EXPLORING ENTREPRENEURIAL SKILLS FOR IMPROVING AGRICULTURAL PERFORMANCE USING COMPARATIVE SIMULATION-BASED STUDY

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Abstract: *This study investigates the correlation between skills and performance to improve agricultural entrepreneurial activities. This research has two primary objectives: first, to determine how entrepreneurial skills influence agricultural performance, and second, to develop informed predictions for the future of agricultural performance based on factors such as digital skills and the involvement of young entrepreneurs in agriculture. To determine the factors that influence agricultural performance, the authors performed regression analyses and comparisons at the level of several countries. The authors incorporated Euro barometer data into their research, conducting simulations and analyzing second-degree functions to anticipate EU citizens' interest in the future of young agricultural entrepreneurs and digital solutions in agriculture. Based on this analysis, it was determined that only one case had a significant effect, while seven had little impact. The findings suggest that young entrepreneurs will become increasingly vital in the agricultural industry within the next years. The insights garnered from this comprehensive study on the correlation between skills and performance in entrepreneurial activities within the agricultural sector pave the way for transformative advancements.*

Keywords: agriculture; performance; entrepreneurial skills; e-skills; competitiveness

J.E.L. Classification: J24, C30, Q12, Q15

Introduction

Throughout history, agriculture has been the dominant driving force of rural economies worldwide and represents the principal source of income, employment, and output for many regions (Gowdy & Krall, 2014). To achieve agricultural performance, it is necessary for agricultural entrepreneurs to benefit from data and advanced technologies correlated with an improvement of individual skills (Khan *et. al.*, 2021). According to Cheriert (Cheriet *et. al.*, 2020), agricultural entrepreneurship remains an emerging field, and developing entrepreneurial skills are a fundamental ingredient of endogenous economic growth and a prerequisite for sustainable local and regional development and social cohesion (Pauna *et. al.*, 2021). Researchers are conducting extensive investigations into the key qualities required for successful rural and farm entrepreneurship and the necessary skills to thrive in such ventures (McElwee *et. al.*, 2012). This growing interest in rural and farm entrepreneurship has sparked a desire to understand better what makes these types of businesses successful (Radu *et. al.*, 2021). Significant structural changes have occurred against the background

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of an economic strategy in the transformation that strongly favors European agriculture (European Commission, 2023). Research on entrepreneurial behavior in European agriculture shows that agricultural entrepreneurs have weaker entrepreneurial capabilities than other sectors (Pindado & Sanchez, 2017). However, much of the work on entrepreneurial skills has been linked to the European research project Entrepreneurial Skills of Farmers (European Commission, 2008). This project identified three essential entrepreneurial skills as “higher-order skills” such as "recognizing and realizing business opportunities, developing and evaluating a business strategy, and networking and using contacts". While professional and management skills may be essential for farmers, the three entrepreneurial skills mentioned are essential for creating and developing new business activities (Radu & Stefan, 2016). Entrepreneurial skills are qualities that are necessary to recognize business opportunities and put them into practice. Efficiency and economic performance in agriculture can be improved by optimizing work procedures (Giannakis & Bruggeman, 2015). This creates the time and space needed to manage the complex demands of a modern farming business using E-skills. In the agricultural context, E-skills include the ability to use and benefit from information and communication technologies (ICT) to improve agricultural activities' efficiency, productivity, and sustainability (Kale *et. al.*, 2016).

ICT development is essential for economic growth, innovation, and change in many sectors, but also in agriculture, being the major driver for finding new ways for agricultural development and farmers or entrepreneurs (Zhong *et. al.*, 2022). By developing a strong information platform and infrastructure, a wireless network for agriculture in different areas, and data sharing, the agriculture industry will know a new technical standard for agriculture development (FAO, 2018). According to Eurostat, the first three EU27 countries with the highest number of holdings from EU27 are Romania (3.422), Poland (1.410,7), and Italy (1.010,3). Of all registered holdings from EU27 (10.321,2) the three analyzed countries have several 5.843 holdings. Thus, making their share from the total registered at the EU27 level 56,61%, indicating that the three analyzed countries in this study have over half of the total EU27 holdings. In 2016, the utilized agricultural areas for the three analyzed countries were 8,4% for Poland, 7,3% for Romania, and 7.1% for Italy (European Commission, 2023).

This research examines the impact of entrepreneurial skills on agricultural performance in Italy, Poland, and Romania. The authors aim to determine whether possessing entrepreneurial skills can improve agricultural performance. The results are expected to demonstrate that entrepreneurial skills are essential for achieving high levels of agricultural performance. The paper includes sections on materials and methods, empirical study results, discussion of hypotheses, and conclusion with limitations, implications, and future directions.

Materials and Methods

Innovation and entrepreneurship must play a key role in agriculture, and attracting the most highly Innovation, entrepreneurship, and young talent are vital for agriculture. New strategies and perspectives are essential to revitalize abandoned areas. Entrepreneurial skills drive performance in agriculture, but more research is necessary. A bibliometric analysis will identify the link between entrepreneurial skills and agriculture.

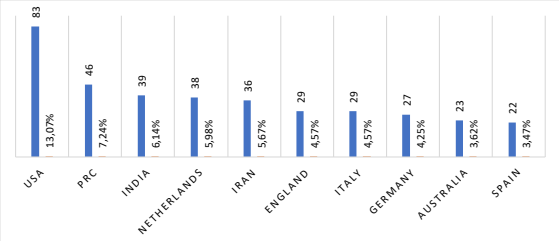

Figure 1. Top ten countries with publications on agriculture and entrepreneurship

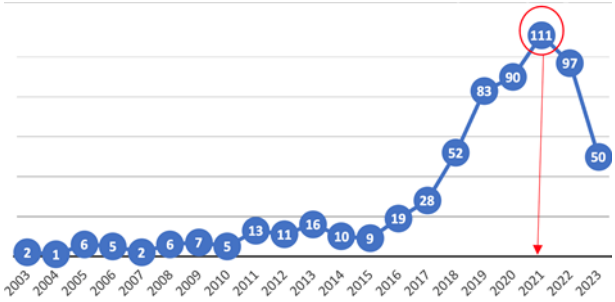

Figure 2. The evolution of publications with the topic of agriculture and entrepreneurship
Source: Authors analyses of WoS database

The main database of WoS was investigated for research related to "agriculture" and "entrepreneurship". The search criteria in the WoS platform were "agriculture and entrepreneurship" (Topic) and Article (Document Types) in Web of Science Core Collection (A&HCI , BKCI-SSH , BKCI-S , CCR-EXPANDED , ESCI , IC , CPCI-SSH , CPCI-S , SCI-EXPANDED , SSCI). The search has been carried out for the last twenty years. Following the research, after applying the filters, several 635 articles dealing with this topic were identified. Figure 1 shows that most published studies were carried out by authors from the United States of America, China, and India, comprising 168 articles or 26.45% of the total. Regarding European countries, most research is found in the Netherlands, England, and Italy. In contrast, other countries with a large size of agriculture register a reduced scientific production. The year 2021 marked a maximum in the research conducted in this domain, with 111 articles published on the WoS Platform (Figure 2). A steady increase has been observed from 2015 leading up to this point. The question that arises is - what has caused this sudden shift towards entrepreneurship in agriculture? The agricultural sector has been a crucial aspect of Europe's history, culture, and economy for centuries (Moysiadis *et al.*, 2021). With varying climates, terrains, and agricultural techniques, European nations have become key players in the worldwide food production industry. Table 1 reveals that out of the 635 articles analyzed, only 159 were cited for entrepreneurship topics. Of those 159, only 6 were from Italy, 2 from Poland, and none from Romania. This indicates a discrepancy between the practice and research in this field.

Table 1. Top 10 Citation Topics counted in WoS

Topic	Record Count	Topic	Record Count
Entrepreneurship	159	Tourism	16
Farmers	104	Academic Entrepreneurship	12
Urban Agriculture	39	CSR	12
Deforestation	21	Knowledge Management	11
Contract Farming	18	Sustainable Development	10

Source: Authors analyses of WoS database

The authors propose exploring new approaches and perspectives to renew the agricultural sector, with innovation, entrepreneurship, and education playing essential roles. Empirical research tested hypotheses connecting entrepreneurship and agriculture.

H1. There is a positive relationship between agriculture output and entrepreneurial E-skills. The development of E-skills in agriculture is necessary and qualified personnel can provide access to ICT opportunities for improved perspectives in various fields, such as education, ICT tools can be extremely beneficial in all activities, including preparing presentations for training, conducting surveys, analyzing research data, reporting, coordination, provision of advisory services to farmers and facilitation of technology transfer (Kale *et. al.*, 2016).

H2. There is a positive relationship between employment in agriculture and spending on education. Education plays a primary role in agriculture, especially since this sector is significant in Italy, Poland, and Romania while closely linked to their culture and traditions. The European Union's rural development policy aims to achieve this mission by providing financial support to educational institutions and conducting extensive research in agriculture (Pe'er *et. al.*, 2019).

H3. There is a positive influence between utilized agricultural areas and the skills of labor freedom. The idea behind labor freedom is to promote land reform and development policy, intending to improve wages and job opportunities for rural workers during times of economic transformation. This approach allows for the allocation of resources towards greater development and efficiency, requiring a series of structural, institutional, and economic changes to enhance agricultural efficiency. The flexibility in employment is also a concern, as firms can hire or reduce labor based on market needs or business strategies without constraints from trade unions or the state (Song *et. al.*, 2019).

H4. A positive relationship exists between the rural population and innovation skills. Using digitalization, businesses must embrace new methods and leverage innovative technologies to stay competitive (Zhan *et. al.*, 2020). Like other sectors, the agricultural sector sees innovation to expand business opportunities. However, it is crucial to consider the impact of innovation on state institutions and society. Developing new technologies can significantly affect different participants in the business system (Di Vaio *et. al.*, 2020).

H5. Skills of business freedom positively influence the GDP from agriculture. Many authors confirm the importance of agriculture in the economy. The ability of agricultural entrepreneurs to work in a free and flexible environment is essential for stimulating economic growth. Freedom of choice in technologies, resource management practices, and business strategies contributes to the efficiency and competitiveness of agricultural businesses (Beckman *et. al.*, 2021). The same research tries to answer questions by which to recover the GDP value from the improvement of business skills.

H6. The costs of starting a business positively impact the number of agricultural holdings. The EU agricultural sector has become increasingly concentrated in fewer but larger farms, often owned by corporations. The number of farms is decreasing, and larger farms acquire the remaining land for agricultural production (Newell *et. al.*, 2019). This has resulted in a dichotomy between small-scale, family-run, labor-intensive, diversified farms and more extensive, specialized corporate farms that rely on machinery and economies of scale. Despite the dominance of industrialized agriculture, smallholder farms still play a crucial role in maintaining genetic diversity in the food supply.

H7. The green skills positively influence the agricultural value added. Using green skills in agriculture can help the sector by creating and maintaining job opportunities, developing resistance to environmental issues like climate change and water scarcity, and increasing competitiveness in the regional and global markets (Herrero *et. al.*, 2017). Green skills for climate-smart agriculture involve reducing energy and water consumption, mitigating emissions and waste, preserving biodiversity and ecosystems, and enhancing climate resilience. These skills are essential for promoting sustainable food production, responsible land use, and biodiversity conservation (Sharma *et. al.*, 2019).

H8. Agricultural training time positively influences the number of agricultural lands. One of the most visible results of urbanization is the loss of natural agricultural land due to land taken for urban development. This is especially true for vegetated areas, which are often the first to be converted for new urbanization and affect many countries (Cobbinah & Aboagye, 2017). Analyzing this trend in most countries can determine an ensemble picture of all the factors that could stop the trend of land use for purposes other than agriculture.

H9. The number of young entrepreneurs in agriculture will be a positive trend for the next three years. The global agriculture industry deserves greater recognition, yet many young people opt for more glamorous professions, posing a challenge for entrepreneurs (Girdziute *et. al.*, 2022). Young entrepreneurs are leaving rural areas for urban centers, which puts the agriculture industry at risk. Sustainable farming practices must be adopted, better working conditions should be offered, and more attractive income opportunities must be provided to retain young farmers. The lack of such

practices and pressure from older farmers for succession further compound the problem, leading to outmigration and a shortage of young talent in agriculture (Borda *et. al.*, 2023).

H10. The digital solutions will show a positive trend for agriculture between 2024-2027 for the three analyzed EU countries. The digitization of any process was a positive trend, and this opportunity also showed an increasing trend for agriculture and its young generation in seizing digital technologies benefits to apply in the agriculture industry. Digitization, big data, and artificial intelligence brought many advantages to the agricultural industry for farms, entrepreneurs, and consumers, such as essential management transformations and improvement for production processes and simulations of the business behavior of agricultural holdings (Ayamga *et. al.*, 2023).

Two stages were applied in the framework of the empirical research. First, an investigation was conducted into the correlation between essential skills inherent in agricultural entrepreneurs, encompassing farmers and managers, and their corresponding performance within the agricultural sector. Correlation analysis was used to succinctly describe the strength and magnitude of the relationship between the identified variables. In contrast, regression analysis was used for prediction, optimization, and improved explanation of the numerical responses between these variables. R-square and MS Excel statistical tools were used for the data analysis process. The data for this analysis was obtained from Eurostat and theglobaleconomy.com, covering the period 2017-2021. The results of this analytical effort are anticipated to provide valuable insights into the determinants contributing to agricultural entrepreneurs' prosperity. In the second stage, a decision was made to improve understanding of future agricultural performance by examining a projected trend using a parabolic equation framework. A quadratic function was used to perform this analysis, and a parabola was graphed to facilitate accurate predictions of future trends.

Results

The research was carried out through the lens of the ten defining hypotheses for which the authors identified the clearest validation option. The collected data referred to the three European countries mentioned in the study: Italy, Poland, and Romania.

1. E-skills in agriculture can benefit entrepreneurs, consumers, the environment, and society. It provides valuable data on crops, soil, farming techniques, and opportunities to increase productivity. Additionally, it enables better e-promotion, e-supply, and e-collaboration

Table 2 shows the results obtained using the Excel data analysis and regression function. The relationship between agricultural production and e-skills was measured using the Eurostat database. In Romania, E-skills have a positive but below-average influence on AO, accounting for 35.77%. Italy boasts a strong influence of 72.67%, while Poland's influence is exceptionally high at 91.81%. Interestingly, despite having lower e-skill levels, Italy outperforms Romania in terms of the output value of agriculture. This relationship is much stronger, as demonstrated in Table 2. E-skills positively and directly impact agriculture output in all three countries analyzed.

Table 2. The relationship between the output of agriculture and E-skills

Year	AO_RO (bil. EUR)	E-skills_RO (% of the population)	AO_PL (bil. EUR)	E-skills_PL (% of the population)	AO_IT (bil. EUR)	E-skills_IT (% of the pop.)
2017	17,180	63.75	24,761	75.99	56,085	63.08
2018	18,554	70.68	24,483	77.54	58,632	74.39
2019	18,964	73.66	25,912	80.44	58,241	67.85
2020	16,824	78.46	26,406	83.18	57,833	70.48
2021	21,107	83.59	27,920	85.37	61,192	74.86
R Square	x	0.3577	x	0.9186	x	0.7267

Notes: AO – Agricultural Output - the total output of goods produced and sold by the agricultural sector during the year valued at producer prices; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

2. The relation between employment in agriculture and education spending

Employment in agriculture includes working-age persons who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not due to temporary absence from a job, or to working-time arrangement. The agriculture sector consists of activities in agriculture, hunting, forestry, and fishing, following division 1 (ISIC 2) or categories A-B (ISIC 3) or category A (ISIC 4).

Table 3. The relationship between employment and spending on education.

Year	AE_RO (% of total employees)	SEI_RO (% of education)	AE_PL (% of total employees)	SEI_PL (% of educ.)	AE_IT (% of total employees)	SEI_IT (% of educ.)
2017	22.78	3.10	10.22	4.56	3.78	4.04
2018	22.31	3.34	9.62	4.62	3.76	4.26
2019	21.24	3.58	9.15	4.67	3.89	4.10
2020	20.51	3.69	9.59	5.19	3.98	4.27
2021	18.61	3.80	8.40	5.30	4.05	4.40
R Square		0.8503	x	0.4467	x	0.4414

Notes: AE – Agriculture Employees; SE – Spending for Education Index; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

In Table 3, the results show that employment in agriculture is the highest in Romania (18.61% of all employees), compared to Poland, which is 8.4%, and Italy, which is 4.05%. The education spending of the three countries is more than 3%, with Poland having the highest percentage at 5.3%. Romania has the highest R squared value at 85.03%, indicating that the change in the number of employees in agriculture can explain 85.03% of the change in education spending. Poland and Italy have average R squared values of 44.67% and 44.14%, respectively. There is a strong relationship between employment in agriculture (%) and fully supported spending on education in all these countries.

3. The relation between utilized agricultural area and labor freedom skills

The results presented in Table 4 show for 2021, Poland and Romania have the highest labor freedom scores, with 66 and 64 points, respectively. On the other hand, Italy received the lowest score of 51 points. Of the three countries under analysis, Romania has the highest % of agricultural land at 57% (Table 5). However, its utilized area for agriculture (UAA) falls behind Italy and Poland. As a result, Romania's R squared value is the lowest, standing at 19.33%, while Poland leads with the highest value of 76.89%, and Italy follows closely with 47.57%. Nevertheless, all three values are affirmative and reinforce the correlation between utilized agricultural area and labor freedom skills.

Table 4. The relation between utilized agricultural area and labor freedom skills

Year	UAA_RO (1,000 ha)	LFI_RO (0-100 pt.)	UAA_PL (1,000 ha)	LFI_PL (0-100 pt.)	UAA_IT (1,000 ha)	LFI_IT (0-100 pt.)
2017	13,521	63	14,406	62	12,843	53
2018	13,378	63	14,498	62	13,006	51
2019	13,414	65	14,540	64	12,910	51
2020	13,826	63	14,550	62	13,150	51
2021	13,079	64	14,755	66	13,122	51

R Square	x	0.1933	x	0.7648	x	0.4757

Notes: UAA – Utilized Agricultural Area; LFI – Labor Freedom Index; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

4. The relation between the rural population and innovation skills

Some studies indicate a positive trend for rural development due to innovation skills through the use of renewable energy, bioenergy and smart agriculture, and studies that align with the policies of the European Union regarding rural development (Koppelmaki *et. al., 2021).* In Table 5, the results present the relationship between the rural population and innovation skills. The rural population registered in 2021 the high values for Romania (45.67%), Poland (39.92%), and Italy (28.65%). The innovation index is close for Romania (35.6) and Poland (39.9) but is higher for Italy (45.7). This is the reason for a high R squared for Italy (88.01%), for Romania (56.92%) due to the increased percentage of rural population, and for Poland only 10.18%.

Table 5. The relationship between the rural population and innovation skills

Year	Rural_RO (% of the pop.)	ISI_RO (0-100 pt.)	Rural_PL (% of the pop.)	ISI_PL (0-100 pt.)	Rural_IT (% of the pop.)	ISI_IT (0-100 pt.)
2017	44.06	39.20	39.90	42,00	29.86	47,00
2018	46,00	37.60	39.94	41.70	29.56	46.30
2019	45.92	36.80	39.96	41.30	29.26	46.30
2020	45.81	36,00	39.96	40,00	28.96	45.70
2021	45.67	35.60	39.92	39.90	28.65	45.70
R Square		0.5692	x	0.1018	x	0.8801

Notes: Rural – Rural Population; ISI – Innovation Skills Index; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

5. The relation between GDP from agriculture and business freedom skills

Based on data from the Global Economy, the business freedom index average across 175 countries in 2022 was 60 points (TheGlobalEconomy, 2023). The highest value was registered in Norway (91 points), while North Korea ranked the lowest with only 5 points. In Table 6, all three countries examined are over the average, with the highest value registered for Italy. The values for R squared for the three analyzed countries are positive and strong for Romania (72.46% and Poland 44.02%). The results for Italy are very weak (3.33%), which leads to the partial validation of the link between the competencies of business freedom and the GDP in agriculture.

Table 6. The relationship between GDP from agriculture and business freedom

Year	GDPA_RO (% of GDP)	BFI_RO (0-100 pt.)	GDPA_PL (% of GDP)	BFI_PL (0-100 pt.)	GDPA_IT (% of GDP)	BFI_IT (0-100 pt.)
2017	4.44	66	3.01	68	1.97	70
2018	4.56	65	2.41	67	1.95	70
2019	4.42	63	2.37	65	1.91	72
2020	4.18	59	2.57	63	2.01	70
2021	4.35	60	2.22	62	1.93	68
R Square		0.7246	x	0.4402	x	0.0337

Notes: GDPA – Gross Domestic Product of Agriculture; BFI – Business Freedom Index; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

6. The relation between the number of agricultural holdings and the cost of new business. Table 7 shows the results for the cost of starting an agriculture business. The lowest cost value is in

Romania and can be an advantage for open businesses in this country. The values were higher for Poland (11,6%) and Italy (13.8%).

All the obtained R squared is over 50%, showing a strong influence of the costs to start a business on agricultural holdings. These holdings are open in Romania three times more than in the other two analyzed countries. Even though there are these differences, the research hypothesis about the cost to start a business has an essential impact on the number of agricultural holdings can be validated.

Table 7. The relation between the number of agricultural holdings and the costs of new business

Year	AH_RO (thousand)	CBI_RO (% of per capita GNI)	AH_PL (thousand)	CBI_PL (% of per capita GNI)	AH_IT (thousand)	CBI_IT (% of per capita GNI)
2017	4,256	0.40	2,476	12.00	1,729	14.11
2018	3,931	0.40	2,391	11.80	1,679	14.11
2019	3,859	0.30	1,507	11.60	1,621	13.80
2020	3,629	0.30	1,429	11.60	1,010	13.80
2021	3,600	0.30	1,400	11.60	1,000	13.80
R Square		0.6707	x	0.8772	x	0.5349

Notes: AH – Agricultural Holdings; CBI – Cost of starting a Business Index; GNI - Gross National Income; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

7. The relation between agriculture value added and green skills. The relationship between agriculture value added and green skills is important to sustainable development and environmental stewardship within the agricultural sector. Agriculture value added refers to the increase in the value of agricultural products at each production stage, from primary production to final consumption. Table 8 shows the consolidated results for the three countries under analysis. Poland and Italy maintained the same trend between 2017 and 2021. Only Romania knows an increasing trend from 9.33 (2017) to 12.36 (2021).

According to the values obtained for R squared, Romania obtained a value close to the average. The other two countries obtained poor values of 14.88% for Italy and 29.22% for Poland. Therefore, it cannot be concluded that it is generally accepted that green skills influence the added value of agriculture.

Table 8. The relation between agriculture value added and green skills

Year	AVA_RO (bil. USD)	GSI_RO (no.)	AVA_PL (bil. USD)	GSI_PL (no.)	AVA_IT (bil. USD)	GSI_IT (no.)
2017	9.33	7,908	15.79	20,276	38.70	66,788
2018	11.11	8,518	14.22	19,224	40.70	69,335
2019	11.10	9,277	14.12	18,655	38.36	70,561
2020	10.50	9,647	15.40	18,598	38.10	71,590
2021	12.36	1,156	15.11	19,986	40.67	75,874
R Square		0.4397	x	0.2922	x	0.1488

Notes: AVA – Agriculture Value Added; GSI – Green Skills Index; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

8. The relation between the agricultural land and the time for agricultural training

Agricultural land and its productivity face numerous threats but enhancing training and skills in agriculture is crucial. This can result in innovative methods to boost production, explore novel applications for agri-food systems, and foster regenerative agricultural practices (Bless *et. al.*, 2023).

In Table 9, it can be seen that only 5.06% of the agricultural land is influenced by training in agriculture in Romania and 9.15% in Poland. The small size of the results determines a low significance. Only in the situation of Italy can it be concluded that the agricultural preparation time influences the surface of the agricultural land (54.03%).

Table 9. The number of training hours in agriculture and agricultural land

Year	AL_RO (sq. km)	TA_RO (no. of hours)	AL_PL (sq. km)	TA_PL (no. of hours)	AL_IT (sq. km)	TA_IT (no. of hours)
2017	133,780	13,306,130	144,620	14,447,290	128,266	12,856,050
2018	134,140	13,306,130	145,120	14,474,290	124,050	12,856,050
2019	138,260	13,055,850	145,230	14,409,870	131,210	12,098,890
2020	135,910	11,016,480	144,610	14,363,590	129,990	12,598,160
2021	135,910	12,762,830	144,610	14,749,240	129,990	12,041,230
R Square		0.0506		0.0915		0.5403

Notes: AL – Agricultural Land; TA – Training hours in Agriculture; RO – Romania; PL – Poland; IT- Italy.

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

9. Forecasting analyse for the role of young agricultural entrepreneurs.

The Eurobarometer surveys carried out in 2017, 2020, and 2022 indicate the priorities of the CAP for encouraging young entrepreneurs in agriculture and developing digital solutions for agriculture. The analysis of the data for the three countries under study leads us to draw a parable to predict the trends in the period 2024-2027.*The parameters will be calculated as:*

$$f(2017) = a \times 2017^2 + b \times 2017 + c \quad (1)$$
$$f(2020) = a \times 2020^2 + b \times 2020 + c$$
$$f(2022) = a \times 2022^2 + b \times 2022 + c$$

QA 7.3. procedure was used to evaluate the answers for the three analyzed countries and for the three analyzed periods (2017, 2020 and 2022). Thus, a parabolic equation was created in the form of a matrix. To calculate the determinant of the matrix A, the triangle rule is used. As det A≠0, a system with a unique solution results and Cramer's formulas were used.

$$Da = \begin{matrix} 2017^2 & 2017 & 1 \\ 2017^2 & 2020 & 1 \\ 2022^2 & 2022 & 1 \end{matrix} \times \begin{matrix} a \\ b \\ c \end{matrix} = \begin{matrix} 0.89 \\ 0.91 \\ 0.94 \end{matrix} \quad (2)$$

= -0.05

with D=-30 result a=0,0017

with $Db = \begin{matrix} 2017^2 & 0.89 & 1 \\ 2017^2 & 0.91 & 1 \\ 2022^2 & 0.94 & 1 \end{matrix}$ = 36,72 (3)

D=-30 result b=-6.7216

$Dc = \begin{matrix} 2017^2 & 2017 & 0.89 \\ 2020^2 & 2020 & 0.91 \\ 2022^2 & 2022 & 0.94 \end{matrix}$ = (4)

-203.340,30

with D=-30 result c=6,778.01

Using these calculations in Table 10, the results were determined for each country included in the study. The maximum value has been reached in the period. Italy and Poland can integrate young entrepreneurs in agriculture. Romania has a slightly reduced CAP for young entrepreneurs, but there is positive growth for all three countries.

Table 10. Forecast data regarding young entrepreneurs.

Country	Registered data (%)			Forecasted data (%)			
	2017	2020	2022	2024	2025	2026	2027
Italy	0.89	0.91	0.94	0.9736	0.9969	1.02	1.05

						(limited to 1)	(limited to 1)
Poland	0.89	0.89	0.92	0.944	0.974	1.01 (limited to 1)	1.05 (limited to 1)
Romania	0.86	0.85	0.87	0.8881	0.9114	0.9401	0.9741

Source: Author's results

10. Forecasting analysis for developing digital solutions for agriculture.

Eurobarometer from 2017, 2020, and 2022, for QA 7.1. were used to extract data for the three analyzed countries. Using the quadratic equation, the same calculations are used to determine the forecast value for the next analyzed period. Table 11 indicates a positive trend of capitalizing on digital solutions for Italy and Poland. Romania is expected to have a reduction in the trend regarding the use of digital solutions in agriculture (from 0.82 in 2020 to 0.61 in 2027). Romania is expected to have a reduced trend for digital agri-solutions due to a lack of trust in CAP policies, reduced interest in new technologies, and an aging farming population. Meanwhile, Italy and Poland are expected to have an increasing trend for digital solutions in agriculture, with Italy reaching its maximum value in 2025 and Poland in 2028.

Table 11. Forecast data for developing digital solutions for agriculture

Country	**Registered data (%)**			**Forecasted data (%)**			
	2017	**2020**	**2022**	**2024**	**2025**	**2026**	**2027**
Italy	0.84	0.88	0.93	0.9618	0.9985	1.039 (limited to 1)	1.085 (limited to 1)
Poland	0.85	0.87	0.89	0.9021	0.9154	0.9301	0.9461
Romania	0.79	0.82	0.79	0.76	0.72	0.67	0.61

Source: Author's results

Discussion and Conclusion

The impact of e-skills on OA proved beneficial across all three examined countries. Poland saw a 91.86% increase, followed by Italy at 72.67% and Romania at 35.77%. Several studies have shown that incorporating information systems and e-skills into agriculture can improve performance and output (Neethirajan, 2023). As a result, the research hypothesis that a positive relationship exists between entrepreneurial e-skills and the output of agriculture (H1) has been fully supported. Education is crucial in agriculture, especially in the three countries analyzed. These nations have rich traditions, vast rural areas, and agricultural knowledge. Policies supporting research create new job opportunities. Educating young people in agriculture can inspire them to remain in the industry. Investment in education and skills has a direct correlation with agriculture employment rates. This supports H2, but to achieve a higher R-squared value for Poland and Italy, there needs to be an increase in agricultural employees. This would allow the younger generation to utilize new technologies while receiving EU support for better information, incomes, and agricultural policies. Regarding the results for H3, Romania showed a positive trend in R squared values at 19.33%, while Poland had a much higher rate at 76.89%, and Italy's rate was at 47.57%. Agriculture labor is a flexible, casual, heavy, and seasonal field (Song *et. al.*, 2020). Urbanized agricultural regions were developed to avoid the perception of entrapment for employees working long distances from the city, such as Brazil (Chase, 1999) and Philippines (Jack *et. al.*, 2022). These regions have implemented agroecological work and organizational practices that offer alternative and future-oriented ways of utilizing agricultural areas efficiently. Therefore, hypothesis H3, which relates to the utilized agricultural area and the skills of labor freedom, has been completely fulfilled.

To confirm H4, it may be helpful to refer to the supplementary information provided in Table 12. According to the statistics, Romania's rural areas account for 85.2% of its total territory, with agricultural land comprising 57%. Additionally, the agricultural sector contributes 4.35% to the

Romanian economy, making it one of the highest proportions in Europe. With a population of 19 million, almost 19% of the country's workforce is employed in agriculture. It is observed that the rural population registered high values for Romania (45.67%), for Poland (39.92%) and for Italy (28.65%). The innovation index is close for Romania (35.6) and for Poland (39.9), but is higher for Italy (45.7), this being the reason for a high R squared for Italy (88.01%), for Romania (56.92) due to the increased percent of rural population and for Poland only 10.18%. Innovation technologies ensure performance, development, and growth, especially in agriculture, where technologies and innovation are perceived as business opportunities, creating new products and access to new markets.

Table 12. Statistics data for agriculture

Indicator	RO	PL	IT
Population (persons)	19,328,838	37,958,138	59,641,488
Area (square meters)	238,398	311,928	302,073
Rural territory (% from the country)	85.2%	80.8%	61.3%
Agricultural land	57%	46%	43%
The share of agriculture in national economy	4.35%	2.22%	2%
Employees in agriculture (%)	18,61%	8.4%	4.05%

Source: Author's results using data retrieved from Eurostat and theglobaleconomy.com

Table 13. The situation of the validation of the research hypotheses

Hypotheses	RO	PL	IT	Status	Hypotheses	RO	PL	IT	Status
H1	X	X	X	Totally fulfilled	H6	X	X	X	Totally fulfilled
H2	X	X	X	Totally fulfilled	H7	X	-	-	Partially fulfilled
H3	X	X	X	Totally fulfilled	H8	-	-	X	Partially fulfilled
H4	X	-	X	Partially fulfilled	H9	X	X	X	Totally fulfilled
H5	X	X	-	Partially fulfilled	H10	-	X	X	Partially fulfilled

Source: Author's results

In these results, electronic skills, education skills, work freedom skills and the skills to start a business are very important factors with a strong influence on the performance of agriculture. Innovation skills and business freedom are also very important, but Poland and Italy must improve them to achieve agricultural performance. Ecological skills and agricultural training have a negligible influence and suffer in Poland and Italy, respectively, in Poland and Romania. So, to get the agricultural performance, a more careful analysis based on simulation and modeling could improve the performance in the agricultural industry. Plans were provided to improve these detected problems to increase the performance of agricultural entrepreneurs, for government, and for society. This study proposes flexible and secure job opportunities for those in agriculture, which can boost productivity and performance in rural areas. The research identifies the pivotal role of entrepreneurial skills, particularly those related to digital proficiency, and the involvement of young entrepreneurs. The study offers a nuanced understanding of current dynamics and lays the foundation for informed predictions. These predictions, grounded in meticulous analyses and simulations, foretell a future in which the contribution of young entrepreneurs will be indispensable in steering the agricultural industry toward enhanced performance and sustainable growth over the next three to four years. As a crucial roadmap for policymakers, stakeholders, and industry leaders, this research serves to strategically navigate the evolving landscape of agriculture. By fostering innovation and resilience,

policymakers can achieve sustainable management practices, cultivate the right mindset and behaviors, and establish a culture of innovation.

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