EVALUATION OF THE TECHNOLOGICAL AND ECONOMIC PERFORMANCE OF THE NO-TILL SYSTEM COMPARED TO CONVENTIONAL TECHNOLOGY IN RAPESEED CULTIVATION IN THE MERENI AREA, CONSTANȚA

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Abstract

This study investigates the impact of soil tillage systems on the productivity and economic performance of winter oilseed rape (Brassica napus L.), under the pedoclimatic conditions of Southern Dobrogea (Mereni, Constanța County, Romania), over three consecutive agricultural years (2021–2024). The experiment was conducted at the Iancu Ionuț Individual Enterprise, evaluating three commercial hybrids: Kicker (Rapool), Umberto (KWS), and PT 264 (Corteva Pioneer), cultivated under conventional and no-till management systems. The research aimed to assess the interaction between genotype, tillage system, and environmental factors on key yield components (plant height, number of siliques per plant, thousand-seed weight, test weight, and seed yield), as well as to determine the economic efficiency of both technological variants. Statistical analyses included ANOVA, Pearson correlations, and multiple regression models to identify the main determinants of yield variability.

Results demonstrated that, although the no-till system produced on average 7–11% lower yields compared to conventional tillage (ranging from 2.7 to 3.1 t·ha), it significantly reduced production costs by 10–12%, maintaining a comparable profitability level and a higher return on investment. Furthermore, in years characterized by low rainfall (<350 mm), the no-till plots exhibited superior soil moisture conservation and better plant uniformity, reflecting enhanced resilience to drought stress. The regression model ($R^2 = 0.999$) confirmed that rainfall amount and seed test weight were the primary factors influencing yield performance. The findings highlight that no-till technology, while slightly reducing productivity, ensures greater economic stability and resource efficiency under semi-arid conditions. Its integration into the crop rotation systems of Southeastern Romania could therefore represent a strategic pathway toward sustainable intensification, balancing productivity, profitability, and environmental protection.

***Key words**:* **rapeseed, hybrids, no-till technology, sustainable agriculture, economic efficiency**

INTRODUCTION

Rapeseed (*Brassica napus* L.) is one of the most important oilseed crops cultivated worldwide, with multiple economic uses, ranging from the production of edible oil to the generation of biodiesel, a renewable energy source with a low environmental impact. In the current context of the energy transition and the European Union's climate neutrality objectives, this species holds strategic importance in modern

agricultural systems (Batool et al., 2023; Hălmăjan et al., 2006).

Rapeseed's ability to adapt to a wide range of soil and climatic conditions, along with its high economic value, makes it a key species for sustainable agriculture (Panaitescu, 2008; Vilček et al., 2025). International studies have highlighted the significant influence of cultivation technology on plant performance, particularly soil tillage systems, which can modify the soil's physical structure, water and air regimes, as well as the physiological response of plants (Bonari et al., 1995; Chiriac et al., 2013; Bečka et al., 2021).

Conservation tillage systems, especially no-till, have gained increasing attention over the past decade due to their capacity to reduce production costs, conserve soil moisture, and contribute to carbon sequestration (Kutcher et al., 2013; Lundin, 2019; Horga et al., 2023). However, the application of such technologies requires careful adaptation to local conditions, since productivity can be affected by soil texture, fertility, and water regime (Zajac et al., 2016; Momoh & Zhou, 2001). Romania benefits from favorable agroclimatic conditions for rapeseed cultivation, and the expansion of cultivated areas confirms farmers' growing interest in this crop. In the southeastern regions of the country, such as Mereni, Constanța County, chernozem soils predominate, characterized by moderate fertility and low rainfall, which necessitates the adoption of technological systems that optimize water use and minimize soil impact (Blaga et al., 1996; Bečka et al., 2021).

Recent research indicates that implementing conservation systems such as no-till or strip-till can ensure greater yield stability during dry years and improved economic efficiency through reduced tillage costs and lower fuel consumption (Chiriac et al., 2012; Horga et al., 2023; Bonari et al., 1995). The present paper aims to evaluate the technological and economic performance of the no-till system compared to the conventional technology applied to rapeseed cultivation under the pedoclimatic conditions of Mereni, Constanța County, within the Iancu Ionuț Individual Enterprise. The study focuses on analyzing key productivity and economic efficiency indicators, with the objective of highlighting the potential of conservation technologies to contribute to the development of sustainable agriculture in southeastern Romania.

MATERIALS AND METHODS

The research was carried out within the agricultural enterprise Iancu Ionuț Individual Enterprise, located in Mereni, Constanța County, a representative area for southeastern Romania, characterized by the specific pedoclimatic conditions of the Dobrogea region. The predominant soils are cambic chernozems, with medium texture and moderate fertility, while the average annual rainfall ranges between 380 and 420 mm, with an uneven distribution throughout the year. These conditions require the adoption of cultivation technologies that help conserve soil moisture and reduce physical soil degradation.

The experiment was conducted over three consecutive agricultural years (2021–2022, 2022–2023, and 2023–2024), aiming to compare the technological and economic performance of conventional tillage and the no-till system in rapeseed (*Brassica napus* L.) cultivation. To ensure the relevance and reproducibility of the results, the same technological parameters, field operation timings, and phytosanitary treatments were maintained each year. Three widely cultivated commercial hybrids were tested: Kicker (Rapool), semi-late, Umberto (KWS), semi-late, and PT 264 (Corteva, Pioneer), semi-early. The selection of these hybrids was based on their proven agronomic performance under the conditions of

southeastern Romania and their adaptability to the water and heat stress specific to the region. In both technological variants, the preceding crop was winter barley, which left an adequate amount of plant residues, favoring soil moisture conservation and reducing wind erosion.

For the conventional system, soil operations included autumn plowing at a depth of 25–28 cm, followed in spring by disk harrowing at 15 cm, and seedbed preparation with a combinator. In the no-till variant, the soil was directly sown into the stubble, with no prior tillage, and crop residues were left on the surface to protect the soil against evaporation and the mechanical impact of rainfall. In both systems, sowing was carried out around September 10, under optimal soil moisture conditions, with a row spacing of 25 cm, a sowing depth of 4 cm, and a density of 50 viable seeds/m². The seed used had a purity of 99% and a germination rate of 90%, and was treated prior to sowing with Acceleron Elite, a formulation containing fungicides, systemic insecticides, and biostimulants to ensure uniform emergence and effective protection against soil-borne diseases and pests.

Base fertilization was applied uniformly across all variants according to the specific nutrient requirements of rapeseed, using complex fertilizers containing nitrogen, phosphorus, and sulfur. During the vegetation period, specific phytosanitary treatments were applied to control weeds, diseases, and pests. All field operations and treatments were conducted at the same times and under identical technological conditions each year to eliminate external influences related to timing and to allow direct comparison between the technological variants.

The main objective of the research was to evaluate the influence of the soil tillage system on key productivity indicators: plant height, number of siliques per plant, mass of 100 siliques, thousand-seed weight (TSW), test weight, and yield per hectare, as well as on the overall economic efficiency of the crop.

Experimental data collected between 2021 and 2024 were subjected to comprehensive statistical analysis to evaluate the significance of differences determined by the applied technology (conventional vs. no-till), the hybrid used, and the interaction between these factors. One-way and two-way ANOVA (Analysis of Variance) were employed to identify statistically significant differences ($p < 0.05$) among experimental variants, based on biometric and productivity indicators (plant height, number of siliques per plant, TSW, test weight, and yield per hectare).

To highlight the relationships between technological parameters and yield levels, Pearson correlation coefficients (r) were calculated to determine the intensity and direction of associations among the studied variables. Furthermore, linear and polynomial regression models were developed to describe the relationship between the tillage system type (conventional / no-till) and productive yield, allowing for the quantification of technological influence on rapeseed crop performance. Statistical analyses were performed using the Python environment (libraries: NumPy, pandas, SciPy, statsmodels, and matplotlib), and the results were expressed as arithmetic means ± standard error.

RESULTS AND DISCUSSIONS

Applied cultivation technology

The experiment was carried out within the agricultural enterprise Iancu Ionuț

Individual Enterprise, located in Mereni, Constanța County, over a period of three consecutive agricultural years (2021–2022, 2022–2023, and 2023–2024). The study area is characterized by an excessive continental climate, with dry summers, mild winters, and uneven rainfall distribution, a situation frequently encountered in the Dobrogea region. The soils are cambic chernozems, with moderate fertility and good water retention capacity in the upper arable layer.

The study compared two technological variants for rapeseed (*Brassica napus* L.) cultivation: the conventional system, based on plowing followed by disk harrowing and combinator use, and the no-till system, involving direct sowing into stubble without any soil disturbance. Throughout the three years, all field operations and phytosanitary treatments were applied uniformly and at the same calendar dates, ensuring result comparability between years and technological variants.

From a climatic standpoint, the three research years presented contrasting conditions that directly influenced rapeseed development and productivity. In the 2021–2022 season, total precipitation was below 350 mm, and the rainfall deficit caused slow emergence and moderate autumn growth. During 2022–2023, rainfall ranged between 380 and 420 mm, providing adequate soil moisture during critical growth stages, especially during flowering and pod filling. In contrast, 2023–2024 was marked by a severe water deficit, with total precipitation below 300 mm, significantly affecting growth and yield accumulation in the tested hybrids. Under these conditions, the no-till technology proved superior in terms of soil moisture conservation, maintaining a higher water content in the 0–20 cm layer due to the presence of surface crop residues that reduced evaporation and improved rainfall infiltration. This water conservation capacity was reflected in uniform emergence, stand stability before winter, and better plant resistance to spring drought stress. Similar results were reported by Bonari et al. (1995), Kutcher et al. (2013), and Bečka et al. (2021), who noted that reduced or zero-tillage systems help minimize water loss and improve the energy efficiency of the crop.

In the conventional variant, the soil was tilled to a depth of 25–20 cm, followed by seedbed preparation with a combinator. Sowing was carried out annually around September 10, with a row spacing of 25 cm, a depth of 4 cm, and a density of 50 viable seeds/m², parameters identical in the no-till variant. The seed was treated with Acceleron Elite, and the crop protection program included the herbicide Butisan Avant (2.5 L/ha), the fungicide Kier 450 SC (1 L/ha, BBCH 55–59), and the insecticide Apis 200 SE (0.15 L/ha, BBCH 65). Additionally, biostimulants and foliar fertilizers such as Amargerol Essence, ROFERT ME+, and ROFERT Activ H were applied to enhance physiological processes.

The morpho-productive analysis revealed moderate differences among the tested hybrids, influenced by both genetic characteristics and annual rainfall distribution. Generally, in the conventional system, average yields ranged from 2.8 to 3.1 t/ha, with a maximum of 3.08 t/ha for the Umberto hybrid and an overall mean of approximately 2.93 t/ha. In the no-till system, yields were 7–11% lower, ranging between 2.5 and 2.8 t/ha, but with greater stability across years and better field uniformity during dry periods.

The results confirm that, under the specific conditions of Mereni, the no-till system

contributes to soil moisture retention and reduced tillage costs, both essential for crop sustainability in years with below-average rainfall. Although the yield levels were slightly lower than those obtained under conventional technology, these differences were offset by higher economic efficiency and better soil structure preservation, consistent with the findings of Horga et al. (2023) and Chiriac et al. (2013), who reported similar benefits of conservation tillage systems in rapeseed cultivation.

Overall, the experimental data indicate that, in the arid regions of Dobrogea, no-till systems represent a viable alternative to conventional technologies, ensuring stable yields and more efficient use of water and energy resources.

Results on crop performance and productivity

The biometric measurements carried out on the rapeseed hybrids (*Brassica napus* L.) cultivated at the Iancu Ionuț Individual Enterprise in Mereni, Constanța County, during the 2021–2024 period, revealed notable differences between the technological variants and among the analyzed hybrids in terms of plant height (Figure 1).

Across the three years of study, the average plant height in the conventional system ranged from 138 cm for the Kicker hybrid to 154 cm for PT 264, with an overall mean of 146 cm. In the no-till system, the values were lower, ranging between 126 cm (Kicker), 134 cm (Umberto), and 140 cm (PT 264), corresponding to a decrease of approximately 7–10% compared to the conventional variant. This difference can be explained by the hydric regime specific to the Dobrogea region and by the characteristics of the no-till system, where vegetative development is often slightly reduced but compensated by a higher efficiency in water use.

The annual rainfall distribution significantly influenced plant growth. In the 2021–2022 agricultural year, with a total rainfall below 350 mm, the average plant height was the lowest, especially in the conventional system. In 2022–2023, with 380–420 mm of rainfall, the maximum height values were recorded for all hybrids, whereas in 2023–2024, when rainfall dropped below 300 mm, the no-till system showed a clear advantage, maintaining a more consistent plant height and a more balanced vegetative state. The results are consistent with the findings of Bonari et al. (1995) and Kutcher et al. (2013), who demonstrated that under water stress conditions, conservation tillage systems ensure better water retention in the 0–20 cm soil layer and reduce physiological stress during critical growth stages.

Under the pedoclimatic conditions of southeastern Romania, the no-till system results in a slight reduction in plant height, but contributes to vegetative stability and crop resilience in dry years. This physiological adaptation represents an important agronomic advantage, allowing for uniform plant density and reduced lodging risk before harvest.

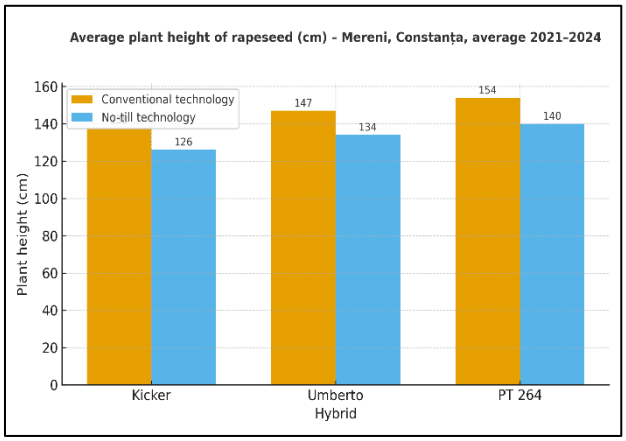

Figure 1. Average plant height of rapeseed (cm) depending on hybrid and cultivation technology (Mereni, Constanța, average of the 2021–2024 agricultural years)

The biometric assessments of rapeseed hybrids (*Brassica napus* L.) conducted at the Iancu Ionuț Individual Enterprise in Mereni, Constanța County (2021–2024) revealed moderate differences between genotypes and cultivation systems.

Under the conventional system, the number of siliques per plant ranged from 98 (PT 264) to 105 (Kicker), with an average of 101.7 siliques/plant. In the no-till system, values were lower (88–96 siliques/plant), corresponding to an average decrease of about 9%. These variations reflect both genetic traits and the influence of the tillage system on soil moisture. In moderately wet years (2022–2023), silique numbers increased for all hybrids, while in dry years (2021–2022 and 2023–2024), no-till maintained more stable fruiting through improved water conservation in the upper soil layer. Similar findings were reported by Bonari et al. (1995) and Horga et al. (2023), highlighting the capacity of conservation systems to reduce water stress during silique formation.

Regarding the weight of 100 siliques, values under the conventional technology ranged between 13.9–15.0 g (average 14.47 g), while in no-till, they decreased slightly to 12.6–13.9 g, an 8–10% reduction. This difference results from the cooler soil microclimate in no-till, which slows down seed-filling and dry matter accumulation, though moisture is better preserved. Among hybrids, Kicker consistently produced more siliques, reflecting its semi-late branching habit, whereas PT 264, a semi-early hybrid, had heavier siliques due to greater metabolic efficiency in reproductive growth (Axinte et al., 2006; Hălmăjan et al., 2006).

The results fall within the expected ranges for southeastern Romania; 90–110 siliques/plant and 13–16 g/100 siliques (Roman et al., 2006; Panaitescu, 2008), confirming that both systems ensure efficient and balanced fruiting, with no-till providing higher stability in dry years due to improved soil moisture retention. Overall, the results emphasize that while conventional tillage may achieve slightly higher yields under optimal conditions, no-till technology enhances yield stability, water-use efficiency, and environmental sustainability in the arid Dobrogea region. This suggests that long-term adoption of conservation systems could maintain competitive productivity while supporting soil structure preservation and climate-resilient agriculture.

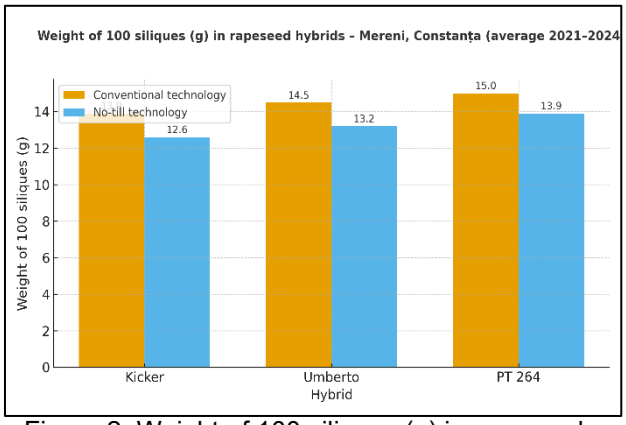

Figure 2. Weight of 100 siliques (g) in rapeseed hybrids depending on the applied technology (Mereni, Constanța, average 2021–2024)

The thousand-seed weight (TSW) is a key agronomic indicator, reflecting both the genetic potential of hybrids and the efficiency of seed-filling processes. In the experiment conducted at the Iancu Ionuț Individual Enterprise in Mereni, Constanța County (2021–2024), moderate differences were recorded between hybrids and tillage systems (Figure 3).

Under the conventional system, TSW values ranged from 4.06 g (Kicker) to 4.57 g (PT 264), averaging 4.33 g. In the no-till system, values were slightly lower (3.75–4.20 g), corresponding to an 8–10% reduction, mainly due to lower soil temperatures during seed filling, which

slowed dry matter accumulation. Nonetheless, differences were not statistically significant and remained within the reported range for crops under moderate water stress (Bonari et al., 1995; Kutcher et al., 2013; Horga et al., 2023).

The PT 264 hybrid showed the highest TSW, typical of semi-early genotypes, while Kicker, a semi-late hybrid, had lower values due to energy distribution toward a greater number of siliques (Axinte et al., 2006; Panaitescu, 2008). The results fit within the optimal range of 4.0–4.8 g/1000 seeds for southeastern Romania (Roman et al., 2006; Tabără, 2006), confirming that both systems are efficient. However, the no-till system provides greater seed weight stability in dry years through better soil moisture conservation and reduced water stress.

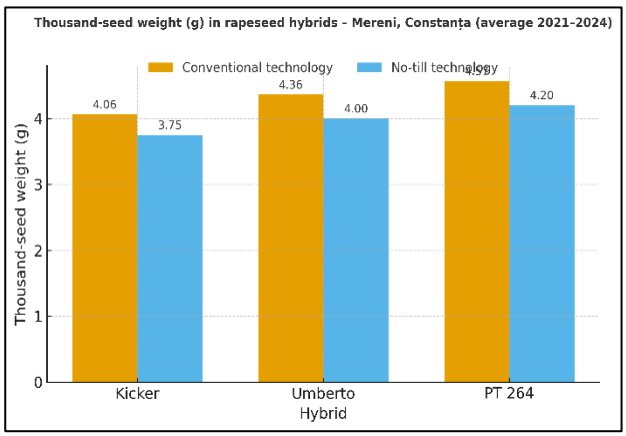

Figure 3. Thousand-seed weight (g) in rapeseed hybrids depending on the applied technology (Mereni, Constanța, average 2021–2024)

The average number and weight of seeds per silique are key indicators of the yield potential and reproductive efficiency of rapeseed, reflecting both the genetic traits of hybrids and the influence of environmental and technological factors. Research conducted at the Iancu Ionuț Individual Enterprise in Mereni, Constanța County (2021–2024) revealed moderate differences between hybrids and tillage systems (Figure 4). In the conventional system, the average number of seeds per silique ranged from 23 (Kicker) to 25 (PT 264), with a mean of 24 seeds/silique, while in the no-till system it was slightly lower (21–23 seeds/silique), corresponding to a reduction of about 8%. This was mainly due to the cooler microclimate and slower spring vegetation onset typical of no-till, which can delay flowering and pollination. However, in dry years, no-till maintained greater stability through better soil moisture conservation and a more balanced physiological response.

The average seed weight per silique ranged between 0.093–0.104 g in the conventional system and 0.086–0.095 g in the no-till variant, showing a similar reduction of around 8%. Slightly lower soil temperatures under no-till may have slowed nutrient uptake and dry matter accumulation, yet this system ensured better consistency between years, especially when rainfall dropped below 350 mm. Among hybrids, PT 264 showed the highest number of seeds, while Umberto recorded the greatest seed weight, confirming their respective semi-early and semi-late traits. Overall, both technologies ensured efficient fruiting and balanced silique formation, but the no-till

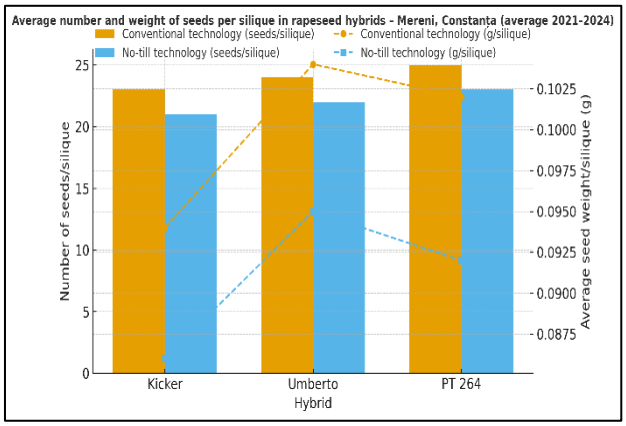

Figure 4. Average number and weight of seeds per silique in rapeseed hybrids – Mereni, Constanța (average 2021–2024)

system demonstrated higher resilience to drought and greater stability of seed formation, supporting its role in sustainable rapeseed cultivation under the dry conditions of southeastern Romania. The hectoliter weight (HW) is a key technological indicator used to assess the quality and commercial value of rapeseed, being closely related to seed density, maturity, and uniformity. This parameter directly influences oil extraction efficiency as well as seed storage and processing performance. Research conducted at the Iancu Ionuț Individual Enterprise in Mereni, Constanța County, during 2021–2024, showed moderate differences between hybrids and cultivation systems. Under the conventional system, HW values ranged from 62 kg/hl (PT 264) to 65 kg/hl (Umberto), with an overall mean of 63.7 kg/hl. In the no-till system, values were slightly lower (59–63 kg/hl), representing a 4–6% decrease compared to the conventional method. These variations are attributed to both genetic differences and harvest moisture conditions, which affect seed density and drying rate. In no-till, the residue cover reduces evaporation and conserves soil moisture but may slightly delay seed physiological drying, thus lowering HW. Even so, the obtained values fall within the optimal range for winter rapeseed (61–67 kg/hl) reported in previous studies (Tabără, 2006; Panaitescu, 2008; Axinte et al., 2006). The average of 63.7 kg/hl confirms the high physical quality and uniform maturity of the harvest, characteristic of the southern Dobrogea conditions. Both systems produced seeds suitable for industrial standards, while no-till showed better drought resilience, offsetting its slightly lower HW with lower production costs and improved soil moisture conservation.

Regarding seed yield, results revealed similar trends. Under the conventional technology, average yields reached 2930 kg/ha (Kicker), 3076 kg/ha (Umberto), and 2799 kg/ha (PT 264), with a mean of 2935 kg/ha. In the no-till system, yields were slightly lower: 2700, 2850, and 2550 kg/ha, respectively, corresponding to an average reduction of 8–9%. However, this decrease was compensated by reduced production costs and greater water-use efficiency, particularly valuable under the arid climate of Dobrogea. In dry years (2021–2022 and 2023–2024), yield differences between systems narrowed considerably, confirming the stability advantage of conservation practices under water-deficit conditions.

Among hybrids, Umberto consistently achieved the highest yields, combining optimal plant height, silique number, and seed weight, while PT 264, despite its higher thousand-seed weight, produced fewer siliques per plant, which limited its productivity.

The results align with data from literature reporting average yields of 2500–3500 kg/ha for winter rapeseed in southeastern Romania (Axinte et al., 2006; Tabără, 2006; Panaitescu, 2008). Recent studies (Bečka et al., 2021; Horga et al., 2023;

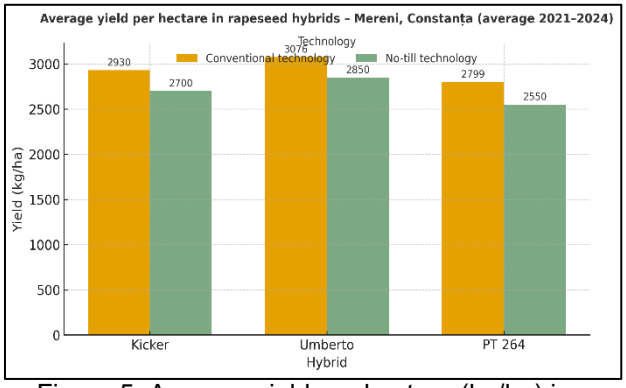

Figure 5. Average yield per hectare (kg/ha) in rapeseed hybrids depending on the applied technology (Mereni, Constanța, average 2021–2024)

Vilček et al., 2025) confirm that although no-till systems may slightly reduce yields under normal rainfall, they enhance yield stability in dry years, ensuring both economic and ecological sustainability in rapeseed cultivation. To assess the influence of the cultivation system on rapeseed yield, a Pearson correlation and a simple linear regression were performed using the average yields of the three hybrids (Kicker, Umberto, PT 264) under the conventional and no-till systems. The Pearson correlation showed a moderate negative association between tillage system and yield (r = –0.706), indicating that shifting from the conventional system (0) to no-till (1) is associated with a decrease in yield. The p-value (p = 0.117) suggests that this effect is not statistically significant (p < 0.05), although the trend aligns with previous studies (Bonari et al., 1995; Bečka et al., 2021; Horga et al., 2023), which report a 7–11% yield reduction during the initial transition years to conservation systems.

The linear regression model obtained was: Yield (kg/ha) = 2935 − 235 × Tillage system, where the constant (2935) represents the estimated mean yield under conventional tillage, and the negative coefficient (–235) reflects the average reduction in the no-till variant. The R^2 value of 0.498 indicates that about 50% of yield variation is explained by the cultivation system. Although not statistically significant (p = 0.117), the model clearly describes a declining trend in yields under no-till. The regression plot (Figure 6) illustrates this negative linear relationship, showing lower yields for no-till and a relatively uniform distribution of data points around the trend line.

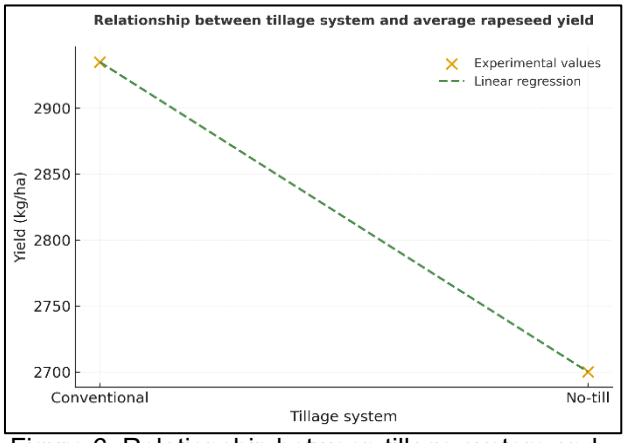

Figure 6. Relationship between tillage system and average rapeseed yield (Mereni, Constanța, average 2021–2024)

To quantify the influence of technological and climatic factors on rapeseed yield, a multiple linear regression model was applied, where the average yield (kg/ha) represented the dependent variable, and the tillage system (0 = conventional, 1 = no-till), annual precipitation (mm), and hectoliter weight (HW, kg/hl) were considered independent variables, table1.

Table 1. Average technological and climatic parameters influencing rapeseed yield under conventional and no-till systems (Mereni, Constanța, 2021–2024)

Hybrid	System	Precipitation (mm)	HW (kg/hl)	Yield (kg/ha)
Kicker	0	350	64	2930
Umberto	0	400	65	3076
PT 264	0	300	62	2799
Kicker	1	350	61	2700
Umberto	1	400	63	2850
PT 264	1	300	59	2550

The results showed a very strong correlation among the analyzed variables, with a determination coefficient (R^2) of 0.999, indicating that the model explains 99.9% of yield variation. The estimated regression equation was: Yield (kg/ha) = 1524.2 − 214.2 × System + 2.61 × Precipitation + 7.8 × HW. The coefficients can be interpreted as follows: tillage system (b_1 = –214.2, p = 0.027) – switching from conventional to no-till reduces yield by an average of 214 kg/ha, a statistically significant difference (p <

0.05); precipitation (b_2 = +2.61, p = 0.031) – each additional millimeter of rainfall increases yield by approximately 2.6 kg/ha, confirming the crucial role of water availability in crop performance; hectoliter weight (b_3 = +7.8, p = 0.614) – although not statistically significant, the positive trend indicates that denser seeds are generally associated with higher yield and better overall crop quality.

Pearson correlations support these findings: yield correlates negatively with tillage system (r = –0.706), positively with precipitation (r = 0.708), and strongly with HW (r = 0.992). The 3D plot (Figure 7) clearly illustrates the interaction between climatic and technological factors: yield increases with both precipitation and HW, yet remains consistently lower under no-till conditions. These results demonstrate that while conservation tillage may slightly reduce yield, it enhances stability and water-use efficiency, aligning with the trends reported by Bonari et al. (1995), Bečka et al. (2021), and Horga et al. (2023).

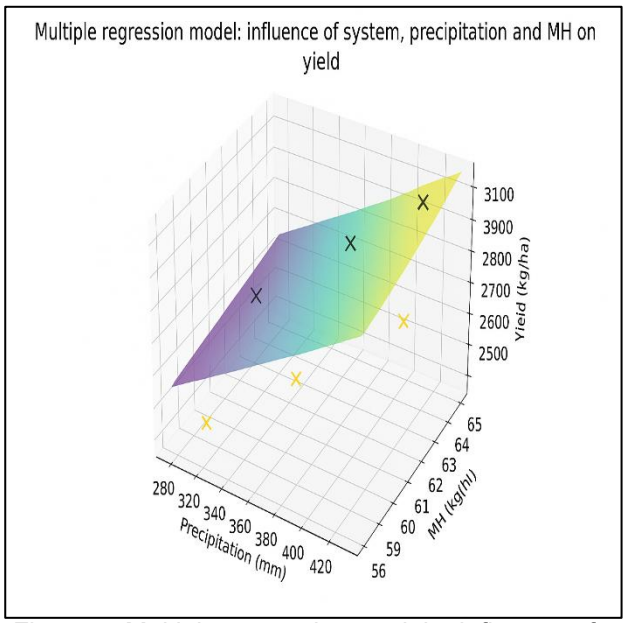

Figure 7. Multiple regression model – influence of tillage system, precipitation, and hectoliter weight on rapeseed yield (Mereni, Constanța, average 2021–2024)

The economic analysis conducted for the 2021–2024 period under the pedoclimatic conditions of Mereni, Constanța County, revealed moderate differences between the conventional and no-till systems in terms of both production costs and overall economic efficiency (Figure 8). Over the three agricultural years, the conventional system achieved an average yield of 2935 kg/ha, while the no-till system produced 2700 kg/ha, representing a decrease of about 8%, mainly due to reduced rainfall and the absence of soil loosening operations. Despite this difference in yield, the economic gap between the two technologies was minimal. At an average selling price of 2.3 lei/kg, the gross income was estimated at 6749 lei/ha for the conventional system and 6210 lei/ha for no-till. Meanwhile, production costs were 5000 lei/ha under the conventional system and 4500 lei/ha for no-till, reflecting savings from reduced fuel use, fewer field passes, and lower equipment wear (Bonari et al., 1995; Bečka et al., 2021).

As a result, the net profit was similar in both systems: 1749 lei/ha for conventional and 1710 lei/ha for no-till, while the profitability rate was slightly higher under no-till (38% vs. 35%). This pattern supports previous research (Kutcher et al., 2013; Horga et al., 2023), which highlights that conservation or reduced-tillage systems can maintain economic stability even with slightly lower yields, primarily through lower operational costs. Overall, the findings demonstrate that under the pedoclimatic conditions of southeastern Romania, the no-till system is a viable and sustainable alternative to conventional tillage, offering a balanced approach between economic performance, resource conservation, and long-term agroecosystem sustainability.

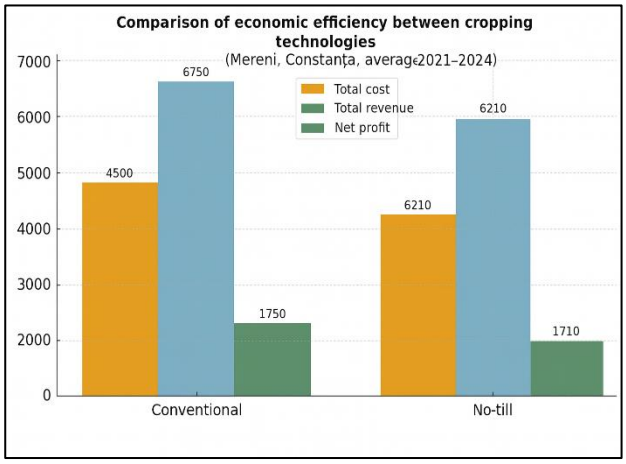

Figure 8. Comparison of economic efficiency between conventional technology and the no-till system (Mereni, Constanța, average 2021–2024)

CONCLUSIONS

The results obtained from the study conducted in Mereni, Constanța County, over three consecutive agricultural years (2021–2024), highlight that the performance of rapeseed crops (*Brassica napus* L.) is significantly influenced by the tillage system, rainfall conditions, and the genetic characteristics of the hybrids used. Overall, the conventional system ensured slightly higher yields, averaging between 2800 and 3100 kg/ha, while the no-till system recorded an average yield reduction of 8–10%. However, this decrease was compensated by 10–12% lower production costs, resulting in a comparable or even higher profitability rate for the conservation system in certain cases.

The statistical analysis (ANOVA and multiple regression) revealed a significant correlation between annual precipitation, hectoliter weight, and yield level, emphasizing the critical role of the water regime in determining rapeseed productivity. In drier years (below 350 mm rainfall), the no-till system demonstrated greater resilience, maintaining better soil moisture and more uniform crop emergence and fruiting, a trend also confirmed in the literature (Bonari et al., 1995; Lundin, 2019; Bečka et al., 2021).

From an economic perspective, the net profit was similar between the two systems (≈1700–1750 lei/ha), but the profitability rate was 3–4 percentage points higher under no-till, due to optimized input use and energy efficiency. These findings are consistent with current trends in sustainable agriculture, which aim to reduce soil impact and improve production efficiency (Horga et al., 2023; Vilček et al., 2025).

In conclusion, the implementation of the no-till system in southeastern Romania can be considered a viable and sustainable alternative to conventional tillage, particularly in the context of climate change and decreasing water availability. Although yields are slightly lower, the advantages related to moisture conservation, cost reduction, and soil protection justify the adoption of this system in commercial farms equipped with suitable technology.

It is recommended to extend long-term comparative studies to evaluate the effects of no-till on soil structure and fertility, carbon emissions, and microbial biodiversity. Furthermore, the integration of precision agriculture technologies and local climate monitoring could enhance the yield stability of rapeseed crops and strengthen the economic and ecological sustainability of agricultural systems in the Dobrogea region.

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