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A DECADE OF CHANGE IN EUROPE'S TOMATO GREENHOUSES: INSIGHTS AND TRENDS

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Abstract

In front of escalating resource limitations in agriculture, this study emphasizes the critical need for efficient crop cultivation. Focusing particularly on tomatoes, a staple in global diets, the research aims to sustenably enhance productivity. Recognizing productivity as a key economic indicator, the study highlights the pivotal role of energy-efficient practices in addressing challenges posed by climate change and depleting natural resources. By optimizing energy use in agricultural processes, this research not only improves economic efficiency but also positions the sector for resilience and innovation in a resource-constrained environment. Through an in-depth analysis of data from Eurostat covering the 2014-2022 period, we trace the trends in greenhouse tomato cultivation across Europe, evaluating changes in cultivation areas and productivity. This research offers insights into how different European countries have adapted their agricultural practices in response to environmental and economic pressures and in the same time, it underscores the need for continued innovation and adaptation in agricultural practices to meet the demands of a growing global population under increasingly constrained environmental conditions.

***Key words*:** *agriculture, tomato production, crop efficiency, productivity, resource constraints, innovation*

INTRODUCTION

In the current context of agriculture, where resources are increasingly limited, the efficient cultivation of crops becomes a significant challenge [9]. Agriculture, as the foundation for providing sustenance to a growing population, necessitates the need for sustainable production [18]. Within this framework, emphasis on the efficient growth of crops, especially species like tomatoes, is essential to meet global food requirements in a sustainable and profitable manner [19].

rom an economic perspective, the tomato, as the most widely-cultivated vegetable globally, holds a significant position in the agricultural industry [2, 15, 17].

Productivity in agriculture serves as a very important indicator of economic success and long-term sustainability [8]. In this perspective, tomato production holds a prominent place in the agricultural industry, being a staple in many global diets [7]. Efficiently increasing productivity in this domain not only contributes to ensuring food security but also optimizes the utilization of natural resources [13].

In light of the ongoing challenges associated with climate change and the reduction of natural resources, prioritizing energy-efficient consumption has become a real necessity [6, 11]. The sustainable use of energy in agricultural processes not only enhances the economic efficiency of the entire production system but also enhances its adaptability to changes in the business environment [16]. In a period where resource efficiency and economic sustainability are becoming increasingly important, strategies focused on energy-efficient consumption are not only a necessity but also an opportunity to innovate and transform the agricultural sector into a more efficient and resilient one [1]. In few words, in order to boost yields and cost-efficiency in tomato production, it is important to extend cultivation in controlled environments like greenhouses [14]. Greenhouse-grown vegetables present a reliable solution for ensuring a continuous supply of fresh produce [10]. By employing

proven technologies, these controlled environments effectively address challenges posed by climate variability, enhancing the sustainability of the production system. Greenhouses allow for year-round cultivation, independent of external weather conditions, thus providing a consistent and dependable source of fresh vegetables [12]. This method not only meets consumer demand but also contributes to a more resilient agricultural system [3].

Such an expansion requires investments in modern agricultural setups that incorporate new farming technologies [15]. This approach can lead to an increase in production, meeting market demands more effectively while maintaining economic and environmental sustainability [5].

In this context, the purpose of the paper is emphasizes the need for an efficient cultivation of tomatoes for a sustainable increase of productivity using energy-efficient practices as a response to climate change and the depletion of natural resources.

MATERIALS AND METHODS

In conducting our study regarding the trends in European greenhouse tomato cultivation from 2014 to 2022, we sourced our data directly from Eurostat, the principal provider of statistical information in the European Union. This ensured that our analysis was grounded in reliable and comprehensive data. We then embarked on a meticulous process of standardizing this data, ensuring consistency across different countries and years. Our analysis involved calculating the percentage changes in cultivation areas for each country over the nine-year period, enabling us to paint a detailed picture of the evolving landscape of greenhouse tomato production in Europe, all grounded in the dependable data from Eurostat.

RESULTS AND DISCUSSIONS

Between 2014 and 2022, tomato production in Europe underwent some notable changes, with the focus being on the top 10 producing countries, which include Romania. Turkey was the leader in tomato production in Europe, with an initially cultivated area of approximately 183,000 hectares in 2014. However, over the period, the cultivated area decreased, reaching 159,000 hectares in 2022. Italy held the second place in tomato production, with an area that varied between 95,000 and 107,180 hectares in 2015, stabilizing at 97,610 hectares in 2022. Spain saw an initial increase in tomato production, reaching about 62,720 hectares in 2016, but later experienced a significant decrease, amounting to 45,150 hectares in 2022. Romania had significant fluctuations in its tomato production during this period. With an initial area of 24,430 hectares in 2014, there was a sharp decrease between 2018 and 2019. Since then, the cultivated area has remained relatively stable around 17,000 - 24,000 hectares. Portugal experienced fluctuations in tomato production, with a peak in 2016 of 20,850 hectares, but then stabilized around 16,580 hectares in 2022, while Greece recorded a steady decline in tomato production, from 17,260 hectares in 2014 to 9,430 hectares in 2022. Poland showed a steady downward trend in tomato production, decreasing from 13,500 hectares in 2014 to 6,700 hectares in 2022. France continued to maintain a relatively small tomato production, with an area that fluctuated between 5,650 and 6,260 hectares during this period, and Bulgaria had a relatively stable tomato production, varying between 3,000 and 5,000 hectares. Ranking last in the top 10 countries is Hungary, which had a small area for tomato production compared to the other countries, decreasing from 1,880 hectares in 2014 to 1,680 hectares in 2022.

Speaking in percentages, From 2014 to 2022, the landscape of European greenhouse tomato cultivation has shifted, with Turkey maintaining a dominant position despite a decline to 86.89% of its initial area. Italy nearly sustained its cultivation area, holding 94.67%, while Spain experienced a decrease to 82.47%. Romania and Greece faced significant reductions, with Romania at 70.28% and Greece at 54.63% of their

respective starting figures. Poland's area saw a sharp fall to 49.63%. Contrastingly, France showed a slight increase, and Bulgaria and Hungary experienced modest declines. Overall, the EU 27's cultivation area contracted to 84.08%, indicating a region-wide trend of diminishing greenhouse space for tomatoes, prompting a push for more efficient production methods (Table 1).

Table 1. Top 10 European countries with the largest areas of tomatoes cultivated, 2014-2022 (1,000 ha)

COUNTRY	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022/2014 %
Turkey	183.00	187.00	181.00	177.00	169.00	173.00	174.00	165.00	159.00	86.89
Italy	103.11	107.18	103.94	99.75	97.09	99.02	99.78	102.06	97.61	94.67
Spain	54.75	58.13	62.72	60.85	56.13	56.94	55.47	56.11	45.15	82.47
Romania	24.43	24.84	22.71	22.21	22.97	23.78	17.47	18.13	17.17	70.28
Portugal	18.46	18.66	20.85	20.87	15.83	15.89	15.04	17.78	16.58	89.82
Greece	17.26	15.25	14.01	13.32	16.02	15.01	15.82	13.14	9.43	54.63
Poland	13.50	13.80	12.42	12.64	13.11	13.50	7.80	7.70	6.70	49.63
France	5.83	5.69	5.65	5.75	5.74	5.66	6.26	6.19	5.89	101.03
Bulgaria	3.59	3.28	4.20	5.01	4.52	5.15	3.09	3.07	3.08	85.79
Hungary	1.88	2.26	2.08	2.19	2.50	2.41	1.82	1.94	1.68	89.36
EU 27 (from 2020)	247.89	254.20	253.95	247.95	239.48	242.52	227.89	231.33	208.43	84.08

Source: Eurostat, 2023 [4].

Analyzing the data from the table on areas cultivated with tomatoes in European countries between 2014 and 2022, the following concrete information can be observed: Turkey maintained the largest share of the total area cultivated with tomatoes in the European Union, with 73.82% in 2014, increasing to 76.28% in 2022. Italy remained in second place, with its share growing from 41.60% in 2014 to 46.83% in 2022, indicating an increase in its relative participation in tomato cultivation. Spain saw a slight decrease in its share, from 22.09% in 2014 to 21.66% in 2022, yet remained in the top three. Romania and Portugal recorded a reduction in their percentages, with Romania dropping from 9.86% to 8.24%, and Portugal from 7.45% to 7.95%. Greece experienced a significant reduction in its share, from 6.96% to 4.52%. Poland, France, Bulgaria, and Hungary show smaller figures and modest variations between the two years. At the EU 27 level (starting in 2020), there was a decrease in the total area cultivated with tomatoes from 247.89 in 2014 to 208.43 in 2022 (Tble 2).

Table 2. Share of tomato cultivation areas, comparison between the year 2014 and the year 2022

Country	% 2014	%2022
Italy	41.60	46.83
Spain	22.09	21.66
Romania	9.86	8.24
Portugal	7.45	7.95
Greece	6.96	4.52
Poland	5.45	3.21
France	2.35	2.83
Bulgaria	1.45	1.48
Hungary	0.76	0.81
EU 27 (from 2020)	100.00	100.00

Source: Own calculation based on data collected from Eurostat, 2023.

The analysis of the 2022 data on cultivated areas in the European Union highlights the need for diversification and optimization of agricultural practices, including through the use of protected spaces such as greenhouses, to meet market demand. This approach is relevant for both countries with large cultivated areas, such as Turkey, Italy, and Spain, as well as those with smaller areas, such as Denmark or Malta. The use of protected spaces allows for better control of environmental conditions, leading to the

optimization of plant growth and increased production. This is vital to ensure a consistent and high-quality yield, regardless of climatic variations. Furthermore, greenhouses and other forms of controlled agriculture can contribute to extending the growing season, providing the opportunity to produce crops outside the usual season. For countries with smaller cultivated areas, this strategy is particularly important as it allows for maximizing production on the available land, thereby contributing to economic efficiency and food security. In the context of a continuously growing market demand and the challenges posed by climate change, the adoption of such innovative and sustainable methods in agriculture becomes essential for all member states of the European Union.

From 2014 to 2022, an analysis of tomato production in the leading European countries reveals a complex landscape of agricultural yields. Turkey remained at the forefront, with its tomato production figures showcasing a high degree of consistency, albeit with minor annual fluctuations. This trend indicates a sustained capacity for tomato cultivation at a large scale. Italy held firmly to its position as the second-largest producer, with an overall trajectory of increasing production. Notable within this period were the slight decreases in the years 2017 and 2018, succeeded by a subsequent recovery and an eventual peak in production in 2021, before a small decline in 2022.

Spain's production narrative unfolded with an initial period of growth, reaching a high point in 2016, after which a gradual decrease in tomato production was observed. By 2022, Spain's production had reduced significantly from its highest point. Portugal, Greece, and the Netherlands presented more variable patterns of production. Portugal's peak in 2017 was followed by a decrease, stabilizing in the later years. Greece saw a general decline over the period, suggesting a reduction in tomato cultivation. The Netherlands demonstrated a steady production until a slight decrease in the last two years.

The production figures from Poland, France, Romania, and Belgium illustrated smaller scales of cultivation. Poland and France maintained relatively stable production with minor annual variations. Romania, after experiencing a sharp decline in 2019, recovered somewhat but then fell significantly in 2022. Belgium, while the smallest among the top ten, indicated an upward trend in the latter years, potentially pointing towards a growing focus on tomato production.

The comparison of tomato production in the top European countries between 2014 and 2022 shows Turkey, Italy, and Belgium increasing their output over the eight years, while Spain, Greece, and Romania see significant declines. From 2021 to 2022, most countries, except for Belgium, which shows growth, experience a modest decrease in production (Table 3).

Table 3. Top 10 european countries with the largest tomato production - standard humidity, 2014-2022 (1,000 tonnes)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022/2014 %	2022/2021 %
Turkey	11,850.00	12,615.00	12,600.00	12,750.00	12,150.00	12,842.00	13,204.00	13,095.00	13,000.00	109.70	99.27
Italy	5,598.08	6,410.25	6,437.57	6,015.87	5,798.10	5,777.61	6,247.91	6,644.79	6,136.38	109.62	92.35
Spain	4,888.88	4,832.70	5,233.54	5,163.47	4,768.60	5,000.56	4,312.90	4,754.38	3,651.94	74.70	76.81
Portugal	1,399.54	1,407.00	1,693.86	1,747.63	1,329.76	1,530.11	1,399.21	1,741.32	1,406.28	100.48	80.76
Greece	1,132.72	1,148.36	1,039.32	878.77	835.94	808.67	908.25	888.32	752.51	66.43	84.71
Netherlands	900.00	890.00	890.00	910.00	910.00	910.00	910.00	880.00	770.00	85.56	87.50
Poland	810.60	789.60	866.98	898.01	928.83	917.80	766.60	815.80	787.20	97.11	96.49
France	786.10	787.88	827.61	771.55	712.02	709.28	703.59	726.17	711.04	90.45	97.92
Romania	473.86	468.75	425.61	435.06	464.04	436.55	493.72	500.20	298.92	63.08	59.76
Belgium	249.25	253.05	259.54	255.96	258.68	270.14	311.50	282.67	298.80	119.88	105.71

Source: Eurostat, 2023 [4].

The data presented in Table 4, regarding tomato cultivation in greenhouses from 2014 to 2022 emphasizes the ongoing necessity of protected agriculture. Turkey currently leads with 25,000 hectares, signaling a robust approach to addressing market demands.

Spain and Italy, maintaining 16,040 and 6,820 hectares respectively, illustrate the critical role that greenhouse cultivation occupies in their agricultural output.

The observed decrease in Spain's greenhouse areas and the fluctuations in Italy's cultivation space highlight the challenges these countries face in meeting the year-round market demand. Particularly from September to May, when there is a notable market shortfall, the need for produce grown in controlled environments becomes even more pressing.

Poland's reduction in greenhouse tomato area to 1,200 hectares might limit its capacity to contribute to market supply during the off-season. Conversely, Romania's steady increase to 1,900 hectares in 2022, and the Netherlands' significant rebound to 1,820 hectares, indicate strategic enhancements to their protected cultivation practices, likely in response to the seasonal market deficit.

Portugal's and Bulgaria's cultivation trends, with the former peaking at 1,400 hectares in 2020 and 2021 and then descending to 1,240 hectares, and the latter maintaining a stable cultivation area, underscore the broader European movement towards optimizing greenhouse tomato production. The current cultivation data points to the essential need for continued and increased investment in greenhouse infrastructure across Europe to secure a consistent supply of tomatoes, thus addressing the market deficits that are most pronounced from September to May.

Table 4. Top 10 European countries with the largest areas of tomatoes cultivated in greenhouses, 2014-2022 (1,000 ha)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	Evolution
Turkey	23.00	25.00	26.00	28.00	28.00	28.00	26.00	28.00	25.00	
Spain	21.13	19.41	19.98	18.95	18.97	17.80	16.79	16.27	16.04	
Italy	7.15	7.44	7.16	7.08	7.23	7.61	7.61	7.35	6.82	
Poland	3.10	3.10	3.25	3.23	3.25	3.20	1.50	1.80	1.20	
Greece	3.06	2.82	2.59	2.67	2.70	2.61	2.67	3.11	2.71	
France	2.07	2.03	2.21	2.09	2.14	2.15	2.17	2.17	2.15	
Netherlands	1.78	1.76	1.78	1.79	1.79	0.91	0.91	0.88	1.82	
Romania	1.62	1.65	1.73	1.66	1.84	1.83	1.79	1.78	1.90	
Portugal	0.93	0.98	0.96	1.00	1.01	0.93	1.40	1.40	1.24	
Bulgaria	0.56	0.59	0.58	0.64	0.61	0.50	0.51	0.64	0.59	

Source: Eurostat, 2023 [4].

Table 5. Top 10 european countries with the largest tomato production in greenhouses, 2014-2022 (1,000 tonnes)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	Tredline
Turkey	3,203.00	3,315.00	3,522.00	3,796.00	3,889.00	3,989.00	4,045.00	4,369.00	4,104.00	
Spain	2,112.02	1,835.31	2,027.86	1,827.11	1,836.19	1,623.43	1,553.19	1,475.06	1,450.44	
Netherlands	900.00	890.00	890.00	910.00	910.00	910.00	910.00	880.00	770.00	
France	580.10	589.32	625.18	560.36	522.86	524.27	486.59	521.17	504.25	
Poland	538.70	553.20	606.59	643.46	675.84	677.30	571.30	654.40	615.70	
Italy	498.61	516.29	447.05	442.56	465.94	524.93	513.66	536.50	485.92	
Greece	384.19	340.77	321.72	309.66	328.38	293.28	344.62	397.46	337.03	
Germany	84.50	80.92	85.29	96.56	103.27	106.69	102.12	101.77	102.18	
Romania	75.93	79.41	98.52	76.55	87.14	76.33	68.79	67.56	71.21	
Austria	56.97	55.38	54.75	53.90	57.80	57.99	58.24	59.34	56.46	

Source: Eurostat, 2023 [4].

Turkey's greenhouse tomato production consistently increased, reaching a high in 2021 with 4,369,000 tonnes before a minor drop to 4,104,000 tonnes in 2022 (Table 5).

Spain's output gradually declined over the years, ending at 1,450,440 tonnes. The Netherlands saw a steady production until a drop in the last two years, concluding with 770,000 tonnes. France and Poland both experienced fluctuations, with France ending at 504,250 tonnes and Poland decreasing after a peak in 2019 to 615,700 tonnes in 2022. Italy's production overall declined slightly to 485,920 tonnes. Greece showed recovery in 2021 but fell again to 337,030 tonnes in 2022.

Germany, Romania, and Austria had more stable production, with slight variations, ending the period near their starting figures (Table 5).

CONCLUSIONS

The landscape of tomato production in European greenhouses has displayed varied trends from 2014 to 2022, with some countries expanding their output and others facing declines. Increases in countries like Turkey, Italy, and Belgium contrast with the significant drops seen in Spain, Greece, and Romania, signaling diverse agricultural conditions and strategies across the continent. Yearly figures from 2021 to 2022 mostly show a downturn, except for Belgium, which notably improved its production.

The general decrease across the EU emphasizes the importance of adopting advanced agricultural technologies and sustainable practices to adapt to the shrinking cultivation spaces and to meet the ongoing demand for tomatoes. The future of European tomato production in greenhouses appears to hinge on integrating innovation and efficiency into the sector's practices, ensuring long-term sustainability and resilience.

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