Challenges to Sustainable and Responsible Management of Agricultural Enterprises: Financing Specifics

ČEREŠ MATEJ, KAPSDORFEROVÁ ZUZANA, ČERYOVÁ DOMINIKA*,
LADVENICOVÁ JANA, ŠVIKRUHOVÁ PETRONELA
Institute of Economics and Management
Slovak University of Agriculture in Nitra
Trieda Andreja Hlinku 2, 949 76 Nitra
SLOVAK REPUBLIC

**Corresponding Author*

Abstract: The agricultural sector is undergoing a profound structural transformation driven by global challenges and socio-economic and environmental changes. The growing need for adaptation and innovation among agricultural enterprises is reflected in increased strategic investment activities aimed at improving sustainability, resilience, and productivity. Empirical evidence shows a clear prioritisation of investments in technological innovation as a key driver of modernisation and competitiveness. In contrast, responses to other global challenges, including geopolitical instability, socio-demographic shifts, economic fluctuations, and environmental pressures, remain fragmented. The availability and structure of financial resources, such as European Union funds, national subsidies, and commercial financing, significantly influence investment behaviour and priorities. Quantitative analyses confirm statistically significant relationships between investment scale, sources, timing, and the types of global challenges addressed. These findings highlight the need for targeted policy instruments and integrated innovation ecosystems to strengthen the adaptive capacity and long-term sustainability of agricultural enterprises.

Key-Words: - agricultural enterprises, agricultural policies, global challenges and trends, agricultural innovation, investment sources, agri-food system transformation

Received: June 8, 2025. Revised: September 19, 2025. Accepted: October 15, 2025. Published: April 30, 2026.

1 Introduction

Agriculture plays a key role due to its multifaceted impact on various aspects of society, [1]. Increasing emphasis is being placed on the development of modern and specialised agriculture, based on innovation, [2]. The transformation of traditional agriculture into advanced modern agriculture appears to be an effective strategy for supporting its development, [3].

The historical development of European agriculture has been a complex process influenced by various political, economic, technological, and environmental factors, [4]. The conditions in which farm managers perform their functions have changed significantly over the last century, as the sector has faced many challenges, [5]. The interest of the agricultural sector in adapting to the challenges and trends within the constantly changing conditions of the 21st century is confirmed by research data on the increasing demand for advisory services, [6].

The Common Agricultural Policy (CAP) is a key framework that sets standards for future agricultural sector policies to reduce regional disparities and improve overall agricultural performance within the European Union (EU), [7]. The level of support allocated to farmers from the overall EU budget depends on several variables, [8], and the impact of CAP direct payments on agricultural incomes in EU Member States underlines the importance of these payments also in shaping the economic performance of agricultural activities, [9]. The CAP is thus also a tool for shaping the economic resources and efficiency of different types of agricultural production within the EU, [10].

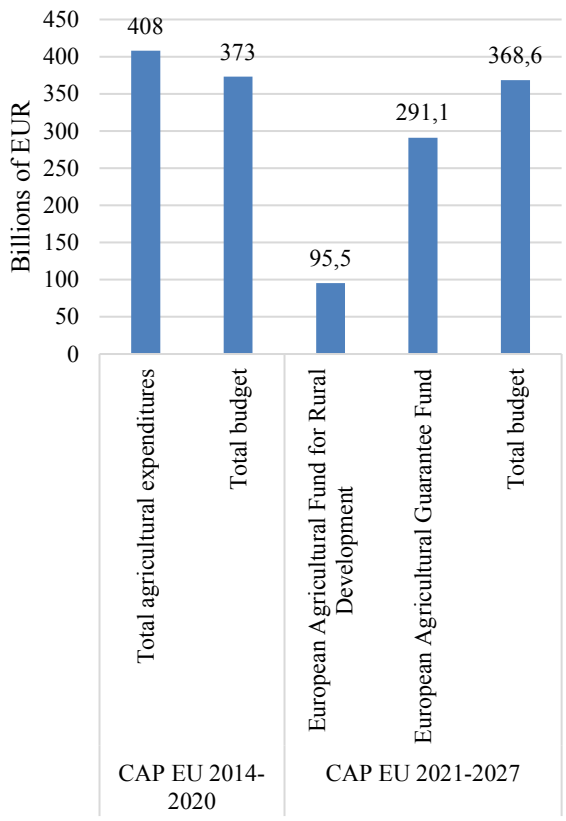

Fig. 1: Support for farmers from the total EU budget under the CAP in the periods 2014-2020 and 2021-2027 in billion EUR
Source: created by the authors according to European Commission, [11]

The EU´s Multiannual Financial Framework (MFF) for 2014-2020 set the overall budget for the CAP at EUR 373.17 billion in 2011 prices, i.e., 38.9% of the total commitment appropriations for the EU-28. The MFF for agriculture was amended in 2015, following transfers between the two pillars of the CAP decided by the Member States. Agricultural expenditure finally reached a total of EUR 408.313 billion for the period 2014-2020, [12]. The CAP for 2021-2027 is based on the key reformed objectives, [13], and the MFF allocated EUR 1.21 trillion, with an additional EUR 808 billion from the Next Generation EU (NGEU) instrument), [14], (Figure 1).

The agri-food system plays an important role in achieving sustainable development, food security, and environmental protection, [15]. Currently, there is 0.21 ha of arable land per person on the planet. However, this is likely to decrease to only 0.15 ha by 2050, and the current world population will increase to an average of 9.7 billion people, [16]. However, the CAP is still not able to reflect effectively enough to changing conditions, challenges, and trends in relation to environmental and socio-economic challenges. Appropriate and effective CAP proposals are lacking, as well as the setting of priorities and the necessary political will to improve them, [17]. The challenges for agriculture and food production concerning more efficient and ecological ways of growing and processing raw materials will increase significantly. Currently, the challenges and trends of sustainable and resilient agriculture can be structurally defined through the PESTLE analysis method from a geopolitical, economic, social, technological, and environmental perspective, [18]

Given the changing global conditions in the 21st century, it is possible to define 15 trends for agricultural enterprises from different areas that individual entities must face: 1. population growth, urbanisation, and ageing; 2. global economic growth, investment, and trade; 3. increasing competition for natural resources; 4. climate change; 5. agricultural productivity and innovation; 6. transboundary pests and diseases; 7. conflicts, crises, and natural disasters; 8. poverty, inequality, and food security; 9. nutrition and population health; 10. structural changes and employment; 11. migration and agriculture; 12. change in the agri-food system; 13. food losses and food waste; 14. management of food security and nutrition; 15. financing for development, [19]

Looking to the future, the main question is whether today's agri-food system can meet the needs of global demand with the current growth of the human population, i.e., whether it can achieve the required volume of production with increasing pressure on land, water resources, and the intensifying impact of climate change, [20]. To achieve efficient, sustainable, and inclusive production, agrifood businesses must face several challenges, which are: 1. sustainably increasing agricultural productivity to meet growing demand; 2. ensuring a sustainable natural resource base; 3. addressing climate change and intensifying natural hazards; 4. eradicating extreme poverty and reducing inequality; 5. ending hunger and malnutrition in all its forms; 6. innovating the agri-food system towards efficiency, inclusion, and resilience; 7. increasing income in rural areas and addressing the causes of migration; 8. building resilience to protracted crises, disasters, and conflicts; 9. preventing transboundary threats to the agri-food system; 10. addressing the need for coherent and effective national and international governance, [21].

2 Problem Formulation

The subject of the research was large Slovak agricultural enterprises with an area of cultivated

land of more than 100 hectares, focused on crop or combined production. The mentioned enterprises formed a sample of respondents for the research, in which 341 enterprises out of a total of 2490 registered in the country were involved through a questionnaire survey. The questionnaire was designed as a combination of specific and thematically relevant open and closed questions, including dichotomous and polytomous forms. The identified key global challenges and trends were summarised for the needs of the research into 5 summary categories according to their character: geopolitical challenges and trends, socio-demographic challenges and trends, economic challenges and trends, technological challenges and trends, and environmental challenges and trends. The individual sources through which the selected enterprises invested in global challenges and trends were also summarized into 5 summary categories: European funds and programmes (Rural Development Programme of the Slovak republic, CAP 2021 – 2027, Horizon Europe, European Territorial Cooperation); national subsidies and support (Ministry of Agriculture and Rural Development of the Slovak Republic, Slovak Guarantee and Development Bank, Support and Guarantee Agricultural and Forestry Fund); bank loans and commercial financing (loans, leasing and installment financing); crowdfunding and alternative sources (crowdfunding platforms, investment partners and business angels); cooperation with research institutions and grants (universities, research centers, Slovak Innovation and Energy Agency). The period monitored in the research was limited to 5 years due to European and national project calls: 2020, 2021, 2022, 2023, and 2024.

2.1 Hypothesis Formulation

Given the fact that, according to FAO, the volume of funds invested by large agricultural enterprises in activities reflecting global challenges and trends in EU countries varies significantly depending on the source of funding and the period under review, this fact was also verified by the following research, [21]:

- Hypothesis H_0: There are no statistically significant differences in the mean volume of investments of large agricultural enterprises according to the source and period of investments in activities related to global challenges and trends.
- Hypothesis H_1: There are statistically significant differences in the mean volume of investments of large agricultural enterprises according to the source and period of investments in activities related to global challenges and trends.

2.2 Statistical Methods

Given the structure and organisation of the database of the obtained data, the following statistical methods were used to analyse the data and interpret the results within the framework of the hypothesis:

- Shapiro-Wilk test:

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_i\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (1)$$

- Spearman's correlation test:

$$r_s = 1 - \frac{6\sum_{i=1}^{n}\left(x_i^* - y_i^*\right)^2}{n(n^2-1)} \quad (2)$$

- ANOVA test:

$$F = \frac{SS_{between}/(k-1)}{SS_{within}/(N-k)} \quad (3)$$

- McNemar's test:

$$\chi^2 = \frac{(b-c)^2}{b+c} \quad (4)$$

3 Problem Solution

The surveyed agricultural enterprises were from all regions of Slovakia. Most enterprises (77%) were privately owned domestically, and their legal form was most often a cooperative or limited liability company. Two-thirds of the enterprises were focused on combined production, and one-third on crop production. The dominant production method of the surveyed enterprises was the conventional agricultural system (over 90%), alternative systems (ecological, precision, and regenerative) were only marginally represented. The most frequently grown crops were cereals and energy and oil crops; medicinal plants were grown the least. Most enterprises achieved production of over 1 thousand tonnes, with the highest production being reported by enterprises with combined production systems.

The largest number of surveyed enterprises invested in activities aimed at addressing technological challenges and trends in the period 2020-2024, up to 60% (204 enterprises). The same number of agricultural enterprises invested in activities aimed at addressing geopolitical and environmental challenges and trends, in both cases 18% (63) of enterprises. Investments were recorded in activities related to socio-demographic challenges and trends from 17% (58) of enterprises. The fewest enterprises invested in activities related to economic challenges and trends, where investments were recorded from 16% (54) of enterprises (Figure 2).

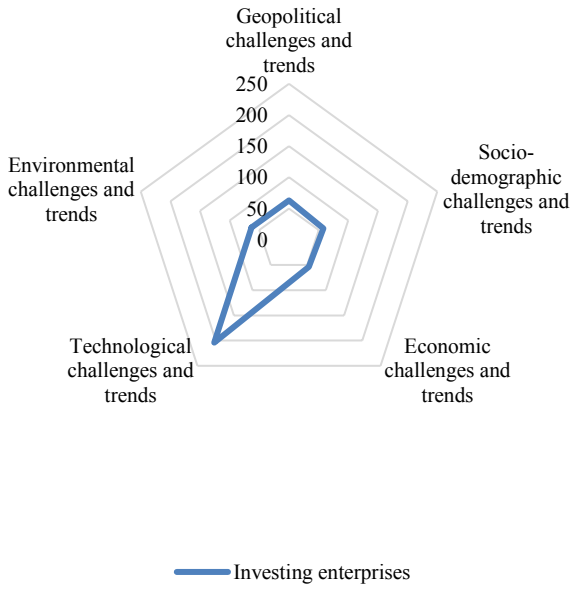

Fig. 2: Number of agricultural enterprises investing in activities related to global challenges and trends (2020-2024)
Source: created by the authors

Most agricultural enterprises exhibited a clear preference for public and non-commercial sources of financing when investing in activities aimed at addressing global trends and challenges. Among these, European Union funds and programmes represented the most frequently utilised source, with utilisation rates ranging from 67% for environmental challenges to 82% for geopolitical challenges. National subsidies and support schemes also played a significant role, particularly in relation to geopolitical challenges – where 77% of enterprises investing up to EUR 50 thousand relied on them— and socio-demographic issues. Alternative financing mechanisms such as crowdfunding, grant schemes, and cooperation with research institutions were employed only marginally. Similarly, bank loans and commercial financing were generally less favoured across all categories, except for technological challenges. In this area, more than one-third of enterprises reported utilising commercial financial instruments, which distinctly differentiated the technological domain from the others. Investment volumes varied according to the type of challenge addressed. Geopolitical and socio-demographic challenges were most frequently associated with investment ranges of EUR 50,000 to 100,000, while economic challenges typically attracted investments of up to EUR 50,000 or in the EUR 100,000 to 200,000 range. Environmental challenges were most linked to investments of EUR 200,000 to 500,000, whereas technological challenges were characterised by the highest investment volumes, often exceeding EUR 500 thousand (Figure 3).

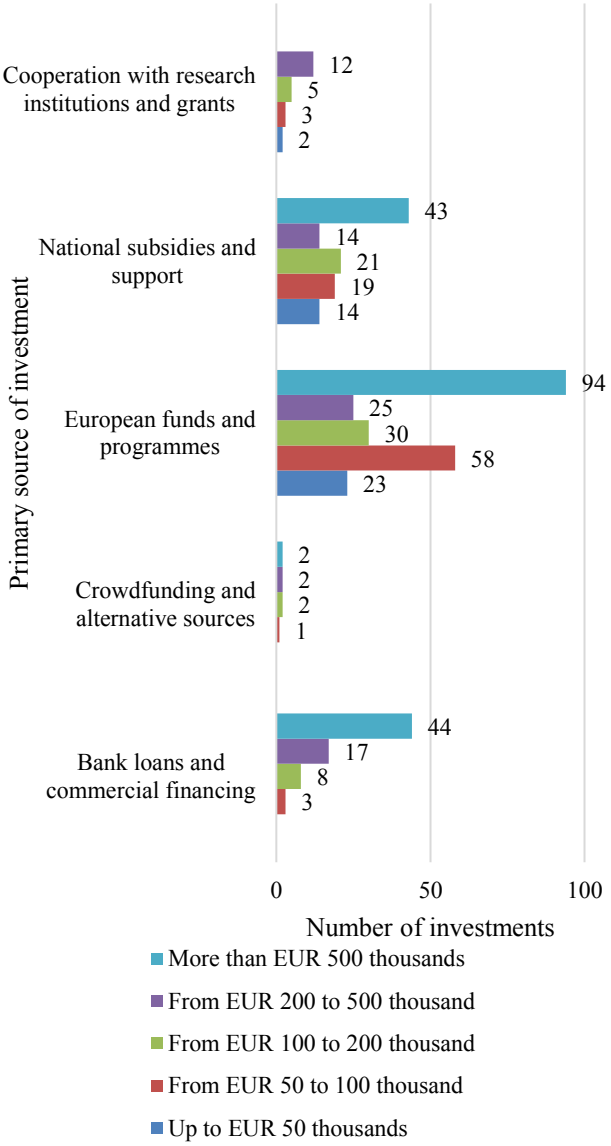

Fig. 3: Number of investments focused on global trends and challenges in terms of funding source, investment volume
Source: created by the authors

In terms of time, companies invested the most in 2020 in addressing geopolitical challenges, while this year was also dominant for smaller investments in socio-demographic trends. The year 2021 was a key year for technological challenges, where up to 24% of companies made investments exceeding EUR 500 thousand. In the same year, investments were also significant in the environmental area (22% of companies). In 2022, environmental (27%) and technological investments dominated. Economic challenges recorded the highest investment intensity

in 2021 and 2024 (both 24%). Socio-demographic challenges recorded the largest wave of investments in 2024, with the same trend repeated for economic challenges. Overall, individual challenge categories showed different time dynamics of investment activity, with technological and environmental challenges dominating in most years with higher investment volumes (Figure 4).

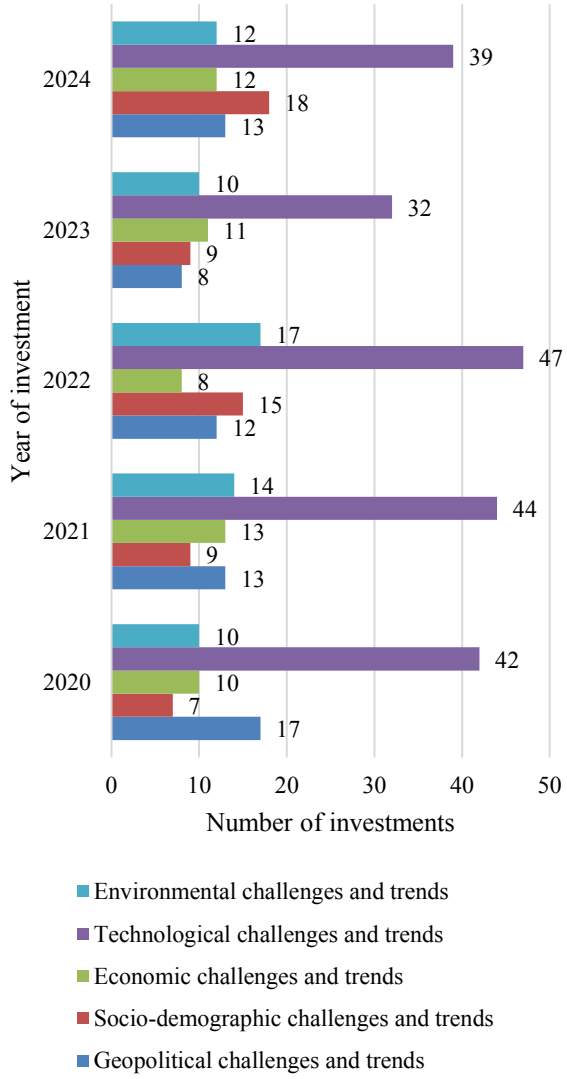

Fig. 4: Number of investments focused on global trends and challenges in terms of funding object and year of investment
Source: created by the authors

For statistical verification of the hypothesis H^0, data on the sources of financing, year, and volume of investments of the surveyed enterprises in individual activities related to global challenges and trends were used as input variables. Performing a test of the normality of the distribution of variables was necessary for the selection of an appropriate statistical method. Descriptive statistics focusing on identifying the distribution of the monitored variables using the Shapiro-Wilk test demonstrated statistically significant deviations from the normal distribution ($p < 0.001$) in relation to the data related to the hypothesis H_0. Based on the above findings, only non-parametric tests that assume a non-normal distribution of variables could be used for further testing of the hypothesis H_0, Table 1, equation (1).

Table 1. Test of normality of data distribution for hypothesis H_0

		Shaphiro-Wilk	
Index	**N**	**W**	**p**
Source of financing	442	0.769	< .001
Volume of investment	442	0.827	< .001
Year of investment	442	0.887	< .001

Source: created by the authors

Spearman's correlation coefficient was applied to examine the statistical dependence between the variables. The results of the correlation analysis indicated only a weak and statistically less significant (**) positive relationship between the source and volume of investments of the surveyed enterprises in activities related to global challenges and trends (0.123). This suggests that no strong or highly significant correlation exists between the variables. Therefore, the null hypothesis could not be fully rejected, and the results provided a rationale for applying analysis of variance to further identify potential differences across groups, Figure 5, equation (2).

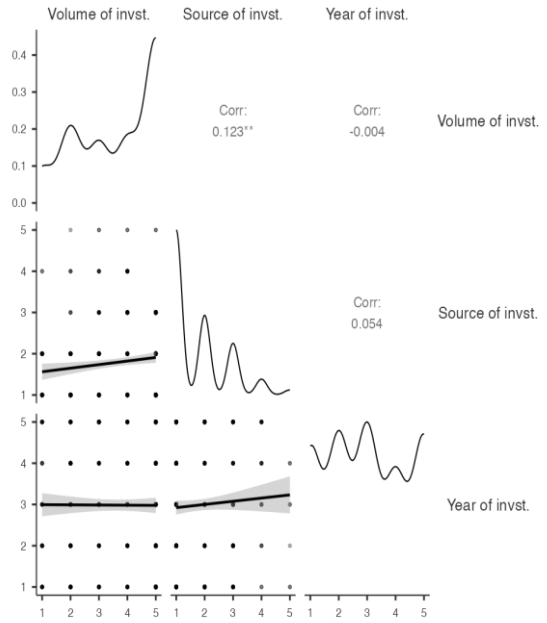

Fig. 5: Spearman's correlation matrix for hypothesis H_0
Source: created by the authors

The results of the ANOVA test show that the source of investment has a statistically significant effect on the mean volume of investments of large agricultural enterprises in activities related to global challenges and trends ($F = 17.48$, $p < 0.001$). This confirms that the average investment volumes differ significantly depending on the source of financing. In contrast, the effect of the period of investment, as well as the interaction between the period and the source of investment, did not prove to be statistically significant ($p = 0.872$), Table 2, equation (3).

Table 2. ANOVA test for hypothesis H_0

ANOVA – volume of investment				
	SUM of Squares	**df**	**Mean Square**	**p**
Year of investment	0.0	NaN	-	-
Source of investment	52.5	3	17.48	< .001
Year of investment * Source of investment	17.3	15	1.15	0.872
Residuals	797.8	418	1.91	-

Source: created by the authors

Based on these findings, the null hypothesis H_0, which assumed no statistically significant differences in the mean volume of investments according to the source and period of investments, was rejected in favor of the alternative hypothesis H_1. This indicates that differences exist particularly in relation to the source of investment, while the period of investment and its interaction with the source do not significantly affect the volume of investments.

The results of the contingency table for independent samples show significant differences in the volume of investments with respect to the source of financing. European funds and programmes represented the dominant source, with 40.9% (94) of enterprises investing more than EUR 500 thousand through them. In total, these sources accounted for 52% (230) of all investments, concentrated mainly in higher volumes above EUR 100 thousand. National subsidies and support were the second most common source of financing, with 38.7% (43) of enterprises investing an amount exceeding EUR 500 thousand. In contrast to European funds, these sources were more evenly distributed between different investment volumes. Although bank loans and commercial financing were used less frequently, 61.1% (44) of enterprises that used them invested more than EUR 500 thousand. This suggests that this source was typical mainly for enterprises making large investments. Cooperation with research institutions and grants was mainly used for investments in the range of 200 to 500 thousand EUR, namely in 54.5% (12) of the enterprises, while none of them invested more than 500 thousand EUR. This source of financing was less significant in the implementation of large investments. Crowdfunding and alternative sources were only marginal. The results indicate that the managements of the surveyed companies preferred European funds, national subsidies, and bank loans to finance large-scale investments, while smaller investment volumes were covered by more diverse sources as shown in Table 1 (Appendix).

McNemar's test was applied to the paired contingency table examining the relationship between the source and volume of investments of the surveyed agricultural enterprises in activities related to global challenges and trends. The obtained test statistic ($\chi_2 = 278$, $df = 10$, $p < 0.001$) indicates that there is a statistically highly significant dependence between the analyzed variables. This result confirms that the distribution of investment volumes significantly differs across the different sources of financing, rejecting the assumption of independence. Consequently, the null hypothesis of no association was rejected, supporting the existence of a significant relationship between the source and volume of investments. This pattern of asymmetry can coexist with the weak monotonic relationships observed in Spearman correlation analyses, illustrating that substantial differences in specific categorical pairings may emerge even in the absence of strong overall monotonic trends, Table 3, equation (4).

Table 3. McNemar's test for volume and source of investments

	Value	**df**	**p**
χ_2	278	10	< .001
χ_2 continuity correction	278	10	< .001
N	442	-	-

Source: created by the authors

4 Conclusion

The identification of key global challenges and trends in agriculture has highlighted five main areas: geopolitical, socio-demographic, economic, technological, and environmental, which have proven to be essential for the direction of farms in changing conditions all over the world. These areas fundamentally formulate the approach to innovation and sustainability of farms, [1]. The transformation of the agri-food system seems to be a logical step regarding reflecting the above areas. Contemporary agriculture faces increasing pressure to transition from traditional production models to sustainable ones. This transition requires the systematic

implementation of strategic innovation, [22], [23] Selecting the surveyed enterprises based on selected indicators enabled a thorough analysis of the behaviour and investment activity of mainly large entities focused on crop or combined production, while confirming their decisive influence on the sustainability of Slovak agriculture and the resilience of the agri-food system.

Quantification of investments showed that the largest volume of funds was invested in technological innovations (more than EUR 500 thousand for 82% of enterprises), while only approximately 17-18% of enterprises invested in areas other than geopolitical or socio-demographic challenges and trends. Technological innovations are associated with a higher level of immediate effectiveness and a faster return on investment, which favours their implementation in farms, [24]. Technological interventions play a crucial role in transforming the agricultural sector. Implementation of technologies enhances the efficiency of agri-supply chains, [25]. The identification of specific investment activities showed that enterprises implemented various measures, such as the implementation of precision technologies, ESG reporting, diversification into processing, cooperation with research institutions, or greening of production. The evaluation of the effects of investments confirmed the positive impact on competitiveness, efficiency, production stability, and modernisation. Effective investment frameworks significantly enhance agricultural productivity and economic robustness in the sector, [26]. Negative effects such as technical complexity, financial risks, or insufficient improvements in environmental areas were less frequent but still present.

Analysis of investment behaviour revealed that companies investing in technological challenges also invested more often in environmental ones, although these two areas are not structurally related. Up to 25% of technologically investing enterprises also invested in environmental activities, compared to 8.8% of non-investing enterprises. Environmental factors have become a significant consideration in agricultural investment strategies, as seen in the adoption of climate-smart agriculture approaches that seek to optimise productivity while minimising environmental impact, [27], [28]. However, most management strategically prioritised only one of these areas. Such strategic behaviour can potentially be related to limited financial capacities and different levels of awareness of the importance of environmental innovations, [29], [30]. This also points to a certain form of selective approach to innovation, which can be seen because of different strategic orientations of management, [31]. Overall, environmental investments remain a less preferred area, which indicates their lower priority in the decision-making process of enterprises.

The analysis of the relationship between the volume of investment, the source of financing, and the period of investment implementation showed differences in the volume of invested financial resources according to the source of financing. The most important source was European funds, through which more than 40% of the enterprises surveyed invested more than EUR 500 thousand. Agricultural subsidies under the CAP account for a major portion of the EU's budget, emphasising their role in promoting agricultural productivity and sustainability. Subsidy programs are designed to improve farmers' incomes and enhance national food security by increasing food production, thus reinforcing the importance of financial support for agricultural investment, [32], [33]. National subsidies followed, more evenly distributed across different investment volumes. In the study, the authors discuss the impact of EU membership on Slovak agricultural practices. They reveal that although Slovakia has the option to supplement EU subsidies with national funds, it often underutilises this potential. This underutilisation hampers the competitiveness of the agricultural sector in Slovakia, [34]. Bank loans and commercial financing, although used less frequently, were typical for large investments, especially in the field of technology in agriculture. The risk associated with credit for agricultural enterprises, indicating that larger enterprises are more likely to access commercial financing due to established relationships with financial institutions and the perceived lower risk associated with investments in advanced agricultural technologies, [35]. Another study indicates that commercial banks are crucial players in agricultural financing, yet their lending practices are heavily influenced by economic conditions, which can limit access for agricultural enterprises seeking to invest, [36].

Acknowledgement:
This work presents the results obtained by the authors within the research project APVV-23-0022 "The integration of eco-innovation into the innovation process".

References:

[1] Kapsdorferová, Z. (2024). Key Drivers and Innovative Approaches to Sustainable Management in the Agricultural and Food Sector. *Bogueva, D. (eds) Consumer Perceptions and Food. 349-362.*

https://doi.org/10.1007/978-981-97-7870-6_18

[2] Li, J. (2023). Simulation optimization of economic benefit model of agricultural industry based on DEA model. Proceedings Volume Second International Conference on Statistics, Applied Mathematics, and Computing Science (CSAMCS 2022), vol. 1259748, 1-7. https://doi.org/10.1117/12.2672774

[3] Magno, C., Becker, A., Kazimzade, E., Mikayilova, U., Schädeli, D., Batkhuyag, B., & Denman, B. (2022). Learning through leadership: capturing practicearchitectures. *International Journal for Academic Development*, *29*(1), 34–47. https://doi.org/10.1080/1360144X.2022.2073447

[4] Blanco, D., Ferasso, M. M., & Bares, L. (2021). The Regional efficiency in the use of European Agricultural Funds in Spain: Growth and Employment Analyses. *Agronomy, 11*(6), 1109. https://doi.org/10.3390/agronomy11061109

[5] Juríčková, Z. (2016). New approaches and innovative activities in the management of agricultural entities. Proceeding International Scientific Days 2016. The Agri-Food Value Chain: Challenges for Natural Resources Management and Society. Nitra: SUA, 2016. 470-476. https://doi.org/10.15414/isd2016.s7.05

[6] Kapsdorferová, Z., Paluš, H., Kadlečíková, M., & Švikruhová, P. (2020). AKIS and advisory services in Slovak Republic. Report for the AKIS inventory (Task 1.2) of the i2connect project. [Online]. 1-46. https://i2connect-h2020.eu/resources/akis-country-reports/ (Accessed Date: February 16, 2026).

[7] Erjavec, E., Volk, T., Rednak, M., Ciaian, P., & Lazdinis, M. (2021). Agricultural policies and European Union accession processes in the Western Balkans: aspirations versus reality. *Eurasian Geography and Economics*, *62*(1), 46-75. https://doi.org/10.1080/15387216.2020.1756886

[8] European Commission (2023). The common agricultural policy at a glance. [Online]. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en (Accessed Date: June 27, 2025).

[9] Mamatzakis, E., & Staikouras, C. (2020). Common Agriculture Police in the EU, direct payments, solvency and income. *Agricultural Finance Review, 80*(4), 529-547. https://doi.org/10.1108/AFR-04-2019-0047

[10] Guth, M., & Smędzik-Ambroży, K. (2019). Economic resources versus the efficiency of different types of agricultural production in regions of the European union. *Economic Research – Ekonomska Istraživanja, 33(1), 1036-1051.* https://doi.org/10.1080/1331677X.2019.1585270

[11] European Commission (2023). Common agricultural policy funds. [Online]. https://agriculture.ec.europa.eu/common-agricultural-policy/financing-cap/cap-funds_en?prefLang=sk (Accessed Date: June 27, 2025).

[12] European Parliament (2023). Financing of the CAP: facts and figures. [Online]. https://www.europarl.europa.eu/factsheets/en/sheet/106/financovanie-spp (Accessed Date: June 28, 2025).

[13] European Commission (2024). Key policy objectives of the CAP 2023-27. [Online]. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27/key-policy-objectives-cap-2023-27_en (Accessed Date: June 27, 2025).

[14] *(text in Slovenian)* Agricultural Paying Agency (2022). ECO-schemes. [Online]. https://web.archive.org/web/20250522065216/https://www.apa.sk/aktuality/eko-schmy/11555 (Accessed Date: June 28, 2025).

[15] Diakosavvas, D., & Frezal, C. (2019). Bio-economy and the sustainability of the agriculture and food system. *OECD food, agriculture and fisheries working papers.* 1-56. https://doi.org/10.1787/d0ad045d-en

[16] The World Bank - IBRD - IDA (2024). Arable land (hectares per person) and population. [Online]. https://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC (Accessed Date: June 27, 2025).

[17] *(text in Slovenian)* Bezák, P. (2020). Statement of scientists concerning the EU Common Agricultural Policy [Online]. https://www.sav.sk/?lang=en&doc=services-news&source_no=20&news_no=9202 (Accessed Date: June 27, 2025).

[18] Liao, X., Nguyen, T., & Sasaki, N. (2022). Use of the knowledge, attitude, and practice (KAP) model to examine sustainable agriculture in Thailand. *Regional Sustainablity, 3*(1), 41-52. https://doi.org/10.1016/j.regsus.2022.03.005

[19] FAO. (2017). The future of food and agriculture - Trends and challenges. [Online]. https://www.fao.org/3/i6583e/i6583e.pdf (Accessed Date: June 28, 2025).

[20] FAO. (2018). The future of food and agriculture – Alternative pathways to 2050. [Online]. https://www.fao.org/global-perspectives-studies/resources/detail/en/c/1157074/ (Accessed Date: June 27, 2025).

[21] FAO. (2022). The future of food and agriculture - Drivers and triggers for transformaton. [Online]. https://www.fao.org/documents/card/en?details=cc0959en (Accessed Date: June 29, 2025).

[22] HLPE-FSN. (2019). Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security.1-163. [Online]. https://openknowledge.fao.org/server/api/core/bitstreams/ff385e60-0693-40fe-9a6b-79bbef05202c/content (Accessed Date: June 27, 2025).

[23] Chaparro-Banegas, N., Sánchez-Garcia, M., Calafat-Marzal, C., & Roig-Tierno, N. (2024). Transforming the agri-food sector through eco-innovation: A path to sustainability and technological progress. *Business Strategy and the Environment, 33*(8), 9075-9097. https://doi.org/10.1002/bse.3968

[24] Huo, M., & Chao, L. (2022).. Impact of managerial power on enterprise innovation performance: The mediating roles of financing constraints and strategic orientation. *Chinese Management Studies, 17*(3), 637-659. https://doi.org/10.1108/cms-06-2021-0249

[25] Agrawal, S., Singh, V., & Upadhyay, Y. (2021). Structural model of information quality framework to e-agri supply chain. *Journal of Advances in Management Research, 18*(4), 609-634. https://doi.org/10.1108/JAMR-06-2020-0113

[26] Akpaeti Aniekan, J., Bassey Nsikan, E., Okoro Udeme, S., Nkeme Kesit, K. (2014). Trends and drivers of agricultural investments and growth in Nigeria: The pre and financial sector reforms experience. *Asian Journal of Economic Modelling, 2*(3), 115-127. https://doi.org/10.18488/journal.8.2014.23.115.127

[27] Govaerts, B., Negra, C., Camacho Villa, T., Chaves-Suarez, X., Espinosa, A., & Fonteyne, S. (2021). One CGIAR and the Integrated Agri-food Systems Initiative: From short-termism to transformation of the world's food systems. *PLoS ONE, 16*(6): e0252832. https://doi.org/10.1371/journal.pone.0252832

[28] Isakhanyan, G., Galgo, C., Gemtou, M., & Pedersen, S. (2024). Business strategies towards climate-smart agriculture in Europe: A literature review. *Business Strategy and the Environment, 33*(6), 5073-5085. https://doi.org/10.1002/bse.3741

[29] Peng, C., Jiang, H., & Zhang, T. (2021). Does the national risk of overseas investment affect the strategic innovation behaviour of enterprises? Evidence from China. *Managerial and Decision Economics, 43*(5), 1548-1565. https://doi.org/10.1002/mde.3473

[30] Sun, Y. (2024). The relationship between corporate sustainability investments and corporate performance. *Finance & Economics, 2*(8), 1-5. https://doi.org/10.61173/1w7z5k45

[31] Nassani, A., & Aldakhil, A. (2021). Tackling organizational innovativeness through strategic orientation: Strategic alignment and moderating role of strategic flexibility. *European Journal of Innovation Management, 26*(3), 847-861. https://doi.org/10.1108/EJIM-04-2021-0198

[32] Schmedtmann, J., & Campagnolo, M. (2015). Reliable Crop Identification with Satellite Imagery in the Context of Common Agriculture Policy Subsidy Control. *Remote Sensing, 7*(7), 9325-9346. https://doi.org/10.3390/rs70709325

[33] Wang, S., Manjur, B., Kim, J., & Lee, W. (2019). Assessing socio-economic impacts of agricultural subsidies: a case study from Bhutan. *Sustainability, 11*(12), 3266. https://doi.org/10.3390/su11123266

[34] Némethová, J., & Rybanský, Ľ. (2021). Development trends in the crop production in Slovakia after accession to the European Union – Case Study, Slovakia. *Sustainability, 13*(15), 8512. https://doi.org/10.3390/su13158512

[35] Belhadi, A., Kamble, S., Mani, V., Benkhati, I., & Touriki, F. (2021). An ensemble machine learning approach for forecasting credit risk of

agricultural sme's investments in agriculture 4.0 through supply chain finance. *Annals of Operations Research, 345*(2-3), 779-807. https://doi.org/10.1007/s10479-021-04366-9

[36] Oyelade, A. (2019). Impact of commercial bank credit on agricultural output in Nigeria. *Review of Innovation and Competitiveness: A Journal of Economic and Social Research*, 5(1), 5-20. https://doi.org/10.32728/ric.2019.51/1

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Matej Čereš was responsible for the chapters Problem Formulation, Problem Solution, and for the formal editing of the paper.
Zuzana Kapsdorferová was responsible for the chapters Problem Formulation and Problem Solution.
Dominika Čeryová was responsible for the chapters Introduction and References and for the formal editing of the paper.
Jana Ladvenicová was responsible for the chapter Conclusion.
Petronela Švikruhová was responsible for the language proofreading of the paper.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

This work presents the results obtained by the authors within the research project APVV-23-0022 "The integration of eco-innovation into the innovation process".

Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

APPENDIX

Table 1. Contingency table for alternative hypothesis H_1 – volume and source of investments

		Volume of investments					Total
Source of investments	**Index**	**Up to EUR 50 thousand**	**From EUR 50 to 100 thousand**	**From EUR 100 to 200 thousand**	**From EUR 200 to 500 thousand**	**More than EUR 500 thousand**	
European funds and programmes	Observed	23	58	30	25	94	230
	% within row	10.0 %	25.2 %	13.0 %	10.9 %	40.9 %	100.0 %
	% within column	59.0 %	69.0 %	45.5 %	35.7 %	51.4 %	52.0 %
National subsidies and support	Observed	14	19	21	14	43	111
	% within row	12.6 %	17.1 %	18.9 %	12.6 %	38.7 %	100.0 %
	% within column	35.9 %	22.6 %	31.8 %	20.0 %	23.5 %	25.1 %
Bank loans and commercial financing	Observed	0	3	8	17	44	72
	% within row	0.0 %	4.2 %	11.1 %	23.6 %	61.1 %	100.0 %
	% within column	0.0 %	3.6 %	12.1 %	24.3 %	24.0 %	16.3 %
Cooperation with research institutions and grants	Observed	2	3	5	12	0	22
	% within row	9.1 %	13.6 %	22.7 %	54.5 %	0.0 %	100.0 %
	% within column	5.1 %	3.6 %	7.6 %	17.1 %	0.0 %	5.0 %
Crowdfunding and alternative sources	Observed	0	1	2	2	2	7
	% within row	0.0 %	14.3 %	28.6 %	28.6 %	28.6 %	100.0 %
	% within column	0.0 %	1.2 %	3.0 %	2.9 %	1.1 %	1.6 %
Total	Observed	39	84	66	70	183	442
	% within row	8.8 %	19.0 %	14.9 %	15.8 %	41.4 %	100.0 %
	% within column	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

Source: created by the authors