Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 25, Issue 3, 2025
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ASSESSING REGIONAL WHEAT AND SUNFLOWER PRODUCTIVITY IN ROMANIA PRE AND POST E.U. ACCESSION: A COMPARATIVE STUDY OF 1990–2006 vs 2007–2023

Dragoș Gabriel ION, Radu Andrei IOVA

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania. E-mails: iondragosgabriel@gmail.com, iova.andrei@managusamv.ro.

Corresponding author: iondragosgabriel@gmail.com

Abstract

This study examines the evolution of agricultural productivity for two key arable crops: wheat and sunflower cross all 41 Romanian counties (plus the Municipality of Bucharest) by comparing two distinct periods: 1990–2006 and 2007–2023. The analysis aims to quantify changes in crop yields (tonnes per hectare) between the pre and post European Union accession eras, evaluate regional disparities in performance, and assess the consistency and variability of outputs over time. Using official statistics from the Romanian National Institute of Statistics (INS) and summary indicators (period averages, standard deviations, and growth percentages), we find that average wheat yields increased by approximately 40% (from about 2.5 to 3.5 tonnes/ha) and sunflower yields by about 58% (from roughly 1.2 to 1.9 tonnes/ha) between the two periods. These substantial productivity gains are accompanied by notable spatial variability: traditionally high-performing counties – such as Timiș, Călărași, Dolj, and Teleorman – maintained their lead, while several less productive counties (e.g. Botoșani, Vaslui) also improved but continue to lag behind the national average. Variability in yields tended to increase in the latter period, with more pronounced year-to-year fluctuations, likely due to climatic volatility and uneven adoption of modern farming techniques. The findings underscore the impact of post 2007 agricultural policies and investments on crop performance, as well as the enduring influence of structural factors (farm size, infrastructure) and climate. We suggest targeted interventions, including improved irrigation infrastructure, dissemination of advanced agronomic practices, and regions specific support, to enhance productivity in underperforming areas and mitigate the growing yield variability. This comparative regional analysis offers insights for policymakers on how to booster the productivity and resilience of Romanian agriculture in the context of both European integration and climate challenges.

Key words**:** *agricultural productivity, wheat; sunflower, yield variability, impact pre and post EU accession*

INTRODUCTION

Agriculture remains a vital component of Romania's economy and rural livelihood, even as the country underwent major socio-economic transformations in the past three decades. As of 2022, roughly 23% of Romania's labor force is employed in agriculture, the highest share among EU member states [10]. The analysis of the technical efficiency in Romanian agriculture highlights the importance of farm size in the efficient use of production factors [4]. Determinants of technical efficiency in agriculture differ among new EU member states, reflecting diverse structural and policy environments [3]. The technical efficiency in cereal production varies across EU countries, influenced by several socio-economic factors [1]. Sunflower crops in Europe are vulnerable to climate change, necessitating adaptation and mitigation strategies [8]. The country's agricultural sector benefits from extensive arable land (over 13 million hectares) and a favorable climate, giving it significant production potential. Land reform processes in Central and Eastern Europe have led to significant land fragmentation, posing challenges for efficient agricultural production [14]. The CAP subsidies have a significant impact on the technical efficiency of Romanian farms, as demonstrated by the stochastic frontier analysis [13]. In the early 1990s, land reform and restitution policies led to the breakup of former collective farms, returning land to millions of private owners [11]. This process resulted in highly fragmented farm structures – by the late 1990s about 90% of

farms operated on less than 5 hectares [11], which posed challenges for efficient, large-scale production. Land fragmentation remains a persistent issue in Southern Romania, affecting agricultural productivity and land use efficiency [9]. Climate change effects on crop yield anomalies in Europe underscore the need for resilient agricultural practices [20]. Since joining the EU in 2007, Romania has gradually integrated into the Common Agricultural Policy (CAP) framework, accessing subsidies and development programs aimed at modernizing the sector [10]. These changes coincided with increased mechanization, adoption of improved crop varieties, and better farm management practices, which collectively have driven yield growth in many areas. Also, the degree of involvement of the rural population in the decision-making process is an important factor that can influence the adoption of modern technologies in agriculture and, consequently, local productivity [7].

Given this context, this study seeks to analyze wheat and sunflower productivity across Romanian counties by comparing two periods, 1990–2006 and 2007–2023, roughly representing the pre- and post-EU accession eras. By conducting a county-level comparison of average yields, variability (standard deviation), and growth rates, we aim to identify how regional disparities have evolved, which areas have achieved the greatest improvements, and whether the consistency of production has changed over time. This research contributes to understanding the long-term trends in Romanian agricultural performance and provides a basis for discussing policy implications related to regional development, land consolidation, and adaptation to climatic risks. Climate change has notably impacted the yields of wheat, maize, and sunflower in Romania between 2017 and 2021 [17].

Agricultural productivity – commonly measured as crop yield (output per hectare – t/ha) – is a core indicator of performance in the agrarian sector. In transitioning economies like Romania, productivity trends reflect both structural changes (land ownership, farm size, technology adoption) and environmental factors (climate variability, soil conditions) [18, 7]. A body of research has examined the post-socialist evolution of agriculture in Central and Eastern Europe, highlighting that the dismantling of collective farming and the subsequent restitution of land often led to initial declines or stagnation in productivity due to farm fragmentation and loss of economies of scale [19, 13]. A study found that in Romania the early transition period was marked by a sharp drop in agricultural output, followed by gradual improvement as new private farms restructured and adapted [19]. It has been documented how policy shifts and land-use changes in post-communist Romania have unevenly influenced regions, with some areas experiencing intensification of production and others facing persistent inefficiencies [2]. It has been noted significant spatial differences in Romania's farm productivity, correlating these with socio-economic determinants such as farm fragmentation, access to markets, and infrastructure quality [16]. Moreover, the non-parametric analysis also reveals disparities in technical efficiency among ex-communist countries, like Bulgarian farms, highlighting areas for improvement [12]. Counties in the southern plains and western part of Romania generally show higher crop yields, attributed to larger average farm sizes, better soils (e.g. chernozem in the Danube Plain), and greater access to irrigation. In contrast, counties in the north-east (Moldavia region) or those with more difficult terrain (e.g., the Carpathian highlands) often lag in productivity [16]. These disparities align with findings in other post-socialist countries, for instance, a study observed in Poland that farm technical efficiency varied widely by region and was strongly influenced by farm structure and investment levels [15]. Contributing factors for yield improvement include technological adoption, increased fertilizer use, and policy support via the CAP after EU accession [10]. Conversely, factors contributing to lingering inefficiencies and variability include small farm sizes, inadequate farmer training, and climate-related shocks [5, 16].

By building on this literature, our study specifically addresses the gap in understanding how the pattern of productivity has changed

between the pre-2007 and post-2007 periods at a granular (county) level. This focus on a split-period analysis allows us to directly observe the outcomes of the first decades of transition versus the EU-integration era, contributing empirical evidence to the broader literature on post-socialist agricultural development and informing future policy directions.

MATERIALS AND METHODS

This research utilizes longitudinal county-level data on wheat and sunflower production in Romania from 1990 through 2023, drawn from the official statistics of the National Institute of Statistics (INS). Specifically, we extracted annual data on total production (tonnes) and cultivated area (hectares) for wheat and sunflower crops from the INS Tempo-Online databases (datasets AGR109A – "Crop production by county" and AGR108A – "Cultivated area by county"). These data series encompass all 41 counties of Romania and the Municipality of Bucharest (though Bucharest has very limited agricultural area, thus data for it are sparse). Using these two indicators, we computed the crop yield for each county and year, defined as output per unit area (tonnes per hectare - t/ha) for the given crop. Yield is a direct measure of land productivity and provides a comparable metric across regions and time.

To facilitate comparison between the pre-EU accession period (1990–2006) and the post-accession period (2007–2023), we aggregated the annual yield data into two sub-periods. For each county and each crop, we calculated the following summary statistics over the years 1990–2006 (17 years) and 2007–2023 (17 years): Average yield (Mean) – an indicator of overall productivity level in that period; Median yield – a measure of central tendency less influenced by outlier years, useful for skewed distributions (for instance, years with extreme drought or bumper harvest); Maximum and minimum yield – the highest and lowest annual yield recorded, highlighting best-case and worst-case outcomes experienced by each county in each period; Standard deviation (Std. Dev.) – $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n}(x_i - \mu)^2}$ measuring the year-to-year variability in yields as an indicator of consistency (a lower standard deviation implies more stable outputs, whereas higher values indicate large fluctuations due to weather, or other factors); Growth percentage – the relative change in average yield from the first period to the second, computed as *(Average 2007–2023)/(Average 1990–2006) * 100%*. This indicates how much yields improved or declined in the later period compared to the earlier period. For convenience, we express this as a percentage (e.g., 150% implies a 50% increase in average yield in the post-2007 era relative to the pre-2007 era). All data processing and calculations were conducted using a combination of spreadsheet analysis and statistical software. The resulting dataset provides a comprehensive picture of how wheat and sunflower productivity has evolved over time in each county. We present the findings through descriptive statistics and illustrative charts. It should be noted that Bucharest and a few very small counties had missing or negligible data for certain years (especially in the early 1990s for Bucharest, which has almost no arable land). In computing national or regional averages, such cases were either excluded or treated as zeros where appropriate, but this has minimal impact on overall results due to their tiny share in national agriculture. The insights gained can inform more detailed future studies that might incorporate multiple inputs (land, labor, capital) and advanced efficiency analyses (such as econometric models or DEA) [5, 6] to further investigate the drivers behind the observed productivity trends.

RESULTS AND DISCUSSIONS

The comparative analysis reveals that Romania's wheat and sunflower yields increased substantially in the 2007–2023 period compared to 1990–2006 (Figure 1).

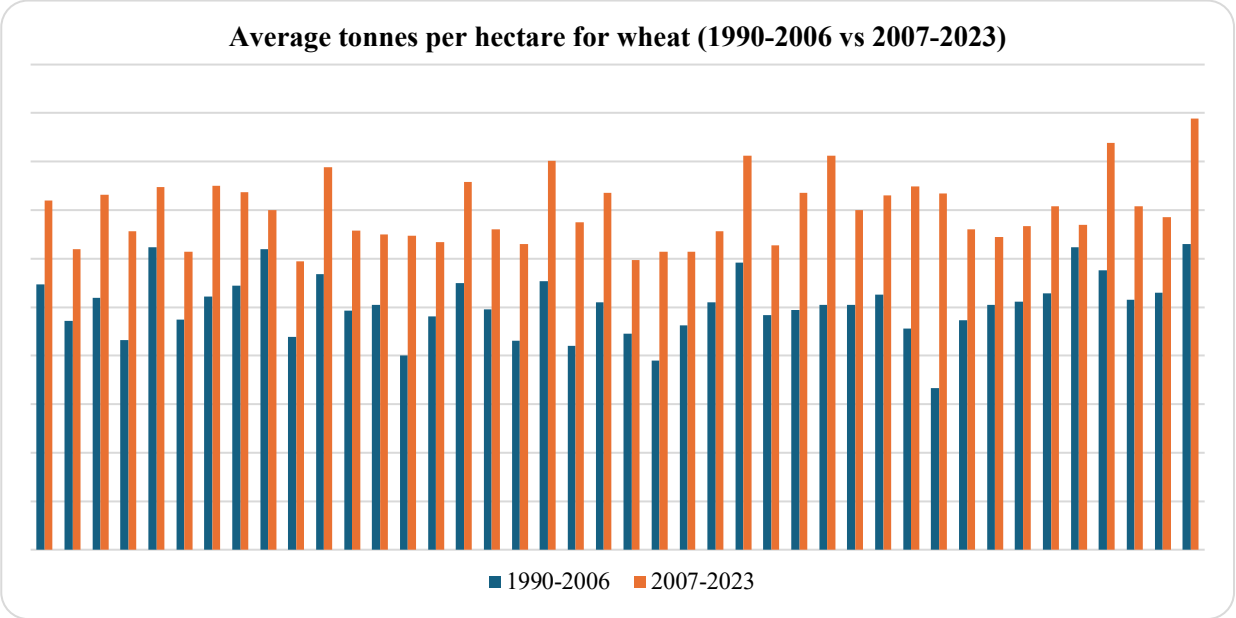

Fig. 1. Comparative analysis for wheat yield between 1990-2006 and 2007-2023
Source: Authors' processed, analyzed and computed data from [21] dataset: AGR108A & AGR109A.

At the national level, the average wheat yield rose from approximately 2.5 t/ha (1990–2006 average across counties) to about 3.5 t/ha in 2007–2023, which is roughly a 40% increase in output per land unit. Similarly, sunflower yields registered an even larger relative jump, from around 1.2 t/ha in the first period to 1.9 t/ha in the second, equating to about a 58% gain.

These improvements reflect the general positive trajectory of Romanian agriculture post-EU accession, aided by better access to inputs and technologies. They align with broader trends reported in regional studies, which note significant yield growth for major crops in Eastern Europe after the mid-2000s [10]. Counties in the fertile plains of the south and west consistently outperform those in the north-east and mountainous center. For wheat, the highest average outputs in 2007–2023 are concentrated in counties like Timiș, Teleorman, Dolj, Călărași, and Ialomița, each recording multi-year mean yields around 3.5–4.0 t/ha or higher. For instance, Timiș a western county with large, mechanized farms – achieved an average wheat yield of 3.8 t/ha in 2007–2023, up from 2.7 t/ha in 1990–2006 (an increase of 41%). Likewise, Călărași, a Danube plain county known for its quality soils and high investment, saw wheat yields rise from 2.9 t/ha to 4.0 t/ha between the two periods; however, Călărași also had years of very poor performance, reflecting vulnerability to weather extremes. In contrast, counties such as Botoșani, Vaslui, and Mehedinți, which historically lagged in wheat yields – improved from roughly 2.0–2.5 t/ha to 3.0–3.3 t/ha averages, narrowing the gap but still falling short of the top performers. The lowest wheat productivity in the 2007–2023 period was observed in Vâlcea (from 3.1 to 3.3) and Covasna (from 3.1 to 3.5 t/ha), both of which, despite improvements, remain about 20–25% below the national mean. Notably, even traditionally low-yield areas experienced significant absolute gains; for example, Harghita's wheat yield grew by 35% in the second period compared to the first (from 2.2 to 2.9 t/ha), indicative of a general uplift across all regions.

For sunflower, the spatial pattern of productivity is somewhat different but still marked by south–east vs. north–west disparities.

The South Muntenia and South-East regions show good outputs in 2007–2023, with counties like Călărași averaging around 2.2 t/ha up to 1.4 t/ha (1990-2006) of sunflower yield. Timiș achieved an impressive 2.4 t/ha average in 2007–2023, up from around 1.3 t/ha previously (+76%), benefiting from large-scale farms and sunflower's adaptation to its climate.

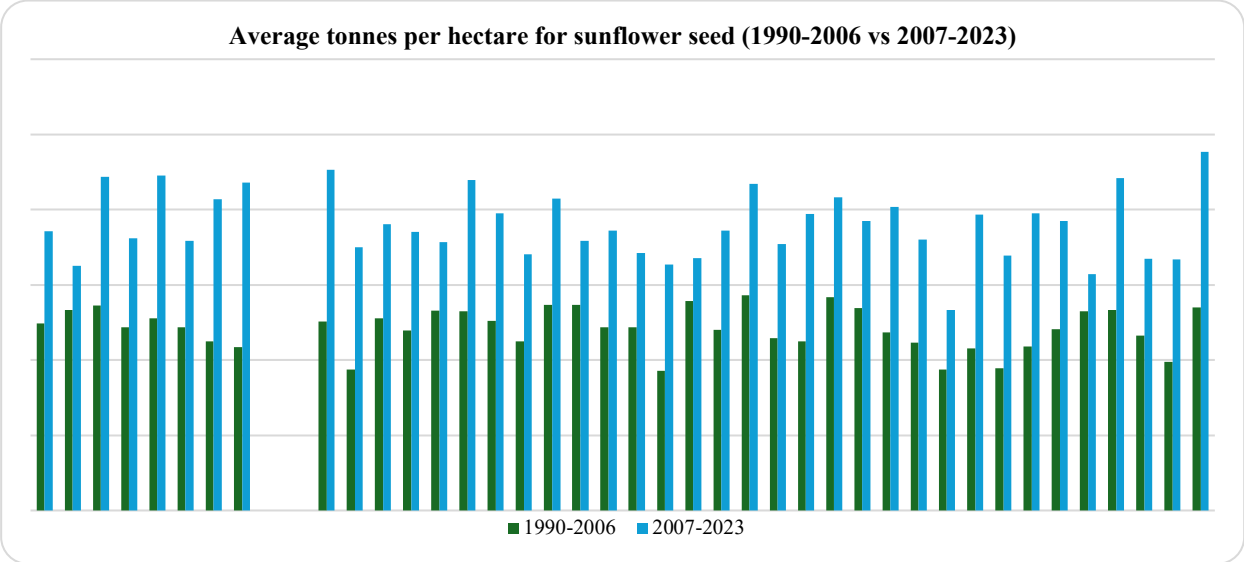

Fig. 2. Comparative analysis for sunflower seed yield between 1990-2006 and 2007-2023
Source: Authors' processed, analyzed and computed data from [21] dataset: AGR108A & AGR109A

On the other hand, several counties which are less traditional for sunflower cultivation remain on the lower end; for instance, Vâlcea, Bistrița-Năsăud, and Tulcea had second-period averages near 1.6 t/ha. These lower yields can be attributed to cooler climate and smaller farm sizes in such areas, as well as the possibility that sunflower is grown on more marginal plots there. Nevertheless, even these counties improved relative to their past: Tulcea increased its sunflower yield from 0.9 t/ha to 1.6 t/ha average (+77%), reflecting the diffusion of better sunflower hybrids and practices nationwide. It is worth highlighting the case of Vaslui in eastern Romania: although it had a modest sunflower yield (1.1 t/ha) in 1990–2006, by the second period Vaslui reached 1.7 t/ha on average (+51%), and an exceptional year (2018) it recorded the highest sunflower yield in the country at 3.92 t/ha. This suggests that with favorable weather and improved techniques, even traditionally lagging areas can momentarily match the top producers.

Alongside changes in average productivity, the consistency of yields over time is a critical aspect of agricultural performance. Our analysis indicates a general increase in yield variability in 2007–2023 compared to 1990–2006. Standard deviations of annual yields were higher in the latter period for the majority of counties and for both crops. For wheat, the nationwide average standard deviation across counties rose from about 0.7 t/ha in 1990–2006 to about 0.9 t/ha in 2007–2023 (a 31% increase), while for sunflower the increase was even more pronounced (from 0.3 t/ha to 0.6 t/ha on average, indicating a variability that has almost doubled). This heightened volatility is largely attributable to climatic fluctuations. For example, as mentioned, Călărași county's wheat yield varied from a disastrous 1.2 t/ha in 2007 to an excellent 5.8 t/ha in 2018 – a range far wider than anything seen in the 1990s.Such findings align with other observations that climate factors have become increasingly pivotal in agricultural outcomes [18].

Interestingly, some high-productivity counties also demonstrate relatively stable performance, while others are quite irregular. Timiș, for instance, not only boasted high wheat productivity but also a moderate variability (wheat yield std.var. of 0.9 t/ha in 2007–2023), partly due to its better infrastructure and perhaps localized irrigation and risk management. On the other hand, Ialomița and Călărași, despite similar high averages, showed greater variability (wheat yield std.var. of 1.4 t/ha in 2007–2023) reflecting their exposure to drought risk in the mostly rain-fed southern plains. In the case of sunflower, Caraș-Severin counties emerged as an example of consistency but not necessarily with improvement: it achieved respectable yields (1.7 t/ha averages in 2007–2023) with relatively lower year-to-year fluctuation

(benefiting from a more temperate and reliable rainfall pattern) wheat yield std.var. of 0.3 t/ha. These patterns suggest that geographical and climatic factors play a significant role in yield stability – western and central counties with moderate climates tend to have steadier outputs, whereas the eastern and southern counties, though capable of very high yields, also face sharp downsides in bad years.

The relative improvements from the first to second period also carry implications for regional disparities. The percentage growth in yields was not necessarily higher for those counties that started with lower baseline productivity. Thus, not following the form of catch-up effect. There are exemptions, for example, many counties in the Moldavia (NE) region saw wheat yield increases on the order of +50% to +66%, outpacing gains in some already high-yielding counties which grew only by +40% to +50%. Although apparently the gap between the traditionally highest and lowest yielding counties narrowed slightly in proportional terms e.g. in 1990–2006, the top wheat-producing county (by average yield) had roughly 1.6 times the yield of the lowest-producing county; by 2007–2023 this ratio fell to about 1.5. If we longitudinally analyze the standard deviation between the counties, the disparities grew from 0.32 t/ha to 0.34 t/ha for the average yields. A convergence is observed for sunflower: the highest county average was about 1.5 times higher than the lowest in the first period, growing to about 1.7 times in the second period, when we longitudinally analyze the standard deviation between the counties, the disparities grew from 0.13 t/ha to 0.22 t/ha for the average yields. This indicates that underperforming areas have not benefited significantly from the post 2007 advancements.

In summary, our findings paint a picture of overall progress in Romanian wheat and sunflower productivity between 1990–2006 and 2007–2023, coupled with persistent but not necessarily moderating regional disparities, and an increase in yield volatility. The improvements testify to successful adoption of better agricultural technologies and the positive impact of agricultural policies in the post-EU accession period. The remaining disparities and high variability, on the other hand, highlight the influence of structural and natural factors that have yet to be fully addressed – including the need for greater land consolidation, improved irrigation and water management (to buffer against drought), and enhanced support for regions with difficult agro-ecological conditions.

There has been a clear and substantial improvement in land productivity for both wheat (Figure 3) and sunflower seed (Figure 4) in the post-2007 period. The average wheat yield is roughly 40% higher, and the average sunflower yield about 60% higher, than in the pre-2007 era. This growth reflects successful developments in the agricultural sector, including the uptake of improved crop varieties, better farm management, and the influence of EU agricultural support.

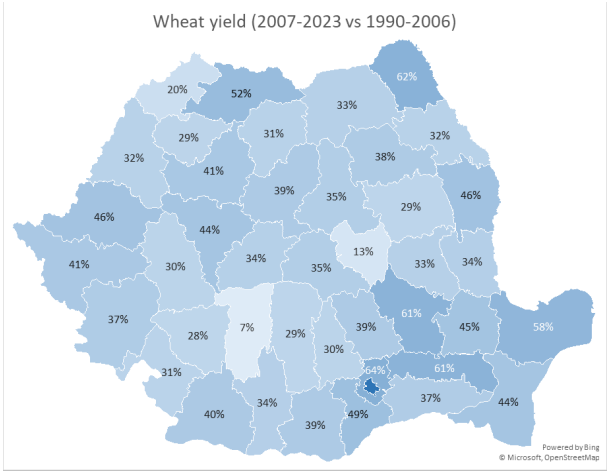

Fig. 3. Wheat increase in yield (t/ha) from 1990-2006 to 2007-2023

Source: Authors' processed, analyzed and computed data from [21] dataset: AGR108A & AGR109A.

It underscores that Romanian agriculture has made positive strides in the last two decades toward realizing more of its production potential.

Despite overall gains, regional yield disparities persist.

The traditional grain belts (Western and Southern counties) remain at the top in terms of productivity, while northern and upland counties continue to produce less per hectare on average.

There is some evidence of convergence, as lower-ranked counties often had higher relative

growth rates, but an absolute gap in output endures. These disparities suggest that inherent advantages (such as soil quality and terrain) and historical differences (such as farm structure and capital availability) are still strongly influencing outcomes. The post-2007 period has seen greater variability in annual yields. This finding is consistent with more frequent extreme weather events (droughts in particular) associated with climate change, as well as possibly market and policy-induced volatility (e.g., price swings affecting input use). Higher variability means higher risk for farmers, as a bumper year may be followed by a very poor year. From a food security and farm income perspective, this is a concern.

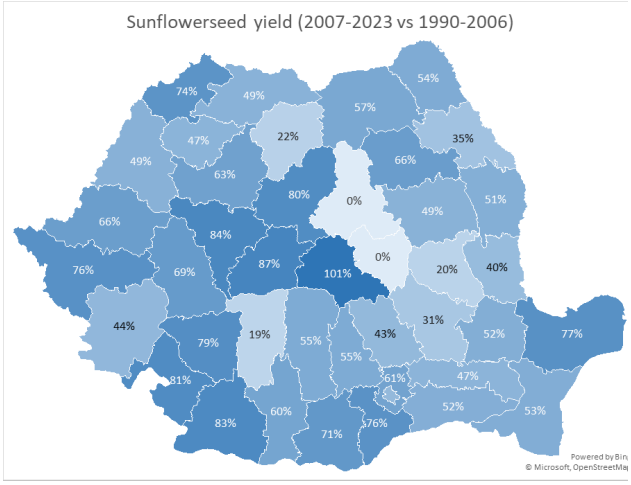

Fig. 4. Sunflower seed increase in yield (t/ha) from 1990-2006 to 2007-2023
Source: Authors' processed, analyzed and computed data from [21] dataset: AGR108A & AGR109A.

The fact that some high-yield regions also experience the biggest swings suggests a need for improved risk mitigation (such as irrigation, crop insurance, and drought-resistant crop varieties) in those areas.
The timing of the yield improvements strongly indicates that policy changes around EU accession played a facilitating role. Access to CAP funds for equipment modernization, better extension services, and integration into European markets likely contributed to yield growth. However, structural issues rooted in the 1990s transition (land fragmentation, demographic challenges in rural areas, etc.) continue to limit the performance of certain regions. In counties with many small subsistence farms, adoption of new technologies can be slower, and investment per hectare is lower, which in turn keeps yields below potential. This dichotomy points to the importance of structural reforms (e.g., encouraging cooperative farming or land consolidation) alongside direct productivity-enhancing measures. The findings highlight that region-specific strategies are warranted. High-performing counties demonstrate what is achievable under current conditions – for example, yields above 4 t/ha for wheat and 2.5 t/ha for sunflower have been attained in multiple counties in favorable years. Transferring the knowledge and resources that enabled those successes to lower-performing counties could raise the national baseline. At the same time, infrastructure development, could stabilize outputs and protect gains.
We must acknowledge that although we qualitatively linked yield variability to climate events, we did not explicitly model the impact of weather or climate change. Year-to-year yield fluctuations due to rainfall and temperature anomalies were evident, but a dedicated analysis (e.g., regression of yields on weather variables) would help quantify these effects. Given the trends of more frequent droughts in Romania, integrating climate data would strengthen the assessment of risk and the need for adaptation measures. We treated the pre- and post-2007 periods as a binary comparison primarily due to EU accession. However, many other changes occurred in these intervals – for instance, market liberalization in the 1990s, fluctuations in global commodity prices, and domestic policy shifts (such as subsidies and credit programs in certain years).
Strengthening the participation of the rural population in decision-making processes can play a crucial role in accelerating agricultural modernization and ensuring that local needs and conditions are properly addressed [7].

CONCLUSIONS

The comparative analysis of Romania's county-level data on wheat and sunflower yields for 1990–2006 versus 2007–2023 leads to several important conclusions.

We concentrated on two major crops for brevity and clarity. However, Romanian agriculture has a diverse crop mix. It is possible that some counties prioritized one crop over another between periods (for instance, expanding sunflower area at the expense of maize, etc.). Such changes in cropping patterns could affect comparative productivity. A more comprehensive study could examine multiple crops or an aggregate productivity index. Moreover, factors like crop rotation, fallow land, or changes in cultivated area (we analyzed yields, which already account for area, but total production trends are also relevant for food security) were not explored in depth. Also, the INS data, while the most authoritative source, may contain inconsistencies, especially in the early 1990s when statistical systems were just re-establishing. Additionally, Bucharest and a few small counties had incomplete data, which we largely excluded from analysis; researchers focusing on those areas might need to supplement with local sources if available. Also, we considered county aggregates – but within each county, there is farm-level heterogeneity. Micro-data at the farm level (if accessible) could reveal, for example, if gains are broad-based or concentrated among larger commercial farms.

In conclusion, Romania's experience from 1990 to 2023 in wheat and sunflower production reflects a broader story of transition: initial difficulties, followed by significant progress, yet with challenges that evolve rather than vanish. Productivity has improved and become more aligned with European norms, but ensuring sustainable and equitable growth remains a key task. Policymakers should capitalize on the positive trends by reinforcing what worked (investment in technology and human capital) and addressing the weaknesses (fragmentation, climate vulnerability). As Romania continues to modernize its agriculture, lessons from the past periods will be invaluable in shaping interventions that boost yields further while also enhancing resilience and reducing regional inequities. Engaging rural communities not only fosters greater adoption of innovative practices but also contributes to building more resilient and inclusive agricultural systems. As Romania moves forward, integrating these social dimensions with technical and structural reforms will be essential for achieving a more productive, sustainable, and equitable agricultural sector.

REFERENCES

[1]Aljohani, E.S., Chidmi, B., 2024, Analyzing Technical Efficiency in Cereal Production across Selected European Union Countries. Sustainability, 16(2), 546. https://www.mdpi.com/2071-1050/16/2/546 Accessed on 27.02.2025.

[2]Balteanu, D., Urșanu Popovici, E.A., 2010, Land use changes and land degradation in post-socialist Romania. https://www.researchgate.net/publication/328929327_LAND_USE_CHANGES_AND_LAND_DEGRADATION_IN_POST-SOCIALIST_ROMANIA 54. 95-105. Accessed on 14.01.2025.

[3]Bojnec, Š., Fertő, I., 2014, Determinants of technical efficiency in agriculture in new EU member states from Central and Eastern Europe. Acta Oeconomica, 64(2),197-17. https://akjournals.com/view/journals/032/64/2/article-p197.xml Accessed on 06.02.2025.

[4]Burja, C., Burja, V., 2016, Farms size and efficiency of the production factors in Romanian agriculture. Ekonomika Poljoprivrede, 63(2), 361-374. https://scindeks.ceon.rs/article.aspx?artid=0352-34621602361B Accessed on 08.02.2025.

[5]Charnes, A., Cooper, W.W., Rhodes, E., 1978, Measuring the Efficiency of Decision Making Units. European Journal of Operational Research, 2(6), 429–444.https://doi.org/10.1016/0377-2217(78)90138-8. Accessed on 22.01.2025.

[6]Coelli, T.J., Rao, D.S.P., O'Donnell, C.J., Battese, G.E., 2005, An Introduction to Efficiency and Productivity Analysis. Springer.

[7]Crețu, D., Iova R.A., Crețu, O.R., Lascar, E., 2021, Analysis of the degree of the rural population involvement in the decision making act. case study, Călăraşi county, Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural development, Vol. 21(1), 133-139, Accessed on 09.04.2025.

[8]Debaeke, P., Casadebaig, P., Flenet, F., Langlade, N., 2017, Sunflower crop and climate change: vulnerability, adaptation, and mitigation potential from case-studies in Europe. OCL, Oilseeds and Fats crops and Lipids, 24(1), D102. 15 p. https://doi.org/10.1051/ocl/2016052 . Accessed on 18.02.2025.

[9]Dogaru, D., Petrișor, A.I., Angearu, C., Lupu, L., Bălteanu, D., 2024, Land Governance and Fragmentation Patterns of Agricultural Land Use in Southern Romania during 1990–2020. Land, 13(7), 1084. https://www.mdpi.com/2073-445X/13/7/1084 Accessed on 18.01.2025.

[10]European Commission. Romania – CAP Strategic Plan. https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans/romania_en. Accessed on 28.02.2025.
[11]FAO. Land Reform in Eastern Europe - Western CIS, Transcaucauses, Balkans, and EU Accession Countries. https://www.fao.org/4/ad878e/AD878E05.htm. Accessed on 01.02.2025
[12]Galluzzo, N., 2018, A Non-Parametric Analysis of Technical Efficiency in Bulgarian Farms Using the FADN Dataset. European Countryside, 10(1), 58-73. https://sciendo.com/article/10.2478/euco-2018-0004 Accessed on 21.02.2025.
[13]Galluzzo, N., 2020, A Technical Efficiency Analysis of Financial Subsidies Allocated by the CAP in Romanian Farms Using Stochastic Frontier Analysis. European Countryside, 12(4), 498-511. https://sciendo.com/article/10.2478/euco-2020-0026 Accessed on 03.02.2025.
[14]Hartvigsen, M., 2014, Land Reform and Land Fragmentation in Central and Eastern Europe. Land Use Policy, 36, 330 341. https://doi.org/10.1016/j.landusepol.2013.08.016. Accessed on 08.02.2025.
[15]Latruffe, L., Balcombe, K., Davidova, S., Zawalinska, K., 2004, Determinants of Technical Efficiency of Crop and Livestock Farms in Poland. Applied Economics, 36(12), 1255–1263. https://doi.org/10.1080/0003684042000176793. Accessed on 07.01.2025.
[16]Mocanu, I., Grigorescu, I., Mitrică, B., Popovici, E.-A., Dumitrașcu, M., 2018, Regional Disparities Related to Socio-Economic Determinants of Agriculture in the Romanian Plain. Journal of Urban and Regional Analysis, 10(1), 79-100. https://www.ssoar.info/ssoar/handle/document/91603. Accessed on 17.01.2025.
[17]Popescu, A., Dinu, T.A., Stoian, E., Șerban, V., 2023, Climate Change and Its Impact on Wheat, Maize and Sunflower Yield in Romania in the Period 2017–2021. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 23(1), 587-602. https://managementjournal.usamv.ro/pdf/vol.23_1/Art63.pdf . Accessed on 12.03.2025.
[18]Pravalie, R., Sirodoev, I., Patriche, C., Rosca, B., Piticar, A., Bandoc, G., Sfica, L., Tiscovschi, A., Dumitrascu, M., Chifiriuc, C., Manoiu, V., Iordache, Ștefan I., 2020, The impact of climate change on agricultural productivity in Romania. A country-scale assessment based on the relationship between climatic water balance and maize yields in recent decades. Agricultural Systems, Volume 179, 77–89. https://doi.org/10.1016/j.agsy.2019.102767. Accessed on 16.03.2025.
[19]Rizov, M., Gavrilescu, D., Gow, H., Mathijs, E., Swinnen, J.F.M., 2001, Transition and Enterprise Restructuring: The Development of Individual Farming in Romania. World Development 29, 1257–1274. https://doi.org/10.1016/S0305-750X(01)00030-4 Accessed on 25.02.2025.
[20]Schmidt, M., Felsche, E., 2024, The effect of climate change on crop yield anomaly in Europe. Climate Resilience and Sustainability, 3, e61. https://doi.org/10.1002/cli2.61. Accessed on 22.02.2025.
[21]Tempo online, Statistics, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table, Accessed on 1 February 2025.