

ECONOMIC INPUT INTENSITY, LAND PRODUCTIVITY, AND ECONOMIC SUSTAINABILITY IN EUROPEAN AGRICULTURE: A COMPARATIVE ANALYSIS

DOI: <https://doi.org/10.36004/nier.es.2026.1-04>

UDC: 338.43(4)

JEL classification: Q1, Q15, Q18, R0

Ana URSU

PhD, researcher. gr. sch. II, ICEADR, Bucharest

<https://orcid.org/0000-003-1822-9690>

ursu.ana@iceadr.ro

Received 15 February 2026

Accepted for publication 12 May 2026

SUMMARY

This study analyzes the relationships between the economic intensity of agricultural inputs, the economic productivity of land, and economic sustainability in selected European countries, using EUROSTAT data for the period 2014–2025. The comparative analysis was conducted for two sub-periods, 2014–2019 and 2020–2025, in the context of transformations driven by agricultural market volatility, rising input costs, and the energy crisis. The research methodology is based on derived indicators constructed using the Economic Accounts for Agriculture: the economic sustainability indicator (ESI), the land productivity indicator (LPI), and the input intensity indicator (III). The statistical analysis included descriptive statistics and Pearson's correlation coefficient. The results highlight the existence of significant structural differences between the agricultural systems analyzed. The positive correlation between the variation in economic input intensity and the variation in economic land productivity ($r = 0.831$) indicates that economic intensification is associated with increased agricultural productivity. In contrast, the negative correlation between the variation in economic intensity and the variation in economic sustainability ($r = -0.593$) suggests that an increase in intermediate consumption does not automatically lead to improved economic performance. Romania recorded simultaneous increases in land productivity (+35.0%) and economic sustainability (+10.4%), against a backdrop of a moderate intensification of input use (+23.5%). The results underscore the importance of an integrated assessment of the relationships between economic intensification, agricultural productivity, and economic sustainability in European agriculture.

Keywords: value of agricultural production, intermediate consumption, GVA, economic efficiency, agricultural convergence, European agriculture

INTRODUCTION

Agriculture plays a vital role in ensuring food security, managing natural resources, and developing rural areas. Over the past decade, European agriculture has been marked by accelerated processes of economic intensification, specialization, and technological modernization, which have contributed to increased production and the economic productivity of agricultural land. These transformations have increased agriculture's dependence on intermediate inputs and the volatility of input prices, amplifying economic pressures on European agricultural systems (EC, 2020; OECD, 2019; FAO, 2024).

Recent literature highlights that agricultural intensification processes have significantly contributed to increased agricultural productivity and the economic performance of European agriculture through the use of higher volumes of inputs, technological adoption, and agricultural specialization (Knocke et al., 2022; Yang et al., 2023). Other studies emphasize that the relationship between agricultural intensification and sustainability is complex and characterized by multiple economic and ecological trade-offs (Reidsma et al., 2023).

Comparative studies highlight significant structural differences between agricultural systems resulting from varying levels of intensification, farm structure, and the degree of technological modernization (Radlinska, 2025; Aleksandrini et al., 2024). However, in Central and Eastern European countries, processes of convergence and structural transformations associated with modernization and increased use of agricultural inputs continue to occur.

Other studies highlight that productivity is one of the main determinants of the economic performance of European agriculture and the competitiveness of

agricultural systems (Hendricks et al., 2023; Vidali, 2025; Bilenko, 2022). Furthermore, significant regional disparities among European countries are highlighted regarding productivity levels, farm modernization, and the economic efficiency of agricultural resource use (Li et al., 2022; Hadelan et al., 2022).

One of the main indicators of economic performance in agriculture is gross value added (Kolodziejczak, 2020). Studies highlight that the relationships between agricultural production, intermediate consumption, and gross value added reflect the level of competitiveness and economic sustainability of European agriculture. European agriculture is shaped by the existence of differentiated processes of convergence and structural transformation between Western European and Central and Eastern European countries (Feher et al., 2017). Romania continues to undergo processes of modernization and economic restructuring characterized by increased productivity and intensified use of agricultural inputs (Ionițescu, 2023).

Intermediate consumption is the central element of the processes of economic intensification in agriculture, reflecting the level of input use, technological adoption, and capitalization of agricultural production (Donovan, 2021). An increase in intermediate consumption can contribute to higher productivity and economic performance in agriculture, but the effects on economic sustainability vary depending on the structure of the systems and the efficiency of agricultural input use.

Studies on agriculture in Central and Eastern European countries highlight that processes of agricultural modernization and convergence are associated with increased use of agricultural inputs and changes in the economic structure of agriculture (Feher et al., 2022;

Andrei et al., 2023). In Romania, the dynamics of intermediate consumption and agricultural production reflect the processes of restructuring and adaptation of agriculture to European economic and technological transformations.

Numerous studies frequently analyze agricultural productivity, economic efficiency, and the sustainability of European agriculture, but there is less comparative research that simultaneously examines the relationships between the economic intensity of inputs, the economic productivity of land, and economic sustainability, using derived indicators constructed on the basis of agricultural economic accounts.

Recent literature highlights that agricultural land productivity is one of the main indicators of the economic performance and competitiveness of European agriculture (Wimmer and Finger, 2026). Increasing agricultural productivity is particularly important both for ensuring food security and for maintaining the economic viability of European farms in the context of climate change, agricultural market volatility, and rising production costs (Khan et al., 2025; Varzaru, 2025). Research highlights that agricultural intensification, technological modernization, and the use of higher input volumes contribute to increased land productivity, but the effects on economic and ecological sustainability differ across the analyzed agricultural systems (Chiarella et al., 2023; Ewert et al., 2005).

Studies on European agriculture highlight structural differences between Western European countries and Central and Eastern European countries in terms of agricultural productivity levels, land use efficiency, and the degree of agricultural modernization (Ion and Crețu, 2025; Janus et al., 2023). Agricultural convergence processes in Eastern European countries are associated with intensified input use and increased economic productivity of agricultural land (Wimmer and Finger, 2026).

The economic performance of agriculture is a central element of analyses concerning the sustainability and competitiveness of European agricultural systems. Studies show that economic performance is influenced by the relationships between productivity, the efficiency of agricultural resource use, farm modernization, and agriculture's ability to create added value (Varzaru, 2026). At the same time, economic performance must be analyzed in relation to the processes of economic sustainability and structural adaptation in European agriculture (Cholet et al., 2026; Martín-García et al., 2026). European agriculture is marked by accelerated processes of structural transformation, driven by technological intensification, digitalization, climate change, and reforms of the Common Agricultural Policy (Tudor & Alexandri, 2015). Central and Eastern European agriculture, including Romania, is influenced by processes of economic convergence, modernization, and restructuring of agricultural holdings (Prigoreanu et al., 2025a; Ursu et al., 2023). In this context, the intensified use of agricultural inputs and increased

economic productivity can contribute to improving the economic performance of agriculture, but the effects on economic sustainability differ among the agricultural systems analyzed.

The economic efficiency and adaptability of agricultural holdings in the context of increasing volatility in agricultural markets and rising production costs are also important (Ursu, 2024). At the same time, agricultural economic performance is influenced by the degree of capitalization, the use of modern technologies, and the level of investment in agriculture. These transformations highlight the need for an integrated assessment of the relationships between agricultural economic intensification, land economic productivity, and economic sustainability in European agriculture.

Agricultural sustainability is one of the main focuses of contemporary agricultural research and European agricultural policies, being associated with the need to balance the economic, social, and ecological performance of agriculture (Liu, 2025; Prigoreanu et al., 2025b). Assessing agricultural sustainability requires the use of complex indicator systems capable of capturing the relationships between productivity, the use of agricultural resources, economic efficiency, and environmental impact (Sinisterra-Solís et al., 2024; Xavier et al., 2025).

In this context, the development of agricultural sustainability indicators and comparative methodologies for evaluating agricultural performance has become a major concern for both academic research and European agricultural policy.

The sustainability of European agriculture, as highlighted in numerous studies, is influenced by processes of agricultural intensification, increasing dependence on agricultural inputs, and structural transformations in European agricultural systems (Mergoni et al., 2024). These studies highlight the fact that increased productivity and economic performance do not necessarily lead to improved agricultural sustainability, as there are often trade-offs between economic efficiency, intensive resource use, and long-term sustainability goals (Alves et al., 2022).

Recent research highlights significant structural differences among European agricultural systems regarding the level of economic sustainability and the capacity to adapt to transformations driven by the Common Agricultural Policy, climate change, and economic volatility (Manta et al., 2024; Hansson et al., 2024). Assessing economic sustainability has become an important component of analyses regarding the competitiveness and resilience of agricultural systems in European agriculture (Prigoreanu et al., 2025a; Boggia et al., 2023).

This study aims to analyze the relationships between the economic intensification of agriculture, the economic productivity of land, the economic productivity of agricultural labor, and economic sustainability for a group of European countries, using EUROSTAT data

for the period 2014–2025. This study is based on the following hypotheses: H1 – the economic intensification of agriculture contributes to an increase in the economic productivity of agricultural land; H2 – an increase in

the economic intensity of agricultural inputs does not necessarily lead to an improvement in the economic sustainability of agriculture.

MATERIALS AND METHODS

To highlight the relationship between agricultural intensification, the economic productivity of land, and the economic sustainability of agriculture, EUROSTAT statistical data for the period 2014–2025 were used. The analysis was based on indicators included in the Economic Accounts for Agriculture, namely: utilised agricultural area (UAA, thousand ha), output of the agricultural sector (OAI, million euros), intermediate consumption (IC, million euros), gross value added at basic prices (GVA, million euros), and the agricultural labor force (thousand AWU).

The comparative analysis was conducted for a sample of 15 European countries: Italy, France, Spain, Germany, the Netherlands, Poland, Romania, Switzerland, Hungary, Austria, Portugal, Denmark, Belgium, Sweden, and Bulgaria. The selection of countries took into account the diversity of European agricultural models and structural differences in agricultural production intensity, economic productivity, and input use.

In order to capture the recent structural changes in European agriculture, the period under analysis was divided into two distinct sub-periods: 2014–2019 and 2020–2025. The first subperiod represents a relatively stable phase from an economic and agricultural perspective, while the second reflects the effects of the COVID-19 pandemic, volatility in agricultural markets,

rising energy costs, increased prices for agricultural inputs, and heightened geopolitical tensions. For each indicator analyzed, average values were calculated for the two sub-periods to reduce annual fluctuations and highlight medium-term structural trends.

To characterize the variability and degree of heterogeneity of the analyzed indicators, descriptive statistics were calculated, namely the minimum and maximum values, the arithmetic mean, the standard deviation, and the coefficient of variation, which were used to assess the dispersion of the indicators among the analyzed European countries.

The research is based on the following working hypotheses:

H1: The economic intensification of agriculture contributes to an increase in the economic productivity of agricultural land.

H2: Increasing the economic intensity of agricultural inputs does not uniformly lead to improved economic sustainability, as there are significant structural differences among the agricultural systems analyzed.

Based on the available statistical indicators, three derived indicators were constructed for each of the two sub-periods analyzed.

The Economic Sustainability Indicator (ESI) is a dimensionless ratio of gross value added to intermediate consumption. The ESI measures the relative economic efficiency of agriculture:

$$ESI = \frac{GVA}{IC}$$

Where:

GVA – Gross value added at basic prices

IC – Intermediate consumption

The Land Productivity Index (LPI) measures the value of agricultural production relative to the area of land used for agriculture and is expressed in thousands of euros per hectare:

$$LPI = \frac{OAI}{UAA}$$

Where:

OAI – Output of the agricultural industry - Production value at basic price;

UAA - Utilised agricultural area

The Input-Output Intensity Index (III) measures agricultural intermediate consumption relative to the utilised agricultural area and is expressed in thousands of euros per hectare.

$$III = \frac{IC}{UAA}$$

Where:

IC – Intermediate consumption

UAA - Utilised agricultural area

Economic Labor Productivity Index (ELPI). To assess the economic efficiency of agricultural labor utilization, the Economic Labor Productivity Indicator (ELPI) was developed, calculated as the ratio of gross value added to the agricultural labor force expressed in annual work units (AWU).

$$ELPI = \frac{GVA}{AWU}$$

Where:

GVA – Gross value added at basic prices

AWU – Annual work units

The indicator is expressed in thousands of euros per AWU and reflects the agricultural sector's ability to generate value added relative to the labor force employed in agriculture.

To highlight the structural changes between the two sub-periods, the percentage changes in the analyzed indicators were calculated. The relationships between the derived indicators were assessed using Pearson's correlation coefficient (UBB, 2016):

$$r_{xy} = \frac{\frac{1}{n} \sum (x - \bar{x})(y - \bar{y})}{S_x S_y}$$

Where:

n = sample size;

x and y = the individual values of the x-variable and the y-variable;

\bar{x} and \bar{y} = the arithmetic mean of all x and y values;

$S_x S_y$ = the standard deviation of all x and y values.

The strength of the correlations was interpreted based on Pearson's correlation coefficients, in accordance with the thresholds used in the specialized statistical literature.

The indicators used are value-based, reflecting the economic dimension of agricultural intensification and sustainability. Consequently, the results obtained are influenced by both structural changes in agricultural production and price dynamics and the volatility of agricultural markets.

Statistical data processing, indicator calculation, and correlation analysis were performed using Microsoft Excel.

The literature analysis was carried out based on existing publications on the Web of Science Core Collection platform.

MAIN RESULTS

To assess the economic sustainability of European agriculture, the derived indicators calculated for the two

sub-periods—2014–2019 (ESI1) and 2020–2025 (ESI2) were analyzed.

1.1 ANALYSIS OF THE ECONOMIC SUSTAINABILITY INDICATOR (ESI)

Table 1 presents the average values of the economic sustainability indicator (ESI) for the two sub-periods analyzed. The results highlight significant differences

among the countries analyzed in terms of agriculture's ability to generate gross value added relative to intermediate consumption.

Table 1.
Economic Sustainability Indicator (ESI)

Countries	ESI1	ESI2	Δ ESI
Italy	1.21	1.17	-3.3
France	0.67	0.62	-6.7
Spain	1.21	1.13	-6.8
Germany	0.54	0.66	22.1
Netherlands	0.55	0.57	4.1
Poland	0.59	0.64	8.0
Romania	0.78	0.86	10.4
Switzerland	0.60	0.62	4.3
Hungary	0.70	0.60	-13.7
Austria	0.69	0.75	9.2
Portugal	0.64	0.61	-5.6
Denmark	0.33	0.39	18.9
Belgium	0.40	0.41	3.5
Sweden	0.38	0.48	25.7
Bulgaria	0.72	0.78	8.7
Minimum	0.33	0.39	-13.7
Maximum	1.21	1.17	25.7
Mean	0.67	0.69	5.3
SD	0.26	0.23	11.3
CV (%)	38.40	33.00	215.2

Source: Our own calculations based on EUROSTAT data

The highest average ESI values were recorded in Italy and Spain, with values exceeding 1.10 in both sub-periods analyzed, highlighting agriculture's strong capacity to generate economic value relative to intermediate consumption. In contrast, the lowest values were observed in Denmark, Sweden, and Belgium, countries characterized by high levels of agricultural economic intensification and intermediate consumption.

Regarding the variation of the indicator between the two sub-periods, the most significant increases in the economic sustainability indicator were recorded by Sweden (+25.7%), Germany (+22.1%), and Denmark (+18.9%). Romania recorded an increase of +10.4%, with the average value of the ESI rising from 0.78 in the 2014–2019 period to 0.86 in the 2020–2025 period. The result suggests an improvement in the ratio of gross value added to intermediate consumption in Romanian

agriculture. At the same time, some countries saw declines in their ESI scores between the two sub-periods analyzed. The most significant declines were observed in Hungary (-13.7%), Spain (-6.8%), and France (-6.7%), highlighting the existence of uneven trends in economic sustainability among the countries analyzed.

The average ESI values for all analyzed countries rose slightly from 0.67 in the 2014–2019 period to 0.69 in the 2020–2025 period. At the same time, the standard deviation decreased from 0.26 to 0.23, and the coefficient of variation fell from 38.4% to 33.0%, indicating a moderate reduction in the indicator's heterogeneity across the countries analyzed. In contrast, the very high coefficient of variation of the indicator (CV = 215.2%) highlights significant differences among countries in changes in economic sustainability between the two sub-periods analyzed.

1.2 ANALYSIS OF THE LAND PRODUCTIVITY INDEX (LPI)

Table 2 presents the average values of the Land Productivity Index (LPI) for the two sub-periods analyzed.

Table 2.*Land Productivity Indicator (LPI)*

Countries	LP11	LPI2	Δ LPI
Italy	4.14	5.21	26.1
France	2.58	3.18	23.1
Spain	2.09	2.69	28.7
Germany	3.42	4.44	29.9
Netherlands	17.29	22.13	28.0
Poland	1.69	2.65	57.5
Romania	1.25	1.69	35.0
Switzerland	6.6	8.09	22.5
Hungary	1.57	2.10	34.2
Austria	2.75	3.87	40.8
Portugal	2.05	2.97	44.6
Denmark	4.11	4.94	20.3
Belgium	6.33	8.40	32.7
Sweden	2.03	2.56	25.7
Bulgaria	0.81	1.10	35.0
Minimum	0.8	1.1	20.3
Maximum	17.3	22.1	57.5
Mean	3.9	5.1	32.3
SD	4.1	5.2	9.7
CV (%)	104.2	102.1	30.1

Source: Our own calculations based on EUROSTAT data

The highest average LPI values were recorded by the Netherlands, with values of 17.29 for the period 2014–2019 and 22.13 for the period 2020–2025, reflecting a very high level of economic intensification and agricultural land utilization. High values of land economic productivity were also observed in Belgium, Switzerland, and Italy, countries characterized by intensive and highly specialized agricultural systems.

In contrast, the lowest LPI values were recorded in Bulgaria, Romania, and Hungary, highlighting significant structural differences among the analyzed agricultural systems. Romania recorded average LPI values of 1.25 for the 2014–2019 period and 1.69 for the 2020–2025 period, corresponding to a percentage change of +35.0%.

Regarding the change in the indicator between the two sub-periods analyzed, the largest increases were recorded in Poland (+57.5%), Portugal (+44.6%), and Austria (+40.8%). Significant increases were also observed in Romania, Bulgaria, and Hungary, where the percentage

changes exceeded 34%. The results suggest the existence of processes of increasing economic productivity of agricultural land, particularly in the Central and Eastern European countries analyzed.

The average value of the LPI indicator for all analyzed countries rose from 3.9 during 2014–2019 to 5.1 during 2020–2025, indicating a general increase in the economic productivity of agricultural land. At the same time, the standard deviation increased from 4.1 to 5.2, highlighting the widening of absolute differences among the analyzed countries. Nevertheless, the coefficient of variation showed a slight decrease, from 104.2% to 102.1%, suggesting that the indicator's heterogeneity remains very high across the analyzed countries.

The coefficient of variation for the LPI indicator (CV = 30.1%) indicates a moderate dispersion in the growth rates of land productivity across the countries analyzed, compared with the much more heterogeneous variations observed for the economic sustainability indicator.

1.3 ANALYSIS OF THE INPUT-OUTPUT INTENSITY (III) INDICATOR

Table 3 presents the average values of the input-output intensity (III) indicator for the two sub-periods analyzed.

Table 3.

Input Intensity Indicator (III)

Countries	III ₁	III ₂	Δ III
Italy	1.87	2.32	23.9
France	1.55	1.90	22.6
Spain	0.93	1.22	31.9
Germany	2.23	2.57	15.3
Netherlands	11.08	13.60	22.8
Poland	1.04	1.53	47.1
Romania	0.70	0.87	23.5
Switzerland	4.03	4.88	20.9
Hungary	0.91	1.26	38.0
Austria	1.58	2.11	33.4
Portugal	1.22	1.75	43.2
Denmark	3.06	3.51	14.6
Belgium	4.47	5.74	28.3
Sweden	1.47	1.67	13.4
Bulgaria	0.48	0.59	22.7
Minimum	0.5	0.6	13.4
Maximum	11.1	13.6	47.1
Mean	2.4	3.0	26.8
SD	2.7	3.3	10.2
CV (%)	109.1	107.3	37.9

Source: Our own calculations based on EUROSTAT data

The highest average values for Indicator III were recorded in the Netherlands, with values of 11.08 for the period 2014–2019 and 13.60 for the period 2020–2025, reflecting a very high level of economic intensification in agriculture. High values of the indicator were also observed in Belgium, Switzerland, and Denmark, countries characterized by intensive and highly technologized agricultural systems.

In contrast, the lowest values of Indicator III were recorded in Bulgaria, Romania, and Hungary, highlighting lower levels of agricultural intermediate consumption relative to the agricultural area utilized. Romania recorded average values for Indicator III of 0.70 during the 2014–2019 period and 0.87 during the 2020–2025 period, corresponding to a percentage change of +23.5%.

Regarding the change in the indicator between the two sub-periods analyzed, the largest increases were recorded by Poland (+47.1%), Portugal (+43.2%), and Hungary (+38.0%). Significant increases were also observed in Austria, Spain, and Belgium, where the

percentage changes exceeded 28%. The results suggest an intensification of the economic growth of European agriculture during the 2020–2025 period compared to the 2014–2019 period.

The average value of Indicator III for all the countries analyzed rose from 2.4 during the 2014–2019 period to 3.0 during the 2020–2025 period, highlighting the overall increase in agricultural intermediate consumption relative to the area of land used for agriculture. At the same time, the standard deviation increased from 2.7 to 3.3, suggesting a widening of the absolute differences among the analyzed countries regarding the economic intensity of agricultural inputs.

The coefficient of variation decreased slightly, from 109.1% to 107.3%, indicating that the indicator's heterogeneity among the analyzed countries remains very high. At the same time, the coefficient of variation of indicator III (CV = 37.9%) highlights the existence of moderate differences among countries regarding the growth rate of the economic intensity of agricultural inputs between the two sub-periods analyzed.

1.4 ANALYSIS OF ECONOMIC LABOR PRODUCTIVITY IN AGRICULTURE (ELPI)

Table 4 presents the results regarding the economic productivity of agricultural labor, which highlight the existence of very significant structural differences among the European agricultural systems analyzed.

Table 4.

Economic Labour Productivity Indicator (ELPI)

Countries	ELPI ₁	ELPI ₂	Δ ELPI
Italy	27.19	36.43	9.23
France	39.93	47.70	7.76
Spain	31.14	39.95	8.81
Germany	41.74	61.86	20.13
Netherlands	71.37	88.93	17.55
Poland	4.94	10.12	5.18
Romania	5.16	9.16	4.01
Switzerland	42.41	56.03	13.62
Hungary	8.21	13.72	5.51
Austria	24.30	35.25	10.95
Portugal	11.83	18.77	6.94
Denmark	48.83	78.86	30.03
Belgium	43.24	63.61	20.38
Sweden	28.91	43.30	14.39
Bulgaria	7.12	13.93	6.81
Minimum	4.94	9.16	4.01
Maximum	71.37	88.93	30.03
Mean	29.09	41.18	12.09
SD	19.34	25.28	7.28
CV%	66.48	61.39	60.24

Source: Our own calculations based on EUROSTAT data

The ELPI values highlight significantly higher levels of economic efficiency in agricultural labor in Western European countries characterized by a high degree of capitalization and mechanization of agriculture, such as the Netherlands, Denmark, Belgium, and Germany.

During the 2020–2025 period, the highest ELPI values were recorded in the Netherlands (88.93 thousand euros/AWU), Denmark (78.86 thousand euros/AWU), and Belgium (63.62 thousand euros/AWU), while the lowest values were found in Romania (9.16 thousand euros/AWU), Poland (10.12 thousand euros/AWU), and Hungary (13.72 thousand euros/AWU). These differences highlight the existence of significant structural gaps in the efficiency of agricultural labor utilization within European agriculture.

Romania has seen an increase in the economic productivity of agricultural labor from 5.16 to 9.16 thousand euros per AWU between the two periods analyzed, suggesting a process of agricultural convergence and economic modernization. However, the indicator's level remains significantly below the average of the analyzed countries, reflecting the persistence of structural constraints associated with the fragmentation of agricultural holdings, low capitalization levels, and the high share of the labor force employed in agriculture.

The high values of the coefficient of variation - 66.48% for the 2014–2019 period and 61.39% for the 2020–2025 period—highlight a high degree of heterogeneity among the European countries analyzed regarding the economic productivity of agricultural labor.

1.5 ANALYSIS OF THE RELATIONSHIPS BETWEEN DERIVED INDICATORS

To highlight the statistical relationships among the derived indicators of agricultural economic performance, Pearson correlation coefficients were calculated, and the relationships between changes in the economic intensity

of inputs, changes in the economic productivity of land, and changes in economic sustainability were plotted graphically.

1.5.1 ANALYSIS OF THE CORRELATIONS BETWEEN ECONOMIC SUSTAINABILITY (ESI) AND ECONOMIC INPUT INTENSITY (III)

The correlations between the economic sustainability indicator (ESI) and the economic input intensity indicator (III) are presented in Table 5. The results highlight the existence of distinct structural relationships between

the level of economic intensification in agriculture and the economic sustainability of the analyzed agricultural systems.

Table 5.

Pearson Correlation Matrix

	<i>ESI1</i>	<i>ESI2</i>	<i>III1</i>	<i>III2</i>	<i>LPI1</i>	<i>LPI2</i>
<i>ESI1</i>	1					
<i>ESI2</i>	0.970	1				
<i>III1</i>	-0.310	-0.330	1			
<i>III2</i>	-0.301	-0.326	0.999	1		
<i>LPI1</i>	-0.214	-0.236	0.994	0.994	1	
<i>LPI2</i>	-0.216	-0.238	0.993	0.995	0.999	1

Source: Our own calculations based on EUROSTAT data

The Pearson correlation coefficient values indicate a strong positive correlation between the ESI indicator values for the two sub-periods analyzed ($r = 0.970$), highlighting a relatively high degree of stability in the economic sustainability patterns of the countries analyzed. Similarly, the values of indicator III show an almost perfect correlation between the two sub-periods ($r = 0.999$), suggesting the structural nature of the economic intensity of agricultural inputs within European agricultural systems.

The relationships between the economic sustainability indicator and the economic intensity of inputs indicator show moderate negative values of the Pearson coefficient, both for the 2014–2019 period and for the 2020–2025 period. The correlations obtained between ESI1 and III1 ($r = -0.310$) and between ESI2 and III2 ($r = -0.326$), respectively, suggest that high levels of economic input intensity are not uniformly associated with high values of economic sustainability.

1.5.2 ANALYSIS OF THE CORRELATIONS BETWEEN ECONOMIC SUSTAINABILITY (ESI) AND LAND PRODUCTIVITY (LPI)

The correlations between the economic sustainability indicator (ESI) and the land productivity indicator (LPI) are presented in Table 5. The results highlight the existence of weak and negative relationships between the two indicators, both for the 2014–2019 period and for the 2020–2025 period.

The Pearson correlation coefficients calculated between ESI1 and LPI1 ($r = -0.214$) and between ESI2 and LPI2 ($r = -0.238$), respectively, suggest that high levels of land economic productivity are not directly associated with high levels of economic sustainability. The results

highlight the existence of structural differences between the agricultural systems analyzed, particularly in the case of countries characterized by a high level of economic intensification of agriculture.

The strong positive correlation between the LPI indicator values for the two sub-periods analyzed ($r = 0.999$) indicates that the structural differences among the analyzed countries persist and that the level of economic productivity of agricultural land remains relatively stable.

1.5.3 ANALYSIS OF THE CORRELATIONS BETWEEN THE ECONOMIC INTENSITY OF INPUTS (III) AND THE ECONOMIC PRODUCTIVITY OF LAND (LPI)

The correlations between the economic input intensity (III) indicator and the land productivity index (LPI) are presented in Table 5. The results highlight the existence of strong positive correlations between the two indicators for both sub-periods analyzed.

The Pearson correlation coefficients calculated between III1 and LPI1 ($r = 0.994$) and between III2 and LPI2 ($r = 0.995$), respectively, indicate a very strong direct relationship between the economic intensity of agricultural inputs and the level of land productivity. The results suggest that countries characterized by

high levels of intermediate consumption relative to the utilised agricultural area generally also record high values of agricultural output relative to the utilised agricultural area.

The strong positive correlations between the values of Indicator III for the two sub-periods analyzed ($r = 0.999$) and between the values of the LPI ($r = 0.999$) highlight the structural and relatively stable nature of the differences between the agricultural systems analyzed in terms of economic intensification and the economic productivity of agricultural land.

1.5.4 ANALYSIS OF CORRELATIONS BETWEEN CHANGES IN INDICATORS

The correlations between the variations in the analyzed indicators are presented in Table 6, Figure 1, and Figure 2.

Table 6.

Correlations between changes in indicators

The relationship between changes in the indicators	Coefficient Pearson (r)	Correlation strength
ΔIII and ΔESI	-0,593	Moderată negativă
ΔLPI and ΔESI	-0,108	Foarte slabă negativă
ΔIII and ΔLPI	0,831	Puternic pozitivă

Source: Our own calculations based on EUROSTAT data

An analysis of changes in the indicators between the two sub-periods reveals a moderate negative correlation between changes in the economic intensity of inputs and changes in economic sustainability ($r = -0.593$). This result suggests that further economic intensification of agriculture does not necessarily lead to increased economic sustainability in all the countries analyzed.

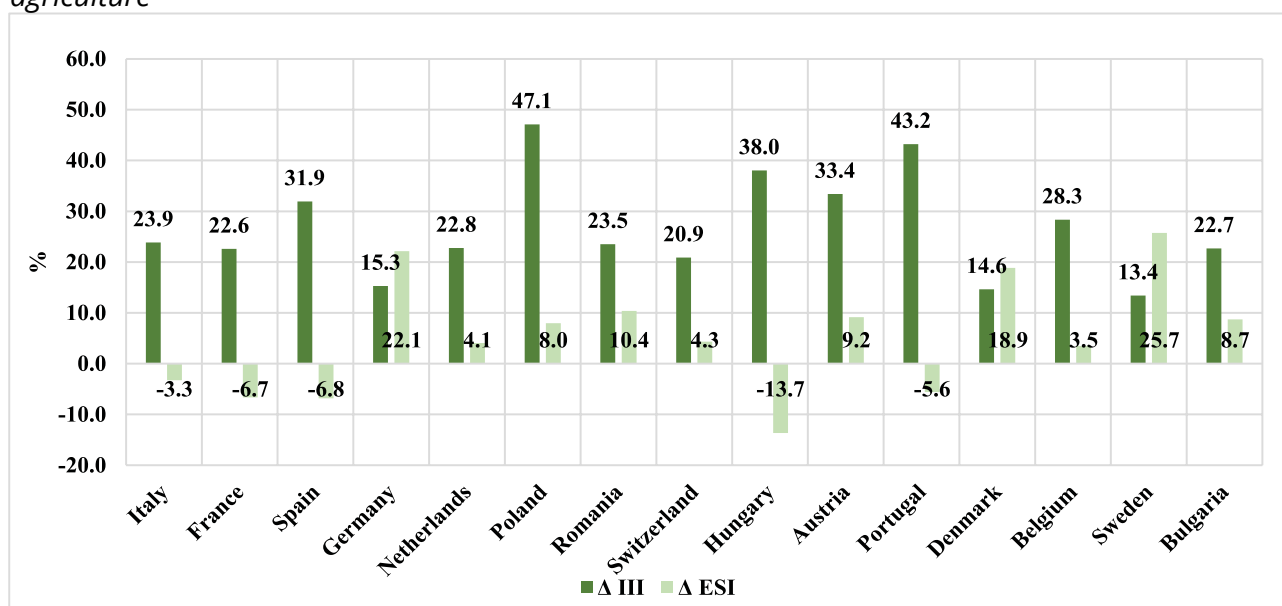
The results regarding changes in indicators between the two sub-periods reveal a very weak and negative correlation between changes in the economic productivity of land and changes in economic sustainability ($r = -0.108$).

This relationship suggests that an increase in the economic productivity of land does not necessarily lead to an improvement in the economic sustainability of agriculture in the countries analyzed.

The results regarding the variations in indicators between the two sub-periods highlight the existence of a strong positive correlation between the variation in the economic intensity of inputs and the variation in the economic productivity of land ($r = 0.831$). The result suggests that the economic intensification of agriculture contributes significantly to the increase in the economic productivity of agricultural land in the analyzed countries.

Figure 1.

Comparative evolution of input intensity (III) and economic sustainability (ESI) in European agriculture



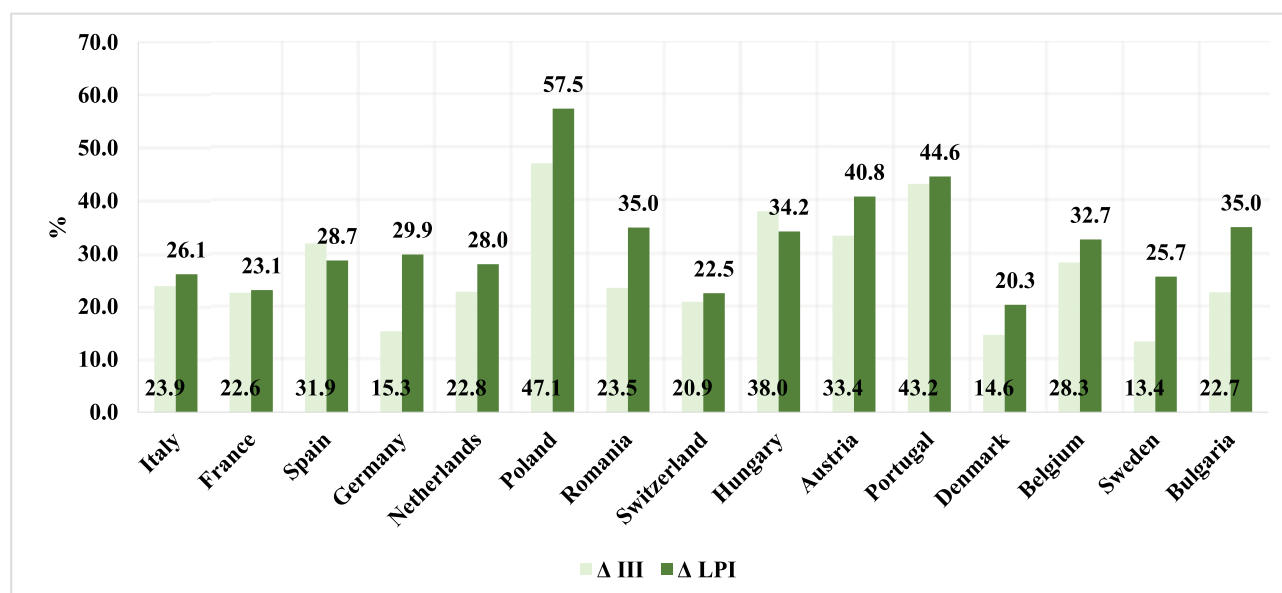
Source: Author's own calculations based on EUROSTAT data, averages for the period 2014–2025

Figure 1 highlights the negative relationship between changes in the economic intensity of inputs and changes in economic sustainability. The distribution of the data points reveals that European agricultural

systems respond differently to processes of economic intensification, suggesting that the relationship between intensification and economic sustainability is not uniform.

Figure 2.

Comparative evolution of input intensity (III) and land productivity (LPI) in European agriculture



Source: Author's own calculations based on EUROSTAT data, averages for the period 2014–2025

Figure 2 highlights the existence of a strong positive relationship between changes in the economic intensity of inputs and changes in the economic productivity of agricultural land. The results suggest that an increase

in agricultural intermediate consumption is associated with an increase in the economic productivity of land in most of the countries analyzed.

DISCUSSIONS

The comparative analysis conducted for the two sub-periods confirms that the processes of economic intensification in European agriculture accelerated between 2020 and 2025, against the backdrop of transformations driven by volatility in agricultural markets, rising energy costs, and higher prices for agricultural inputs. Similar findings are highlighted in recent literature, which emphasizes that European agriculture is undergoing a period of structural transformation associated with increasing dependence on agricultural inputs and pressures stemming from economic and geopolitical volatility (*European Commission, 2020; FAO, 2024; Donovan et al., 2021*).

Processes of agricultural productivity growth are influenced both by agricultural policies and investments in modernization, as well as by pressures arising from climate change, land use, and natural resource constraints (Chatzitheodoridis et al., 2025; Hua et al., 2025). In this context, assessing the relationships between economic intensification, economic productivity, and agricultural sustainability becomes relevant for analyzing the performance of European agricultural systems.

The economic productivity of agricultural land highlights the fact that processes of economic intensification and agricultural modernization contribute to improving the economic performance of European agriculture (Khan et al., 2025; Wang et al., 2020). The strong positive correlation identified between changes in the economic intensity of inputs and changes in the economic productivity of land confirms the role of agricultural input use and economic intensification in increasing the value of agricultural production relative to the area of agricultural land used.

High levels of economic land productivity, such as in the Netherlands or Belgium, are associated with highly intensive and specialized agricultural models, characterized by high use of agricultural inputs and a high level of agricultural capitalization. In contrast, the Eastern European countries analyzed, including Romania, continue to undergo processes of agricultural convergence, in which moderate growth in economic intensification is associated with significant increases in the economic productivity of agricultural land. These results are consistent with the conclusions drawn by Wimmer and Finger (2026) and by Ion and Crețu (2025), which highlight the existence of persistent disparities in agricultural productivity across Europe.

Increased agricultural productivity does not necessarily lead to improvements in the economic or environmental sustainability of agriculture (Chiarella et al., 2023; Khan et al., 2025). The research findings confirm this perspective, highlighting that the relationship between the economic productivity of land and economic sustainability is weaker compared to the relationship between economic intensification and agricultural productivity.

The economic performance of European agriculture is influenced by the relationships between the intensification of agricultural input use, economic productivity, and the efficiency of agricultural resource use (Varzaru, 2026). The strong positive correlation identified between changes in the economic intensity of inputs and changes in the economic productivity of land confirms that processes of economic intensification contribute to the growth of the economic performance of European agriculture.

High economic performance in agriculture is not necessarily associated with improved economic sustainability. The negative correlations between economic intensification and economic sustainability suggest that there are limits to highly intensive and specialized agricultural models. These results are similar to the conclusions drawn by Cholet et al. (2026) and Martín-García et al. (2026), who highlight that agricultural economic performance must be analyzed alongside resource use efficiency and the sustainability of agricultural systems.

The results obtained for Romania highlight the existence of a process of agricultural convergence and economic modernization, characterized by the simultaneous increase in the economic productivity of land and economic sustainability. These results are consistent with studies on the structural transformations of Romanian agriculture, which emphasize the role of farm modernization, investment, and increased capitalization in improving the economic performance of agriculture (Tudor and Alexandri, 2015).

The processes of agricultural intensification and economic performance growth must be linked to the efficient use of agricultural inputs and to agriculture's ability to generate sustainable long-term added value. The research results confirm this perspective and highlight the importance of a balanced approach to agricultural intensification within European agricultural policies (Varzaru, 2026).

The research results confirm the conclusions of recent literature regarding the complex and multidimensional nature of European agricultural sustainability (Liu, 2025; Sinisterra-Solis et al., 2024). The relationships identified between the economic intensification of inputs, the economic productivity of land, and economic sustainability highlight the fact that agricultural performance cannot be assessed solely by the level of agricultural production or economic productivity.

The negative correlations between economic intensification and economic sustainability confirm the conclusions drawn by Mergoni et al. (2024) and Alves et al. (2022), which highlight that agricultural intensification processes can have different effects on sustainability depending on the structure of agricultural systems and the efficiency of agricultural resource use. The results suggest that agricultural models characterized by very

high levels of economic intensification and agricultural input use do not necessarily exhibit higher levels of economic sustainability.

At the same time, the results obtained for Central and Eastern European countries, particularly Romania, Poland, and Bulgaria, highlight the existence of processes of agricultural convergence and economic modernization associated with simultaneous improvements in economic productivity and economic sustainability. These conclusions are consistent with recent literature on structural transformations and existing sustainability differences in European agriculture (Manta et al., 2024; Prigoreanu et al., 2025b).

The analysis highlights the importance of using derived indicators and comparative approaches to assess the economic sustainability of European agriculture. Recent literature emphasizes that assessing agricultural sustainability requires the simultaneous integration of the economic, social, and ecological dimensions of agriculture (Boggia et al., 2023; Xavier et al., 2025). In this context, the research contributes to the literature by highlighting the relationships between economic intensification, economic productivity, and economic sustainability in European agriculture.

An analysis of the economic productivity of agricultural labor reveals significant structural differences among European agricultural systems. Western European countries report high levels of gross value added

per agricultural worker, reflecting high levels of capitalization, mechanization, and economic efficiency in agriculture. In contrast, Eastern European countries, including Romania, continue to record low levels of economic productivity of agricultural labor, a phenomenon associated with the fragmentation of agricultural holdings and the high share of the labor force employed in agriculture (Ursu, 2024).

Limitations of the study. The study uses purely value-based indicators, which means that the results may reflect both structural changes in agricultural performance and the influence of fluctuations in agricultural prices and inflation during the period under review. This aspect is particularly relevant for the 2020–2025 period, characterized by significant increases in energy costs, agricultural input prices, and agri-food product prices. Under these conditions, some of the variations in the analyzed indicators may be associated with value changes driven by price trends and not exclusively with changes in the economic efficiency or productivity of agricultural systems. Nevertheless, the use of the same statistical sources and a uniform methodology for all analyzed countries allows for relevant relative comparisons between European agricultural systems. Future research could complement the analysis by using indicators expressed in constant prices and by incorporating physical and ecological indicators of agricultural performance.

CONCLUSIONS

The research findings highlight the fact that the economic intensification of agriculture contributes significantly to increasing the economic productivity of agricultural land, a finding confirmed by the strong positive correlation identified between the economic intensity of inputs and the economic productivity of land. Thus, the first working hypothesis of the study is validated for the European countries analyzed.

At the same time, the results show that increasing the economic intensity of inputs does not uniformly lead to improved economic sustainability in agriculture. The negative correlations between the economic intensity of inputs indicator and the economic sustainability indicator highlight the existence of significant structural differences among European agricultural systems, confirming the second working hypothesis of the study. The high values of the coefficients of variation calculated for the analyzed indicators highlight a high level of heterogeneity among European agricultural systems, both in terms of economic intensification and economic sustainability.

The research highlights the existence of distinct agricultural models across Europe. Agricultural systems characterized by very high levels of economic intensification exhibit high levels of economic land productivity, but with fewer benefits in terms of

economic sustainability. In contrast, some Eastern European countries undergoing a process of agricultural convergence continue to show simultaneous improvements in economic productivity and economic sustainability, against a backdrop of moderate intensification in the use of agricultural inputs.

The results support economic theories regarding the role of agricultural intensification in increasing productivity, but also highlight the fact that the relationship between intensification and economic sustainability depends on the structural characteristics of the agricultural systems analyzed. From this perspective, the research contributes to the literature by using indicators derived from economic accounts for agriculture and by analyzing the statistical relationships among the economic intensity of agricultural inputs, the economic productivity of land, and economic sustainability.

Future research directions may consider incorporating physical and ecological indicators to conduct a multidimensional assessment of the sustainability of European agriculture. Furthermore, expanding the analysis using econometric models and more detailed datasets could improve understanding of the relationships among agricultural intensification, economic efficiency, and the sustainability of European agricultural systems.

REFERENCES

- Alessandrini, M., Alblas, E., Batten, L., & Bothé, S. (2024). Smallholder farms in the sustainable food transition: A critical examination of the new Common Agricultural Policy. *Review of European, Comparative & International Environmental Law*, 33(1), 124-135. <https://doi.org/10.1111/reel.12539>
- Alves, J. M., Souza, F. N. D., Sieber, S., Vergara, F. E., & Bonatti, M. (2022). Assessment of land use relations and the sustainability of agricultural systems: Considering different views to foster social learning. *Journal of Land Use Science*, 17(1), 368-385. <https://doi.org/10.1080/1747423X.2022.2099592>
- Andrei, J. V., Sima, V., & Gheorghe, I. G. (2023). An overview of the European Union agricultural sectorial dynamics: A draft analysis from the Romanian perspective. *Economics of Agriculture*, 70(4), 1235-1251. <https://doi.org/10.59267/ekoPolj23041235V>
- Bilenko, Y. (2022). Labor productivity in agriculture, structural shifts, and economic growth in the Central and Eastern European countries. *Agricultural and Resource Economics*, 8(4), 5-32. <https://doi.org/10.51599/are.2022.08.04.01>
- Boggia, A., Fagioli, F. F., Paolotti, L., Ruiz, F., Cabello, J. M., & Rocchi, L. (2023). Using accounting dataset for agricultural sustainability assessment through a multi-criteria approach: An Italian case study. *International Transactions in Operational Research*, 30(4), 2071-2093. <https://doi.org/10.1111/itor.13141>
- Chatzitheodoridis, F., Spinthiropoulos, K., Loizou, E., Kalfas, D., Kalogiannidis, S., & Gortsilas, E. (2025). Rationale of government policies on agricultural productivity and sustainability: A European perspective. *Research on World Agricultural Economy*, 6(2), 605-628. <https://doi.org/10.36956/rwae.v6i2.1712>
- Chiarella, C., Meyfroidt, P., Abeygunawardane, D., & Conforti, P. (2023). Balancing the trade-offs between land productivity, labor productivity, and labor intensity. *Ambio*, 52, 1618-1634. <https://doi.org/10.1007/s13280-023-01887-4>
- Chollet, P., Enjolras, G., Pavez, I., & Saïssset, L. (2026). The sustainability performance of agricultural cooperatives: A systematic literature review. *Annals of Public and Cooperative Economics*, 97(2), 321-367. <https://doi.org/10.1111/apce.70013>
- Donovan, K. (2021). The equilibrium impact of agricultural risk on intermediate inputs and aggregate productivity. *Review of Economic Studies*, 88(5), 2275-2307. <https://doi.org/10.1093/restud/rdaa084>
- European Commission. (2020). *Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System*. https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf
- Eurostat. (2026). *Economic Accounts for Agriculture*. <https://ec.europa.eu/eurostat/data/database>
- Ewert, F., Rounsevell, M. D. A., Reginster, I., Metzger, M. J., & Leemans, R. (2005). Future scenarios of European agricultural land use I: Estimating changes in crop productivity. *Agriculture, Ecosystems & Environment*, 107(2-3), 101-116. <https://doi.org/10.1016/j.agee.2004.12.003>
- Feher, A., Gosa, V., Raicov, M., Harangus, D., & Condea, B. V. (2017). Convergence of Romanian and European Union agriculture: Evolution and prospective assessment. *Land Use Policy*, 67, 670-678. <https://doi.org/10.1016/j.landusepol.2017.06.016>
- Feher, A., Stanciu, S., Iancu, T., Adamov, T. C., Ciolac, R. M., Pascalau, R., Banes, A., Raicov, M., & Gosa, V. (2022). Design of the macroeconomic evolution of Romania's agriculture 2020-2040. *Land Use Policy*, 112, 105815. <https://doi.org/10.1016/j.landusepol.2021.105815>
- Food and Agriculture Organization (FAO). (2024). *The State of Food and Agriculture 2024: Value-driven transformation of agrifood systems*. Food and Agriculture Organization of the United Nations. <https://doi.org/10.4060/cd2616en>
- Hadelan, L., Zrilić, M., Rogelj M.J., Sušac M.Z. (2022). Enhancing the productivity of small farmers in Croatia through the agricultural fund for rural development. *Ekonomika poljoprivrede*, 9 (4), 1043-1059, <https://doi.org/10.5937/ekoPolj2204043H>
- Hansson, H., Sall, S., Abouhatab, A., Ahlgren, S., Berggren, Å., Hallström, E., Lundqvist, P., Persson, U. M., Rydhmer, L., Rööös, E., Tidåker, P., Winkvist, A., & Zhu, L. H. (2024). An indicator framework to guide food system sustainability transition: The case of Sweden. *Environmental and Sustainability Indicators*, 22, 100403. <https://doi.org/10.1016/j.indic.2024.100403>
- Hendricks, N. P., Smith, A., Villoria, N. B., & Stigler, M. (2023). The effects of agricultural policy on supply and productivity: Evidence from differential changes in distortions. *Agricultural Economics*, 54(1), 44-61. <https://doi.org/10.1111/agec.12741>
- Hua, T., Hu, X. P., Austrheim, G., Speed, J. D. M., Van Oort, B., & Cherubini, F. (2025). Reconciling crop production, climate action, and nature conservation in Europe by agricultural intensification and extensification. *Nature Communications*, 16(1), 10289. <https://doi.org/10.1038/s41467-025-65201-4>

- Ion, D. G., & Cretu, D. (2025). Agricultural productivity and land use efficiency in Romanian arable crops: A regional analysis of wheat and sunflowerseed (1990-2023). *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 25(3), 485-508. https://managementjournal.usamv.ro/pdf/vol.25_3/Art46.pdf
- Ionitescu, S. (2023). The role of agriculture in Romania's economy in the period 2013-2022. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 23(4), 407-418. https://managementjournal.usamv.ro/pdf/vol.23_4/Art39.pdf
- Janus, J., Ertunç, E., Muchová, Z., & Tomic, H. (2023). Impact of selected land fragmentation parameters and spatial rural settlement patterns on the competitiveness of agriculture: Examples of selected European and Asian countries. *Habitat International*, 140, 102911. <https://doi.org/10.1016/j.habitatint.2023.102911>
- Khan, Z., Badeeb, R. A., Ali, S., Bilan, Y., & Majewski, S. (2025). Land productivity and environmental sustainability for G7 economies: Does an inverted U-shaped curve exhibit green finance? *Land Degradation & Development*, 36(3), 706-723. <https://doi.org/10.1002/ldr.5251>
- Knoke, T., Gosling, E., Reith, E., Gerique, A., Pohle, P., Carrión, L. V., Moreno, W. S. O., Castro, L. M., Calvas, B., Hildebrandt, P., Döllner, M., Bastit, F., & Paul, C. (2022). Confronting sustainable intensification with uncertainty and extreme values on smallholder tropical farms. *Sustainability Science*, 17(5), 1977-1994. <https://doi.org/10.1007/s11625-022-01133-y>
- Kolodziejczak, W. (2020). Employment and gross value added in agriculture versus other sectors of the European Union economy. *Sustainability*, 12(14), 5518. <https://doi.org/10.3390/su12145518>
- Li, J., Cheong, T. S., Huang, W. Y., & Shum, W. Y. (2022). Examining the regional disparity of agricultural development: A distribution dynamics approach. *Sustainability*, 14(19). <https://doi.org/10.3390/su141912779>
- Liu, S. Y. (2025). Measuring agricultural sustainability: Revisiting Sustainable Development Goal Indicator 2.4.1 and its proxy. *Global Food Security*, 47, 100887. <https://doi.org/10.1016/j.gfs.2025.100887>
- Manta, A. G., Doran, N. M., Badircea, R. M., Badareu, G., Ghertescu, C., & Lapadat, C. V. M. (2024). Does the Common Agricultural Policy influence regional disparities and environmental sustainability in European Union countries? *Agriculture*, 14(12), 2242. <https://doi.org/10.3390/agriculture14122242>
- Martin-García, J., Gómez-Limón, J. A., & Granado-Díaz, R. (2026). Exploring the dynamics of farms' economic and environmental performance. *Structural Change and Economic Dynamics*, 78, 104-117. <https://doi.org/10.1016/j.strueco.2026.03.003>
- Mergoni, A., Dipierro, A. R., & Colamartino, C. (2024). European agricultural sector: The tortuous path across efficiency, sustainability, and environmental risk. *Socio-Economic Planning Sciences*, 92, 101848. <https://doi.org/10.1016/j.seps.2024.101848>
- Organisation for Economic Co-operation and Development (OECD). (2019). Innovation, Productivity and Sustainability in Food and Agriculture: Main Findings from Country Reviews and Policy Lessons. *OECD Food and Agricultural Reviews*, 3 October. OECD Publishing. <https://doi.org/10.1787/c9c4ec1d-en>
- Prigoreanu, I., Grigore-Sava, A., Avarvarei, S. C., Radu, G., Padurar, S. B., Gherasim, R. E., Chihulca, M., & Ignat, G. (2025a). Agricultural sustainability in the European Union: A review of concepts, policies and economic perspectives. *Frontiers in Agronomy*, 7, 1054321. <https://doi.org/10.3389/fagro.2025.1714297>
- Prigoreanu, I., Radu, G., Grigore-Sava, A., Costuleanu, C. L., Ungureanu, G., & Ignat, G. (2025b). Assessing the economic sustainability of the EU and Romanian farming sectors. *Sustainability*, 17(10), 4440. <https://doi.org/10.3390/su17104440>
- Radlinska, K. (2025). Changes in the structure of agriculture in Central and Eastern Europe in the light of the European Green Deal. *Sustainability*, 17(1), 104. <https://doi.org/10.3390/su17010104>
- Reidsma, P., Accatino, F., Appel, F., Gavrilescu, C., Krupin, V., Tasevska, G. M., Meuwissen, M. P. M., Peneva, M., Severini, S., Urquhart, J., Zawalinska, K., Zinnanti, C., & Paas, W. (2023). Alternative systems and strategies to improve future sustainability and resilience of farming systems across Europe: From adaptation to transformation. *Land Use Policy*, 134. <https://doi.org/10.1016/j.landusepol.2023.106881>
- Sinisterra-Solis, N. K., Sanjuán, N., Ribal, J., Estruch, V., Clemente, G., & Rozakis, S. (2024). Developing a composite indicator to assess agricultural sustainability: Influence of some critical choices. *Ecological Indicators*, 161, 1934. <https://doi.org/10.1016/j.ecolind.2024.111934>
- Tudor, M. M., & Alexandri, C. (2015). Structural changes in Romanian farm management and their impact on economic performance. *Procedia Economics and Finance*, 22, 747-754. [https://doi.org/10.1016/S2212-5671\(15\)00299-3](https://doi.org/10.1016/S2212-5671(15)00299-3)
- Universitatea Babeş Bolyai (UBB). (2016). *Corelații și regresii*. Universitatea Babeş Bolyai din Cluj Napoca. <https://phys.ubbcluj.ro/~dana.maniu/BIOSTAT/C6.pdf>

- Ursu, A. (2024). *Eficiența economică a sectorului agricol din România*. Editura Economică.
- Ursu, A., Sterie, M. C., & Petre, I. L. (2023). The contribution of the agricultural labour force in Romania to the sector's economic performance. *Sustainability*, 15(24), 16700. <https://doi.org/10.3390/su152416700>
- Varzaru, A. A. (2025). Agricultural price fluctuations and sectoral performance: A long-term structural analytical perspective across Europe. *Agriculture*, 16(1), 80. <https://doi.org/10.3390/agriculture16010080>
- Varzaru, A. A. (2026). The relationship between economic performance, sustainability, and agricultural productivity: Empirical evidence from the European Union. *Agriculture*, 16(2), 217. <https://doi.org/10.3390/agriculture16020217>
- Vidali, M. E. (2025). Measuring productivity and convergence across countries and sectors. *Bulletin of Economic Research*, 77(3), 368-384. <https://doi.org/10.1111/boer.12492>
- Wang, X. X., Dietrich, J. P., Lotze-Campen, H., Biewald, A., Stevanovic, M., Bodirsky, B. L., Brümmer, B., & Popp, A. (2020). Beyond land-use intensity: Assessing future global crop productivity growth under different socioeconomic pathways. *Technological Forecasting and Social Change*, 160, 120208. <https://doi.org/10.1016/j.techfore.2020.120208>
- Wimmer, S., & Finger, R. (2026). Productivity dispersion and persistence in European agriculture. *American Journal of Agricultural Economics*, 108(1), 204-231. <https://doi.org/10.1111/ajae.12529>
- Xavier, A., Fragoso, R., & Freitas, M. D. C. (2025). Building sustainability composite indicators using a multi-criteria approach. *European Journal of Operational Research*, 326(2), 326-342. <https://doi.org/10.1016/j.ejor.2025.04.024>
- Yang, X., Delgado-Baquerizo, M., Niu, Y. X., Christie, P., Chen, J., Hu, H. W., & Chen, Y. L. (2023). Optimizing cropping systems to close the gap between economic profitability and environmental health. *New Phytologist*, 240(6), 2498-2512. <https://doi.org/10.1111/nph.19310>