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**SPATIAL DIFFERENTIATION OF THE IMPACT  
OF THE COVID-19 PANDEMIC ON AGRICULTURE  
IN SELECTED EUROPEAN UNION COUNTRIES**

Key words: COVID-19, agriculture value added, ammonia emissions from agriculture, fresh vegetables, strawberries, cultivation area, COVID-19 pandemic effects on agriculture

**ABSTRACT.** The article aimed to assess the direction and strength of the impact of the COVID-19 pandemic on agriculture in six of the most important for EU agriculture countries. A comparative analysis of the agricultural activity indicators was the research method. The Eurostat was the data source. The analysis covered different years from 2016-2023. For some indicators the period is shorter because not all data have been available for 2022 and 2023. The research shows that the COVID-19 pandemic influenced the agriculture of the EU countries. The immediate adverse effect occurred in the animal production sector in the form of stopping animal sales as meat processing companies had severe problems with workers' infections and quarantines. In the plant production sector the effects appeared in the second and third years of the pandemic. In general, the impact of the COVID-19 pandemic on agriculture took the form of an absolute decline in the value added by this sector or a reduction in its growth rate. The effects of the pandemic are at least medium-term, as the pandemic has triggered or accelerated phenomena limiting the availability of labour in agriculture. The effects of the pandemic varied significantly between countries. The pandemic most affected Italy's and France's agriculture and also hurt agriculture in Poland. Agriculture in Spain, the Netherlands, and Germany was quite resistant to the pandemic influence.

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## INTRODUCTION

The COVID-19 pandemic, the official end of which was declared on May 5, 2023, by the head of the UN World Health Organization, was a global phenomenon [UN 2023]. Like global pandemics in the past, the COVID-19 pandemic has caused many effects in various areas of society: demographic, health, social, and economic. Identifying and assessing effects in many areas qualitatively and quantitatively is a complex undertaking. Referring to the economic effects of the pandemic, Maureen Lewis [2001] noted that measuring them is problematic because health and economic development are interconnected. A lower level of economic growth is associated with a worse state of health in society and *vice versa*.

Even though the COVID-19 pandemic ended only a few months ago (December 2023), there is a massive amount of literature on its micro and macroeconomic effects. The first publications began to appear at the beginning of the second half of 2020 [S. Aday and S. Aday 2020, Elleby et al. 2020, Kerr 2020, Et-Touile and Fatima Arib 2021]. However, many publications from 2020 and 2021 were forecasts based on the authors' assumptions regarding the strength, direction, and transmission channels of the pandemic to the economy. It stemmed from the natural process of phenomenon development over time and the postponement of the availability of statistical data on the economy, based on which the effects of the pandemic on macroeconomic and sectoral variables could be assessed. Experiences from past global pandemics show that some effects of a pandemic are only visible many years after its end. An example may be the impact of the Spanish flu and AIDS pandemics on the quality of human capital [Ainsworth and Over 1992, Almond 2006, Garrett 2007]. Moreover, long-term effects may differ from short-term ones; hence, the current or very short-term assessment may differ from the assessment made from a longer-term perspective [Daniłowska 2022].

Although it constitutes a small part of GDP in many countries, agriculture is a fundamental sector from the perspective of ensuring food security for society, understood in the simplest way as physical access to an appropriate amount of food. Although the societies of many developing countries constantly struggle with this problem, in wealthier countries where this problem affects a relatively small percentage of citizens, only shocks such as the global pandemic remind us that food security is a "fragile" phenomenon. According to Olivia Jarrell et al. [2023], the scale of the global hunger crisis in 2020-2022 is more than twice as large as during the financial crisis in 2008. Of course, the problem is complex, and the critical determinants of malnutrition vary by country, district, or region [Awad 2023]. The potential scale of the effects of the pandemic on agriculture is evidenced by the numerous channels of transmission of the pandemic's impact on this sector. Josef Schmidhubert, Jonathan Pound and Bing Qiao [2020] divided them into two groups: channels on the supply (production) side and channels on the demand side for agricultural products. The group of supply channels included inputs of working capital,

capital, labour, exchange rate, energy and fertilizer prices, loans, and imports. The demand side included food consumption and export. The authors emphasized that agriculture in developed countries is intensive and, therefore, exposed to the risk of disruptions in the supply of working capital for production in the short term and investment goods in the longer term. Agriculture in most European Union countries is characterized by such high input intensity [Zakrzewska and Nowak 2022].

Due to the potentially large scale of adverse effects, the agricultural response to the pandemic is a significant research problem with scientific and practical dimensions. The aim of the article is a comparative assessment of the effects of the pandemic on agriculture in the European Union countries that contribute the most to European Union agriculture. The analysis undertaken in the article aimed to answer the question of which European Union countries were most affected by the COVID-19 pandemic in terms of agriculture and whether there were any similarities in the type of effects of the COVID-19 pandemic and their size.

## RESEARCH MATERIAL AND METHODS

The six largest agricultural producers in the European Union were selected to assess the effects of the COVID-19 pandemic on agriculture: France, Italy, Germany, Spain, Poland, and the Netherlands. The share of these countries in the value of added agricultural production of the European Union was approximately 75% in 2022 [Eurostat 2023]. In a situation of free movement of goods in the European Union, such a large share indicates the critical role of these countries in ensuring food security throughout the European Union. Therefore, identifying the direction and strength of the impact of the pandemic on the agriculture of these countries is essential from the perspective of assessing the level of threat to food security in the European Union as a result of the COVID-19 pandemic and taking actions to improve the resilience of agriculture to possible pandemics in the future.

Several indicators illustrate the impact of the COVID-19 pandemic on agriculture in selected countries to identify the particular areas of influence of the COVID-19 pandemic and, therefore, the most important effects. Agricultural production is an aggregate. It is very heterogeneous. It covers many branches of production that differ significantly from each other. The most general division distinguishes the animal production and plant production sections. However, in each of them, you can indicate many branches that are specific to the others. The COVID-19 pandemic has affected all production branches unevenly. Therefore, when examining the impact of the pandemic on the sector, a three stage analysis was used – at the sector level, section, and selected production branch. The synthetic measure of the situation in agriculture sector is added value. The article uses the dynamics of added value to check whether its value has changed during the pandemic and

in what direction. Indicators that capture certain aspects of the entire section were used to assess the impact of the pandemic on the particular section. The ammonia emissions of agriculture stems mainly from animal production so the rate of ammonia emission represents the pandemic influence on the situation in the animal production section. The impact of the pandemic on plant production is shown by the change in the cereal sowing. The rate of change in the area under vegetable and strawberry cultivation illustrates the pandemic impact on particular production branch.

Eurostat was the primary data source. The basic research method was a comparative analysis of time series values of the selected indicators. The analysis covered different years from 2016-2023, depending on the nature of the indicator and data availability. However, for some indicators, this period is shorter because not all data for 2022 have already been published.

## RESEARCH RESULTS

The analysis of the annual growth rate of value added by agriculture provides the most synthetic information about the effects of various agricultural phenomena in individual years of the period under study. However, it is essential to remember the specificity of agricultural activity, which involves delaying the effects of the production decision for many months. Therefore, the effects achieved by agriculture in 2020 were the result not only of the pandemic that developed in Europe in the second half of March but, to a large extent, the decisions made by agricultural producers in 2019.

Figure 1 shows that in the year before the pandemic (2019), the added value of agriculture decreased in four out of six countries surveyed. However, in the first year of the pandemic, the decline occurred only in two countries – France and Italy, and it was another year of decline in these countries. In the remaining four countries, added value increased. An exceptionally high fifteen percent increase occurred in Poland. The increase in Germany should also be considered significant – 8%. In 2021, the effects of the pandemic may have become evident. They took the form of an absolute decline in added production in France, Italy, and Poland and a significant reduction in the growth rate in two countries, Germany and Spain. The decline in France and Italy was slight, but it reached as much as 11% in Poland. Only Dutch agriculture showed resilience to the pandemic, as evidenced by an increase in value-added of 2.4% – a much higher rate than in the previous years, in which value-added also increased. The results of the third year of the pandemic show the effects of the accumulation of problems caused by the pandemic, namely the pessimism of producers making production decisions for 2022, problems with shortages in labour, and rising energy prices. As a result, the value of added production fell in five countries. A spectacular decline occurred in Germany, which had seen significant,

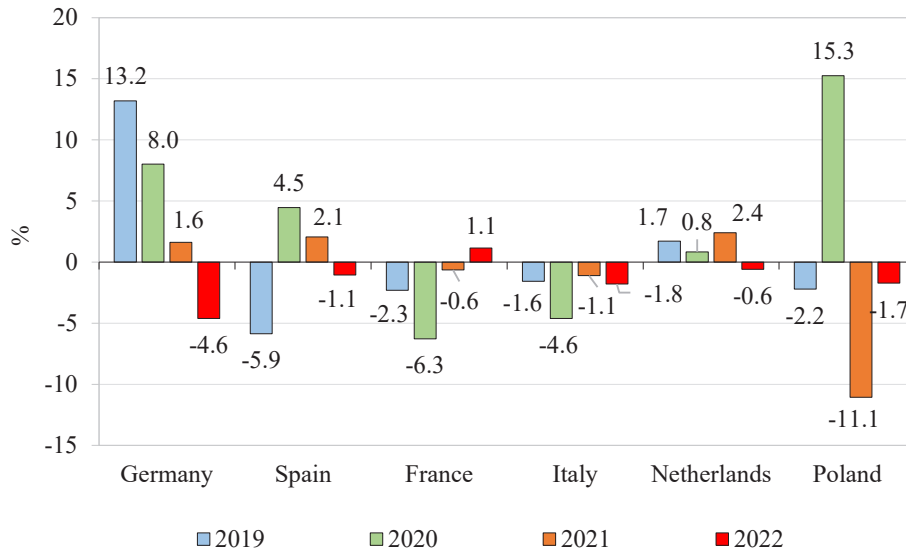


Figure 1. Annual growth rate of value added by agriculture, forestry and fishing in selected EU countries

Source: own study based on [Eurostat 2023]

although increasingly lower, increases in previous years. France was the only country with a slight increase in this indicator.

A partial indicator showing comprehensive changes in the animal production sector is agriculture's emission of ammonia ( $\text{NH}_3$ ). The analysis of Figure 2 shows that emissions systematically decreased in all surveyed countries in the three years examined. This fall had started before pandemic. It resulted from decreased production of pigs due to African Swine Fever [Gauly et al. 2021] and poultry due to bird flu [EMA 2023] and the COVID-19 pandemic. During the COVID-19 pandemic, animal producers had problems with selling on time due to reduced demand from restaurants, closure of markets with direct sales by farmers, closure of borders, which made exports impossible or very difficult, and problems the meat processing plants faced. After the outbreak of the COVID-19 pandemic, meat plants had huge problems with ensuring work continuity due to workers' infections and quarantine, which even resulted in their shutdown [EC 2020, EFFAT 2020, Brzáková et al. 2021, Ijaz et al. 2021]. The only exception to the downturn trend in emission was the increase in emissions in 2020 in three countries: Spain, Italy, and Poland. It stemmed from the extension of animal breeding period. As the aforementioned problems with the sale of animal production occurred the only rational form of farmers' adaptation to new conditions was to extend the breeding period [Gauly et al. 2021, D'Souza and Dunshea 2021, Tokach et al. 2021]. It led to many negative consequences, including for the

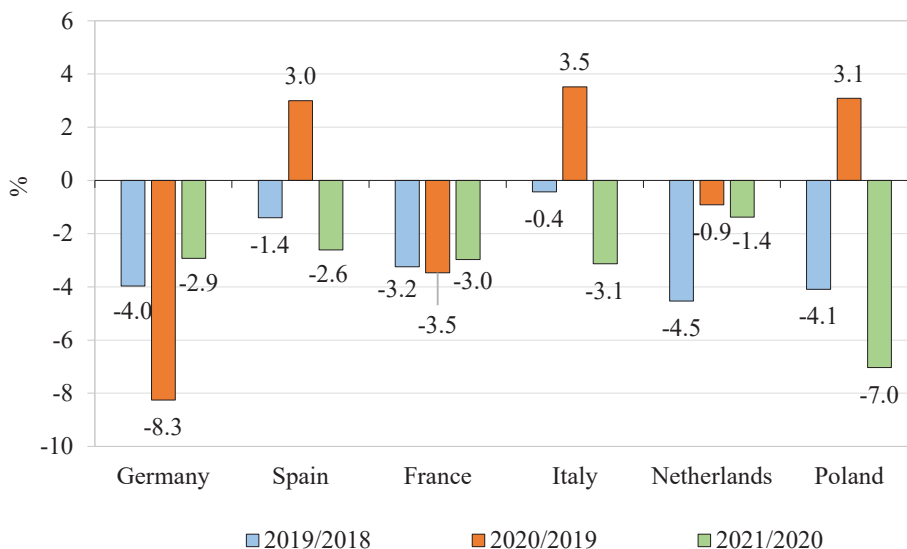


Figure 2. Annual growth rate of NH<sub>3</sub> emissions from agriculture

Source: own study based on [Eurostat 2023]

environment [Millet et al. 2021]. It should be emphasized that similar problems in animal production caused by COVID-19 have been observed worldwide.

The next two indicators refer to the impact of the COVID-19 pandemic on plant production. Due to the very significant impact of natural conditions on the level of production, the changes in the area of the sowing of cereals and cultivation of vegetables were adopted as impact indicators. They reflect, to some extent, the scale of farmers' reactions to the severity of the pandemic.

The data analysis in Table 1 shows that the trends in changes in the cereal area in 2016-2019 were varied. The area decreased gradually in Spain and Italy and increased in Poland, while in Germany, France, and the Netherlands, after three years of decline, in 2019 it returned to the level of 2016. In 2020 the downward trend continued in Italy, in Spain the area increased slightly, while declines occurred in Germany, France, Poland, and the Netherlands. In the case of the first three countries mentioned, the decline was significant, reaching 5%. However, these changes in 2020 resulted from reasons other than the COVID-19 pandemic because decisions about sowing were made before the outbreak of the pandemic, i.e., in 2019 or the first quarter of 2020, although some problems with sowing spring cereals may have occurred [Meuwissen 2021]. In 2021, slight declines occurred in five countries; only in France was there a return to the situation from 2019. This proves that farmers are very cautious. In 2022, a decline was observed in three countries: Poland, Spain, and France, while the situation stabilized in Germany and Italy.

Table 1. Area of cultivation of cereals for the production of grain (including seed) by countries in 2016-2023

Country	Area of cultivation [thousand ha]							
	2016	2017	2018	2019	2020	2021	2022	2023
Germany	6,325.00	6,276.20	6,148.90	6,380.00	6,074.90	6,063.50	6,112.50	6,091.30
Spain	6,239.80	6,015.23	6,027.61	5,975.71	6,069.24	6,034.58	5,832.99	5,457.92
France	9,529.98	9,339.87	9,055.31	9,394.03	8,926.69	9,325.70	9,005.01	8,759.27
Italy	3,256.99	3,140.58	3,092.69	3,066.52	3,011.73	2,978.39	3,010.64	3,042.87
Netherlands	179.16	162.88	166.38	178.16	172.27	169.73	185.40	-
Poland	7,400.30	7,602.00	7,806.31	7,891.43	7,466.68	7,451.27	7,196.91	7,122.27

Source: own study based on [Eurostat 2023]

The biggest change occurred in the Netherlands, where the cereal area increased to the highest level in the period under study by over 9% compared to the previous year and by almost 14% compared to the lowest level in 2017. In 2023, the decrease in the area concerned 4 out of five countries for which data are available.

To sum up, it can be said that, except for the Netherlands, the cereal cultivation area at the end of the pandemic was lower than in the years before. However, in Spain and Italy, it was rather the result of continuing the downward trend from before the pandemic. The impact of the pandemic can be seen in other countries. Although in opposite directions, the strongest effects occurred in Poland and the Netherlands.

The study of trends in changes in the area under cultivation of vegetables and strawberries can complement the above analysis (Figure 3). Growing vegetables and strawberries requires significant amounts of work. Labour shortages due to the COVID-19 pandemic have been widespread across countries and industries. The COVID-19 pandemic has caused significant restrictions on access to labour in agriculture due to employee illness, quarantine, and difficulties in the flow of labour. An essential factor limiting production was also the fact that vegetables and strawberries are essential export products, and the pandemic led to the disruption of supply chains, especially international ones.



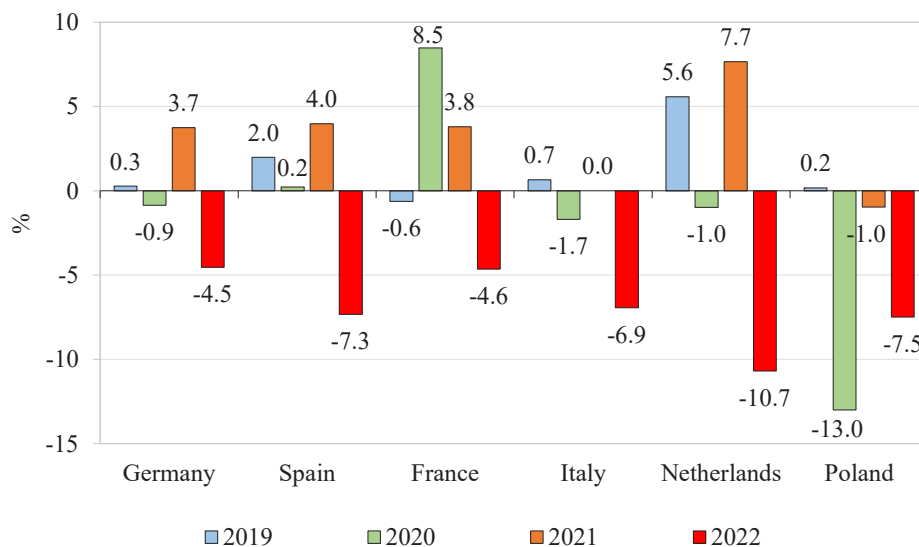


Figure 3. Annual growth rate of the area under vegetable and strawberry cultivation

Source: own study based on [Eurostat 2023]

The impact of these restrictions is visible in the decline in vegetable cultivation areas in the first year of the pandemic. In 2020, the cultivated area decreased in 4 countries, including Poland, by as much as 13%. There was a slight increase in Spain and a significant increase of 8.5% in France. In the second year of the pandemic, the situation improved as countries initiated mass vaccinations and loosened restrictions on population movement. The organization of the flow of goods between countries has also improved. The cultivated area increased significantly in the Netherlands, quite significantly in Germany, Spain and France, did not change in Italy and decreased slightly in Poland. However, in 2022, the area under cultivation has decreased dramatically in all countries surveyed. It was the result of a combination of several factors. The first is limitations in access to the labour force. According to Orsetta Causa et al. [2023], in conditions of a tight labour market, which was the labour market during and after the pandemic, employees are more likely to change jobs in search of better employment opportunities.

Moreover, cultural changes have occurred in the form of preferences, as some employees may no longer accept low wages and poor or exhausting working conditions, which are the characteristics of work in agriculture. For this group of reasons, the choice of countries offering higher wages made by seasonal agricultural workers belongs. This reason may largely explain the reduction in the area of the vegetable and strawberry cultivation in Poland because the wages offered in Germany, France, or Italy are much

higher than in Poland [Kraciński 2020]. The second factor was inflation, causing a decline in the purchasing power of consumers and, as a result, a decline in demand for vegetables and fruits; the increase in production costs, mainly caused by the increase in energy costs due to the war in Ukraine, was also significant [Fresh Plaza 2023].

## CONCLUSIONS

The analysis shows that the COVID-19 pandemic impacted the agriculture of the European Union countries selected for analysis. The impact took the form of an absolute decline in the value added by this sector or a reduction in its growth rate. However, the limitation of the research stems from the fact that the agriculture performance depends on complex determinants not only from pandemic. What is worth emphasizing is that the effects of the pandemic are at least medium-term, as the pandemic has triggered or accelerated certain phenomena limiting the availability of labour in agriculture.

Due to the specific nature of agricultural production, which involves postponing the supply effect from the moment of production decisions, the effects of the pandemic in the plant production sector occurred mainly in the second and third year of the pandemic and the first fully post-pandemic year of 2023. However, in the case of animal production, adverse effects in the form of forced extension of the cycle production, mainly due to the problems of the processing industry, were immediate. As a result, there was an increase in production costs and an increase in environmental pollution. However, these problems were solved relatively quickly. In the plant production sector the effects appeared in the second and third years. Cultivation of vegetables and strawberries was especially affected by the pandemic, mainly due to the sector's high dependence on hired labour, the availability of which was directly and indirectly affected by the pandemic.

The effects of the pandemic varied quite significantly between countries. In light of the indicators included in the study, the pandemic most affected Italy's and France's agriculture. It also hurt agriculture in Poland, although the excellent results in 2020 were only partially offset in the following years. Agriculture in Spain, the Netherlands, and Germany was quite resistant to the negative impact of the pandemic.

In all countries, there were visible adaptation processes to the impact of the pandemic on the labour market in the form of changes in the directions of agricultural land use, especially labour-intensive ones such as the production of vegetables and strawberries.

To sum up, it would be helpful to continue more advanced research on the pandemic effects on agriculture from a longer perspective to better understand the phenomena's complexity and recognize the regularities and differences in pandemic outcomes.

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## PRZESTRZENNE ZRÓŻNICOWANIE WPŁYWU PANDEMII COVID-19 NA ROLNICTWO W WYBRANYCH KRAJACH UNII EUROPEJSKIEJ

Słowa kluczowe: COVID-19, wartość dodana rolnictwa, emisje amoniaku przez rolnictwo, warzywa, truskawki, zboża, powierzchnia uprawy, wpływ pandemii COVID-19 na rolnictwo

ABSTRAKT. Celem badań była ocena kierunku i siły wpływu pandemii COVID-19 na rolnictwo w sześciu najważniejszych dla rolnictwa krajach Unii Europejskiej. Metodą badawczą była analiza porównawcza wskaźników działalności rolniczej. Głównym źródłem danych był Eurostat. Z badań wynika, że pandemia COVID-19 wpłynęła na rolnictwo krajów UE. Natychmiastowy niekorzystny efekt wystąpił w sektorze produkcji zwierzęcej, przez wstrzymanie sprzedaży zwierząt, ponieważ przedsiębiorstwa zajmujące się przetwórstwem mięsnym miały poważne problemy z infekcjami pracowników i kwarantannami. W sektorze produkcji roślinnej efekty pojawiły się w drugim i trzecim roku trwania pandemii. Generalnie wpływ pandemii COVID-19 na rolnictwo przyjął formę bezwzględnego spadku wartości dodanej tego sektora lub ograniczenia jego dynamiki wzrostu. Skutki pandemii mają charakter co najmniej średnioterminowy, gdyż pandemia wywołała lub przyspieszyła zjawiska ograniczające dostępność siły roboczej w rolnictwie. Skutki pandemii znacznie różniły się w poszczególnych krajach. Pandemia najbardziej dotknęła rolnictwo Włoch i Francji, a także zaszкодziła rolnictwu w Polsce. Natomiast rolnictwo w Hiszpanii, Holandii i Niemczech pozostało dość odporne na wpływ pandemii.

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