

STUDY OF YIELD QUANTITY AND ECONOMICAL IMPACT OF MAIZE OBTAINED IN A PRIVATE FARM LOCATED IN MACEA MICROZONE, ARAD COUNTY

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Abstract

This paper investigates the yield efficiency of maize cultivated in a private farm located in Macea, Romania. The study spans two agricultural years, 2024 and 2025, and involves eight commercial maize hybrids developed by three major seed companies. Field experiments were conducted to monitor and compare the performance of these hybrids in terms of grain yield. The average grain yield achieved in 2024 was 3,963 kg/ha, while in 2025 it declined to 2,920 kg/ha, likely reflecting interannual climatic variability and other environmental factors. Despite the lower yield in 2025, the market selling price increased from 0.70 RON/kg in 2024 to 0.80 RON/kg in 2025, partially compensating for the production drop. The study offers a practical assessment of maize productivity in a private farming context and highlights the influence of hybrid selection, seasonal conditions, and market trends on crop efficiency. The results are relevant and aiming to optimize maize production under field conditions in Western Romania and similar agroecological regions. Further investigations integrating input use and cost-efficiency analysis could provide a more comprehensive picture of farm-level maize performance.

Key words: maize, corn hybrids, agriculture technology, impact, economic impact.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops worldwide, with major roles in food, feed, biofuel production, and industrial processing. Its wide adaptability to different pedoclimatic conditions has enabled its cultivation across diverse agricultural systems, from subsistence farming to highly intensive production systems. In Romania, maize occupies a central position in the cereal economy, accounting for a substantial share of the cultivated cereal area and contributing significantly to national agricultural output (Vili, 2022; Popescu et al., 2021).

The productivity of maize depends on the interaction between genetic potential, environmental conditions, and crop management practices. Among these factors, hybrid selection plays a decisive role because modern maize hybrids combine high yield potential with improved tolerance to abiotic stress, particularly drought and heat stress

(Tollenaar & Lee, 2011). The development and adoption of hybrid maize varieties have represented one of the most important technological advances in cereal production, mainly due to the heterosis effect, which improves plant vigor, biomass accumulation, and grain yield stability compared with open-pollinated varieties (Duvick, 2005; Tollenaar et al., 2017).

Despite favorable pedoclimatic conditions, Romania has often recorded maize yields below its production potential. Previous analyses have indicated that, between 1961 and 2013, the national average yield exceeded 4 t/ha only in a limited number of years, suggesting persistent constraints related to technology adoption, climatic variability, and management practices (Halmajan, 2017). In this context, the evaluation of maize hybrids under local field conditions remains essential for identifying cultivars that combine high productivity with adaptability and yield stability.

Environmental adaptation is particularly important in regions where seasonal variability influences crop performance. Water availability during flowering and grain filling is one of the main factors affecting maize yield, while temperature stress, soil fertility, and nutrient availability further contribute to differences among hybrids (Bänziger et al., 2000; Lobell et al., 2014; Ray et al., 2015). Regional and farm-level trials therefore provide practical information on genotype $\times$ environment interactions and support more accurate hybrid selection for specific agroecological conditions. Western Romania, including Arad County, is one of the country's relevant maize-growing regions due to its fertile soils and generally favorable climatic conditions. However, even in this region, yield variability may occur as a result of annual weather fluctuations and differences in crop management. Farm-level research is especially useful because it evaluates crop performance under real production conditions, where environmental, technological, and economic factors interact simultaneously (Van Es & Woodard, 2017).

In addition to agronomic performance, economic efficiency is increasingly important in maize production. High grain yield does not automatically ensure profitability, as farm outcomes also depend on production costs, selling prices, and market fluctuations. Therefore, integrating yield results with market-based indicators provides a more practical assessment of maize production efficiency at farm level (Kay et al., 2016).

The novelty of this study lies in the farm-level assessment of commercial maize hybrids under real production conditions in Macea, Arad County, Western Romania, by integrating agronomic performance with a basic economic evaluation based on market selling price and gross revenue. Unlike controlled experimental trials, this approach reflects the practical conditions faced by private farms and provides directly applicable information for hybrid selection and production planning.

Therefore, the objectives of this study were to compare the grain yield performance of eight commercial maize hybrids cultivated under private farm conditions in Macea, Western Romania, to assess the influence of interannual variability on maize productivity during the

2024 and 2025 agricultural years; and to evaluate the economic efficiency of maize production using selling price and gross revenue per hectare as practical farm-level indicators.

MATERIALS AND METHODS

Biological Material and Crop Management

The study was conducted under commercial farming conditions on a private farm located in the Macea microzone, Arad County, Western Romania, during the 2024 and 2025 growing seasons. The objective was to evaluate the agronomic performance and economic efficiency of commercial maize hybrids cultivated under the technological conditions specific to the farm.

Eight commercial maize hybrids developed by major seed companies were included in the study. The hybrids were selected based on maturity group, agronomic characteristics, yield potential, and suitability for the pedoclimatic conditions of the western Romanian Plain. The evaluated hybrids belonged to different maturity classes, providing a broad range of genetic backgrounds and adaptation strategies. Their principal agronomic characteristics, including maturity classification, FAO group, and thousand-kernel weight (TKW), are presented in Table 1.

The total maize-cultivated area of the farm was 200 ha in both agricultural years; however, the area allocated to each hybrid varied according to farm management decisions and production planning objectives. Depending on the agricultural season and the production strategy adopted by the farm, the cultivated area assigned to individual hybrids ranged from 15 to 45 ha in 2024 and from 15 to 40 ha in 2025.

All hybrids were cultivated using the same general crop management practices, including soil preparation, fertilization, weed control, and harvesting operations, in order to minimize management-related variability among hybrids. The study was organized as a comparative on-farm field evaluation. Maize hybrid represented the primary comparison variable, while agricultural year represented the temporal component of the study. Because the research was conducted under real commercial farming conditions, it followed a comparative farm-

scale evaluation approach rather than a fully randomized and replicated experimental design. The experimental unit was represented by the commercial field area cultivated with each individual maize hybrid. Grain yield and economic performance were evaluated separately for each hybrid in each agricultural year, allowing comparative assessment of agronomic and economic performance under practical farming conditions. No formal randomization procedure or experimental replications were established, as hybrid placement and cultivated area were determined by operational and management considerations specific to the farm. Consequently, the results should be interpreted as a comparative assessment of hybrid performance under commercial production conditions rather than as inference derived from a strictly controlled experimental trial.

Table 1. Maize hybrid selected for cultivation on the farm

Hybrid	Maturity group	FAO Group	TKW
Pioneer P0217	Semi-early	420	390-420
Pioneer P0710	Late	450	430-450
Pioneer P0450	Semi-late	450	420-445
Pioneer P0412	Semi-late	480	420-445
Pioneer P9889	Semi-late	350	400-425
RAGT Urbanix	Semi-late	420	310-330
Dekalb 5075	Semi-late	400-440	300-350
Dekalb 4611	Semi-early	350-390	300-350

The maize crop was established on a well-prepared seedbed, characterized by loose soil structure, adequate depth, absence of hardpan, good surface crumbling, adequate soil moisture, and low weed infestation. Autumn ploughing was performed at a depth of 28-30 cm. Before sowing, the seedbed was prepared by a single pass with a combinator at a depth of 7-8 cm. This operation ensured seedbed uniformity, preserved soil moisture, and reduced the risk of compaction caused by repeated field passes. Sowing was carried out during the last decade of April, on 24-25 April. Certified and calibrated seed was used, with 99% physical purity and germination exceeding 97%. The seeding rate was 75,000 kernels ha⁻¹, with a sowing depth of 6-7 cm and 70 cm row spacing. Sowing was performed mechanically using precision seed drills.

Before sowing, seeds were treated with fungicidal and insecticidal products to protect seedlings during the early growth stages. Seed treatment included Maxim XL, containing 25 g L⁻¹ fludioxonil and 10 g L⁻¹ metalaxyl-M, for protection against soil-borne pathogens such as *Fusarium* spp. and *Pythium* spp. Seeds were also treated with Seedoprid, containing imidacloprid 600 g L⁻¹, for protection against early-season pests, including *Tanymecus dilaticollis*, *Agriotes lineatus*, and *Diabrotica virgifera virgifera*. Weed control was carried out chemically through pre-emergence and post-emergence treatments. Immediately after sowing, pre-emergence weed control was applied using Guardian at 2.5 L ha⁻¹ in 2024 and Adengo at 0.4 L ha⁻¹ in 2025. Post-emergence weed control was performed in both years using Mustang at 0.5 L ha⁻¹ in combination with Gat Motion at 1.5 L ha⁻¹. Mustang was used for the control of thermophilic dicotyledonous weeds, while Gat Motion targeted annual monocotyledonous weeds and perennial grass weeds propagated by rhizomes, particularly *Sorghum halepense* and *Agropyron repens*.

Yield Determination and Economic Relevance

Grain yield was used as the main agronomic indicator for evaluating hybrid performance. Harvesting was performed mechanically, and grain production was recorded automatically by the harvesting machine. The obtained production was expressed as standard grain yield in kg ha⁻¹, adjusted to standard grain moisture, allowing comparison among hybrids and between agricultural years.

For each hybrid and year, yield data were used to calculate mean yield, yield difference between years, relative yield reduction, and performance compared with the annual average. These indicators were used to assess hybrid productivity, yield stability, and adaptation to the pedoclimatic conditions of the study area.

Soil and Climatic Conditions

The experimental field is located in the Macea microzone, Arad County, Western Romania, within the western Romanian Plain, part of the Pannonian Basin. The area is characterized by

fertile soils and climatic conditions generally favorable for maize cultivation.

The dominant soils are chernozems, with medium to high humus content, good structure, and favorable water-holding capacity. Their loam to clay-loam texture supports adequate aeration, permeability, root development, and nutrient uptake. These soil characteristics are suitable for maize cultivation because the crop requires deep, well-structured soils with good moisture retention and moderate to high fertility.

The climate of the area is temperate-continental, with warm summers and moderate precipitation. Climatic conditions during the maize growing season, from April to

September, were analyzed for the 2024 and 2025 agricultural years and compared with multiannual averages for the Arad region.

Temperature conditions during both experimental years were generally close to the regional climatic norms, with average monthly temperatures ranging from approximately 14-15°C in April to 25-26°C in July-August. These values correspond to favorable thermal conditions for maize germination, vegetative growth, flowering, and grain filling.

Precipitation distribution during the growing season showed higher rainfall in May and June, when monthly values reached approximately 65-82 mm.

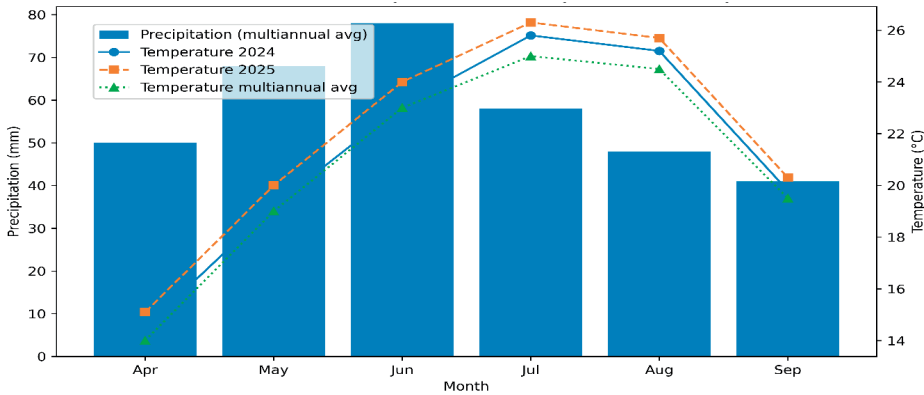


Figure 1. Climatic conditions during the maize growing season

This period coincides with the phase of intensive vegetative growth, when water availability supports biomass accumulation and reproductive organ formation. During July and August, precipitation decreased to approximately 45-60 mm, which is characteristic of the regional climatic pattern. Although these values did not indicate severe drought, reduced rainfall during the reproductive and grain-filling stages may have contributed to differences in hybrid productivity between years.

Overall, the pedoclimatic conditions of the Macea microzone correspond well to the ecological requirements of maize. However, interannual variation in temperature and precipitation distribution may influence hybrid performance, especially during the critical stages of tasseling, silking, and grain filling (Figure 1).

Statistical Analysis and Data Processing

The collected data were processed using Microsoft Excel 365. Descriptive statistical indicators, including mean values, year-to-year comparisons, and relative differences among hybrids, were used to characterize agronomic and economic performance under commercial farming conditions.

Economic indicators were calculated based on grain yield, input costs, and market prices recorded during each agricultural season. Comparative analyses were performed to evaluate differences in productivity and economic performance among hybrids and between years.

Because the study was conducted as a comparative on-farm evaluation under commercial production conditions without formal randomization or experimental replication, the statistical assessment focused primarily on

descriptive and comparative analyses rather than inferential statistical testing.

RESULTS AND DISCUSSIONS

Maize productivity was influenced by the combined effect of hybrid genetics, seasonal climatic conditions, and crop management. The comparison between 2024 and 2025 showed clear differences in grain yield, confirming that interannual variability strongly affected maize performance under the conditions of the western Romanian Plain. The analysis focused on identifying differences in hybrid productivity, examining the influence of

environmental conditions on yield variability, and assessing the economic implications of maize cultivation under farm-level management. Attention was given to the relationship between climatic conditions recorded during the study period, hybrid adaptability, and the resulting economic outcomes of maize production.

The results presented in this section therefore provide an integrated evaluation of agronomic performance and production economics, highlighting the importance of hybrid selection and adaptive management strategies for maintaining productivity and profitability under variable environmental conditions.

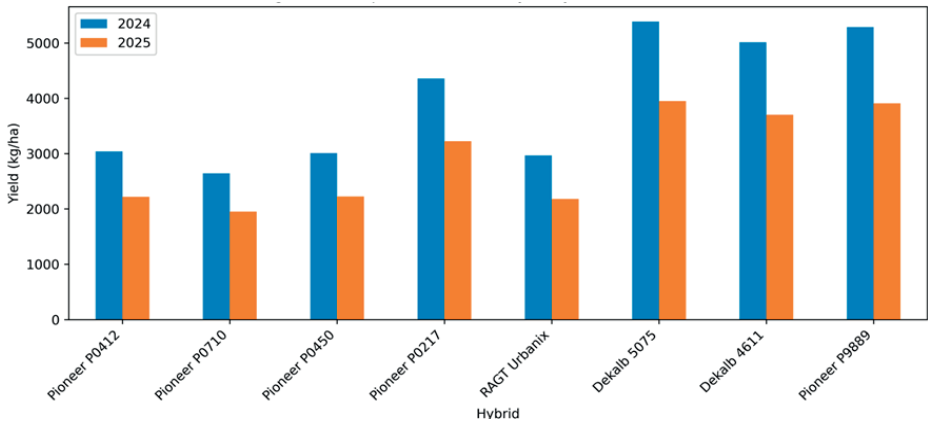


Figure 2. Comparison of maize hybrid yields (2024 vs 2025)

Figure 2 highlights the variability in grain yield among the eight maize hybrids evaluated during the 2024 and 2025 growing seasons. Dekalb 5075 and Pioneer P9889 recorded the highest grain yields in both years, whereas Pioneer P0710 consistently produced lower yields under the environmental conditions of the study area. The observed variation among hybrids confirms the importance of genotype selection for maize production under the pedoclimatic conditions specific to the western Romanian Plain.

The reduction in average grain yield from 3,821 kg ha⁻¹ in 2024 to 2,924 kg ha⁻¹ in 2025 suggests a strong influence of seasonal climatic variability on maize productivity. As presented in the climatic analysis, the second growing season was characterized by less favorable moisture conditions during critical developmental stages, which may have

negatively affected grain formation and kernel filling. Similar responses have been reported by Grassini et al. (2015), who identified water deficits during flowering and grain filling as major determinants of yield reduction in maize production systems.

The comparatively higher productivity observed for Dekalb 5075 and Pioneer P9889 across both seasons suggests better adaptation to the environmental conditions of the study area. Previous studies have shown that hybrid-specific responses to climatic variability may substantially influence final grain yield through differences in phenology, resource-use efficiency, and the ability to maintain productivity under environmental stress (Tollenaar & Lee, 2011; Lobell et al., 2014).

Overall, the results indicate that hybrid choice remains a key agronomic decision for improving productivity and reducing

production risk under increasingly variable climatic conditions.

Table 2. Main input costs for maize cultivation (2024–2025)

Input	2024 cost (RON)	2025 cost (RON)
Fuel	56595	76125
Urea fertilizer	93600	96400
Calcium nitrate	89500	85500

Table 2 summarizes the principal operational costs associated with maize production during the 2024 and 2025 growing seasons. The results indicate that production expenditures were influenced by both seasonal economic conditions and farm management decisions regarding hybrid allocation and input use. Although the overall cost structure remained relatively similar between years, variations in selected input categories contributed to differences in total production costs. These results provide the economic framework necessary for interpreting the relationship between production costs, grain yield, and farm profitability discussed in the following sections.

Table 3. Grain yield of maize hybrids during the 2024–2025 seasons

Hybrid	Yield 2024 (kg/ha)	Yield 2025 (Kg/ha)
Pioneer P0217	4358	3224
Pioneer P0710	2642	1951
Pioneer P0450	3010	2225
Pioneer P0412	3041	2218
Pioneer P9889	5288	3908
RAGT Urbanix	2967	2181
Dekalb 5075	5387	3949
Dekalb 4611	5013	3702

Table 3 presents the grain yield obtained by the evaluated maize hybrids during the 2024 and 2025 growing seasons. Yield performance varied considerably among hybrids and between years, indicating the influence of both genetic background and seasonal growing conditions on maize productivity. Across all hybrids, average grain yield decreased from 3,821 kg ha⁻¹ in 2024 to 2,924 kg ha⁻¹ in 2025, reflecting less favorable environmental conditions during the second experimental season. Dekalb 5075 and Pioneer P9889 recorded the highest grain yields in both years, whereas Pioneer P0710 consistently showed

lower productivity under the conditions of the study area.

The observed variation among hybrids highlights the importance of genotype selection for maintaining productivity under variable growing conditions. A more detailed interpretation of hybrid performance in relation to seasonal climatic conditions is presented in Figure 2.

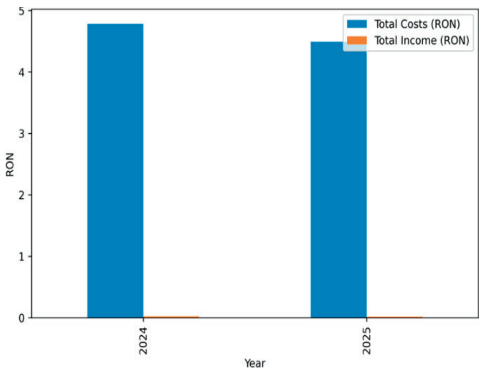


Figure 3. Total production costs vs total income

Figure 3 highlights the economic balance between total production costs and total income for the two seasons. Figure 3 illustrates the distribution of operational costs among the main input categories associated with maize cultivation during the 2024 and 2025 growing seasons. The results indicate that input allocation varied between seasons, mainly due to fluctuations in fuel prices and adjustments in hybrid allocation strategies. The increase in fuel-related expenditures observed during the 2025 season reflects the growing influence of energy prices on the economic sustainability of agricultural production systems. In contrast, fertilizer-related costs remained relatively stable, suggesting consistent nutrient management practices at farm level. Seed-related expenditures represented an important component of the analyzed operational costs due to the comparative evaluation of multiple commercial hybrids under field conditions. This economic structure therefore reflects the experimental and comparative framework of the study rather than the standard cost distribution typically encountered in large-scale commercial maize production systems. These results confirm that yield variability remains one of the most critical factors

influencing farm profitability in maize production systems (Ray et al., 2015).

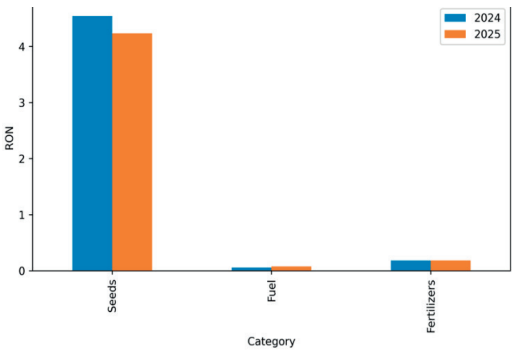


Figure 4. Distribution of maize production costs (2024 vs 2025)

The distribution of operational costs associated with maize cultivation is presented in Figure 4. The results indicate that production expenses varied between the two agricultural seasons mainly due to fluctuations in fuel prices, input

procurement costs, and differences in hybrid allocation strategies.

Fuel-related expenditures increased during the 2025 growing season, reflecting the influence of rising energy prices on the economic sustainability of agricultural production systems. In contrast, fertilizer-related costs remained relatively stable between seasons, suggesting consistent nutrient management practices at farm level.

Seed-related expenditures represented an important component of the analyzed operational costs due to the comparative cultivation of multiple commercial hybrids within the experimental framework adopted in this study. Therefore, the economic structure presented should be interpreted in relation to the comparative hybrid evaluation strategy rather than as the standard cost distribution typical of commercial maize production systems.

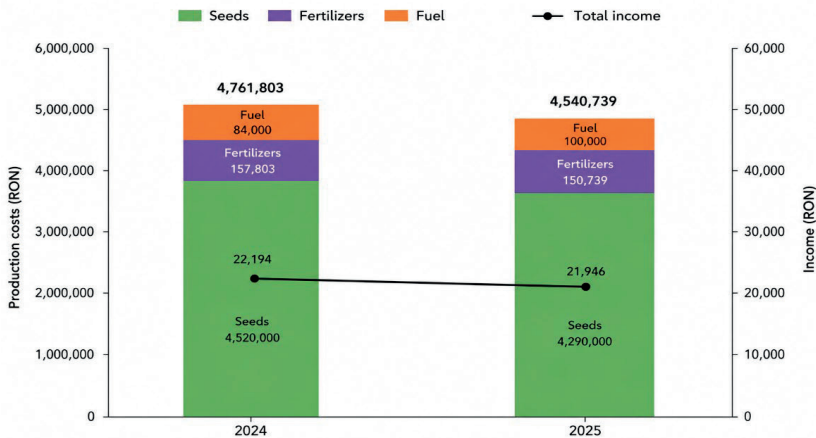


Figure 5. Economic performance and operational costs structure of maize production during 2024 and 2025 growing seasons

Figure 5 integrates the overall economic performance of maize production with the distribution of the principal operational costs recorded during the 2024 and 2025 growing seasons. Total production costs decreased slightly from 4,783,120 RON in 2024 to 4,491,350 RON in 2025, whereas total income declined from 22,194.45 RON to 18,686.80 RON during the same period. This trend suggests that the reduction in grain yield observed during the second growing season

exerted a greater influence on farm income than the modest decrease in production expenditures.

Although the maize selling price increased from 0.70 RON kg⁻¹ in 2024 to 0.80 RON kg⁻¹ in 2025, the economic benefit associated with higher market prices was insufficient to compensate for the decline in productivity. Consequently, lower grain yields were associated with reduced economic returns, highlighting the strong dependence of maize

profitability on production performance under variable environmental conditions.

The analysis of production costs revealed a relatively similar cost structure in both growing seasons. Seed procurement represented the largest share of operational expenditures, accounting for approximately 4.52 million RON in 2024 and 4.29 million RON in 2025. Fuel-related expenses increased from 56,595 RON to 76,125 RON, reflecting the influence of rising energy prices on agricultural production systems, whereas fertilizer costs showed only minor fluctuations between years, suggesting relatively stable nutrient management practices at farm level.

These findings indicate that the economic sustainability of maize production depends not only on input management but also on the ability to maintain productivity under contrasting seasonal conditions. Similar observations were reported by Ray et al. (2015), who emphasized that yield variability remains one of the main determinants of economic performance and production risk in agricultural systems exposed to climatic uncertainty.

From a practical perspective, the results underline the importance of selecting maize hybrids capable of maintaining satisfactory productivity across different environmental conditions. Such an approach may contribute to improving economic resilience, reducing production risk, and supporting the long-term sustainability of maize-based farming systems in regions increasingly affected by climatic variability.

CONCLUSIONS

The present study demonstrated that maize productivity under the pedoclimatic conditions of the Macea microzone was strongly influenced by both hybrid selection and seasonal climatic variability. Across all evaluated hybrids, average grain yield decreased from 3,821 kg ha⁻¹ in 2024 to 2,924 kg ha⁻¹ in 2025, indicating the substantial impact of environmental conditions on crop performance. Among the tested hybrids, Dekalb 5075 and Pioneer P9889 consistently recorded the highest grain yields in both growing seasons, suggesting good suitability

for cultivation under the environmental conditions of the western Romanian Plain.

The economic analysis showed that the increase in maize selling price from 0.70 RON kg⁻¹ to 0.80 RON kg⁻¹ was insufficient to compensate for the reduction in grain yield. Consequently, total income declined from 22,194.45 RON to 18,686.80 RON, indicating that farm profitability was more closely associated with production performance than with short-term market price fluctuations. These findings emphasize the importance of maintaining productivity under variable climatic conditions in order to ensure economic sustainability.

The results further suggest that hybrid selection should be considered not only from a productivity perspective but also from an economic risk-management perspective. Under the conditions of this study, hybrids that maintained comparatively higher yields across contrasting growing seasons contributed to a more favorable economic outcome despite climatic constraints.

The combined agronomic and economic assessment applied in this study provides useful information for hybrid selection under the environmental conditions of the western Romanian Plain. From a practical perspective, the findings indicate that improving yield performance remains one of the most effective strategies for enhancing farm profitability and reducing production risk under increasingly variable climatic conditions.

REFERENCES

- Bänziger, M., Edmeades, G. O., Beck, D., & Bellon, M. (2000). *Breeding for drought and nitrogen stress tolerance in maize: From theory to practice*. CIMMYT.
- Bougma, L. A., Ouedraogo, M. H., Nikiéma, D., & Sawadogo, M. (2024). Performance evaluation of hybrid maize (*Zea mays* L.) in Burkina Faso, sub-Saharan region of Africa. *Heliyon*, 10(19), Article e38133. <https://doi.org/10.1016/j.heliyon.2024.e38133>
- Butler, E. E., & Huybers, P. (2015). Variations in the sensitivity of US maize yield to extreme temperatures by region and growth phase. *Environmental Research Letters*, 10(3), Article 034009. <https://doi.org/10.1088/1748-9326/10/3/034009>
- Ciampitti, I. A., & Vyn, T. J. (2012). Physiological perspectives of changes over time in maize yield dependency on nitrogen uptake and associated nitrogen efficiencies: A review. *Field Crops*

- Research*, 133, 48–67. <https://doi.org/10.1016/j.fcr.2012.03.008>
- Dragomir, V., Brumă, I. S., Butu, A., Petcu, V., Tanasă, L., & Horhocea, D. (2022). An overview of the global maize market compared to Romanian production. *Romanian Agricultural Research*, 39, 535–544. <https://doi.org/10.59665/rar3941>
- Duvick, D. N. (2005). Genetic progress in yield of United States maize (*Zea mays* L.). *Maydica*, 50, 193–202.
- Erenstein, O., Chamberlin, J., & Sonder, K. (2021). Farms worldwide: 2020 and 2030 outlook. *Outlook on Agriculture*, 50(3), 221–229. <https://doi.org/10.1177/00307270211025539>
- Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., & Prasanna, B. M. (2022). Global maize production, consumption and trade: Trends and R&D implications. *Food Security*, 14, 1295–1319. <https://doi.org/10.1007/s12571-022-01288-7>
- Finger, R., Swinton, S. M., El Benni, N., & Walter, A. (2019). Precision farming at the nexus of agricultural production and the environment. *Annual Review of Resource Economics*, 11, 313–335. <https://doi.org/10.1146/annurev-resource-100518-093929>
- Grassini, P., van Bussel, L. G. J., van Wart, J., Wolf, J., Claessens, L., Yang, H., Boogaard, H. L., de Groot, H. L. E., van Ittersum, M. K., & Cassman, K. G. (2015). How good is good enough? Data requirements for reliable crop yield simulations and yield-gap analysis. *Field Crops Research*, 177, 49–63. <https://doi.org/10.1016/j.fcr.2015.03.004>
- Grote, U., Fasse, A., Nguyen, T. T., & Erenstein, O. (2021). Food security and the dynamics of wheat and maize value chains in Africa and Asia. *Frontiers in Sustainable Food Systems*, 4, Article 617009. <https://doi.org/10.3389/fsufs.2020.617009>
- Halmajan, H. V., Sitaru, B., Dosinescu, S., Surca, E., & Petre, I. (2017). Maize yield evolution in Romania and farmers' involvement to increase it. *Scientific Papers. Series A. Agronomy*, 60, 270–274.
- Hatfield, J. L., & Prueger, J. H. (2015). Temperature extremes: Effect on plant growth and development. *Weather and Climate Extremes*, 10, 4–10. <https://doi.org/10.1016/j.wace.2015.08.001>
- Kay, R. D., Edwards, W. M., & Duffy, P. A. (2016). *Farm management*. McGraw-Hill Education.
- Lobell, D. B., Roberts, M. J., Schlenker, W., Braun, N., Little, B. B., Rejesus, R. M., & Hammer, G. L. (2014). Greater sensitivity to drought accompanies maize yield increase in the U.S. Midwest. *Science*, 344(6183), 516–519. <https://doi.org/10.1126/science.1251423>
- Ministry of Agriculture and Rural Development. (2022). *Evolution of areas under organic farming and number of enterprises*. <https://www.madr.ro/docs/agricultura/agricultura-ecologica/2022/Dinamica-operatorilor-%C8%99i-a-suprafe%C8%9Belor-%C3%AEn-agricultura-ecologic%C4%83.pdf>
- Mueller, S. M., & Vyn, T. J. (2016). Maize plant resilience to N stress and post-silking N capacity changes over time: A review. *Frontiers in Plant Science*, 7, Article 53. <https://doi.org/10.3389/fpls.2016.00053>
- Obunyal, C. O., Karanja, J., Oikeh, S. O., Omany, G. O., Mugo, S., Beyene, Y., & Oniang'o, R. K. (2019). On-farm performance and farmers' perceptions of DroughtTEGO climate-smart maize hybrids in Kenya. *Agronomy Journal*, 111(6), 2754–2768. <https://doi.org/10.2134/agronj2019.08.0600>
- Organisation for Economic Co-operation and Development, & Food and Agriculture Organization of the United Nations. (2021). *OECD-FAO agricultural outlook 2021-2030*. OECD Publishing. <https://doi.org/10.1787/19428846-en>
- Popescu, A., Dinu, T., & Stoian, E. (2019). Trends in maize production in Romania. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 19, 451–458.
- Popescu, M., Mureșan, C., Horhocea, D., Cindea, M., & Cristea, S. (2021). The genetic potential for the grain yield of some maize hybrids studied in different environmental conditions in Romania. *Romanian Agricultural Research*, 38, 21–29.
- Ray, D. K., Mueller, N. D., West, P. C., & Foley, J. A. (2013). Yield trends are insufficient to double global crop production by 2050. *PLOS ONE*, 8(6), Article e66428. <https://doi.org/10.1371/journal.pone.0066428>
- Schauberger, B., Archontoulis, S., Arneth, A., Balković, J., Ciais, P., Deryng, D., Elliott, J., Folberth, C., Khabarov, N., Müller, C., Pugh, T. A. M., Rolinski, S., Schaphoff, S., Schmid, E., Wang, X., Schlenker, W., & Frieler, K. (2017). Consistent negative response of US crops to high temperatures in observations and crop models. *Nature Communications*, 8, Article 13931. <https://doi.org/10.1038/ncomms13931>
- Shiferaw, B., Prasanna, B. M., Hellin, J., & Bänziger, M. (2011). Crops that feed the world 6: Past successes and future challenges to the role played by maize in global food security. *Food Security*, 3, 307–327. <https://doi.org/10.1007/s12571-011-0140-5>
- Tollenaar, M., & Lee, E. A. (2011). Strategies for enhancing grain yield in maize. *Plant Breeding Reviews*, 34, 37–82. <https://doi.org/10.1002/9780470880579.ch2>
- Van Es, H. M., & Woodard, J. D. (2017). Innovation in agriculture and food systems in the digital age. In S. Dutta, B. Lanvin, & S. Wunsch-Vincent (Eds.), *The Global Innovation Index 2017: Innovation feeding the world* (pp. 97–104). World Intellectual Property Organization.