

RENEWABLE AND STIMULATING AGRICULTURE: EXAMINING INNOVATION BEHAVIOUR IN HUNGARIAN AGRICULTURAL ENTERPRISES

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ABSTRACT

Today, the turbulently changing economic and social influences are having a significant impact on the sustainability and innovation policies of companies. The keys to economic efficiency and effectiveness are flexibility, adaptation to change, innovation, modernisation, and implementation of the potential new practices in business. The aim of the empirical research was to assess how the innovation policy of companies in the field of agricultural SMEs evolves in relation to management contribution and employee activity, and what kind of strategic objectives they formulate for the future. The primary survey was conducted in the form of a questionnaire in 2024. The hypotheses formulated in the light of international and national trends were tested with non-parametric statistical methods. The first hypothesis was tested using Wilcoxon rank test, and the second hypothesis was tested using Spearman rank correlation. The main finding of the research shows that the innovation policy and philosophy of agricultural SMEs' operations are significantly influenced by the activation and involvement of employees in innovation processes, and management's efforts to increase employees' motivation. The innovation behaviour of companies in the sector is diverse, however, a significant percentage of companies consider themselves to be innovation-driven, even if their innovation activity is currently stagnating and their innovation performance is expected to remain low in the future. It remains important that similar research is produced that supports the promotion of innovation activity with up-to-date information and strategic considerations.

Keywords: innovation, employee, SME, agriculture, Hungary

JEL codes: D23, O3, O13

INTRODUCTION

Agriculture is a key sector ensuring people's livelihood, as its scope of activity is primarily specialised in animal husbandry and crop production. It also plays a key role in supporting raw materials for other industries. Agriculture not only serves economic and social aspects but also contributes significantly to environmentally conscious farming. That is why the application of innovations is essential for the

sustainable development of agriculture. Innovative solutions contribute to modernising the methods used in the industry, increasing food safety, and the well-being of employees in agriculture. The introduction and acceptance of innovations depend on the corporate culture and the atmosphere created by the manager. The more valuable employees feel, the more willing they are to keep the company's interests in mind and adapt to innovations. This is also true for SMEs operating in agriculture. Preparing employees for innovation is one of the most important aspects of the success of innovation. Despite the small sample size, the practical usefulness of the results lies in the fact that they point to a scientific gap, that the number of domestic research examining innovation behaviour of various industries is still insufficient, despite the fact that this is a current problem. This research seeks to contribute to filling this gap.

The aim of the research was to examine how the innovation behaviour of SMEs operating in the Hungarian agricultural sector changes over time, and how incentives provided by management influence employees' innovation motivation.

LITERATURE REVIEW

The concept of innovation is associated with the name of the economist J. A. Schumpeter, who first mentioned it in his book *The Theory of Economic Development*. The theory is about a new, diverse combination of production factors, which forms basis of all theories dealing with innovation (Bajkó *et al.*, 2020; Lin *et al.*, 2024). The innovation activity in enterprises contributes to economic growth and development and ensures access to new markets and competitive advantage in industry. It is important for SMEs to secure their market position, leverage their existing resources, and gain new resources or competitive advantage (Carrasco-Carvajal *et al.*, 2023). In Central Europe, SMEs contribute significantly to promoting employment, yet they lag far behind the performance of Western European SMEs in terms of productivity and market competitiveness. The reason for the lag can be traced back to technological disadvantages, the use of old marketing methods, and low innovation activity (Gódány *et al.*, 2021). The economic structure, innovation activity and competitiveness of Central and Eastern European countries are similar (Szabó & Hortoványi, 2021). In recent years, various methods have been used to support innovation, the development of the economy, education and research, and entrepreneurship (Mester & Gavriluț, 2024). According to Kvilinski *et al.* (2025), by aligning the innovation ecosystem, trade policy and intellectual property frameworks of the Visegrad countries, there is an opportunity to attract innovation-driven and sustainable investments. Innovation ecosystems play a prominent role in green investments therefore decision-makers need to develop support programs that specifically target the economic utilization of research. According to Ivanová (2017), small and medium-sized enterprises are an important part of the Slovak economy, but despite this, economic conditions are not adequate, and the entrepreneurial environment is not motivating. The lack of financial support limits the innovative activities of companies. In the Slovak SME sector, the most common source of financing for innovations is company profits. Dobos & Csizsárik-Kocsir (2024) found

that it is also important for Hungarian and Slovak SMEs to participate in successful projects, thereby ensuring their competitiveness in the market. For Slovak SMEs, an innovative approach and participation in innovative projects are much more important than for Hungarian SMEs. This shows that Slovak SMEs are more inclined to innovate and launch innovative projects. The application of innovative solutions makes it possible to modernise companies operating in agriculture. Partnerships, technological innovations, and sharing knowledge support the development of SMEs in agriculture (Kondrat, 2025). The development rate of the Hungarian agricultural sector shows a varied picture, with developed and developing areas. Innovation can be a solution to reduce regional inequalities (Kelemen et al., 2023). Angyal & Vajnai (2025) emphasize in their research that companies often underestimate the importance of aligning innovation initiatives with market needs and long-term strategic goals. They highlight further research in innovation, networking, and collaboration. Popp et al. (2025) highlight that the goal is to support the increase in the number of active producing agricultural enterprises. These enterprises are trying to implement innovative developments. Innovative solutions can ensure the sustainability and competitiveness of the domestic agricultural sector. In agriculture, innovation is manifested in the application of new agricultural technologies, the development of markets, the efficient allocation of resources, and the change of organisational structures (Ofosu-Ampong et al., 2025). Challenges affecting agriculture include financing difficulties, obstacles to sustainable operations, climate change risks, volatile pricing policies, and financial insecurity (Fan & Rue, 2020). According to Chindasombatcharoen et al. (2024), the main barriers to agricultural innovations are access to financial resources, lack of knowledge and competencies, infrastructural and regulatory problems, and psychological problems. The size and age of enterprises have an impact on their innovation activity. Large companies have more resources to support innovation and carry out R&D activities. Large companies often invest in radical innovation, creating a completely new product or process. Small companies typically invest in incremental innovations, meaning they develop and improve an existing product or process (Acemoglu et al., 2022). According to Virglerova et al. (2025), medium-sized enterprises are more open to incorporating innovation into their strategy than smaller enterprises. The strategic importance of innovation is more evident in companies that are less than five years old, and companies that also engage in export activities place greater emphasis on innovation. Small companies react quickly and flexibly to market needs, but they are less likely to participate in large-scale innovation projects. The age of the company and its business experience also affect innovation. Companies that have been on the market for a long time have a better understanding of consumer needs. Managers also play a significant role in the innovation behaviour of employees (Naparín & Astuti, 2025). They develop the innovation strategy they create the corporate culture necessary to accept innovation. The basis of a corporate culture that supports innovation is the involvement of employees in innovation and the development of trust within the company (Karácsony et al., 2025; Avelar et al., 2024). Employees' innovation behaviour also influences the success of a company's innovation activities (Bindel Sibassaba et al., 2025). SMEs support innovation provides the right conditions for new methods. Innovation

management methods and leadership techniques are built on emphasizing innovation and encouraging new, creative solutions. This requires the introduction of new personnel development methods, the implementation of knowledge management, and corporate behaviour that supports innovation. The result of innovation is an improved, changed or completely new solution (Lesáková, 2014). According to Dayan *et al.* (2024), managers play a key role in developing the innovation capacity of SMEs. They should provide training programmes that support critical thinking and breaking away from routines. They must provide an environment conducive to innovation and encourage employees to think of new ideas. According to Menzies *et al.* (2025), the development of a loyalty-based HR management system plays an important role in supporting innovation. Resources invested in employee training and development pay off, which contributes to workforce retention. According to Yesuf *et al.* (2024), the innovation behaviour of companies depends on the creativity of employees therefore, measures taken to improve the working environment and develop employees' creativity are very important. According to Juarez *et al.* (2024), employee training and knowledge development are essential for the company's effective innovation activities. Employees' knowledge and competencies are important for implementing innovation practices (Janasz *et al.*, 2022). According to Mukhiyayeva *et al.* (2024), innovation activity is the key to business success, yet few resources are devoted to supporting innovation, which is affected by the lack of strategic planning and the innovation attitude of managers. Mardonbek (2025) states that technological and organisational innovation play an essential role in economic development for agricultural SMEs. Innovations in animal husbandry and crop production promote employment and GDP growth. The biggest obstacle to innovations is the lack of financial resources and interorganisational relationships. According to Shahini (2025), employee commitment is essential in agricultural SMEs. Modern agricultural enterprises must provide an environment that encourages the active participation of employees in decision-making and the development of corporate culture, and the effective adaptation of modern technologies and innovative solutions. Innovation in the life of SMEs means openness to new technological solutions and partnerships, a willingness to take risks and explore development opportunities, and cooperation to create creative solutions (Ferincz, 2012).

MATERIALS AND METHODS

For the empirical research, a quantitative research method was applied through an online questionnaire survey. During the survey, it was ensured the anonymity of the potential respondent and fully complied with data protection regulations. Participation in the survey was voluntary. The data from the survey will be used for research purposes. The sampling method was purposive sampling, which means that the sample was selected based on predetermined criteria. The target group was corporate representatives of SMEs operating in the Hungarian agricultural sector. Data collection took place in 2024. The questions in the questionnaire can be divided into three main groups. The first half of questionnaire contained questions discussing basic information about the enterprise, such as size, and year of establishment. The

second half of the questionnaire contained questions discussing the innovation behaviour of enterprises. The third part of the questionnaire discussed the tools used to encourage innovative behaviour among employees. The questionnaire consisted of scale-type questions, with the aim of identifying and assessing respondent preferences. The scale-type questions were evaluated on a seven-point Likert scale, where 1 meant slightly or not at all important and 7 meant completely or completely important. The validity of the hypotheses was examined in SPSS. Non-parametric statistical tests were used to verify the validity of the hypotheses.

To test hypothesis H1, the Wilcoxon rank test was used, which is suitable for comparing variables from the same database over time and detecting differences between them. We were able to perform the statistical test because the variables are measured on an ordinal scale, the data come from the same sample, and the distribution of differences is symmetrical.

To test hypothesis H2, the Spearman rank correlation analysis was used, which shows the extent to which the large of one variable determines the large of the other variable, as well as the direction and strength of the relationship between the variables. We were able to perform the statistical test because the variables are measured on an ordinal scale, there is a monotonic relationship between the variables, their values increase proportionally, and they allow for paired, related observations.

The aim of the research was to examine the innovation willingness of Hungarian SMEs operating in agriculture and to map out the means by which they ensure the commitment and motivation of employees towards innovation. Based on the aim, the following research questions were formulated:

RQ1: Does the innovation activity and propensity of agricultural companies change over time?

RQ2: To what extent and by what means can managers encourage employees to develop their innovative behaviour?

We examined the following hypotheses:

- H0: There is no difference between current and future innovation activity of Hungarian agricultural SMEs.
- H1: There is a significant difference between current and future innovation activity of Hungarian agricultural SMEs.
- H0: There is no correlation between the improvements provided by management to increase employee motivation.
- H2: There is a significant correlation between the improvements provided by management to increase employee motivation.

Sample

The sample is presented in *Table 1*. A total of $n=103$ enterprises participated in the research. 34.6% of the enterprises are small enterprises (<50 employees), 32.7% are medium-sized enterprises (<250 employees), and 31.7% are micro-enterprises (<10 employees). 60.2% of enterprises were established between 1990 and 2010, 25.2% between 2011 and 2024, and 13.6% between 1960 and 1989.

Table 1: Basic information about the sample (N=103)

		Frequency	Percent
Size	Micro enterprise	33	31.7%
	Small enterprise	36	34.6%
	Medium enterprise	34	32.7%
Year of establishment	between 1960 and 1989	14	13.6%
	between 1990 and 2010	62	60.2%
	between 2011 and 2024	26	25.2%

RESULTS AND DISCUSSION

Table 2. presents the results of the statistical test for the alternative hypothesis H0 and the related hypothesis H1. The table shows the difference between enterprises' current innovation activity and their future innovation activity using ranks. The significant level, i.e., $p=0.000$, satisfies the $p<0.05$ condition, so it can be stated that there is a significant difference between the enterprises in the assessment of innovation activity. Overall, based on the Wilcoxon rank test ($Z=-3.726$; $p=0.000$), it can be said that there is a significant difference between enterprises regarding the future application of innovations. In the case of 31 enterprises currently engaged in innovation activities, it can be stated that the willingness to engage in innovation activities in the future is lower. In the case of 8 enterprises currently engaged in innovation activities, it can be stated that there is a higher willingness to engage in innovation activities in the future. In the case of 64 enterprises, it can be stated that their willingness to innovate is stagnant and unchanged. During the hypothesis test, it was found that enterprises evaluate their future innovation activities to different degrees. Of the 103 enterprises included in the survey, only 8 enterprises would like to develop their innovation activities, while 31 enterprises show moderate willingness to innovate in the future, and the willingness of most enterprises, i.e., 64, to innovate remains unchanged. In the light of this, the null hypothesis was rejected, and the validity of hypothesis H1 was confirmed.

Table 2: Hypothesis testing based on Wilcoxon rank test

Current innovation activity Innovation activity in the future		N	Mean Rank	Sum of Ranks
	Negative Ranks	31 ^a	20.26	628.00
	Positive Ranks	8 ^b	19.00	152.00
	Ties	64 ^c		
	Total	103		
^a Current innovation activity > Innovation activity in the future				
^b Current innovation activity < Innovation activity in the future				
^c Current innovation activity = Innovation activity in the future				
Z				-3.726 ^b
Asymp. Sig. (2-tailed)				.000
a. Wilcoxon Signed Ranks Test				
b. Based on positive ranks				

In line with the results, we believe that the continuation of innovation activity is the basis for the development of SMEs, which is also emphasized by *Carrasco-Carvajal et al.* (2023). The competitiveness of SMEs depends to a significant extent on their willingness and activity to innovate. *Gódný et al.* (2021) see the problems of SME development in outdated methods and moderate innovation activity. However, *Mester and Gavrilut* (2024) emphasize that in recent times, Central and European countries have made significant developments and concrete steps to promote their innovation activities. *Kwilinski et al.* (2025) agree with this, and emphasize the role of decision-makers, who can achieve even greater positive effects through support programs, coordination of the innovation ecosystem, trade policy and intellectual property frameworks to promote innovation willingness and activity. *Chindasombatcharoen et al.* (2024) also believes that the constraints to agricultural innovations can be linked to support difficulties, lack of competence, regulatory and infrastructure issues. Innovation is a potential tool for the modernization of SMEs, including agricultural enterprises (*Kondrat*, 2025), which should not be neglected. According to *Mardonbek* (2025), innovations in animal husbandry and crop production would significantly transform the innovation activities of agricultural companies. Based on our results, it can be said that the innovation activity of agricultural SMEs shows a fluctuating tendency. The majority of companies focus more on stability and maintaining the status quo. The stagnation of innovation activity can be linked to several factors, which we could associate with the findings made at level of assumptions or in the literature.

Table 3. presents the variables included in the H2 hypothesis test with descriptive statistics. 24.0% of enterprises (Md=4; Mn=3.72) motivate employees by introducing employee development practises to increase their willingness to innovate. 21.2% of enterprises (Md=5; Mn=4.10) consider it important to establish a stable reward system to enhance innovation behaviour and increase productivity. 20.2% of enterprises (Md=4; Mn=4.00) believe in developing a task planning and employee/team performance monitoring system to motivate employees and increase their willingness to innovate.

Table 3: Descriptive Statistics

	Percentage	Mean Mn	Mode Md	Median	Std. Deviation
V1: Practices and programs aimed at HR development	24.0%	3.72	4	4	1.774
V2: Reward system to enhance innovation behaviour and increase productivity	21.2%	4.10	5	4	1.791
V3: Task planning and employee/team perfor- mance monitoring system	20.2%	4.00	4	4	1.815

Table 4. presents the analysis of the relationship between the variables (V1, V2, V3) included in the hypothesis test using Spearman rank correlation. The aim is to demonstrate the relationship between developments that help increase employee motivation. According to the statistical test, it can be determined that there is a significant correlation between variables V1 and V2 at a significance level of $p=0.000 < 0.01$, $\rho = 0.479^{**}$, which indicates a linear and medium strong relationship. Since $p=0.000$, it can be concluded with a 99.9% probability level that there is a significant correlation between the introduction of practises aimed at employee development and the reward system designed for them that enhances their innovation behaviour and increases their productivity. Employee motivation can be increased proportionally to a moderate extent as a result of both measures. There is a significant correlation between variables V1 and V3 at a significance level of $p=0.000 < 0.01$, $\rho = 0.647^{**}$, which shows a linear and strong relationship. Since $p=0.000$, it can be concluded with a 99.9% probability level that there is a significant correlation between the introduction of practices aimed at employee development and the establishment of a task planning and employee/team performance monitoring system. Employee motivation can be significantly increased proportionally as a result of both measures. There is a significant correlation between variables V2 and V3 at a significance level of $p=0.000 < 0.01$, $\rho = 0.662^{**}$, which shows a linear and strong relationship. Since $p=0.000$, it can be stated with a 99.9% probability level that there is a significant correlation between the development of a task planning and employee/team performance monitoring system and the reward system designed for employees that enhances their innovation behaviour and increases their productivity. Employee motivation can be significantly increased proportionally as a result of both measures. In this light of this, the null hypothesis was rejected, and the validity of hypothesis H2 was confirmed.

Table 4: Hypothesis testing based on Spearman's rank correlation

			V1	V2	V3
Spearman's rho	V1	Correlation Coefficient	1.000	0.479**	0.647**
		Sig. (2-tailed)		0.000	0.000
		N	103	103	103
	V2	Correlation Coefficient	0.479**	1.000	0.662**
		Sig. (2-tailed)	0.000		0.000
		N	103	103	103
	V3	Correlation Coefficient	0.647**	0.662**	1.000
		Sig. (2-tailed)	0.000	0.000	0.000
		N	103	103	103
** Correlation is significant at the 0.01 level (2-tailed)					
V = Variable					
V1: Practices and programs aimed at HR development					
V2: Reward system to enhance innovation behaviour and increase productivity					
V3: Task planning and employee/team performance monitoring system					

Encouraging employees' innovation behaviour (Bindel Sibassaha *et al.*, 2025) and developing their competencies is a key factor in the success of innovations. The managerial attitude (Naparín & Astuti, 2025), the creation of an appropriate work environment (Avelar *et al.*, 2024; Karácsony *et al.*, 2025; Lesáková, 2014) and incentive system support the innovation efforts of enterprises. Dayan *et al.* (2024) specifically emphasize the leadership approach in promoting innovation activity and work environment favourable to innovation. It is important to provide training programs for employees that help them learn new things and break away from the usual. Yesuf *et al.* (2024), Juárez *et al.* (2024) and Janas *et al.* (2022) also hold a similar view. Menzies *et al.* (2025) also believe in the power of training and see the future in the development of a stable and loyalty-based HR management system. According to Shahini (2025), employee engagement is also an important factor in agricultural companies, which the employer can support and strengthen with modern incentives. Supporting and encouraging employees is essential for accepting changes and innovations. Our results also try to highlight that the leadership attitude towards motivating employees will be the key to strengthening and developing employees' innovative behaviour.

CONCLUSIONS

The economic and social importance of SMEs is unquestionable, which is also true of SMEs operating in the Hungarian agricultural sector. Researchers around the world use different approaches to examine the innovation behaviour of SMEs. However, we believe that there is still a scientific gap that is worth filling with scientific findings. In general, the willingness to innovate in post-socialist countries has lagged behind that of leading European countries. However, regardless of industry, economic activity and company size, pursuing an innovative and sustainable thinking and strategy is becoming increasingly important. In the research, we dealt with the change in the innovation activity of SMEs operating in Hungarian agriculture and the motivation of employees' innovation behaviour. A total of $n=103$ enterprises participated in the research. We believe that this sample size is satisfactory, as we are talking about a less accessible industry. However, it is important to note that one of the constant limitations of questionnaire surveys is reaching the target population, achieving an adequate and analysable sample size and data distortion. Results from a small sample cannot be generalized to an industry, but they can provide valuable information and start a scientific dialogue, encouraging researchers to address the topic more, even from different aspects. A significant proportion of employees work as manual workers, for whom innovation may be particularly important in order to modernise and facilitate their work. Based on the research, we found that enterprises evaluate their innovation behaviour differently. If they are currently engaged in innovative activities, this does not mean that they will continue to be so in the future. More than half of enterprises are stuck at a certain level of innovation, and it is hardly possible to predict how they will get beyond this level. Only 8% of enterprises stated that they would continue their innovation activities in the future. Our research also found that the development of employees' innovation behaviour and motivation can be enhanced depending on the incentive

systems, innovative practises, and training opportunities provided by managers. In the case of agricultural SMEs, it is also important that employees are committed, which ensures their positive attitude towards changes. Decision-makers and practitioners are concerned with promoting the innovation activity of SMEs at a global level. At the same time, experts from the scientific world also try to contribute to the development of the innovation activity of SMEs with the findings made during their studies. Research specialising in countries and industries examines the effectiveness of companies' innovation behaviour in different forms and levels. Future research will focus on issues of sustainability and artificial intelligence, which will also be reflected in companies' innovation efforts.

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