AGRICULTURAL AND RURAL DEVELOPMENT IN EU MEMBER STATES: A PRE- AND POST-COVID-19 ASSESSMENT

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ABSTRACT

The Covid-19 pandemic has tested the sustainability of the agricultural sector and rural areas of the European Union. Beyond the short-term responses of the member countries, the pandemic has raised the issue of redefining long-term development policies. The purpose of this paper is a comparative assessment of the agricultural and rural development of the European Union member states before and after the Covid-19 pandemic. Hierarchical and K-means cluster analysis are applied in the research. The study aims to evaluate the resilience of European Union member states to the Covid-19 pandemic and their heterogeneity by analysing changes in indicators of agricultural and rural development. The research results confirmed the resilience of most countries of the European Union, as well as the existence of specific patterns of their agricultural and rural development. These findings indicate that redefining agricultural and rural development policies still requires careful consideration of country-specific characteristics.

Introduction

The Covid-19 pandemic represented a strong external shock that emphasised the issue of sustainability of agricultural sector and rural development of the European Union (EU). In parallel, the scientific focus during the pandemic shifted from economic results

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to the resilience of agricultural and rural systems. Namely, in the era of deep socio-economic transformations, crisis periods, and environmental challenges, understanding the development dynamics of agricultural and rural areas requires a comprehensive, systemic approach that goes beyond traditional concepts focused solely on increasing productivity. On the other hand, the Covid-19 pandemic redefined the importance of rural areas as safer environments for both living and working and affirmed the question of their long-term revitalization, as a response to potential future crises among other things. The empirical picture of the European Union reveals that the short-term responses of the member states to the challenges of the Covid-19 pandemic were heterogeneous, while in parallel the countries made efforts to change the policies and approach to agricultural and rural development (Gonzales-Martinez et al., 2021; Stanišić et al., 2022; Daniłowska, 2024). In the years after the pandemic, the achieved results and indicators of agricultural and rural development represent an objective assessment of the success of the redefined policies.

A review of the literature on the effects of the Covid-19 pandemic on the agricultural and rural development of the EU member states concluded that the researchers' focus was primarily on the current resilience of the agricultural and rural sector and recommendations for redefining policies and strategies for future development. Also, there is a limited body of research that included the analysis of a large number of agricultural and rural development indicators, all the EU member countries or those that were conducted after the end of the Covid-19 pandemic. In accordance with this identified gap, the research objective was formulated. The aim of the paper is to assess the resilience of their agricultural and rural systems and the existence of specific patterns of agricultural and rural development of the EU member states in the year before and the year after the Covid-19 pandemic. Pre- and post-Covid-19 assessment implies a quantitative analysis of changes in indicators of agricultural and rural development of the EU member states in 2023 compared to 2019.

To achieve the defined research aim, this paper addresses the following research questions:

RQ1: Do the changes in agricultural and rural development indicators across the EU member states, comparing the year before and the year after the Covid-19 pandemic, indicate the resilience of the agricultural and rural sector?

RQ2: Is there heterogeneity among the EU member states regarding the dynamics of agricultural and rural development indicators when comparing the year before and the year after the Covid-19 pandemic?

The paper is organised into five sections. Following this introduction, a review of the literature on the impact of the Covid-19 pandemic on agricultural and rural development is given, both in general and in the context of the European Union. After that, the information base and methodological framework of the research are explained. The results of the cluster analysis and their discussion are the next segment of the paper, followed by concluding remarks.

Literature review

The Covid-19 pandemic was an external shock that tested the sustainability and resilience of agriculture, and indirectly rural development, through numerous restrictions, from movement restrictions to market and supply chain disruptions and labour availability. The impact of the Covid-19 pandemic on agriculture and rural development can be viewed through the prism of resilience theory. The way to do this is through assessment of the ability of agricultural and rural systems to absorb external shocks, to successfully adapt to changed conditions, to recover, and to progress despite crisis situations. At least for a short time, the pandemic shifted the focus away from agricultural productivity and economic outcomes. Instead, it highlighted the ways and relationships that enable agricultural systems to adapt to crisis events, evolve, and leverage unexpected circumstances (Darnhofer, 2021).

Empirical evidence of European agricultural systems has shown that resilience is multi-layered and dynamic in nature. The response of agricultural system actors was focused on immediate overcoming of problems, without considering long-term implications. Transformative capacities of European agricultural were not expressed and the crisis was not used as an opportunity to initiate significant structural reforms (Meuwissenet al., 2021). Also, empirical findings confirmed the lower resilience of large agricultural producers, due to less flexibility to adapt to drastically changed business conditions, while resilience increases with diversification and greater orientation towards the products that have added value (Guedegbe et al., 2023). The resilience of agricultural systems must be improved through technical, economic, social and institutional measures that mitigate disruptions caused by shocks such as the Covid-10 pandemic, primarily by ensuring the food security (Štreimikienė et al., 2022). Technical measures should provide adequate adaptive infrastructure capacities. Economic support from the state is also a desirable mechanism. The proactive engagement of the system's organisations and a resilient rural community are key drivers for the long-term social stability of the agricultural sector. Their inclusion is the basis of the social sustainability of agriculture (Krstić, 2018). Lioutas & Charatsari (2021), based on the lessons learned from the Covid-19 pandemic, propose the synergistic application of smart technologies and the introduction of community-based hybrid marketing models as key mechanisms for strengthening the resilience and transformative capacity of agriculture.

Agnoletti et al. (2020) observe the relationship between rural development and the Covid-19 pandemic in an inverse way, reaching and confirming empirically a conclusion about the importance of the revitalization of rural areas. The population's resistance to future health crises, as well as society's resistance to external shocks of a different nature, can be increased by the revitalization of rural areas and a more balanced relationship with nature. Consideration of the problem of resilience of rural areas to crises, including the Covid-19 pandemic, brought to the fore the role of local solutions and decisions. These solutions must be in line with the goals and interests of the community with its active participation. Diversification, local leadership, and trust in the local business community can significantly contribute to the reduction of tensions in times of crisis and the resilience

of rural areas. The Covid-19 pandemic has redefined the perception of rural areas as safer and more functional spaces for living and working. Future development of these areas must be based on intergenerational access, innovation, knowledge, entrepreneurship, and diversification of non-agricultural activities (Chigbu et al., 2021; Panić et al., 2024; Dimitrijević, 2025). In order to avoid long-term socioeconomic and ecological imbalances, many countries have realised that it is necessary to innovate development strategies. Their implementation should, through the creation of new sources of income, transform the village into a resilient and attractive entity with the same living conditions as those of the city. In the context of complementary agricultural and rural development, Gusmanov et al. (2023) argue that agricultural production is vital for rural sustainability during a pandemic. This stability can be achieved through effective producer support programs and by creating space for agribusiness localization.

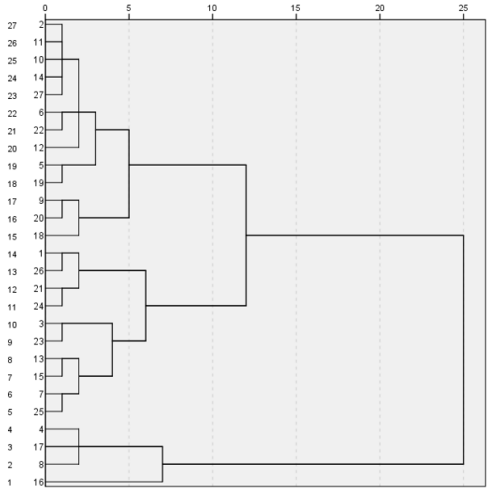
Research on the resilience of agriculture and rural areas to the Covid-19 pandemic within the European Union examines these issues from different perspectives. Gonzales-Martinez et al. (2021) confirmed that the European Union's agricultural sector proved highly resilient in the early stages of the Covid-19 pandemic and predicted that this trend would continue. In doing so, they conclude that the impact of the Covid-19 pandemic on food production varied across member states. The scale of this impact was directly dependent on the low elasticity of demand for food and supportive economic policy measures. Stanišić et al. (2022) investigate the impact of the Covid-19 pandemic on the economic performance of agriculture in the European countries in the initial year of the Covid-19 pandemic (2020) and conclude that the role of agriculture in contributing to key macroeconomic determinants at the country level has not changed. They note the differences between countries when it comes to the contribution of agriculture to the GDP during the Covid-19 pandemic, while the difference in the contribution to employment was not recorded. Through a comparative analysis of agricultural and rural development indicators from 2016 to 2023, Daniłowska (2024) confirmed that the Covid-19 pandemic caused a medium-term decline or slowdown in agricultural value-added growth across the six leading EU countries. This trend was accompanied by severe labour shortages as well as disruptions in both the livestock and crop sectors. The author concludes that there is a different intensity of the pandemic influence in the different analysed countries. Marcuță et al. (2021) explore the impact of the Covid-19 pandemic on food security as a key component of global, national, and human security. Their empirical analysis of key economic and agricultural indicators indicated that food supply stability within the European Union was preserved thanks to the high level of agricultural production development. At the same time, preserving the food supply chain was one of the key challenges and key tasks during the pandemic (Paraschivu & Cotuna, 2021). Through an empirical analysis conducted in the early stages of the Covid-19 pandemic, from March to June 2020, Matthews (2020) reaches similar results. The author points to a high degree of resilience within the EU food system, as farmers, processors, and traders successfully maintained supply continuity and adapted to structural changes in demand.

Materials and methods

The indicators included in the analysis are those defined and measured by the World Bank, expressed in relative values for the purpose of comparability. The difference in the values of the following indicators in the year after (2023) compared to the year before the Covid-19 pandemic (2019) represents the informational basis of the research: Agricultural raw materials exports (% of merchandise exports), Agricultural raw materials imports (% of merchandise imports), Employment in agriculture (% of total employment), Employment in agriculture, male (% of male employment), Employment in agriculture, female (% of female employment), Agriculture, forestry, and fishing, value added (% of GDP), and Rural population (% of total population) (World Bank, 2000; World Bank, 2026).

Hierarchical and K-means cluster analysis were applied in the paper. When determining the number of clusters, the possibility of a three-cluster, four-cluster, and five-cluster solution was considered. Based on the results of the hierarchical cluster analysis, utilising Ward's method and squared Euclidean distance, a decision was made to retain the three-cluster solution. The analysis of the agglomeration schedule showed a sudden jump in the value of the coefficients in the penultimate steps of the merger (from 93.15 to 121.98, and then to 182.00), which indicates the merger of mutually heterogeneous groups. This solution was fully confirmed by a visual inspection of the dendrogram, where three primary, stable branches can be clearly observed by cutting the scale of the rescaled distance at 12 (Figure 1).

Figure 1. Dendogram



Source: Author's calculation based on SPSS 25.0

K-means cluster analysis was applied in order to group the EU member states according to changes in the value of agricultural and rural development indicators in the year after compared to the year before the Covid-19 pandemic. Statistical significance of the difference between the defined clusters was examined by analysis of variance.

Results and discussions

Table 1 shows the final cluster centres and the characteristics of the three defined clusters. Cluster 1 includes countries with the largest negative changes in all observed indicators of agricultural and rural development. Negative changes in the export of agricultural raw materials, employment in agriculture, and the share of the rural population in the total were particularly pronounced. Cluster 2 stands out as the cluster with the most stable performance. It is characterised by values close to zero or positive values for certain indicators. Positive changes in the value of the indicators were recorded for total employment in agriculture, male employment in agriculture, and the share of value added of agriculture, forestry, and fishing in GDP. This indicates relative stability or an increase in the value of these indicators in 2023 compared to 2019. At the same time, the recorded change in the share of the rural population in the total population indicates its decrease in 2023 compared to 2019. Based on this, it can be concluded that changes in employment and the economic role of agriculture do not have to move in the same intensity and direction as changes in the rural demographic structure. This cluster, therefore, includes countries where changes were not equally pronounced in all dimensions of rural and agricultural development. The third cluster is characterised by negative changes in the values of most indicators, but they are less pronounced in some indicators than in the first cluster. At the same time, this is the only cluster where there is a positive change in the share of the rural population in the total. This once again confirms that negative changes in the economic indicators of agricultural and rural development do not necessarily have to be accompanied by a decrease in the share of the rural population.

Table 1. Final Cluster Centres

Indicator	Cluster		
	1	2	3
Agricultural raw materials exports (% of merchandise exports)	-1.00	-0.27	-0.20
Agricultural raw materials imports (% of merchandise imports)	-0.52	-0.17	-0.26
Employment in agriculture (% of total employment)	-1.14	0.03	-0.43
Employment in agriculture, male (% of male employment)	-1.49	0.12	-0.36
Employment in agriculture, female (% of female employment)	-0.76	-0.07	-0.48
Agriculture, forestry, and fishing, value added (% of GDP)	-0.32	0.02	-0.21
Rural population (% of total population)	-0.92	-0.69	0.07

Source: Author's calculation based on SPSS 25.0

The membership of European Union member states in the defined clusters is shown in Table 2. Four countries belong to Cluster 1, which was identified as the cluster with the largest negative changes in the values of the observed indicators, 14 countries belong to Cluster 2, as the cluster with the most stable values of the observed indicators, while

9 countries belong to Cluster 3, as the cluster with moderate changes in the values of the observed indicators.

Table 2. Cluster membership

Country	Cluster	Distance	Country	Cluster	Distance	Country	Cluster	Distance
Austria	2	1.024	France	2	0.773	Malta	2	0.618
Belgium	2	0.298	Germany	2	0.322	Netherlands	2	0.855
Bulgaria	3	0.581	Greece	2	0.997	Poland	3	0.846
Croatia	1	0.657	Hungary	3	0.332	Portugal	2	0.736
Cyprus	3	1.035	Ireland	2	0.456	Romania	3	1.320
Czechia	2	0.890	Italy	3	0.453	Slovak Republic	3	0.749
Denmark	2	0.841	Latvia	1	1.329	Slovenia	3	0.608
Estonia	1	0.783	Lithuania	1	1.010	Spain	3	0.800
Finland	2	0.682	Luxembourg	2	1.015	Sweden	2	0.339

Source: Author's calculation based on SPSS 25.0

The belonging of Croatia, Estonia, Latvia and Lithuania to Cluster 1 as the cluster that recorded the largest negative changes in agricultural and rural development indicators can be attributed to the less favorable structural characteristics of its agricultural sector, dependence on imported raw materials in production and, in the case of the aforementioned Baltic countries, a lower level of economic development heavily reliant on the primary sector (Jurjević et al., 2023; Marković & Marjanović, 2025). The structural problem and the extinction of property in Croatia or the lower technical equipment of agriculture in the Baltic countries made them more vulnerable to the consequences of the crisis caused by the Covid-19 pandemic. Economic results and incomes in Croatian agriculture are still below the EU average. Croatia records a deficit in the trade exchange of agricultural products, and there are also numerous obstacles to the application of innovations in this sector (OECD, 2025).

More than half of the EU member states belong to cluster 2 as a cluster with stable performance. Changes in the value of certain indicators in this cluster, such as employment and value added, are even positive in the year after the pandemic compared to the year before the Covid-19 pandemic. This can be attributed to the development of countries, a high level of modernization of agricultural production and digitalization, larger capital-intensive farms and high labor productivity (Marcuță et al., 2021; Herman, 2025).

Cluster 3, in addition to the countries of Central and Eastern Europe, also includes two countries of Southern Europe (Italy, Spain, and Cyprus). Their location in the group of countries with moderate, but predominantly negative changes in indicators of agricultural and rural development can be explained, among other things, by the dependence of agriculture and tourism and their exposure to a double shock during the period of the Covid-19 pandemic, as well as the pronounced and parallel impact of climate change (Jiménez-Donaire et al., 2020; Coderoni & Pagliacci, 2023). The moderate negative changes can be attributed to the diversified structure of agriculture, which proved to be more resistant to shocks.

The results of the analysis of variance (ANOVA), which evaluated the statistical significance of cross-cluster differences, are shown in Table 3. The grouping of the EU member states is similar to the results of research of Herman (2024), which applied multivariate analysis to group them according to socio-economic indicators of agriculture. In this research, the new EU member states and the former central-planned economies are grouped in separate and lower-performing clusters than those in which the developed countries of Western and Northern Europe were located. Filipović et al. (2025) identify most of the countries that belong to Cluster 2 in this study as countries oriented towards sustainable agricultural production.

Table 3. ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Agricultural raw materials exports (% of merchandise exports)	Between Groups	1.991	2	0.995	9.391	0.001
	Within Groups	2.544	24	0.106		
	Total	4.535	26			
Agricultural raw materials imports (% of merchandise imports)	Between Groups	0.368	2	0.184	5.872	0.008
	Within Groups	0.752	24	0.031		
	Total	1.121	26			
Employment in agriculture (% of total employment)	Between Groups	4.464	2	2.232	33.526	0.000
	Within Groups	1.598	24	0.067		
	Total	6.062	26			
Employment in agriculture, male (% of male employment)	Between Groups	8.173	2	4.086	27.187	0.000
	Within Groups	3.607	24	0.150		
	Total	11.780	26			
Employment in agriculture, female (% of female employment)	Between Groups	1.840	2	0.920	14.634	0.000
	Within Groups	1.509	24	0.063		
	Total	3.349	26			
Agriculture, forestry, and fishing, value added (% of GDP)	Between Groups	0.497	2	0.249	2.143	0.139
	Within Groups	2.786	24	0.116		
	Total	3.283	26			
Rural population (% of total population)	Between Groups	4.095	2	2.047	10.702	0.000
	Within Groups	4.591	24	0.191		
	Total	8.686	26			

Source: Author's calculation based on SPSS 25.0

The results of the analysis of variance indicate the existence of statistically significant differences between the three clusters of European Union countries in terms of changes in most of the observed indicators in 2023 compared to 2019. Statistically significant differences are found in six of the seven analysed indicators, where the most pronounced differences are recorded in the share of employment in agriculture in total employment ($F = 33.326$; $p < 0.001$), as well as in the share of men employed in agriculture in total men employment ($F = 27.187$; $p < 0.001$). Statistically significant differences in changes in the value of indicators are also recorded in the employment of women in agriculture, the share of the rural population in the total population, as well as the share of agricultural raw materials in merchandise exports and imports. In contrast, there are no statistically significant differences between the clusters when it comes to the

changing share of agriculture, forestry and fishing value added in the GDP ($F = 2.143$; $p = 0.139$). Therefore, the formed groups of countries differ according to the patterns of changes in most of the observed structural indicators, while the differences in the change in the contribution of agriculture, forestry and fishing to the creation of GDP cannot be statistically confirmed at the 5% significance level.

Conclusions

The agriculture and food industry sector in the European Union showed a high degree of resilience during the Covid-19 pandemic. Macroeconomic shocks have had a limited long-term impact on overall supply and consumption. However, the crisis has exposed vulnerabilities in terms of temporary access to food due to reduced imports, labour shortages, and disruptions in supply chains for specific sectors. This required quick and short-term responses from the EU member states that differed from country to country. In this context, the aim of the research was to analyse the indicators of agricultural and rural development and their dynamics to confirm the resilience and heterogeneity of the EU member states in the context of the impact of the Covid-19 pandemic on the agricultural and rural sector. By applying cluster analysis, the EU member states are grouped into three clusters depending on the change in the value of the analysed indicators of agricultural and rural development in the year after compared to the year before the Covid-19 pandemic.

The results of the cluster analysis showed that more than half of the EU member states are in Cluster 2, which was singled out as a cluster with stable performance. A total of 9 countries belong to Cluster 3, characterised by minimal negative changes in the analysed indicators, while only four countries are in Cluster 1, characterised by somewhat larger negative changes in the analysed indicators. As the majority of EU member states belong to the second or third cluster, it can be concluded about a positive answer to the first research question. The values of indicators of agricultural and rural development in the year after the Covid-19 pandemic, compared to the year before, confirmed the resilience of the agricultural and rural sectors of the European Union. The analysis of variance confirmed a statistically significant difference between the formed clusters when it comes to 6 out of 7 analysed indicators. Statistically significant differences between clusters were recorded in terms of changes in import and export of agricultural raw materials, employment in agriculture and rural population, while there are no statistically significant differences between clusters when it comes to changes in the share of agriculture, forestry, and fishing value added in the GDP. It can be concluded that there is still a certain heterogeneity among the EU member states regarding the dynamics of agricultural and rural development indicators when comparing the year before and the year after the Covid-19 pandemic. This heterogeneity can be explained by different levels of economic development of countries, different structural characteristics of agriculture, different levels of modernization and digitization of agricultural production or exposure to climate change.

The limitation of the research is reflected in the fact that it is impossible to statistically completely isolate the percentage of the change in the value of the indicator that can be attributed to the Covid-19 pandemic, and which to another geopolitical shock (the war in Ukraine) or to changes in the common agricultural policy that were instigated under the influence of the pandemic. As a direct response, the European Union has integrated recovery mechanisms into its common agricultural policy to strengthen the sustainability and digital and green transition of rural areas. Although the choice of 2023 as the year of analysis can partially separate these impacts, future research can be aimed at evaluating the changes caused by the joint impact of the aforementioned crises and the redefined political responses of the European Union in the context of agricultural and rural development.

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Conflict of interests

The authors declare no conflict of interest.

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