COMPARATIVE ANALYSIS OF VITICULTURAL YIELD IN THE EUROPEAN UNION

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Abstract: *This paper presents a comparative analysis of viticultural yield in the European Union (EU) over a three-decade period (1990–2020), highlighting significant regional differences and the multiple factors influencing grape production efficiency. Yield, measured in tons per hectare (t/ha), is a key indicator of agricultural performance, reflecting both technological advancement and the sector's ability to adapt to pedoclimatic, economic, and institutional conditions. The study contrasts yield trends in two distinct regions: Western Europe—represented by Italy, France, Spain, Germany, and Portugal—and Central and Eastern Europe—including Romania, Hungary, and Bulgaria. Statistical data from harmonized official sources reveal a stable and upward trend in Western EU countries, where Common Agricultural Policy (CAP) instruments, infrastructure investments, and the widespread adoption of modern technologies have contributed to an efficient and sustainable viticulture model. In contrast, Eastern EU countries have shown more fluctuating developments, shaped by economic transition, fragmented farm structures, and limited access to resources. Romania, although possessing notable viticultural potential, still records yields below the EU average, despite recent improvements driven by modernization projects and EU funding. The paper emphasizes the need for continued investment and structural reform to reduce regional disparities and strengthen the overall competitiveness of European viticulture in the context of current sustainability and climate adaptation challenges.*

Key words*: grapes, yield, European Union, viticulture, Romania, sustainable agriculture*

INTRODUCTION

Viticulture is a strategic sector of European agriculture, with an important share in the rural economy, but also of profound cultural significance [2,5,6,8,12]. The European Union is a world leader in wine production, benefiting from favorable natural conditions, historical traditions and consistent support policies [3,4,10,11]. The performance of the wine sector is not only assessed in terms of production volume, but also in terms of yield – an essential indicator for the efficiency of resource use.

The yield expressed in tons/hectare (t/ha) reflects the production capacity per unit area and is influenced by a series of determining factors: soil characteristics, climate regime, cultivated varieties, applied technologies, degree of mechanization, investments in irrigation, but also agricultural and environmental policies [1,7,9,16].

In recent decades, grape production yields have developed differently depending on the region [13,17,18]. Western European countries, such as Italy, France and Spain, have implemented modern efficiency policies, while Eastern European countries – including Romania – have faced challenges generated by economic transition, farm restructuring and adaptation to European standards [14,15].

Romania has significant viticultural potential, being one of the oldest wine-producing countries in the world. However, the yields obtained vary significantly, depending on the region and the investments made in the modernization of plantations. The comparative analysis of yields in the European Union, including Romania and its neighbors, provides an overview of the technological progress and efficiency of European wine production.

At the same time, the analysis of viticultural yields must also be correlated with sustainability objectives, since the efficiency of grape production cannot be evaluated exclusively through quantitative results. Climate change, with its effects on rainfall distribution, temperature variations, and the frequency of extreme events, directly influences vineyard productivity and quality. Moreover, sustainable vineyard management practices—such as soil conservation, biodiversity protection, and the reduction of chemical inputs—are increasingly shaping the competitiveness of the wine sector in the European Union [19,20]. Thus, yield performance must be understood in an integrated framework that includes not only technological and economic factors but also environmental and social dimensions, ensuring long-term resilience and alignment with European sustainability policies.

In the case of Eastern European countries such as Romania, Bulgaria, Hungary, and the Republic of Moldova, the evolution of viticultural yields reflects both the legacy of traditional practices and the gradual modernization of the sector after the 1990s. While Hungary and Bulgaria have managed to stabilize their yields through investments in mechanization, irrigation systems, and improved varieties, Romania still registers high variability between regions, largely due to the fragmented farm structure and unequal access to funding programs [21,22]. Moldova, although not an EU member, remains an important reference point for regional comparison, as its viticulture is strongly export-oriented and heavily dependent on external markets. A comparative approach among these countries highlights not only differences in productivity, but also disparities in the capacity to adapt to climate challenges, implement innovative technologies, and integrate sustainability objectives into vineyard management.

Therefore, the objective of this research is to analyze the evolution of viticultural yields in the European Union during the period 1990–2020, with a dual focus: (i) examining trends in the major wine-producing countries of Western Europe, and (ii) comparing Romania with its neighboring countries, Hungary and Bulgaria, in order to assess regional disparities, technological progress, and the capacity to adapt to sustainability challenges.

MATERIALS AND METHODS

The paper applies a quantitative methodology that combines statistical analysis and comparative assessment of viticultural yields across European Union countries. The main indicator used is grape production yield, expressed in tons per hectare (t/ha), which reflects productivity per unit of cultivated area.

Data sources. The dataset covers the period 1990–2020 and is extracted from official, harmonized databases, primarily Eurostat and the FAO Statistical Database (FAOSTAT), which provide consistent and comparable time-series information. National statistical yearbooks were also consulted for cross-validation in the case of Romania, Hungary, and Bulgaria. The data are reported at annual and national levels, ensuring homogeneity and compatibility between countries.

Analytical framework. The methodology follows two complementary directions:

- Trend analysis of yields in Western Europe's main wine-producing countries (Italy, France, Spain, Portugal, and Germany), aimed at capturing the long-term dynamics and technological trajectories of the sector.
- Comparative benchmarking of Romania against its Eastern European neighbors (Hungary and Bulgaria), in order to highlight regional disparities and identify specific challenges and opportunities.

Data processing and interpretation. Descriptive statistics (mean, minimum, maximum, standard deviation) were calculated to capture variability and performance

differences between countries and periods. For graphical representation of the results, Excel and SAS OnDemand for Academics were used to generate line charts and boxplots, which illustrate both temporal evolution and cross-country comparisons. In addition, a three-year moving average was applied to smooth fluctuations and provide a more stable overview of yield dynamics.

Contextual analysis. Beyond quantitative comparisons, the interpretation of results integrates key contextual factors, such as European Union enlargement, the implementation of the Common Agricultural Policy (CAP), structural reforms in Eastern Europe, adoption of modern technologies, climate change impacts, and investments in irrigation and vineyard modernization. This mixed approach ensures that yield evolution is not only described statistically but also understood in relation to broader agronomic, economic, and environmental drivers.

RESEARCH RESULTS

The comparative analysis of grape production yields in the European Union, carried out over the period 1990–2020, highlights structural and functional differences between countries with a consolidated tradition in viticulture and those in the process of developing or modernizing the sector. The yield expressed in tons/hectare (t/ha) reflects not only the technological level, but also the adaptability of the agricultural sector to the economic, climatic and institutional challenges of recent decades.

1. Yield evolution in Italy, France, Germany, Portugal and Spain (1990–2020)

Table 1.

Grape production yield (t/ha)

Year	France	Germany	Italy	Portugal	Spain
1990	9.04	13.44	8.24	5.68	4.62
1991	6.06	14.29	9.46	5.04	3.77
1992	8.81	17.92	10.89	4.04	4.40
1993	7.38	13.33	10.28	2.66	3.70
1994	7.73	14.65	10.07	3.63	2.73
1995	8.06	14.40	9.40	4.12	2.89
1996	8.70	12.33	10.56	5.58	4.43
1997	8.19	11.19	9.16	3.66	4.90
1998	8.02	14.39	10.59	2.28	4.60
1999	9.31	16.37	10.67	4.87	5.03
2000	9.02	13.40	10.16	4.19	5.60
2001	8.39	12.30	10.45	4.83	4.65
2002	7.95	13.85	8.84	4.20	5.00
2003	7.41	11.50	8.96	4.66	6.17
2004	8.88	12.03	11.04	4.82	6.03
2005	7.94	14.65	10.79	4.76	5.22
2006	7.66	12.35	10.59	5.06	5.81
2007	7.26	14.05	9.45	4.16	5.27
2008	7.39	13.55	9.89	4.00	5.37
2009	7.66	12.34	10.28	4.33	5.28
2010	7.64	9.53	10.02	5.26	6.09
2011	8.69	12.53	10.26	4.16	6.03
2012	7.08	12.32	10.08	4.69	5.63
2013	7.29	11.46	11.41	4.61	7.92
2014	8.19	12.44	10.16	4.57	6.68
2015	8.32	12.00	11.76	5.22	6.16
2016	8.02	12.25	12.28	4.42	6.53
2017	6.68	10.12	10.70	4.86	5.75
2018	8.35	14.01	12.60	4.49	7.43
2019	7.27	11.19	11.32	4.92	6.13
2020	7.71	11.41	11.68	4.86	7.32

Source: FAO, 2025

Interpreting the data presented in the previous table allows a clearer understanding of the evolution of the yield in the analyzed Western countries. To more visually highlight these trends and differences between the states, the following figure shows a graphical representation of the yield dynamics for the period 1990–2020.

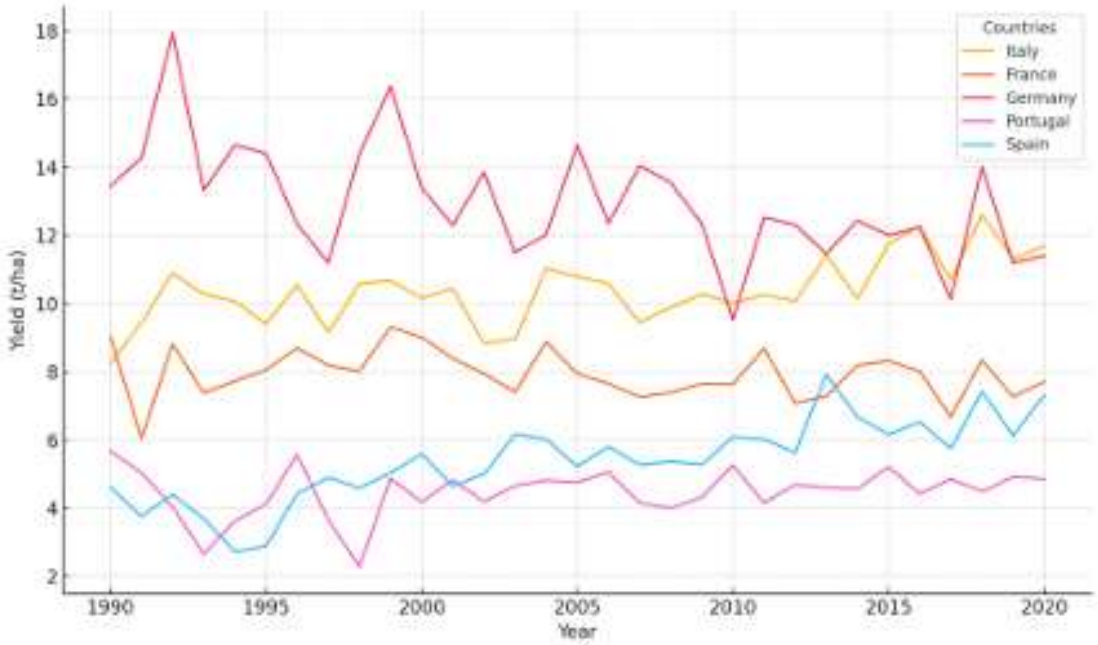

Figure 1. Yield evolution in Western countries

Source: FAO, 2025

The data analyzed for the five major wine-growing powers of Western Europe indicate a general trend of stability and controlled yield growth.

• Italy and France, with millennial traditions in wine production, have managed to maintain high yields, around 10–12 t/ha, with minor fluctuations caused by extreme weather events or changes in the subsidy regime. It is noteworthy that these countries have had the ability to quickly absorb modern technologies, while maintaining product quality through strict regulatory standards.

• Spain, although one of the countries with the largest wine-growing areas in the world, started with a modest yield in the early 1990s (approximately 5–6 t/ha), but has experienced a significant increase towards 8–9 t/ha in recent decades. This evolution is due to an accelerated modernization process, especially after joining the EU.

• Portugal has had a slower but constant evolution, reaching values of 8–9 t/ha today, thanks to a combination of traditional farms and the gradual introduction of innovations in the cultivation process.

• Germany, although with a less favorable climate than Mediterranean countries, has managed to stabilize its yields around 7–8 t/ha, reflecting a balanced approach between quantity and quality, adapted to the specifics of local wines.

In all five cases, it is noted that the yield was positively influenced by European agricultural policies, in particular through subsidies for the restructuring of vineyard plantations and through support for the implementation of irrigation and crop protection systems.

2. **Yield evolution in Romania, Hungary and Bulgaria (1990–2020)**

Table 2.

Grape production yield (t/ha)

Year	Bulgaria	Hungary	Romania
1990	5.21	7.77	4.27
1991	5.40	6.88	3.77
1992	5.76	5.91	3.85
1993	4.12	5.69	5.47
1994	4.55	6.06	4.18
1995	6.25	5.44	5.28
1996	6.18	6.67	5.68
1997	5.95	7.25	4.68
1998	3.53	7.26	3.48
1999	3.37	5.76	4.53
2000	4.06	7.71	5.29
2001	3.37	9.87	4.69
2002	3.57	6.05	4.62
2003	3.31	6.25	4.83
2004	2.71	8.46	5.99
2005	2.10	5.54	2.96
2006	2.38	6.91	4.79
2007	3.13	7.18	5.01
2008	3.28	7.53	5.33
2009	2.77	7.24	5.39
2010	2.78	3.99	4.21
2011	3.11	5.96	4.99
2012	4.31	4.93	4.20
2013	6.49	6.51	5.58
2014	4.16	5.74	4.46
2015	6.76	6.54	4.51
2016	5.78	7.00	4.21
2017	5.91	7.90	6.06
2018	5.91	8.07	6.60
2019	5.94	7.04	5.52
2020	5.54	7.30	5.63

Source: FAO, 2025

The yield value recorded by Romania and its neighbors provides a synthetic picture of the efficiency of the wine sector in this region of the European Union. To more clearly highlight the specific trajectories of each country and the differences in level or evolution, the data is also transposed in graphical form in the figure below.

The countries of Central and Eastern Europe present a contrasting picture. In these states, the post-communist transition had a significant impact on agriculture, and this fact is clearly reflected in the data on grape yields.

• Romania recorded an oscillating evolution of yields, with values between 3 and 7 t/ha. This variability is explained by the fragmented nature of agricultural holdings, the lack of sustained investments in infrastructure and mechanization until 2007–2010, as well as by the high vulnerability to drought and cryptogamic diseases. However, in recent years a trend of production consolidation has been observed, supported by investments in modernization, European-funded projects and the professionalization of some producers.

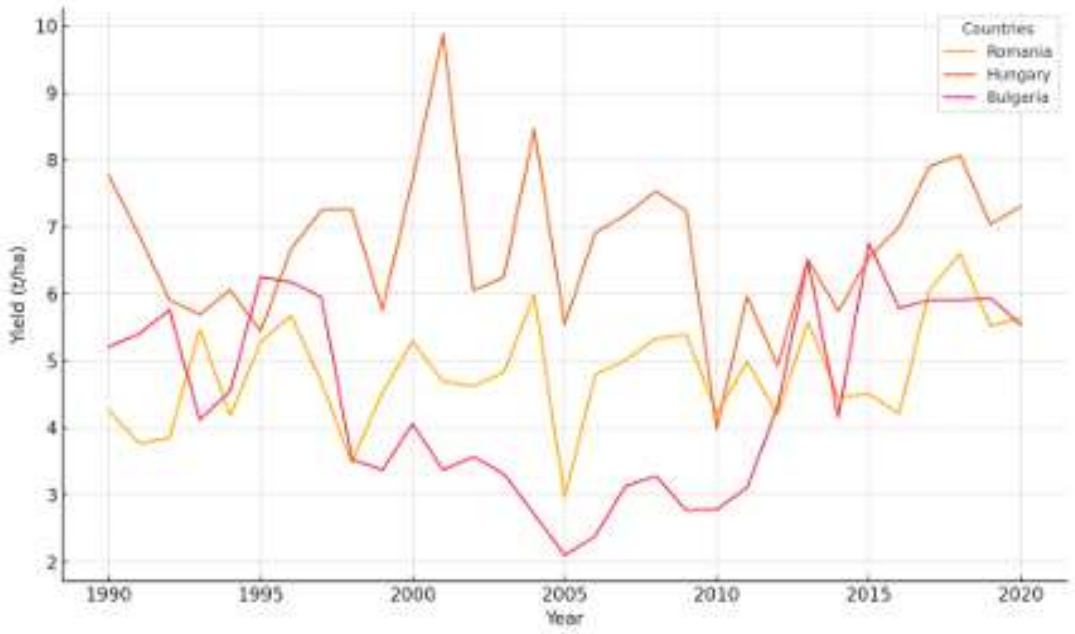

Figure 2. Yield evolution in Romania, Hungary and Bulgaria (1990–2020)
Source: FAO, 2025

• Hungary, despite a more stable agricultural base, had a relatively constant yield, between 5 and 8 t/ha. This level is higher than in Romania and Bulgaria, reflecting a better structuring of the wine sector and a more efficient economic transition.

• Bulgaria consistently ranks at lower yield levels (below 4 t/ha on average), indicating persistent difficulties related to viticulture restructuring, agricultural labor migration and a low level of absorption of European funds for agriculture.

Compared to Western countries, Eastern European countries face specific challenges related to the lack of modern infrastructure, excessive fragmentation of land ownership and weak association between producers. However, the dynamics of recent years indicate a progressive alignment with European standards, especially in Romania and Hungary, where yields are increasing.

CONCLUSIONS

The yield of grape production in the European Union has followed a general upward trend over the last three decades, especially in the Western countries. This evolution reflects the application of high-performance agricultural practices, access to modern cultivation, mechanization and irrigation technologies, as well as coherent agricultural policies focused on efficiency and sustainability. Also, a favorable climate and investments in research and development have contributed to the increase in productivity per hectare in countries such as Italy, France and Spain.

Western countries such as Italy, France, Germany, Portugal and Spain have managed to maintain a high and relatively constant yield, most exceeding 10 tons/hectare. These results highlight the consolidation of a viticultural model oriented towards competitiveness and adaptability to market demands. The stability of the yield is supported by modern agricultural infrastructure, efficient use of resources and the application of regional specialization strategies depending on the type of wine produced.

Romania, despite its considerable wine-growing potential, has not managed to reach the EU average in terms of grape production yield. The variability of yield from year to year is influenced by factors such as climatic instability, fragmentation of vineyard

areas, low level of technology, but also by limited access to forms of financial support. However, a positive trend has been observed in recent years, as a result of the absorption of European funds and the increased interest in the modernization of vineyard plantations.
Romania's neighbours, Bulgaria and Hungary, also have lower yields than the major wine-growing economies of Europe. Bulgaria is experiencing the lowest values in the region, while Hungary is relatively stable, with values between 5 and 8 t/ha. These results suggest that, although there is an important wine-growing tradition, the current level of technological development and economic organisation in these countries is not yet sufficient to bring them into the EU's competitive yield zone.

There is a trend of convergence between the countries of the Eastern and Western European Union, especially after EU accession and the implementation of the Common Agricultural Policy. However, the pace of this alignment is uneven and depends largely on the capacity of each country to attract investment, to professionalize the agricultural workforce and to adapt the ownership structure to modern efficiency requirements.
Grape production yield is an essential indicator of the performance of the wine sector, and its increase can be considered a sign of the maturation of the agricultural economy. In the current context, in which sustainability and adaptation to climate change are becoming imperative, maintaining high yields must be achieved through sustainable methods, which combine product quality with environmental protection and the economic balance of agricultural holdings.

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