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# ECONOMIC ANALYSIS OF PRECISION TECHNOLOGICAL CULTIVATION OF WINTER OILSEED RAPE

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**Abstract:** By using precision farming and animal husbandry systems, we can optimize resource use and reduce wastefulness and loss. The basis for well-functioning precision agriculture is the immediate and continuous recording of accurate data at the point of cultivation, followed by processing and analysis of the data. This requires a change of approach not only by developers and machine manufacturers, but also by farmers, to turn data into decision-support information that can be quickly made available without external assistance.
In our work, we want to analyze the economics of autumn oilseed rape production in an agricultural company whose crop production sectors are considered to be at the forefront of precision technologies at national level. The company has decades of professional experience in rapeseed production. The principle that the more intensive a cropping system, the more benefits there are from the use of site-specific technology, is fully applied in the enterprise under study. With high input material use, proper positioning is more important, and increasingly expensive production costs are recovered faster through the use of automated steering and non-overlapping cultivation. The aim of this work is to demonstrate the efficiency of rapeseed production economic situation in 2021-2022. Using a technological and economic approach to production, we have highlighted opportunities for more economical and profitable production.

*Keywords*: winter oilseed rape (*Brassica napus subsp. napus forma napus*), economic analysis, precision cultivation

## 1. Introduction

According to Molnár et. al (2018), precision farming is a giant step in innovation in agriculture. Young, well-capitalized, large-scale farmers with higher education levels are typically more inclined to adopt and apply new technologies. Many are embracing this new tool because it allows them to measure important farming factors and collect a wealth of decision-support data without extra effort. Kemény et al. (2017) also found that in Hungary, precision farming is predominantly practised by farmers under 40 years of age, with higher education and over 300 hectares, which is in line with international data. The income generating capacity (EUME) of a given farm matters less than the attitude of decision makers towards the adoption of the technology. Site-specific soil sampling, the use of row guides and automated steering are already common practice among precision farmers. According to Gaál and Illés (2020), precision technology is mainly used in wheat and rapeseed during nutrient replenishment, while in maize and sunflower it is used in sowing. According to research by Takácsné et al. (2018), almost 80% of farmers who could not imagine the successful application of precision technology due to their economic size, cultivated less than 200 ha. 85% of those who indicated a lack of financing were small farmers, family farms and sole proprietors. According to Pathak et al. (2019), despite the expected benefits, the uptake of precision farming technology has to date fallen short of expectations. A higher level of cooperation between actors is needed than at present and the transfer of knowledge between science and practice is not satisfactory. Excellent learning skills and receptiveness to new ideas are also needed to integrate technology and use it effectively. However, a major barrier to implementation is the high initial cost and the long payback period for the necessary investments. Lencsés (2013) used modelling to show that small farmers are unable to adopt elements of precision technology on their own because in some cases the return on investment is not guaranteed. His research has also shown that a complex precision farming system using several elements together can only work economically for medium and large enterprises. When calculating the payback period, it should also be taken into account that site-specific crop production is more efficient the more variable the factors affecting yields on a given farm and during the cultivation of a given crop. However, precision farming does not necessarily require an investment of its own, as some elements can be purchased as a service. Software can capture and manage data from different farms separately, making sharing relatively easy, and giving smaller farms the chance to take advantage of the benefits of these technologies. Use on a rental basis also benefits the service provider, as it can speed up the return on investment in machinery. Farmers also have the possibility to gradually introduce precision farming, depending on their financial possibilities, as the different technologies can be more or less integrated into a conventional machinery fleet. In this case, it is necessary to clearly define which elements should be introduced in which order (Takácsné, 2020). Takácsné et al. (2018) compared precision farming with conventionally producing agricultural enterprises. Precision rapeseed growers realized the largest income gains.

Over the past decades, the biggest upturn in the domestic crop sector has been in the area under autumn oilseed and in its cultivation technology. Over the years, the cost of production has steadily increased, while the value of production has increased, but has fluctuated due to varying yields (Popp et al., 2018). Based on studies by Gaál and Illés (2020), precision farms growing winter oilseed rape (Brassica napus subsp. napus forma napus) have achieved an average yield increase of more than 600 kg per hectare over the 3 years between 2018-2020 compared to conventional producers. Rapeseed growers who are new to the technology have seen an average yield increase of 23% compared to their previous results. Despite the fact that they also increased their costs by almost 30%, their sectoral result was higher on average 25 thousand HUF/ha than before.

## 2. Materials and methods

### 2.1. Description of the company under investigation

The agricultural enterprise is located in the southern part of Bács-Kiskun county. It cultivates crops on an area of 3 300 hectares, of which it owns almost 1 600 hectares. With the help of European Union and national subsidies and self-financing, continuous investments and machinery replacements have been carried out in the field of crop production. Among the elements of precision arable farming, the company under study uses UAVs for site-specific soil sampling, row management, automatic power and implement steering, differential nutrient application and seeding, yield mapping, crop protection monitoring. In the 2021-2022 business year, the company produced winter oilseed rape on more than 12 % of the total leased arable area, on 185.78 hectares, in 6 different fields. The pre-sowing crop in all fields was cereals.

### 2.2. Methods

#### *2.2.1. Production costs*

The costs incurred in the cultivation of rapeseed can be broken down into work in progress and current year production based on the calendar year in which they were incurred.

**Work in progress** includes the value of the labor, materials and other inputs used in the cultivation of rapeseed up to 31 december, which have been applied to the production of the crop to be harvested in the following year. The value of crops in the course of production is the field inventory, which includes the cost of fertilisers and seeds used in autumn nutrient replenishment, the cost of plant protection products used in autumn crop protection work, autumn wages and benefits, autumn soil work and the proportional part of long-lasting organic fertiliser application.

The **personnel costs** of the enterprise for the cultivation of rapeseed are the wages, benefits and public charges. The wage costs include the wages of manual workers involved in handling materials, plant protection and harvesting.

**Machine work costs** include the cost of machinery involved in serving the rapeseed production technology. They are calculated in accordance with the enterprise's cost accounting rules. Auxiliary operating costs include the wages and salaries of the machine operators and their social insurance, depreciation, maintenance and repair costs of the machines and equipment. They also include the cost of fuel, lubricants, technical inspection and insurance for the operation of the machinery.

In **general overheads**, the *overhead of the primary sector* includes the wages and contributions of managers, administrators and its service staff. It also includes car maintenance costs, lawyer's fees, depreciation and maintenance costs of buildings on the premises. Overheads are allocated in proportion to the direct costs of the sectors. The other, *crop production overhead*, is allocated in proportion to the area under crop production.

The most significant of the **services used** is the *land rent*. Under the provisions of the Land Registration Act, companies are not allowed to acquire land ownership rights, so the 185,78 hectares required for the cultivation of cabbage rape are leased. **Other expenditure** includes *insurance premiums* to cover damage caused by natural disasters.

*2.2.3. Revenues, results, performance indicators*

**Revenue from sales.** The entire quantity of rapeseed produced, cleaned and dried is put up for sale, so that the quantity sold equals the total net yield. A little over half of the yield is sold on the basis of pre-contracts, the other half is sold in the autumn at a higher market price.

**The revenue from subsidies** consists of aid for the single area payment scheme (SAPS), the greening premium and agricultural insurance premiums.
When claiming a **tax refund on diesel** used in agriculture, the company is entitled to a refund of 83% of the excise duty on 97 litres of diesel per hectare.

**Sectoral result** is the difference between revenues and costs for the examined year 2022. In our work, we also look at the unsubsidised result, as this shows the actual revenue-generating capacity of the sector. Among the performance indicators, we have determined the unit cost, efficiency and profitability of rapeseed. The latter is examined both with and without subsidies.

## 3. Results

3.2. Costs of production

The company used two types of complex fertiliser as a pre-sowing autumn base fertiliser, depending on the growing location, to meet the needs of the crops as closely as possible. Application was site-specific and differentiated, based on application maps. The cost of the fertilisers used for the autumn replenishment was 7 885 678 HUF. In the autumn of 2021, the company sowed 6 different hybrids of rapeseed at a cost of HUF 3 545 532. Timely weed control is an essential element of winter oilseed rape production and also the most difficult crop protection challenge, pest control. In the autumn, several applications of insecticides were necessary, along with growth regulators to promote growth and autumn hardiness. In the period under review, pesticides worth HUF 6 945 037 were used for rapeseed production. The cost of the machine work is charged to the crop on the basis of the number of standard hectares used.

For the autumn work on rapeseed cultivation, 1470 standard hectares were used, and, in 2021, at a conversion rate of 13 680,05 HUF/standard hectare, 20 109 674 HUF was used for the mechanical work on the incomplete production.

Only HUF 439 200 in labor costs were incurred for the work in progress. Overall, it can be concluded that the *total cost of unfinished production* of rapeseed in the period under examination was HUF 43 501 151. The current year's labor costs during harvesting were in the order of HUF 453 000 for the *wages and and social charges* of the delivery note writers and the persons who measured the moisture content of the crop. The spring mechanical work on rape crops produced 678 standard hectares, which, using the 15 121 standard hectares calculated by the firm, represented a cost of EUR 10 252 038. The harvesting of rapeseed produced 288 combine hectares, so that the unit cost of the harvesting of rapeseed in 2022 was HUF 5 503 104 per hectare, calculated at a unit cost of HUF 19 108 per hectare.

612 tons of rapeseed were placed in the drying plant. The company calculated a unit cost of 3 526 HUF/tonne for the drying plant, so the cost of cleaning the crop in the period under review was in the order of 2 157 912 HUF. In 2022, the *total cost of mechanical work* for the current year's cultivation was HUF 17,913,054.

In the period under consideration, the *general costs of the primary sector* amount to 8 336 000 HUF, allocated in proportion to the direct costs, and the *general costs of crop production* amount to 3 865 000 HUF, allocated in proportion to the area under production.

In the 2021-2022 business year, the enterprise paid HUF 2 800 per Golden Crown (GC) for the rented land. The value of the land used for rapeseed cultivation is GC 4558, so the land rent paid in 2022 amounted to HUF 12 762 400. The cost of cultivation in the current year includes the cost of drying the crop. This *agricultural service* was performed at a cost of 7000 HUF per hectare, which amounted to a cost of 1 302 000 HUF per hectare for the nearly 186 hectares in the period under study. The cost structure of rapeseed production is shown in *Table 1*.

***Table 1***: Total costs and unit cost of winter oilseed rape production

| Designation | | Total (Ft) | Unit Cost (Ft/ha) | Unit Cost (Ft/t) |
|---|---|---|---|---|
| Value of work in progress | | 43 501 151 | 234 154 | 74 335 |
| Material | | 25 479 535 | 137 149 | 43 539 |
| Labor | | 414 000 | 2 228 | 707 |
| Social Insurance | | 39 000 | 210 | 67 |
| Machine Cost | | 17 913 054 | 96 421 | 30 610 |
| Cost of External Services | Land Rent | 12 762 400 | 68 696 | 21 808 |
| | Self-propelled sprayer | 1 302 000 | 7 000 | 2 225 |
| | Laboratory analysis | 6 000 | 32 | 10 |
| | Insurance | 7 898 000 | 42 513 | 13 496 |
| Direct production cost | | 109 315 140 | 588 412 | 186 797 |
| Primary sector overheads | | 8 336 000 | 44 870 | 14 245 |
| Production cost of the primary product | | 117 651 140 | 633 282 | 201 042 |
| Crop production overheads | | 3 865 000 | 20 804 | 6 605 |
| **Total cost of primary product** | | **121 516 140** | **654 086** | **207 646** |

Source: own calculation

### 3.5. Income, results and performance indicators for winter oilseed rape production

The enterprise under investigation sold the 585 250 kg of produce produced at an average price of HUF 311 000 per tonne. During the period under examination, the company generated a turnover of HUF 181 935 390. The Single Area Payment Scheme (SAPS) subsidy of HUF 11 157 761 (HUF 60 059/ha), the greening subsidy of HUF 6 210 254 (HUF 33 428/ha), the insurance premium subsidy of HUF 5 133 700 (HUF 27 633/ha) and the income from the tax refund on diesel fuel of HUF 1 988 617 per 185,78 ha increased the company's result by a total of HUF 24 490 291.

In 2022, the production of winter oilseed rape generated a total revenue of 206 425 681 HUF or 1 111 130 HUF/ha for the agricultural enterprise.

One way of judging the sector's performance is to ignore subsidies, including EU subsidies. In this case, the production costs are deducted from the sum of the income from sales, tax refunds and insurance premium subsidies. In 2022, subsidies, primarily European Union subsidies, significantly increased the *results of cultivation*. The components of the result are illustrated in *Table 2*.

***Table 2***: Development of revenue for winter oilseed rape growing

| **Components of Result** | **Value** |
|---|---|
| Revenue (turnover + tax refund) | 183 924 007 Ft |
| Revenue without EU subsidy | 189 090 707 Ft |
| Total Revenue (with EU subsidy) | 206 458 722 Ft |
| Total production costs | 121 516 140 Ft |
| Result without subsidies | 62 407 867 Ft |
| Result without EU subsidies | 67 574 567 Ft |
| Result with subsidies | 84 909 541 Ft |

Source: own calculation

The calculation and values of the **Performance Indicators** are presented in *Table 3*.

***Table 3:*** Crop performance indicators without and with subsidies

| **Performance indicator** | **Calculation** | **Value** |
|---|---|---|
| Unit cost | $\frac{\text{Total Cost: 654 086 Ft/ha}}{\text{Yield: 3,15 t/ha}}$ | 207 647 Ft/t |
| Efficiency | $\frac{\text{Yield: 3,15 t/ha}}{\text{Total Cost: 654 086 Ft/ha}}$ | 480 kg/100 000 Ft |
| Income from 1 tonne of crop without subsidy | $\frac{\text{Income: 67 574 567 Ft}}{\text{Area: 185,78 ha}}$ | 335 923 Ft/t |
| Income from 1 hectare of crops without subsidy | $\frac{\text{Income: 67 574 567 Ft}}{\text{Area: 185,78 ha}}$ | 335 923 Ft/ha |
| Income from 1 tonne of crop with subsidy | $\frac{\text{Income: 84 909 541 Ft}}{\text{Yield: 585,25 t}}$ | 145 083 Ft/t |
| Income from 1 hectare of crops with subsidy | $\frac{\text{Income: 84 909 541 Ft}}{\text{Area: 185,78 ha}}$ | 457 043 Ft/ha |
| ROS without subsidies | $\frac{\text{Income: 62 407 867 Ft}}{\text{Revenue: 181935390 Ft}} x\ 100$ | 34,3 % |
| ROS with subsidies | $\frac{\text{Income: 84 909 541 Ft}}{\text{Revenue: 181935390 Ft}} x\ 100$ | 46,7 % |
| Cost-related profitability without subsidy | $\frac{\text{Income: 62 407 867 Ft}}{\text{Total Cost: 121 516 140 Ft}} x\ 100$ | 51,4 % |
| Cost-related profitability with subsidy | $\frac{\text{Income: 84 909 541 Ft}}{\text{Total Cost: 121 516 140 Ft}} x\ 100$ | 69,9 % |

Source: own calculation

## 4. Discussion

In our work, we investigated the precision technology and its economical aspects of growing winter oilseed rape in a successful crop farming enterprise. The unit cost of the production of the studied enterprise exceeded 650 thousand HUF per hectare. Also 75 % of this was accounted for by the cost of materials and machine cost. Winter oilseed rape production was also subject to an overhead cost of around 10 %, which is considered acceptable for a firm of this size. The unit cost of rapeseed in the enterprise under study was 207 646 HUF/t, more than double the figure published by the Institute for Agricultural Economics Research, but the average price of rapeseed sold in four batches was 300 000 HUF, thus the sector achieved an excellent result despite the high production costs. Using the production techniques described, an average net weight of 3.15 tonnes per hectare was achieved, 43% above the national average in a year of historic drought. This result is explained by the company's strict adherence to technological discipline, which entails an increase in production costs but significantly increases the safety of production. For the 2021-2022 business year, the company made a profit of HUF 336,000 per hectare on its winter oilseed rape, while taking into account the subsidies for the sector, it even reached HUF 457,000 per hectare. This means an almost 47% Return on Sales.

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