economic conditions compared to the previous campaign will contribute to increased interest in sugar beet cultivation. It should be stated that the positive financial result from sugar beet production is primarily ensured by the high price of sugar beet sales. The income of sugar beet growers is also significantly influenced by the sugar subsidy per hectare of sugar beet cultivation amounting to 303 EUR and direct payment per hectare (JPO) amounting to 109.34 EUR. The existence of these subsidies makes sugar beet cultivation profitable in the future, just as it was profitable in previous years.

The presented analysis of the costs of growing sugar beets can be transferred to other voivodships or regions of Poland, if growers deliver sugar beets to sugar factories belonging to the National Food Group. The production conditions for sugar beets are the same throughout the entire cultivation area covered by the national food group. There may be only minor differences in the profitability of sugar beet cultivation resulting from a geographical point of view (topography, climatic conditions). However, for areas with the same geographical conditions but belonging to other sugar producers, they will be different because there are differences in the price of purchased sugar beets.

The presented analysis of the costs of growing sugar beets is a typical case study and should be considered as such. Some researchers dealing with the economics of sugar beet production introduce modern analyses of three-dimensional computer visualization, but they also limit themselves to case study analysis [16].

**Summary**

The profitability of sugar beet production is also influenced by the good economic situation on the sugar market, especially its sales abroad. In the period January-October 2023, Poland exported a total of 543,777 tons of sugar. The National Food Group also contributed to this amount of sugar sold.

In accordance with the provisions of the contractual agreement, all growers belonging to KGS S.A. received an additional benefit per tonne of sugar beet delivered. Growers are entitled to such a benefit when the average annual net price from sugar sales by a sugar producer in the 2023/2024 marketing year exceeds the equivalent of 440 EUR per ton. Growers are paid 50% of the difference between the sales price and 440 EUR per ton of sugar beet.

This amount is paid after the end of the marketing year (currently, only an advance payment of 6.89 EUR has been paid). This benefit significantly increases the growers' income, but its total amount is currently unknown, and it does not always occur, so it was not included in the presented analysis of the profitability of sugar beet production.

In the analysed Lublin region, represented by growers supplying sugar beets to the KGS S.A. branch, "Cukrownia Krasnystaw" 2023/2024 purchase campaign ended after 111 days of work with a record result, because for the first time in the history of the sugar factory, 11.717 tons of sugar beets were processed in 24 hours.

A total of 1262 tons of beets were processed into sugar, from which 181.746 tons of sugar were produced [28].

This season, the purchase campaign at the "Cukrownia Krasnystaw" branch started in September 2023 and lasted until December 2024. In the "Cukrownia Krasnystaw" branch, 2,908 sugar beets were cultivated on an area of 19.118 ha. Due to favourable weather conditions in spring and little rainfall in the autumn, the average polarization value was 16.87%, the average yield per 1 hectare was 63.4 tons. However, the average contamination of the raw material was 10.1%. Some growers experienced a surplus of raw material (the amount of sugar beets purchased by the sugar factory over the amount specified in the contract), this amount increases the grower's income, but is unpredictable, therefore it was not included in the presented calculation of sugar beet production. The price of the surplus was set at 21.76 EUR per ton.

The development of sugar beet production both in the Lublin region and throughout Poland depends on the conditions of the common agricultural policy in the European Union.

The future of sugar beet production in the EU will be a major challenge due to the expected decline in production and consumption – factors such as changing consumer diets and limited harvests are contributing to this decline – the area of agricultural land devoted to sugar beet cultivation is expected

to decline and will gradually decrease to 1.43 million ha by 2035 due to competition from other crops and lower sugar prices [8].

The 2023/2024 sugar campaign was profitable for sugar producers and sugar beet growers. With the currently stabilized prices of white sugar, sugar beet production will be profitable in the near future. Increasing growers' income increases the possibility of investing in the farm and using investment funds [49].

The interest of plant producers in growing sugar beets has not decreased, thanks to the guaranteed price for the raw material for sugar production in the contractual agreement, which is attractive compared to the prices for other agricultural products.

## Conclusions

1. Analysis of sugar beet production showed that it was profitable. The value of the income was over 620.54 EUR per 1 hectare with the production profitability index value: 1.26.
2. It was found that in the production of sugar beets, indirect costs had a decisive influence on the value of income (with a share of 61.96%), their share was 23.62% higher than direct costs (with a share of 38.04%). A large share in indirect costs had the costs of services (share 15.19%) and own labour costs (share 14.09%).
3. The largest share in direct costs had the costs of mineral fertilizers (share 21.46%), which determine the production costs to the greatest extent.
4. The main factor influencing the income from sugar beet cultivation was the price of the raw material, which increased by 6.90 EUR in the marketing year under consideration (2023) compared to the previous season (2022).
5. Sugar beet cultivation is characterized by high production costs, consuming 79.67% of the production income.
6. The limitation of the calculation of sugar beet cultivation is its reference to the group of individual farms that meet the criteria established and described in the study related to the analysed area, as well as the area of the farm and its equipment.
7. Further research should be carried out taking into account the division of the analysed farms into groups with different but specific criteria, this will allow for a better approximation of the analyses of cultivation costs to real conditions. This can be done by conducting surveys of farms and selecting representative groups.
8. Future studies may attempt to compare cultivation costs between countries if data are available to do so. However, this will be extremely difficult due to the establishment of comparison criteria, which should take into account the specificity of sugar production and geographical conditions, including climate, soil conditions and topography.

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