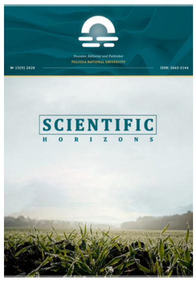
SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua
Scientific Horizons, 27(12), 47-55



UDC 336.22+633.854.778:631.582.5
DOI: 10.48077/scihor12.2024.47

The efficiency of short-term crop rotations with different sunflower saturation

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Article's History:
Received: 11.04.2024
Revised: 13.10.2024
Accepted: 27.11.2024

Abstract. The study aimed to determine short-term crop rotations' economic and energy efficiency with varying sunflower saturation. The economic and energy efficiency of crop rotations saturated with sunflower under the conditions of the Left-Bank Forest-Steppe region of Ukraine was calculated using technological maps and prices as of 2024. The study employed the following methods: bibliometric analysis – a review of other researchers' findings on the economic and energy efficiency of sunflower cultivation; grouping – an assessment of the economic and energy effects of varying sunflower saturation in crop rotations; and monographic – the generalisation of the results. The optimum sunflower share in crop rotations was found to be 20% and 40%, at which the production cost remained consistently high at 1,218.0-1,240.8 USD/t. Increasing the sunflower share to 60% led to a decline in the production cost, not only for other crops but also for the sunflower itself. This negatively impacted overall price stability, reducing crop competitiveness and the economic efficiency of crop rotations.

Suggested Citation:
Dehtiarova, Z., Shevchenko, M., Dehtiarov Yu., & Budyonny, V. (2024). The efficiency of short-term crop rotations with different sunflower saturation. *Scientific Horizons*, 27(12), 47-55. doi: 10.48077/scihor12.2024.47.

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Winter rye exhibited the lowest production costs among all crops, regardless of the crop rotation, at 268.9-321.1 USD/ha. The production costs of soybeans and winter wheat remained stable irrespective of sunflower share, at 413.5 USD and 553.7 USD, respectively, indicating their adaptability. A 20% sunflower share in the crop rotation exhibited the highest energy intensity at 63,348 MJ/ha, while a 60% saturation slightly reduced this figure to 63,279 MJ/ha. However, the 60% sunflower saturation resulted in lower energy consumption compared to other crop rotation options, at 30,293 MJ. These findings indicate the high efficiency of crop rotations with a 60% sunflower share, as evidenced by the energy efficiency ratio of 2.65. As a result of implementing the optimised crop rotation system across 78.9 hectares, sunflower seed yields increased by 0.16 t/ha compared to traditional practices. This improvement led to an additional 1,046 UAH/ha in net profit and a 25.6% increase in production profitability

Keywords: agricultural economy; sunflower share; crop rotation; energy efficiency

INTRODUCTION

Due to its high profitability, sunflower is the most preferred crop for cultivation. As a result, agricultural enterprises are increasing the area allocated for sunflower cultivation and shortening the interval between successive plantings in crop rotations. The oil extraction industry exerts a significant influence on the price of sunflower seeds, as approximately 95% of sunflower is processed within Ukraine's domestic market. The processing capacity for sunflower seeds is estimated at approximately 5 million tonnes (Statistics Service of Ukraine, n.d.). An integrated system of sustainable agriculture relies on the application of technologies that ensure stable and continuous production. This system is founded on scientifically validated measures aimed at achieving high product quality. Such an approach not only satisfies human needs but also preserves natural resources, maintaining ecological balance and biodiversity within the agricultural system. Additionally, the concept of sustainable development encompasses two other dimensions: social and economic. The social dimension focuses on ensuring sufficient food supplies, promoting fair employment, and fostering the development of local communities. The economic dimension prioritises the viability, efficiency, and profitability of agricultural enterprises. In this context, the implementation of crop rotation serves as a key strategy to enhance the productivity and sustainability of agricultural production (Kuts & Makarchuk, 2021).

Crop rotation plays a vital role in agriculture: it optimises resource use, reduces dependency on fertilisers and agricultural inputs, and increases yields. From an economic perspective, crop rotation can lower resource costs and facilitate the optimal organisation of crop cultivation, while addressing the demands of both domestic and international markets. These factors collectively enhance the profitability of cultivated products (De Souza Linhares *et al*., 2020; Moldavan *et al.,* 2023).

In recent years, the development of agricultural enterprises has largely depended on sunflower production. This is because sunflower is one of the primary oilseeds in high demand in both domestic and international markets. Current climatic trends significantly impact agricultural productivity in Ukraine and globally. In particular, the effects of climate change are increasingly evident in the cultivation of winter crops, which are more frequently affected by adverse weather conditions. Over the past decade, the average air temperature in Ukraine has increased by 0.8-1.2°C, and globally by 1.45°C (The Intergovernmental Panel on Climate Change, 2024). According to the State Statistics Service of Ukraine (n.d.), rising air temperatures have resulted in a 5-10% reduction in grain yields. Over the past 30 years, the number of days with severe drought in Ukraine has risen by 20-25%, while precipitation in some regions has decreased by 10-15%, creating unfavourable conditions for winter crops. In response to these challenges, Ukrainian farmers have expanded the area devoted to industrial crops, which are more stress-resistant and adaptable to changing weather conditions. In 2021, the area under sunflower cultivation increased by 8.2% compared to 2020. This trend aligns with global patterns: in countries at high risk of drought, industrial crops comprise up to 20% of total agricultural land (Ukraine Common Country Analysis, 2021).

In Ukraine, the expansion of sunflower cultivation began between 2000 and 2014, during which the total cultivated area grew from 8.4% to 28.4%. As of 2024, the area under sunflower cultivation exceeds 4.9 million hectares. However, sunflower acreage statistics for 2023 remain incomplete due to the inability to account for territories affected by military operations (State Statistics Service of Ukraine, 2024). Despite these challenges, the acreage allocated to sunflower in Ukraine currently exceeds scientifically recommended levels. According to estimates by A. Gavrilyuk (2022) and T. Kostiukevych *et al.* (2022), up to 80% of sunflower crops are concentrated in the Steppe zone and adjacent eastern Forest-Steppe regions. These areas, characterised by their climatic conditions, are classified as risky farming zones, with cultivated land in these regions comprising approximately half of Ukraine's total cultivated land. In these regions, sunflower accounts for 30-40% of the sown area, while the remaining 50-57% is devoted to grain crops.

The research conducted by D. Khmelkova (2020) and Yu. Kolupaev *et al.* (2024) have demonstrated that the area of Ukraine dedicated to sunflower cultivation is approximately two million hectares greater than that of the European Union. A higher proportion of high-yielding crops in the structure of sown areas enables the gross harvest to be obtained from a smaller sown area, thereby achieving a significantly higher yield. Consequently, elevated sunflower yields result in increased gross production. However, due to the redistribution of sown areas, the cost of field operations has risen annually. This increase is attributed to higher rents for land shares, rising prices for fuel and lubricants, mineral fertilisers, plant protection products, and growing wages for employees involved in the production process, all of which constitute the most significant costs. The economic efficiency of sunflower production has been extensively researched by numerous Ukrainian and international authors (Revto & Naboka, 2022). As outlined by V. Zuza *et al.* (2022), the evaluation of economic indicators and production components will facilitate the implementation of existing and the discovery of new reserves to improve the economic efficiency of oilseed production.

The sunflower share in crop rotation significantly impacts the economic efficiency of the entire crop production system. Scientists observe that increasing the sunflower share to 50% or more reduces its profitability from 162% to 56%. Therefore, when planning sunflower cultivation, producers should consider its impact on the yield and productivity of the entire crop rotation, as well as the overall cost of production (Dehtiarova, 2022). From this perspective, growing sunflower in crop rotations is of paramount importance.

The study aimed to determine the economic and energy efficiency of sunflower cultivation about its share in the structure of short-term crop rotations.

MATERIALS AND METHODS

The research was conducted between 2020 and 2022 at the Dokuchaevske Experimental Field Training and Research and Production Centre of the State Biotechnological University, situated in the Left-Bank Forest-Steppe region of Ukraine. Variants of five-field crop rotations with differing sunflower saturation levels were investigated:

- **Variant 1** (20% sunflower share): 1. Peas. 2. Winter wheat. 3. Corn. 4. Winter rye. 5. Sunflower.
- **Variant 2** (40% sunflower share): 1. Peas. 2. Winter wheat. 3. Sunflower. 4. Winter rye. 5. Sunflower.
- **Variant 3** (60% sunflower share): 1. Sunflower. 2. Winter wheat. 3. Sunflower. 4. Winter rye. 5. Sunflower

The sowing plot size was 750 m^2, and the accounting plot was 100 m^2. The experiment consisted of three repetitions. The location of the plots remained consistent throughout the study. The technology used for sunflower cultivation adhered to standard practices suitable for the Forest-Steppe region of Ukraine. Fertilisation was applied using ammonium nitrate at 150 kg/ha during sowing and 70 kg/ha for inter-row application. Sunflower was sown when the soil temperature reached 8-10°C. The sowing rate was 50-55 thousand seeds/ha. The crop protection system included the application of soil herbicides Teaser and Selefit at 2 L/ha, and Heliantex (45 g/ha) during the growing season. Harvesting was conducted by direct combining when the seed moisture content was 8-10% (Tishchenko *et al.,* 2015).

The impact of sunflower saturation in short-rotation crop systems was assessed in terms of its yield, along with the economic and energy efficiency of increasing the crop area. For this purpose, economic efficiency was calculated using technological maps, yields, unit costs, profit per hectare, profitability levels, and prices as of 2024 (Drobot *et al.,* 2003). Energy efficiency was evaluated using technological maps (Tarariko *et al.,* 2005).

The experimental studies on plants (both cultivated and wild), including the collection of plant material, complied with institutional, national, and international guidelines. The authors adhered to the standards of the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1979).

RESULTS AND DISCUSSION

Between 2021 and 2023, Ukraine was among the largest producers and exporters of sunflower and sunflower oil globally. The gross harvest of sunflower was approximately 14-15 million tonnes. However, unfavourable weather conditions in some regions resulted in lower yields compared to previous years (Table 1).

***Table 1**. Sunflower production in Ukraine (2021-2023)*

Indicator	Years			
	2020	**2021**	**2022**	**2023**
Gross harvest, thousand tonnes	13,110	16,392	1,138	12,760
Harvested area, thousand hectares	6,480.9	6,665.1	5,238.0	5,201.6
Yield, t/ha	2.0	2.5	2.2	2.5

***Source:** developed by the authors developed by the authors based on data from the State Statistics Service of Ukraine (2023)*

In 2021, sunflower yields increased due to favourable weather conditions. The total gross harvest reached approximately 16 million tonnes, one of the highest recorded in Ukraine's history. Oil exports also remained consistently high. In 2022, due to the war and military operations in Ukraine, a significant portion of sunflower-growing areas was damaged or became inaccessible. This resulted in a sharp reduction in the area under cultivation, negatively impacting the gross harvest. The harvesting campaign was lower than in previous years, partly due to logistical challenges and infrastructure damage. In 2023, the situation remained challenging owing to ongoing hostilities and risks to agriculture. However, producers adapted to the new conditions, and yields partially improved due to the restoration of some cultivated areas and the application of improved agricultural technologies (Statistics Service of Ukraine, n.d.).

Crop rotation with a sunflower saturation of 20% demonstrated high crop yields, particularly for winter wheat and corn, which reached 4.20 and 4.73 t/ha, respectively (Fig. 1). With a 40% sunflower share, crop yields declined slightly. However, the optimal agrochemical parameters of this variant contributed to an increase in sunflower yield to 2.72 t/ha (Dehtiarova, 2023). In the variant with sunflower saturation in crop rotations increased to 60%, yields decreased for all crops, including sunflower, which fell to 2.63 t/ha.

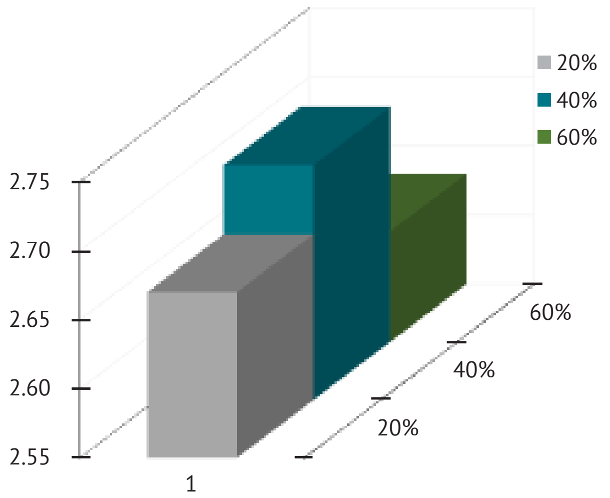

***Figure 1**. Sunflower yield depending on its share in crop rotation, t/ha*
***Source:** developed by the authors*

The high market price of sunflower makes it the most profitable crop in crop rotations. In the variant with 20% saturation, sunflower yielded the highest profitability, while other crops exhibited a relatively stable and lower cost structure. For crop rotations with a sunflower saturation of up to 40%, the cost of production for all crops, except sunflower, decreased. At 60% saturation, a downward trend in the costs of all crops, including sunflower, was observed, with sunflower costs reaching 1,199.8 USD/t. This level of saturation had a notably negative impact on the overall costs of growing crops in rotation, primarily due to low yields. At 20% saturation, the cost of growing sunflower was the highest among all crops, at 618.0 USD/t. A similar trend continued across other variants. The lowest costs were recorded for winter rye, ranging between 268.9 and 315.3 USD/t. The costs of growing soybeans and corn also remained relatively low.

The economic assessment of crop rotations with varying sunflower saturation levels indicated that variants with 20 and 40% sunflower saturation generated relatively high notional net profits, ranging between 600 and 622.8 USD/ha (Table 2). In contrast, in the crop rotation with 60% saturation, profit from sunflower decreased by approximately 18.3 USD. An analysis of the economic performance of the crop rotation with 40% saturation showed that sunflower provided a high notional net profit in the first year, amounting to 622.8 USD/ha. The profitability of an enterprise is a comprehensive indicator that assesses how effectively material, financial, and human resources are utilised to generate profit. It also helps evaluate the competitiveness of the company's goods and services. High profitability often signifies product quality, appropriate pricing strategies, the ability to meet market demand, and the efficient organisation of production processes (Sobolev, 2020; Zbarskyi & Matsybora, 2023). The economic evaluation of crop rotations with 60% sunflower saturation indicated a decline in profitability, primarily due to reduced notional net profits and increased production costs. The profitability of crops demonstrated a downward trend with higher shares of sunflower cultivation, indicating the impact of intensive monoculture practices on economic performance. Among all crops in the rotation, sunflower achieved the highest profitability across different saturation levels, particularly at 20% and 40%, where it exceeded 97%.

***Table 2**. Economic efficiency of short-term crop rotations with different sunflower saturation levels per 1 ha, (average for 2020-2022)*

Sunflower share, %	Crop rotation	Indicator					
		Yields, t	Product cost, USD	Production expenses, USD	Cost of sales, USD	Profit, USD	Profitability level, %
20	Soy	1.78	647.6	413.5	232.3	227.6	55.0
	Winter wheat	4.20	806.7	553.7	131.8	253.0	45.7
	Corn	4.73	678.5	553.0	117.4	125.5	22.7
	Winter rye	3.13	481.0	321.1	102.6	159.9	49.8
	Sunflower	**2.67**	**1,218.0**	**618.0**	**231.5**	**600.0**	**97.1**

Table 1. Continued

Sunflower share, %	Crop rotation	Indicator					
		Yields, t	Product cost, USD	Production expenses, USD	Cost of sales, USD	Profit, USD	Profitability level, %
40	Soy	1.73	623.5	413.5	239.0	209.6	50.7
	Winter wheat	4.11	789.43	553.7	134.7	235.8	42.6
	Sunflower	2.71	1,236.3	618.0	228.01	618.2	90.4
	Winter rye	3.10	476.4	315.3	101.7	161.0	51.1
	Sunflower	**2.72**	**1,240.8**	**618.0**	**227.2**	**622.8**	**100.8**
60	Sunflower	2.58	1176.9	618.0	239.5	558.9	78.6
	Winter wheat	3.84	737.6	553.7	144.2	183.9	33.2
	Sunflower	2.64	1204.3	618.0	234.1	586.3	72.7
	Winter rye	2.97	352.5	268.9	90.5	83.6	31.1
	Sunflower	**2.63**	**1,199.8**	**618.0**	**235.00**	**581.72**	**94.1**

Note: *exchange rate – 41.23 UAH per 1 USD as of 01.11.2024*
Source: *developed by the authors*

Increasing the sunflower share to 60% resulted in higher production costs for most crops, particularly for sunflower and winter wheat, which demonstrated the highest production costs compared to the 20 and 40% saturation levels. Winter rye, in contrast, remained the least expensive crop to cultivate and sell, especially at 60% sunflower saturation, indicating its economic efficiency and cost stability. The optimum sunflower saturation level for cost control was 20%, at which point sales costs for all crops remained relatively low, ensuring the stability and cost-effectiveness of the crop rotation. However, at 60% saturation, sunflower efficiency decreased, indicating that excessive sunflower cultivation can result in resource depletion and reduced economic performance.

Among the options studied, a 60% sunflower saturation yielded the highest notional net profit per hectare – 404.3 USD. This level of saturation resulted in a profitability rate of 69.7%, which was nearly 1.3 times higher than the profitability achieved with the optimal sunflower saturation of 20% (Fig. 2). Reducing the sunflower share to 40% lowered the notional net profit and profitability by 34.8 USD and 0.7%, respectively. These findings underscore a stable market demand for sunflower, which offsets price declines for other crops.

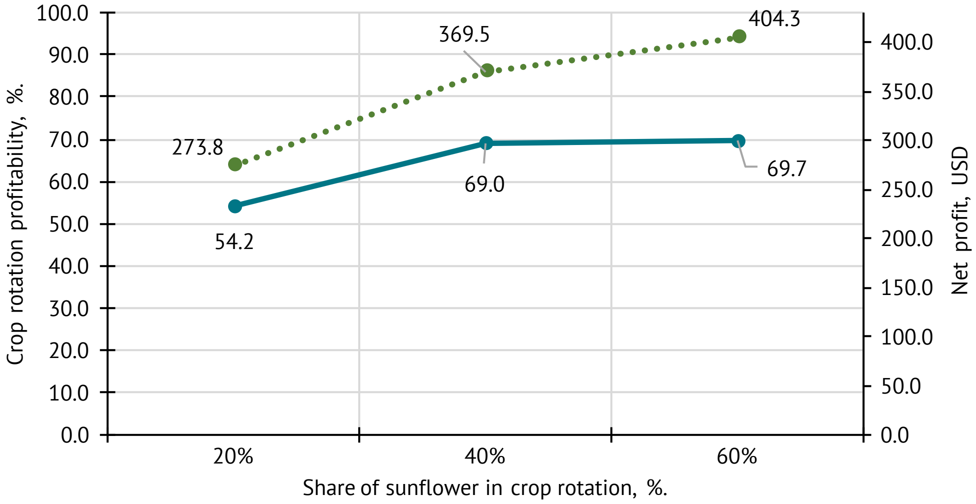

Figure 2*. Influence of sunflower share on profitability and net profit of crop rotation, (average for 2020-2024)*
Source: *developed by the authors*

High sunflower yields in the 20 and 40% saturation variants resulted in a substantial notional net profit, with profitability levels exceeding 120%. Yu.V. Mashchenko & I.M. Sokolovska (2023) reported that saturating crop rotations with sunflower up to 50% increases grain yields to 3.51 t/ha, feed units to

1.93 t/ha, and digestible protein to 0.66 t/ha. Compared to monoculture sunflower cultivation, this approach improved yields by 0.72 t/ha, 0.39 t/ha, and 0.14 t/ha, respectively. The researchers also determined that rotating sunflower with corn increased sunflower yields to 1.75 t/ha, compared to 1.39 t/ha under continuous cultivation. This rotation produced a yield increase of 0.36 t/ha, equivalent to 21.5%. Similarly, A. Slobodianyk *et al.* (2021) noted in their studies that the highest level of profitability in sunflower cultivation is achieved when resource costs for sunflower seeds remain at approximately 55.5 thousand UAH per hectare, with a yield of 2.2 t/ha (18% below the standard level). According to the research conducted by L. Kvasnitska (2020), a high profitability rate of 157% was observed in crop rotations with a 40% saturation of oilseeds. At this level, the value of produced products was maximised while cultivation costs remained low. Scientists generally agree that sunflower holds significant economic importance in agriculture, primarily due to its adaptability to diverse climatic conditions (Khakbazan *et al.,* 2022; Puttha *et al.,* 2023).

The energy assessment is based on the use of the indicator for total energy consumption and determines the value of agrophytocenosis productivity (Tarariko *et al.,* 2005). In the agricultural sector, the efficient use of energy resources is achievable through intensive technologies that promote resource conservation, with sunflower serving as a key crop in this process. When cultivating sunflower, it is important to manage production processes using a system of integrated energy efficiency indicators. Machinery and equipment constituted the largest proportion of energy consumption (29.5%). Seeds, pesticides, fuels, lubricants, agricultural machinery, and fertilisers also contributed significantly to total energy consumption. The energy costs of short-rotation crop rotations vary depending on the crop mix, their yields, and the use of mineral and organic fertilisers. To identify the most efficient practices, it is advisable to carry out an energy assessment during the planning phase of the process. This enables the recommendation of solutions that ensure optimal energy use.

In this research, an energy assessment was conducted based on the level of energy consumption, accumulated energy by the crop, and the calculation of the energy efficiency ratio (EER). The energy assessment was derived from technology maps by calculating the energy required to grow a crop on an area of 1 ha and the energy intensity of the crop, expressed as the energy efficiency ratio. This was determined by the ratio of the crop's accumulated energy to the energy required by the agricultural technologies. For this purpose, it is important to analyse the level of fertiliser and pesticide use, fuel consumption, types of vehicles and implements employed, as well as the impact of natural resources, soil and climatic conditions, and solar radiation. This research revealed that energy consumption for crop rotations with a sunflower share of 60% and 40% was comparable, ranging between 30,293 and 33,428 MJ/ha (Table 3). Crop rotation with a 60% sunflower saturation resulted in lower energy consumption – 30,293 MJ, while the energy intensity of the crop was 63,279 MJ/t. The highest energy consumption was recorded in the crop rotation with a 20% sunflower share – 45,793 MJ/t, primarily due to the inclusion of corn in this rotation. The calculation of the energy efficiency ratio demonstrated that the most energyefficient crop rotation was the one with 60% sunflower saturation, yielding an EER of 2.65. A gradual decline in this indicator was observed as the sunflower share in the crop rotation decreased to 40 and 20%.

***Table 3**. The energy efficiency of short-term crop rotations with different sunflower saturation*

Indicator	Sunflower share in crop rotation, %		
	20	40	60
Energy costs, MJ	45,793	33,428	30,293
The energy intensity of the crop, MJ/t	63,348	59,586	63,279
Energy efficiency ratio (EER)	1.53	1.94	2.65

***Source:** developed by the authors*

In the variants studied, the EER was the highest in the crop rotation with 20% sunflower saturation (3.03). A gradual decline in this indicator was observed with an increase in the sunflower share in the crop rotation, reaching 40% and 60%, with values of 2.74 and 2.60, respectively. This suggests that each additional unit of sunflower cultivation incurs diminishing returns in terms of energy output from the crop. Thus, the lowest energy consumption for producing 1 tonne of sunflower seeds was recorded in the crop rotation variant with 60% saturation. Conversely, the highest energy intensity was observed in the variant with 20% sunflower saturation.

Many researchers have studied the energy efficiency of sunflower cultivation. For example, in the experiments conducted by G.V. Pinkovsky and S.P. Tanchyk (2019), the energy efficiency ratio of sunflower cultivation ranged between 3 and 4. For comparison, the study by C. Oguz and A. Yener Ogur (2022) indicates that the energy consumption for producing 1 kilogram of sunflower was 5.06 MJ/kg^{-1}. According to O.K. Medvedovsky and P.I. Ivanenko (1988), the energy efficiency ratio should be at least 2. With such values, the gross energy yield from the harvest exceeds the total energy consumption. The results of the study by

N. Gerasymchuk and T. Mirzoyeva (2017) indicate that in recent years, the economic efficiency of sunflower seed production in Ukraine has improved as a result of production intensification. L. Kvasnitska (2020) has established a high level of energy efficiency in crop rotations with sunflower saturation of up to 40%. At this level, the energy efficiency ratio was found to be 4.57 conventional units.

The results of the study on the economic efficiency of sunflower cultivation conducted by O. Pysmennyi (2018) indicate that the intensification of production in Ukraine has a significant economic impact on sunflower cultivation. The study found that the highest sunflower yields were achieved by enterprises with the greatest expenditure on seeds, fertilisers, and plant protection products. Research by A. Andriienko *et al.* (2024) demonstrated that cultivating high-productivity sunflower hybrids significantly increases profitability and reduces seed costs. In addition, the results of research conducted by E. Vilvert *et al.* (2023) show that, in two regions of Tanzania, sunflower accounts for 12% of the highest income from crop production. This profitability is contingent upon the rate of yield increase for the crop exceeding the rise in production costs per hectare of sown area. Limagrain sunflower hybrids are characterised by strong economic performance. G.V. Pinkovsky and S.P. Tanchyk (2019) determined that net profits from cultivating these hybrids can range between 20,307 and 22,043 UAH/ha.

The results of N. Kondratyuk's (2015) research indicate that, with production costs accounting for 24.5% of sunflower cultivation, a profit of 33% can be achieved. Seeds constituted the largest share of total expenditures (15.0-18.7%), followed by fuel and lubricants (11.3-12.7%). Research by Ye. Domaratskyi and O. Kozlova (2020) revealed that the net profit from sunflower cultivation could reach 26,292 UAH, while the cost price was 3,441 UAH, resulting in a profitability level of 196%. An economic analysis of sunflower cultivation conducted by Y. Tsymbal *et al.* (2022) found that notional net profits can vary depending on crop rotation, ranging between 24.9 and 30.1 thousand UAH/ha, with profitability levels of 176-211%. Sunflower grown in a short rotation crop system with a 20% share provided a notional net profit of 24.9 thousand UAH/ha, achieving profitability of 176%. In this case, the value of gross output was 39.1 thousand UAH. Growing sunflower in eight-field crop rotation with 12.5% crop saturation generated a profit of 29.3 thousand UAH/ha and profitability of 207%, with expenses amounting to 14.18 thousand UAH. Scientists also determined that growing sunflower in a seven-field crop rotation with 14.3% saturation yielded the highest profits. In this scenario, the notional net profit amounted to 30.14 thousand UAH/ha, with a profitability level of 211%. Crops grown in this rotation generated 5.21 thousand UAH/ha more profit compared to the five-field crop rotation and 0.82 thousand UAH/ha more than the eight-field crop rotation.

CONCLUSIONS

Studies have shown that different levels of sunflower saturation in short-term crop rotations influence economic and energy efficiency indicators. The variants with 20 and 40% sunflower saturation achieved the highest notional net profit of 419.4-432.5 USD, with a profitability level of 120-126%. In contrast, the profitability of growing sunflower in a crop rotation with 60% saturation was 100%. Incorporating sunflower into a crop rotation with a 20% share resulted in high energy intensity (77,798 MJ/t) and the highest energy consumption (25,664 MJ/t), which led to an increase in the energy efficiency ratio to 3.03. The variant with 60% sunflower saturation had a lower energy intensity (65,042 MJ/t) and lower energy costs (24,994 MJ/t), with an EER of 2.60. The ratio of energy intensity to energy costs in the variant with 40% saturation in short-term crop rotations was 2.74. To maintain profitability and ensure consistent returns, it is advisable to keep the sunflower share in crop rotations at no more than 40%. An important direction for future research is to assess the adaptive capacity of sunflower under different crop rotation saturations in response to abiotic and biotic stress factors within the conditions of the Left-Bank Forest-Steppe region of Ukraine.

ACKNOWLEDGEMENTS

The authors express their gratitude to the Ministry of Education and Science for recognising the significance of this research. The results presented in this article form the basis of the project "Development of Measures to Ensure Sustainable Productivity of Agrophytocenoses Under the Influence of Abiotic and Biotic Stress Factors" (State registration number 0124U000457).

CONFLICT OF INTEREST

None.

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Ефективність короткоротаційних сівозмін з різним насиченням соняшником

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Анотація. Метою дослідження було визначення економічної та енергетичної ефективності короткоротаційних сівозмін з різним насиченням соняшнику. Економічну та енергетичну ефективність сівозмін з різною часткою соняшнику в умовах Лівобережного Лісостепу України розраховано за допомогою технологічних карт та цін станом на 2024 р. У дослідженні використано такі методи: бібліометричний – аналіз результатів інших науковців щодо економічної та енергетичної ефективності вирощування соняшнику; групування – визначення економічного та енергетичного ефекту від насичення сівозмін соняшником; монографічний – узагальнення отриманих результатів. Встановлено оптимальну частка соняшнику у сівозміні на рівні 20 і 40 %, при яких вартість продукції залишалася стабільно високою 1 218,0-1 240,8 дол./т. Зростання частки соняшнику до 60 % призводить до зниження вартості продукції не тільки для інших культур, але й для самого соняшнику, що негативно впливало на загальну цінову стабільність, знижуючи конкурентоспроможність культур і загальну економічну ефективність сівозміни. Озиме жито демонструвало найнижчі виробничі витрати серед усіх культур не залежно від сівозміни – 268,9-321,1 дол. Витрати на сою і озиму пшеницю залишалися стабільними незалежно від частки соняшнику – 413,5 і 553,7 дол., відповідно, що свідчить про їх адаптивність. Частка соняшнику у сівозміні 20 % мала найвищу енергоємність серед варіантів – 63,348 МДж/га. Насичення на 60 % знижувало цей показник до 63,279 МДж/га. Однак, така сівозміна забезпечила енерговитрати на нижчому рівні порівняно з іншими варіантами – 30,293 МДж. Отримані дані свідчать про високу ефективність сівозміни з часткою соняшнику 60 %, про що свідчить коефіцієнт енергетичної ефективності на рівні 2,65. У результаті впровадження наукової розробки на площі 78,9 га було встановлено, що за рахунок оптимізації сівозмін порівняно з традиційно прийнятими, врожайність насіння соняшнику зросла на 0,16 т/га. Це дозволило отримати додатково 1 046 грн/га чистого прибутку та підвищити рентабельність виробництва на 25,6 %

Ключові слова: економіка сільського господарства; частка соняшнику; сівозміна; енергоефективність