# THE ROLE OF FINANCIAL SUPPORT IN THE DEVELOPMENT OF ORGANIC FOOD PRODUCTION IN EU MEMBER STATES

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ABSTRACT

This study examines the effect of annual expenditure on organic agriculture, both total and per hectare, on the growth of the organic share in total agricultural land in EU member states. The research covers data from 2018, 2019, and 2023, with correlation analysis, a paired t-test, and a ROC curve used for data processing. The results indicate that total annual expenditure on organic agriculture has no short-term effect, but leads to an increase in the organic share of total agricultural land in the observed countries over the longer term. The same findings reveal that when total annual expenditure on organic agriculture at the national level exceeds €50 million, the probability that the organic share of total agricultural land will exceed 10% increases. The study concludes that financial instruments of state support for organic production are an important driver of its faster development in the EU market. Accordingly, it is recommended that EU member states with a lower share of organic land increase their planned budget for organic agriculture above the established threshold value.

## Introduction

Organic production is the most visible subsystem of sustainable agriculture. Its defining feature is that it relies to the greatest possible extent on inputs produced on the farm itself, while avoiding, or largely excluding, the use of external inputs. In many countries

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organic production is regulated by law, which secures a range of positive effects for the economic, ecological, and social system (Vehapi, 2025). Its importance is recognised above all in EU member states, where the area under organic production is expanding and the number of consumers willing to pay more for organically sourced products is growing. Consumer behaviour in the food market has changed considerably under the influence of digitalisation and growing concern for the environment and personal wellbeing, steering consumer choice toward healthier and more sustainable products (Coman et al., 2025). Against this background, the organic food market in the EU is becoming a significant market segment.

Although driven by new trends in the end-consumer market and independent of external inputs, organic production remains heavily dependent on state support. Experience shows that without state assistance this type of production can hardly withstand competition from conventional production. Producers who decide to convert to organic production methods may be motivated by a range of reasons, including farm management and technical considerations, financial motives, personal health, and general concern (Padel, 2001). Among these, the most significant are financial motives in the form of higher income, driven by higher prices for organic products and lower costs of external inputs (Khaledi, 2007). Variable costs in organic production are lower than in conventional production owing to the limited use of artificial fertilisers and pesticides. However, organic production is burdened by higher labour costs resulting from the greater need for manual work, the high price of organic seed, higher depreciation costs for buildings and equipment, and the costs of certifying organic products (Offerman & Nieberg, 2000; Wehinger, 2011). For this reason, state financial support is the most important form of assistance for producers who engage, or intend to engage, in organic production.

Financial support for organic agriculture is strongest in the EU, which is also the world's second-largest organic food market after the United States. The authors therefore set out to examine the effect of payments for organic agriculture on the expansion of organic agricultural production in EU member states, and to identify the level of total and average expenditure that determines faster development of organic production in certain national markets. Accordingly, the paper is organised into several logical sections. Following the introductory remarks, the second section reviews the state of the EU organic food market, describing in detail the characteristics of both supply and demand. The third section analyses indicators of financial support for organic agriculture in EU member states across two consecutive programming periods. The fourth section is devoted to the research methodology, while the fifth presents and discusses the findings obtained. The paper closes with concluding remarks, the limitations of the study, and recommendations for future research.

## Literature review

### *Supply and Demand Characteristics of Organic Food in the EU Market*

At the end of 2024, 18.1 million ha of agricultural land in the EU was under organic production, reaching a share of 11.1% of total agricultural land. This represents a 0.7%

increase in EU organic agricultural land relative to the previous year, and a rise of as much as 83% relative to a decade earlier (Table 1). In absolute terms, the largest areas under organic production are found in Spain, with 2,944,904 ha, followed by France (2,711,567 ha), Italy (2,514,551 ha), and Germany (1,913,212 ha); together, these four countries account for more than half of the area under organic production in the EU. Austria is the country with the largest share of organic land in total agricultural land, at 27.2%. Besides Austria, a significant share of organic land in total agricultural land is also found in Estonia (22.5%), Portugal (20.3%), and Italy (19.2%) (Table 2). These are also the countries that have reached, or come close to, the target of 25% of agricultural land under organic production by 2030, set out in the "Farm-to-Fork" strategy (European Commission, 2020). Depending on the growth of organic areas and their share in total agricultural land over the period 2018-2022, Muska et al. (2025) classify all EU member states into four groups: (1) countries such as Portugal, Greece, and Slovakia have a high share of organic land in total agricultural land and rapid growth of organic areas; (2) Austria, Estonia, Spain, and Italy form a group of countries characterised by a high share but slower growth of organic areas; (3) a group of countries including Germany, France, Romania, and others recorded significant growth in organic areas, but their share in total agricultural land remains below the EU average; and (4) a group of countries including Bulgaria, Ireland, Lithuania, and others recorded slower growth of organic areas, while their share in total agricultural land is likewise below the EU average.

**Table 1.** Key indicators of the development of the EU organic food market, 2014-2024.

| Year | Organic agricultural land (ha) | Organic share of total agricultural land (%) | Producers | Processors | Retail sales (mill. €) | Growth rate (%) |
|---|---|---|---|---|---|---|
| 2014 | 9,861,503 | 6.1 | 257,746 | 47,890 | 21,707 | |
| 2015 | 10,639,203 | 6.5 | 265,677 | 52,178 | 24,885 | 14.7 |
| 2016 | 11,557,673 | 7.1 | 291,721 | 57,202 | 28,433 | 14.1 |
| 2017 | 12,321,896 | 7.6 | 302,131 | 63,384 | 32,089 | 13.0 |
| 2018 | 13,237,754 | 8.1 | 321,772 | 69,368 | 35,509 | 10.6 |
| 2019 | 14,120,632 | 8.6 | 338,212 | 74,866 | 38,570 | 8.7 |
| 2020 | 14,868,842 | 9.2 | 349,509 | 77,893 | 44,948 | 16.3 |
| 2021 | 16,181,013 | 10.0 | 385,905 | 84,452 | 46,397 | 3.1 |
| 2022 | 17,121,218 | 10.5 | 425,524 | 87,467 | 45,237 | -2.4 |
| 2023 | 17,958,840 | 11.1 | 432,776 | 89,451 | 47,760 | 5.8 |
| 2024 | 18,079,934 | 11.1 | 438,447 | 88,977 | 49,468 | 3.6 |

*Source:* based on data from FiBL[5]

Table 1 shows that the number of producers in the EU increased by 70% over the past decade, from 257,746 to 438,447 producers, so that in 2024 EU producers accounted for 9% of the total number of producers worldwide (FiBL). In terms of the number of

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organic producers, the absolute leader among EU member states is Italy, with 87,042 producers, followed by France with 67,886, Greece with 58,601, and Spain with 56,243 producers. Unlike producers, the number of processors of organic products in the EU market is considerably smaller. This is confirmed by the fact that in 2024 there were a total of 88,977 processors of organic products in the EU, which is still insufficient, although the number of processors has nearly doubled compared with 2014, when there were 47,890 processors. Thus, in parallel with the expansion of organic production, the number of processors is increasing significantly from year to year. Among the countries with the largest number of organic food processors are Italy (24,844), Germany (21,915), and France (20,493) (Table 2).

**Table 2.** Leading EU countries ranked by indicators of organic food market development, 2024.

| Indicator | Rank 1 | Rank 2 | Rank 3 | Rank 4 |
|---|---|---|---|---|
| Organic agricultural land | Spain (2,944,904 ha) | France (2,711,567 ha) | Italy (2,514,551 ha) | Germany (1,913,212 ha) |
| Organic share of total agricultural land | Austria (27.2%) | Estonia (22.5%) | Portugal (20.3%) | Italy (19.2%) |
| Producers | Italy (87,042) | France (67,886) | Greece (58,601) | Spain (56,243) |
| Processors | Italy (24,844) | Germany (21,915) | France (20,493) | Spain (6,174) |
| Retail sales | Germany (€16.9 billion) | France (€12.2 billion) | Italy (€5.2 billion) | Spain (€2.7 billion) |
| Growth rate | Luxembourg (20.2%) | Hungary (13.9%) | Belgium (11.7%) | Sweden (6.7%) |
| Organic share of the total market | Denmark (11.6%) | Austria (11.4%) | Luxembourg (9.0%) | Sweden (6.7%) |
| Per capita consumption | Denmark (€373) | Austria (€292) | Luxembourg (€254) | Germany (€204) |

*Source:* based on data from FiBL

Over the past decade, the retail value of organic food in the EU has more than doubled. At the end of 2024, the EU organic food market was worth close to €50 billion, an increase of 3.6% relative to the previous year, with an average growth rate of this market of 8.8% over the period 2014-2024 (Table 1). Following a period of slower market growth caused by the global economic crisis, faster growth that began in 2014 continued in subsequent years, reaching a high of 16.3% by the end of 2020. After 2020, the market experienced a marked slowdown and a decline in organic food sales as a result of several factors, including the war in Ukraine, high energy costs, and rising living costs.

Table 2 also provides an overview of the leading EU countries according to additional market criteria, such as market size, growth rate, per capita consumption, and the share of organic products in the total market. The largest market for organic food products was Germany, with a turnover of €16.9 billion, followed by France (€12.2 billion) and Italy (€5.2 billion). The market with the highest growth rate was Luxembourg

(20.2%), followed by Hungary (13.9%) and Belgium (11.7%), which managed to achieve double-digit growth rates in 2024. A reliable indicator of market development is annual per capita consumption of organic food. By this indicator, Denmark, together with Switzerland, can be considered a global leader. Annual per capita consumption of organic food in Denmark stands at €373, while Austria, with €292, and Luxembourg, with €254, rank second and third. These three countries are also the countries with the highest market share of organic products relative to other food products, ranging from 9% to 11.6% (Table 2). Among the categories of organic products, EU consumers spend most of their money on eggs, fresh fruit and vegetables, and milk and yoghurt. Fresh organic fruit and vegetables account for a share of over 10% of the organic market in Austria, Belgium, and Denmark; eggs account for a share of as much as 41% of the Danish organic market, while milk and yoghurt account for over 20% of total sales of organic products in Austria and Denmark (Willer et al., 2026, p. 211).

In the EU, most consumers do not purchase organically sourced products on a regular basis. According to a study conducted in the French market, only 37% of organic food buyers purchase these products regularly (daily or weekly). This means that a narrow core of loyal consumers generates most of the organic food turnover (Willer & Lernoud, 2018, p. 150). Another feature shared by EU consumers concerns the motives for, and barriers to, purchasing organic food. Many studies from EU countries (the Netherlands, Poland, Italy, Denmark, and Romania) identify health as the main motive for purchasing organic food products, showing that most consumers buy these products for health reasons (Schifferstein & Oude Ophuis, 1998; Bryla, 2016; Chinnici et al., 2002; Magistris & Gracia, 2008; Squires et al., 2001; Petrescu et al., 2017). Besides health, the absence of pollutants and chemicals, as well as concern for environmental protection, are also reasons that strongly motivate consumers to buy organic food, as is the case with Belgian, Norwegian, Danish, Swedish, Irish, and German consumers (Aertsens et al., 2011; Torjusen et al., 1999; Ekelund, 1990; Davies et al., 1995; Von Alvensleben, 1998). Consumers in Czechia, Spain, Italy, and Croatia report that price is the main barrier to purchasing and increasing their consumption of organic food (Magnusson et al., 2001; Zagata, 2014; Vega-Zamora et al., 2014; Janssen, 2018; Zanoli & Naspeti, 2002; Radman, 2005). Another important barrier to purchasing organic food in the Greek and Polish markets, as well as among regular consumers in Denmark and Italy, is limited availability (Fotopoulos & Krystallis, 2002; Bryla, 2018; Jensen et al., 2011).

*Financial Instruments Supporting Organic Food Production in the EU*

State support for organic agriculture can be viewed through three basic instruments (Stolze & Lampkin, 2009): legal, financial, and communication instruments. This paper focuses solely on analysing financial support instruments. The basic form of financial support for organic agriculture in all EU member states is area-based payments for conversion to, and maintenance of, organic production. This form of financial support has contributed to the expansion of organic agriculture in the EU, which is why payment rates rose in the 2014-2020 programming period relative to the previous 2007-2013 programming period. In some countries, such as Germany, Italy, and Denmark, area-

based payments rose considerably, while they remained unchanged only in Sweden and Slovakia. Depending on the land-use category, the highest payment rates in 2019 were identified as follows: (1) in Malta, for grassland and arable land – 209 €/ha for conversion and €555/ha for maintenance of organic production; (2) in Spain, Germany, Italy, and Belgium, for annual vegetables and herbs – maximum payments exceed €1,000/ha for conversion and €900-1,000/ha for maintenance of organic production; (3) in Germany, for protected cropping – €415-6,000/ha for conversion and €300-3,800/ha for maintenance of organic production; (4) in Belgium, Germany, Italy, and Luxembourg, for perennials, orchards and fruits – maximum payments reach over €1,000/ha for conversion and €800-975/ha for maintenance of organic production; (5) in Germany, for vineyards – €750-2855/ha for conversion and €675-2855/ha for maintenance of organic production; and (6) in Malta, Italy, and Slovenia, for olives – maximum payments range from €900-1209/ha for conversion and €677-810/ha for maintenance of organic production (Lampkin & Sanders, 2022).

The total budget allocated to support organic agriculture under the Common Agricultural Policy (CAP) 2014-2020 amounted to €6.3 billion, or 6.4% of the total rural development budget in the EU-28 (Katto-Andrighetto et al., 2017). For the following five-year period, 2023-2027, the planned budget for supporting organic agriculture amounts to more than €16 billion, representing 5% of total CAP expenditure and 20% of expenditure on environmental protection measures (Willer et al., 2025, p. 216). The data in Table 3 indicate that EU member states plan to support organic agriculture with more than €3.3 billion in annual payments by 2027/28, an increase of 85% relative to 2018, when they invested more than €1.8 billion. EU member states plan to double the supported area of organic agricultural land in the EU over the period 2018-2027. In 2018, annual payments for conversion to, and maintenance of, organic production covered 8.4 million ha of land, while for 2027/28 an increase in supported area of 93% is planned, which would bring the supported area to 16.4 million ha. In addition, average expenditure per hectare is expected to decrease by 5% in 2027/28 relative to 2018. Observed at the national level, and based on the data presented in Table 3, the following can be noted:

- With the exception of Estonia, Italy, and Sweden, an increase in total annual expenditure on support for organic agriculture is planned in the remaining EU member states. The highest expenditure in 2018 was recorded in Italy (386 million €), while the highest expenditure planned for 2027/28 is in France (603 million €);
- In most EU countries, payments per hectare are planned to increase relative to the previous programming period, significantly so in some countries, such as Malta. In 2018, average expenditure per hectare was highest in Cyprus (€805/ha), while by 2027/28 the highest expenditure per hectare is planned to be in Malta (€3,913/ha).
- In all EU member states except Estonia, an increase in the supported area under organic production is planned. In 2018, the largest total supported area of agricultural land was in Germany (1,150 kha), while by 2027/28 the largest supported area is planned to be in France (3,384 kha);

**Table 3.** Comparative overview of expenditure supporting organic agriculture in 2018 and planned expenditure for 2027/28.

| | Expenditure (M€) | | | Expenditure/ha (€) | | | Supported area (kha) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Country** | **2018** | **2027/28** | **Relative** | **2018** | **2027/28** | **Relative** | **2018** | **2027/ 28** | **Relative** |
| Austria | 121 | 154 | 127% | 234 | 252 | 107% | 515 | 610 | 118% |
| Belgium | 19 | 46 | 238% | 243 | 281 | 116% | 80 | 163 | 205% |
| Bulgaria | 24 | 101 | 416% | 354 | 503 | 142% | 68 | 200 | 293% |
| Cyprus | 4 | 5 | 143% | 805 | 459 | 57% | 5 | 11 | 250% |
| Czechia | 53 | 105 | 198% | 105 | 140 | 134% | 506 | 750 | 148% |
| Germany | 300 | 553 | 184% | 261 | 232 | 89% | 1,150 | 2,384 | 207% |
| Denmark | 41 | 74 | 181% | 184 | 184 | 100% | 223 | 403 | 181% |
| Estonia | 18 | 6 | 30% | 99 | 37 | 38% | 186 | 150 | 81% |
| Spain | 159 | 169 | 106% | 152 | 134 | 88% | 1,045 | 1,257 | 120% |
| Finland | 56 | 90 | 160% | 205 | 155 | 76% | 274 | 580 | 212% |
| France | 180 | 603 | 335% | 173 | 178 | 103% | 1,040 | 3,384 | 325% |
| Greece | 97 | 259 | 267% | 390 | 306 | 78% | 248 | 846 | 340% |
| Croatia | 33 | 63 | 191% | 350 | 226 | 65% | 94 | 279 | 296% |
| Hungary | 21 | 63 | 294% | 186 | 226 | 121% | 115 | 279 | 296% |
| Ireland | 8 | 89 | 1,116% | 111 | 265 | 239% | 72 | 337 | 468% |
| Italy | 386 | 298 | 77% | 352 | 200 | 57% | 1,098 | 1,489 | 136% |
| Lithuania | 36 | 64 | 175% | 197 | 205 | 104% | 184 | 309 | 168% |
| Luxembourg | 1 | 8 | 656% | 258 | 342 | 133% | 5 | 24 | 494% |
| Latvia | 28 | 33 | 117% | 107 | 89 | 83% | 261 | 368 | 141% |
| Malta | 0.002 | 1 | 43,639% | 374 | 3,913 | 1,045% | 0.01 | 0 | 4,175% |
| Netherlands | 0 | 22 | ∞ | 0 | 200 | ∞ | 0 | 109 | ∞ |
| Poland | 47 | 250 | 530% | 138 | 380 | 275% | 342 | 659 | 193% |
| Portugal | 25 | 86 | 338% | 124 | 125 | 101% | 206 | 689 | 193% |
| Romania | 42 | 57 | 133% | 232 | 190 | 82% | 183 | 298 | 163% |
| Sweden | 75 | 73 | 97% | 211 | 167 | 79% | 355 | 437 | 123% |
| Slovenia | 10 | 22 | 228% | 210 | 269 | 128% | 46 | 82 | 178% |
| Slovakia | 17 | 36 | 212% | 108 | 134 | 124% | 158 | 270 | 171% |
| EU27 | 1,803 | 3,329 | 185% | 213 | 203 | 95% | 8,460 | 16,369 | 193% |

*Source:* Lampkin, 2023

## Materials and methods

The information basis for this research is the FiBL database, together with the data presented by Lampkin (2023) in the report Policy support for organic farming in the European Union 2010-2020 (Table 4). The analysis covers data from 2018 for indicators of financial support, as well as data from 2019 and 2023 for the share of organic land in total agricultural land[6]. The main objective of the research is to examine the role and importance of financial support, both in total amount and per hectare, for the growth of the area under organic production in EU member states. The effect of financial support

6 Data for the period 2020-2022 were excluded due to the negative impact of the global COVID-19 pandemic on the development of organic agricultural production worldwide.

on the expansion of organic areas is considered in the short term, taking into account the percentage of organic areas already in the following year, 2019, and in the longer term, observing the percentage of organic areas at the end of 2023. In pursuing this research objective, the following research questions were formulated:

1) Do higher total annual expenditures on support for organic agriculture contribute to a higher share of organic land in total agricultural land in EU member states?

2) Do higher average expenditures per hectare of supported organic land contribute to a higher share of organic land in total agricultural land?

3) What are the threshold values of annual total and average expenditure that separate countries with a higher share from countries with a lower share of organic land in total agricultural land?

Answers to these questions can help in assessing current, and planning future, financial support for organic agriculture, given that the "Farm-to-Fork" strategy envisages that at least 25% of agricultural land in the EU should be under organic production by 2030 (European Commission, 2020). The research questions are tested below using correlation analysis, a paired t-test, and a ROC curve.

**Table 4.** Variables — annual expenditure on organic agriculture (total and per hectare) and the share of organic land in total agricultural land, by EU member state

| Country | Expenditure (M€) | Expenditure/ha (€) | Organic share of total agricultural land | |
|---|---|---|---|---|
| | 2018 | 2018 | 2019 | 2023 |
| Austria | 121 | 234 | 26.1% | 27.3% |
| Belgium | 19 | 243 | 6.9% | 7.5% |
| Bulgaria | 24 | 354 | 2.3% | 2.9% |
| Cyprus | 4 | 805 | 5.0% | 7.7% |
| Czechia | 53 | 105 | 15.4% | 16.9% |
| Germany | 300 | 261 | 9.7% | 11.3% |
| Denmark | 41 | 184 | 10.9% | 11.6% |
| Estonia | 18 | 99 | 22.3% | 22.9% |
| Spain | 159 | 152 | 9.7% | 12.2% |
| Finland | 56 | 205 | 13.5% | 13.7% |
| France | 180 | 173 | 7.7% | 9.6% |
| Greece | 97 | 390 | 8.7% | 17.6% |
| Croatia | 33 | 350 | 7.2% | 8.0% |
| Hungary | 21 | 186 | 5.7% | 6.4% |
| Ireland | 8 | 111 | 1.6% | 4.0% |
| Italy | 386 | 352 | 15.2% | 18.7% |
| Lithuania | 36 | 197 | 8.1% | 8.5% |
| Luxembourg | 1 | 258 | 4.4% | 6.3% |
| Latvia | 28 | 107 | 14.8% | 15.1% |
| Malta | 0.002 | 374 | 0.5% | 0.6% |
| Netherlands | 0 | 0 | 3.8 | 4.8% |
| Poland | 47 | 138 | 3.5% | 4.4% |

| Country | Expenditure (M€) | Expenditure/ha (€) | Organic share of total agricultural land | |
|---|---|---|---|---|
| | 2018 | 2018 | 2019 | 2023 |
| Portugal | 25 | 124 | 8.2% | 21.7% |
| Romania | 42 | 232 | 2.9% | 5.1% |
| Sweden | 75 | 211 | 20.4% | 18.3% |
| Slovenia | 10 | 210 | 10.4% | 11.3% |
| Slovakia | 17 | 108 | 10.3% | 13.7% |

*Source:* FiBL; and Lampkin, 2023

## Results and Discussions

To determine whether a statistically significant association exists between the variables under consideration — total expenditure on organic agriculture in 2018, expenditure per hectare of supported organic land in 2018, and the share of organic land in total agricultural land in 2019 and 2023 — a correlation analysis was carried out. The association was examined using Spearman's rho coefficient, given that, according to the results of the Shapiro-Wilk normality test, normality of distribution was not confirmed for total expenditure and expenditure per hectare ($p=0.000<0.05$). Values of Spearman's correlation coefficient range from -1 to +1, where values from 0.1 to 0.29 indicate a weak correlation, values from 0.30 to 0.49 indicate a moderate correlation, and all values above 0.50 up to 1 indicate a strong positive correlation (Pallant, 2011).

Table 5 shows the results of the correlation analysis which finds a strong positive correlation between total expenditure on organic agriculture in 2018 and the share of organic land in total agricultural land in 2019 ($\rho=0.501$, $p=0.008< 0.05$) across 27 EU countries. The correlation analysis also showed a statistically significant moderate association between total expenditure on organic agriculture in 2018 and the share of organic land in total agricultural land in 2023 ($\rho=0.490$, $p=0.009<0.05$). The analysis did not confirm a statistically significant association between expenditure per hectare in 2018 and the share of organic land in total agricultural land in 2019 ($p=0.246>0.05$), nor with the share of organic land at the end of 2023 ($p=0.478>0.05$). The results obtained also confirmed a strong positive correlation between the share of organic land in total agricultural land in 2019 and in 2023 ($\rho=0.905$, $p=0.000<0.05$).

**Table 5.** Correlation matrix

| Variables | Expenditure (mil euro) 2018. | Expenditure (ha/ euro) 2018. | Organic shares of total agriculture land 2019 | Organic shares of total agriculture land 2023 |
|---|---|---|---|---|
| Expenditure (mil euro) 2018. | 1.000 | .118 | .501** | .490** |
| Expenditure (ha/ euro) 2018. | .118 | 1.000 | -.231 | -.143 |
| Organic shares of total agriculture land 2019 | .501** | -.231 | 1.000 | .905** |

| Variables | Expenditure (mil euro) 2018. | Expenditure (ha/ euro) 2018. | Organic shares of total agriculture land 2019 | Organic shares of total agriculture land 2023 |
|---|---|---|---|---|
| Organic shares of total agriculture land 2023 | .490** | -.143 | .905** | 1.000 |

**Correlation is significant at the 0.05 level (2-tailed).

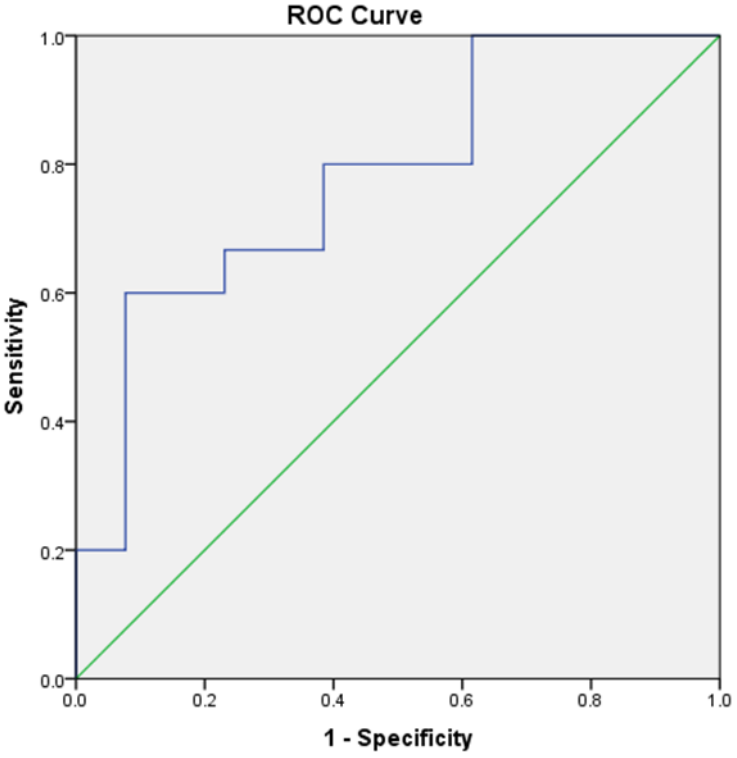
*Source:* Authors' calculations

Over the period 2019-2023, the share of organic land in total agricultural land increased in almost all EU countries observed. Whether this difference is also statistically significant is shown by the results of the paired t-test. In 2019, the average share of organic land in total agricultural land across the 27 EU countries was 9.44% (SD=6.38%), while the average share of this land in 2023 was 11.67% (SD=6.57%). The results of the t-test show that the 2.23-percentage-point difference between the share of organic land in total agricultural land in 2019 and 2023 is statistically significant ($p=0.002<0.05$). This significant increase in the share of organic land in 2023 could plausibly be linked to the total investment (in millions of euros) made in 2018.

For this purpose, a ROC curve (Receiver Operating Characteristic Curve) was applied, linking sensitivity (the probability of correctly detecting the presence of a trait) and specificity (the probability of incorrectly detecting the presence of a trait). Each point on the ROC curve represents an ordered pair (sensitivity, 1-specificity) corresponding to an individual value of the variable. For ROC analysis to be applied, the dependent variable must be dichotomous. Accordingly, two new variables were constructed referring to the share of organic land in total agricultural land: a share of less than 10%, coded as zero (0) and indicating countries with a lower level of development of organic agriculture, and a share of more than 10%, coded as one (1), representing countries with a higher level of development of organic agriculture. When examining the results of a given test for these two constructed populations of EU countries, it is very rarely possible to achieve complete separation between the two. In such cases, the separation should be based on the value of some continuous random variable (e.g., expenditure on organic agriculture in millions of euros), by determining the cutoff that best separates the two populations. One way of determining the cutoff is to take the value of the variable at which the difference between sensitivity and 1-specificity is maximal. A variable is better suited for testing, that is, for distinguishing countries with a higher share from countries with a lower share of organic land, the larger the area under the ROC curve (AUROC). The closer the area is to 0.5, the less suitable the variable is as a marker, while the closer it is to 1, the more suitable it is as a marker. To determine whether total expenditure on organic agriculture for 2018 can serve as a good marker for classifying countries into the group with a share of organic land in total agricultural land above 10%, data for 2019 were used first. The results for 2019 were not statistically significant (Area=0.618, $p=0.315>0.05$), which can be explained by the fact that, although a positive correlation exists, 2018 expenditure could not yet produce positive results in terms of increasing the share of organic land as early as

the following year. The share of organic land in total agricultural land in 2023 was therefore taken in the next step, with countries classified into two groups in the same way. Besides numerical values, the results of the ROC analysis also provide a graphical interpretation of the findings (Figures 1).

**Figure 1**. ROC curve




*Source*: Authors' calculations

The results obtained show that total expenditure on organic agriculture (in millions of euros) in 2018 can serve as a good marker for classifying countries into the group that will have a share of organic land in total agricultural land above 10% (area = 0.764, p=0.020<0.05) (Table 6). The value of total annual expenditure of €50 million was obtained as the optimal cutoff point separating countries into these groups (a share of organic land >10% and a share of organic land <10%). Based on this cutoff, Table 7 was constructed, showing the number of countries according to the optimal cutoff point and the share of organic land.

**Table 6.** Area under the curve

| Area | Std. Error | Asymptotic Sig.[b] | Asymptotic 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| 0.764 | 0.093 | 0.020 | 0.581 | 0.947 |

*Source:* Authors' calculations

**Table 7.** Number of countries according to the optimal cutoff point and the share of organic land in total agricultural land

| | Organic shares of total agriculture land < 10% 2023 | Organic shares of total agriculture land > 10% 2023 |
|---|---|---|
| **Expenditure < 50 million euro** | 12 | 6 |
| **Expenditure > 50 million euro** | 1 | 8 |

*Source:* Authors' calculations

Table 7 above shows that:

$$\text{Sensitivity} = 8/(8+6)=0.571=57.1\%$$

$$\text{Specificity} = 12/(12+1)=0.923=92.3\%$$

$$\text{Positive predictive value} = 8/(1+8)=0.889=88.9\%$$

$$\text{Negative predictive value} = 12/(12+6)=0.667=66.7\%$$

The positive predictive value of 88.9% means that eight of the nine countries with annual expenditure above €50 million had an organic land share above 10% in 2023. The negative predictive value of 66.7% means that 12 of the 18 countries below this threshold had a share under 10%, while the other six exceeded 10%. Expenditure above €50 million predicts a higher organic land share better than expenditure below it predicts a lower one. The sample is small (27 countries), so the results are preliminary.

## Conclusions

The EU is one of the largest organic food markets in the world, recording high growth rates and increasing per capita consumption of organic products. Alongside continuous growth in demand, the area under organic production in EU countries is also expanding, supported by financial instruments in the form of payments for conversion to, and maintenance of, organic production. EU member states generally allocate a significant budget to support organic agriculture, which increases considerably with each successive programming period. Nevertheless, the EU organic market is heterogeneous, both in terms of total and relative expenditure on organic agriculture and in terms of the representation of organic land in total agricultural land. The findings obtained indicate that differences in the share of organic land may be caused by the level of total annual expenditure on organic agriculture. In those EU member states that have higher total

annual expenditure on organic agriculture, an increase in the share of organic land in total agricultural land occurred over the longer term. A particular contribution of the analysis is that it reveals that once total annual expenditure on organic agriculture at the national level exceeds €50 million, the probability that the share of organic land in total agricultural land will exceed 10% increases. This means that EU member states must continuously increase their annual budget above the threshold value of €50 million in order to raise the share of organic land above the EU average and move closer to the planned target of 25% of land under organic production by 2030. The main limitation of this study relates to the period observed, since the indicators analysed come from the previous programming period, so future research should cover data from the current programming period. In addition, in examining the effect on the growth of the share of organic land, alongside financial support instruments, future research could include other factors such as legal and communication instruments. Future research should also apply other statistical methods, such as regression analysis.

## Conflict of interests

The authors declare no conflict of interest.

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