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THE EFFECT OF PRECISION AGRICULTURE TENDER ON THE EFFICIENCY OF SUNFLOWER CULTIVATION

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Abstract: By using precision farming systems, we can optimize the use of resources, reducing waste and wastage. The basis of a well-functioning precision agriculture is the immediate and continuous recording of accurate data at the point of cultivation, and then processing and analyzing 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 aim to provide an economic analysis of the production of sunflower using precision technology. The production of sunflower is studied at an agricultural enterprise whose crop production sector is considered to be at the forefront of the application of precision technologies on a national level. The principle that the more intensive a cropping system, the more advantages there are in using site-specific technology, is fully realized in the enterprise under study. In our work we present the elements of precision technology applied in sunflower production. On this basis, we calculate the costs of cultivation and the income that can be generated. We determine the results with and without subsidies, which can provide information on the actual income-generating capacity.

Keywords: precision cultivation, agricultural tenders, cost analysis

1. Introduction

The competitive future of agriculture is influenced by digitalization and the use of precision agriculture. Precision agriculture is becoming increasingly popular in practice, as it can make a major contribution to sustainable food production (Erdeiné Késmárky-Gally & Vágány 2022).

Site-specific, or precision farming, is about measuring the factors that shape yields in the immediate environment of the crops we grow and applying operations or treatments accordingly. In other words, precision farming is also called 'site-specific', referring to the implementation of technology at the plot level within the field (Reisinger 2013). The technical conditions for this major production trend have been made possible by the development of various geospatial tools. It requires a rather different kind of thinking from the previous ones, new scientific research and development from representatives of different fields of agricultural sciences (Sulecki 2018). The indisputable advantage of precision farming is that it provides much more information about agricultural areas than before, and management units that are much smaller than the size of a field are the basic units of management in this system, so that variability within the field can be managed (Pecze et al. 2001). According to Erdeiné Késmárky-Gally (2020) the precision farming is a set of technical, IT, information technology and cultivation technology applications that make production and the organization of agricultural machinery more efficient. In the next few decades, the demand for agricultural products will increase dynamically, and this can be met with more efficient production, an important tool of which is precision farming (Erdeiné Késmárky-Gally 2020). The main objective of precision farming is to produce good quality and safe food by using the available resources in the most efficient way. It therefore implies the application of digital solutions in agriculture, as developments focus on how to farm competitively and increase efficiency, while placing a strong emphasis on environmental sustainability (Gál et al. 2013).

The 2000s saw the emergence of the tools that still underpin precision farming today, based on the widespread use of global positioning systems (GPS), the potential for a high degree of automation of agricultural machinery and the emergence of advanced geographic information systems (GIS) software. In the next major period of development of precision farming, precision systems linked to machinery were complemented by additional IT elements covering the entire production process (Jóri 2017). Erdeiné Késmárki-Gally & Vágány (2022) wrote, that the precision farming is a management approach that focuses on (near real-time) observation, measurement and responses to variability in crops, fields and animals. Precision farming means the practical appearance of digitized agriculture, the use of digital solutions in agriculture, where developments are directed to how to manage in a more competitive way, to increase efficiency, while also placing great emphasis on environmental sustainability (Erdeiné Késmárki-Gally & Vágány 2022). The number of farmers using site-specific farming is also growing dynamically worldwide, and the spread of the technology has accelerated in Hungary in the last two to three years. However, precision farming is currently not yet widespread in Hungary (Molnár 2018). There are a significant number of farmers who believe that they cannot introduce and operate precision farming technology due to the high investment costs. Another barrier to the uptake of site-specific farming technology among farmers is that the theoretical benefits of the technology can depend to a large extent on the heterogeneity of the area, the knowledge and skills of the operating staff and the practical commitment of management (Swinton & Lowenberg-DeBoer 2001). Many fear the cost of the initial investment, which can now be quantified and is not the biggest barrier. A different approach, a paradigm shift, is needed to adopt the technology (Hadászi et al. 2018).

Increasing the costs of obtaining the information needed to prepare any economic decision is an econometric issue, which should be decided according to the same principles as determining the optimal amount of other inputs (Ferencz et al. 2023). Precision farming of major crops such as wheat, maize, rapeseed and sunflower has clear additional yield, cost and profitability advantages over conventional farming. However, the main barrier to its uptake is the significant investment required. Several experiments show that for farms with areas above and below 1,000 ha, both the installation of structural elements and software and the installation of precision equipment are worthwhile, as the cost is recovered in the additional income generated by the technology (Kemény et al. 2017).

Precision technology has a positive impact on production costs by optimizing the use of inputs and reducing labor costs. It also increases the quantity and quality of the yield per hectare and reduces yield losses. The reduction in production costs resulting from lower input use, and the increase in yields improves profitability (Schieffer & Dillonet. 2014). Depending on the production objective, it either makes production more efficient by reducing input use or optimizes input use per animal unit in the management zones (EIP-AGRI Focus Group 2014). The issues of farm size, economies of scale, profitability, returns on technology-related investments have been addressed in a number of studies. In all of them, margin and profitability as a plant economics issue has been directly or indirectly addressed. The extent of the use of precision technology (and the number of elements used) increases with the size of the farm (Takácsné 2020).

2. Materials and methods

2.1. Presentation of the precision machinery tender

The VP2-4.1.8-21 call for proposals was aimed at supporting precision improvements related to the digital transformation of agriculture. The aim was to increase the quantity and quality of arable and horticultural crops. The use of modern technology will allow the rational use of different inputs (fertilizers, pesticides), improve soil water retention and minimize soil disturbance through smart cultivation.

2.2. Equipment purchased with grant funding

The applicant farms a total of 750 hectares, of which 95 hectares are under sunflower cultivation.

The desire for continuous improvement and the emergence of public subsidies encouraged farm owners to apply for precision machinery tenders. In this one, they aimed to purchase a John Deere 7R310 power machine, fully compliant with precision specifications, as it is equipped with ISOBUS connection, RTK sign, Gen 4 monitor, full automatic steering, and available reflow valve. This machine is fully suitable for precision work tool operation. The tender has also enabled the purchase of a RAUCH AXIS-H 30.2 W fertilizer spreader and a John Deere R740i/24M field sprayer.

2.3. Cost calculation method

Our work compared the amount of inputs used in conventional and precision farming. We examined the costs of the two technologies based on the unit price of the inputs. We calculated the cost savings associated with the reduction in input material in terms of fuel, fertilizer, pesticides and seeds. The costs are for the year 2022, therefore, for example, the price of fuel was calculated at an average price of 480 HUF/liter. The reduction in input costs in precision farming has led to an increase in the sector's profit.

3. Results

3.1. Fuel consumption

Our studies were carried out in sunflower production. The impact of the grant is shown in *Table 1*. The average amount of fuel used per hectare of sunflower, calculated on the basis of fuel consumption for each working operation, was 90 liters, compared with 110 liters using the old technology. In 2022, using the official price of diesel at 480 HUF, a saving of 9,600 HUF per hectare could be achieved.

Table 1.: Average diesel consumption per 1 ha of sunflower production (2022)

Name	**Old technology**	**Precision technology**	**Savings in liters**	**Saving** (Ft)
Diesel	110	90	20	9,600

Source: own calculation

One of the reasons for the fuel savings was that the automatic steering system allowed the work to be carried out with minimal overlap. In many cases, the old technology meant that the operator would turn back incorrectly, resulting in sections being uncultivated. Cultivation of the missing area resulted in reduced area performance, increased uptime and increased fuel consumption.

3.2. Fertilizer use

Table 2. illustrates the fertilizer savings per hectare when using pesticides.

Table 2.: Fertilizer use per 1 ha of sunflower

Name	**Ft/t**	**Old technology**	**Precision technology**	**Amount saved**	**Savings (Ft)**
Pétisó*	225,000	0.33 t/ha	0.30 t/ha	30 kg /ha	6,750

Source: own calculation
*Pétisó: a type of ammonium-nitrate fertilizer produced in Hungary

It can be concluded that the use of precision technology resulted in a saving of 30 kg of fertilizer per hectare. This amount of input material, calculated at a price of 22,500 HUF, meant a cost reduction of 6,750 HUF in sunflower cultivation thanks to precision technology. The CDA system of the RAUCH AXIS-H 30.2 W fertilizer

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spreader ensures easy adjustment of the quantity and the dosing point. The EMC has the advantage over the classic scale fertilizer spreaders that the spread rate is always kept constant on both the left and right side. In many cases, the old technology resulted in more fertilizer being applied than the set amount. Spreading was staggered by the operator, causing overlapping in the turns and fertilizer was also spread beyond the boundary of the board.

3.3. Pesticide use

Table 3. illustrates the change in pesticide use per 1 ha of sunflower area.

Table 3.: Trends in pesticide use per 1 ha in sunflower

Name	**Price Ft/l**	**Old technology**	**Precision technology**	**Savings in liters**	**Savings in HUF**
Pulsar	10,000	1.4	1.2	0.2	2,000
Pictor	15,000	0.6	0.5	0.1	1,500
Reglone Air	13,000	2.2	2	0.2	2,600
Total:					6,100

Source: own calculation

By using precision technology, the cost per hectare was reduced by HUF 6100. The significant input use is due to the fact that the John Deere R740i/24M field sprayer purchased with the tender is an automatic sprayer, which applies the exact amount of pesticide required. Sensors on the sprayer frame prevent drift and the automatic steering ensures that the sprayer always turns back to follow the tractor, eliminating unnecessary ground trampling.

3.4. Evolution of seed use

The John Deere 7R310, which will be purchased with the help of the tender, is equipped with ISOBUS connection, RTK signal, Gen 4 monitor, full automatic steering, free return branch, which allows for more accurate seeding and spacing. *Table 4.* shows the evolution of seed consumption. For sunflower, one bag of seed is sufficient for 2.5 ha. The cost of a bag of seed is 68,000 HUF, so the cost of materials per hectare is 27,000 HUF. In many cases, using conventional technology, several seeds were sown at the same time, while in other cases there were seed gaps and the rows were not properly designed. Poor row design affects the success of other operations and makes harvesting and crop protection more difficult.

It can be concluded that thanks to the precision technology, 5 thousand seeds per hectare were saved resulting in savings of 2,250 HUF per hectare, thanks to the precise row connections, GPS and ISOBUS technology.

Per 95 hectares 475 thousand seeds can be saved (95 x 5,000 = 475,000) which means a savings of 213,750 HUF (95 x 2,250 = 213,750 HUF).

Table 4.: Changes in seed use with precision technology

Seed cost	Old technology	Precision technology	Saving (number of units)	Saving Ft/ha
27,000 HUF/ha	65,000	60,000	5,000	2,250

Source: own calculation

Thanks to precision technology, less input material is applied due to overlaps and proper row connections. Compared to the old technology, the investments made during the tender resulted in an additional income of 27,450 HUF per hectare, altogether a savings of 2,607,750 HUF.

4. Discussion

The amount of aid awarded in the tender will allow the company to improve its economic performance and it also expects a significant reduction in the use of inputs. The reduction in inputs illustrated above is due to the production of sunflower, but the farm also grows a number of other crops (winter barley, maize, poppy, grain sorghum) and therefore similar calculations need to be made. Among the input materials, the price of fuel has risen most sharply after one year, by an average of HUF 120 per liter. If the increase in other costs is not taken into account, this increase in fuel would result in savings of an additional 12,000 HUF per hectare, or 114,000 HUF per 95 hectares. This would mean an increase in income of 3,747,750 HUF for all inputs.

It can be concluded that such aid is highly recommended for businesses, as the additional income can help them to recoup the value of their own investment within a few years.

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