Studies in Agricultural Economics 127 (2025) 152-161 https://doi.org/10.7896/j.3109

SCIENTIFIC ARTICLE

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Do short food supply chains impact on efficiency of farms? Evidence from Poland and Czechia

ABSTRACT

Short food supply chains (SFSCs) are a model promoted among farmers in many countries. This model is popularised as an opportunity to increase the economic efficiency. However, the research results found in the literature are ambiguous. This study therefore aims to assess the impact of participation in short food supply chains on the productivity and efficiency of farms. Poland and the Czech Republic are taken as examples of countries with a contrasting agrarian structure and different size classes of farms are investigated. Primary data come from semi-structured face-to-face interviews conducted among 375 producers divided into two groups – participating and not participating in SFSCs. The indices of productivity and non-parametric data envelopment analysis (DEA) were applied to assess differences in efficiency for two groups mentioned above. It was demonstrated that in Poland small farms participating in SFSC achieve higher production efficiency than farms not participating in SFSC.

ARTICLE INFO

Keywords:
short food supply chains, farms, Poland, Czechia, productivity, efficiency

JEL classifications:
C14, D24, L22, N54, O13, Q13.

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Received: 28 October 2024; **Revised:** 6 August 2025; **Accepted:** 9 August 2025.

Introduction

The dominant position of large retail chains and global agri-food corporations – often resulting from extensive horizontal and vertical integration – has significantly weakened the bargaining power of farmers in conventional food value chains. In many agricultural sectors, such as seed production or food retail, a small number of international actors control key stages of the supply chain. This concentration of power leads to the separation of producers from consumers and marginalises farmers in the process of value creation. The length and complexity of traditional supply chains – with multiple intermediaries – further dilute the economic benefits for primary producers, who often receive only a small share of the final product value. As a result, farms have limited influence over the pricing of their raw materials or products, while most of the added value is appropriated by dominant intermediaries, including processors and retailers. According to transaction cost theory (Williamson, 1979), long and fragmented chains increase coordination and monitoring costs, and favour large, vertically integrated firms capable of managing these costs – leaving smaller farms at a disadvantage. In response to these structural inefficiencies and power imbalances, short food supply chains (SFSCs), also known as alternative food networks, have emerged as a viable model to re-embed food production in local contexts (Darlot *et al.,* 2016). SFSCs reduce the distance – both physical and relational – between producers and consumers, promote local economic development, and enhance the social embeddedness of food systems (Demartini *et al.,* 2017; Mundler and Jean-Gagnon, 2020). By limiting the number of intermediaries, they reduce transaction costs and allow farmers to retain a greater share of the added value, improving their economic resilience and restoring their role in the food system. Consequently, SFSCs represent not only a response to global market pressures but also a pathway toward more sustainable and equitable agri-food systems.

There is no universal definition of short food supply chains. Various typologies and classifications of SFSCs have been presented in literature (Darlot *et al.*, 2016; Matysik-Pejas *et al.*, 2017), and some of them are also reflected in legislation (Matysik-Pejas *et al.*, 2017). SFSCs are defined in Article 2 of Regulation (EU) No 1305/2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), which came into force with the reformed Common Agricultural Policy 2014-2020. According to this regulation, SFSCs

are defined as 'a supply chain involving a limited number of economic operators, committed to cooperation, local economic development and close geographical and social relations between producers, processors and consumers'. Participation in SFSCs appears to be an appealing instrument for increasing the competitiveness of farms in the agri-food market. The attractiveness of this sales model is evidenced, for example, by the fact that in 2015, 15% of EU farms sold more than half of their production directly to consumers (European Parliament, 2016). However, from the farmers' perspective, involvement in SFSCs entails both benefits and costs (Bauman *et al.*, 2019; Mancini *et al.*, 2019; Mundler and Jean-Gagnon, 2020).

Short food supply chains support sustainable development of agriculture and rural areas in the economic, social and environmental context (Michalský and Hooda, 2015). SFSC farms utilise land in ways that prioritises sustainability and community engagement. They often implement organic farming practices, enhancing soil health and biodiversity, which can lead to improved crop resilience (Tiwari, 2021). They also strive to use local and/or raw ingredients to emphasise the quality, freshness and healthiness of the prepared meals (Torok *et al.,* 2022). For smallholder producers, SFSCs reduce the uncertainty and risk associated with economic processes and allow for future income flows to be planned with greater predictability. Consequently, they can limit the farm's vulnerability and increase the farm's resilience to negative external factors. The shortening of supply chains enables the producers to adapt to crisis conditions (Berti and Mulligan, 2016). Moreover, as SFSCs are less integrated into international markets on the output side and are more oriented toward local production, they may be less affected by international trade disruptions such as pandemic crisis or broken supply chains (Van Hoyweghen *et al.,* 2021). The local nature of SFSCs also allows for the reduction of transaction costs in farm operations, including costs related to finding buyers, negotiating prices, and transportation (Collison *et al.,* 2019).

However, SFSCs are not without drawbacks. They may pose challenges for consumers, such as limited product variety, dependence on local production, and issues related to seasonality, which can affect both availability and prices (Kawecka and Gębarowski, 2015). SFSCs often require rapid and frequent deliveries, leading to increased transportation costs and logistical complexities. Many producers find that the demands of SFSCs, including flexibility and time commitments, can outweigh the economic benefits, resulting in lower profitability (Rucabado-Palomar and Cuéllar-Padilla, 2020). Producers engaged in SFSCs often face challenges such as lower labour productivity in production tasks, high workload due to multiple roles, and low net earnings despite significant effort. These factors can hinder both financial sustainability and overall farm viability (Mundler and Jean-Gagnon, 2020).

In our research, we aim to evaluate the impact of participation in SFSCs on the productivity and efficiency of farms in two countries with different agrarian structure. To the best of our knowledge, a research gap exists in this area. Studies that have attempted to assess the influence of "short" selling on the economic performance of farms are few, and their findings are inconclusive or ambiguous. For example, Chiaverina *et al.* (2021) found that farms participating in SFSCs were more likely to report higher incomes compared to farms selling through intermediaries. Raftowicz *et al.* (2024), based on a literature review, stated that short food supply chains support the sustainable development of rural areas but often conflict with farm economic efficiency, as price competition tend to favour longer supply chains. Filippini *et al.* (2023), on the other hand, underlined that the efficiency of SFSC remains a subject of debate, requiring further investigation into their economic benefits. These cases justify the need for additional research in this area.

Taking the above into account, the main aim of our study is to assess the impact of participation in short food supply chains on the productivity and efficiency of farms. Poland and the Czech Republic are taken as examples of countries with contrasting agrarian structures. A comparative analysis of two countries with different land structures make it possible to determine whether the impact of participation in SFSCs on farm efficiency is independent of, or dependent on, a country's agrarian structure. These dependencies are also examined across different farm size classes.

The paper is structured as follows: the next section presents spatial scope of the study and dataset used. Section 3 describes the methods applied. The following section presents the results of the productivity and efficiency analysis for farms participating and not participating in SFSCs in Poland and Czechia. Finally, the paper ends with a discussion and conclusions.

Territorial scope and data set

The selection of Poland and the Czech Republic for this study stems from a research project carried out by the authors. The project aims to investigate the impact of the post-pandemic economic crisis on the functioning of short food supply chains. The two countries covered by the study - Poland and the Czech Republic - differ significantly in terms of farm size structure. The Czech Republic has the largest agricultural farms in the EU, with an average utilised agricultural area (UAA) of approximately 130 hectares, whereas Poland is characterised by a predominance of small farms, with an average UAA of around 11 hectares.

Nearly 90% of farms in Poland have less than 20 hectares of UAA, compared to 55% in the Czech Republic. At the same time, farms with more than 100 hectares of UAA account for 1.1% of all farms in Poland and 17.3% in the Czech Republic (Eurostat, 2020). There is also a substantial difference in the total number of farms - 1.3 million in Poland versus 29,000 in the Czech Republic – as well as in production and added value per farm, which are approximately ten times higher in the Czech Republic. Moreover, the more intensive use of capital by Czech farms results in approximately four times lower labour input per unit of capital.

The differences in agrarian structure and the use production resources result from divergent approaches to land management during the systemic transformation processes

that took place in both post-communist countries. In Poland, land previously managed by the State Agricultural Farms was mostly transferred to another state agency (currently the National Support Centre for Agriculture) and subsequently leased to individual farms by this institution. In contrast, in the Czech Republic, agricultural land was allocated primarily to large cooperatives and state-owned enterprises (often transformed into companies), which continue to constitute the core production base of Czech agriculture (Stacherzak *et al.*, 2019).

Currently, more than 80% of agricultural land in the Czech Republic is held by farms exceeding 1000 hectares of UAA, compared to 23% in Poland. The structural divergence between the two countries' agricultural sector is also influenced by socio-demographic and political factors. In Poland, these conditions continue to support the quasi-social nature of many farms (Soliwoda *et al.*, 2017).

Primary data were collected through qualitative research based on semi-structured interviews conducted with representatives of agricultural enterprises and individual farmers, both involved and not involved in short food supply chains (SFSCs). The selection of respondents followed a purposive-random sampling strategy, combining snowball sampling with expert selection, based on the knowledge and experience of the research team members. These experts had in-depth knowledge of the regional context and maintained direct contacts with relevant stakeholders. This approach allowed for the inclusion of a heterogeneous sample of entities varying in size, legal form, production orientation, and degree of integration into local markets.

In each country, 200 farms were selected and divided into two groups: those participating in short food supply chains (SFSC farms) and those not participating (non-SFSC farms). After eliminating incomplete and incorrect responses, the final sample consisted of 375 farms - 192 in Poland (85 of SFSC farms and 103 of non-SFSC-farms) and 183 in the Czech Republic (107 and 80, respectively) (data available at https://doi.org/10.18150/7RSDKB). The research was conducted in 2023 and 2024.

The interviews were guided by a pre-defined interview protocol that encompassed thematic areas such as organisational structure, production systems, economic performance, and distribution strategies. Example questions includes: *What is the average daily working time on the farm (in hours)? Which systems do you use to sell your products? What percentage of your production (including on-farm processed agricultural products) is sold through each channel (e.g., direct farm sales, neighbourhood sales, bazaar and market sales, delivery to consumers' households, own retail shop, box system, delivery to external units such as local retail shops, restaurants, bars, educational institutions, hospitals)? What is the estimated value of the farm buildings, machinery, and equipment (in the event of a hypothetical sale)? What is the total annual value of agricultural production (including processed products)? What is the total agricultural land area (in hectares), including leased land?*

The semi-structured format allowed for a combination of standardised questions and open-ended segments, enabling in-depth exploration of context-specific issues. All interviews were conducted in person, with the informed consent of respondents, and subsequently transcribed into textual form. The resulting data were systematically entered into a respondent database, which includes basic characteristics of the entities as well as coded outputs from the interviews.

The main advantages of the chosen methodology include the flexibility of data collection, allowing adaptation to individual case specifics; the high validity of data resulting from direct interaction with respondents; and the potential for mixed-methods analysis. However, certain limitations must also be acknowledged, such as the limited representativeness of the sample due to the non-probability selection method, the time and resource intensity required to conduct and process the interviews, and the potential for selection bias stemming from the reliance on personal networks during respondent recruitment.

The average farm size in the research sample was 20.48 hectares of UAA for Poland and 286.0 hectares for the Czech Republic. These figures highlight significant differences in the agrarian structure of the two countries.

In terms of the farm specialisation, mixed farms – those combining animal production and crop production – were the most common in both Poland and the Czech Republic (30.3% in Poland and 28.1% in Czechia). In Poland, these were followed by farms specialising in pigs (11.4%) and cereal production (10.3%), whereas in the Czech Republic, cereal production (21.1%) and wine production (13.0%) were the next common specialisations. Overall, it can be concluded that livestock-oriented farms were more prevalent among Polish farms compared to those in the Czech Republic.

Methods

Data Envelopment Analysis (DEA) as method for calculating efficiency in research

The use of productive resources determines the outcomes of manufacturing activities, including agriculture. As early as the time of W. Petty, land and labour were considered as the primary factors of national wealth. Commodity prices are determined by the remuneration of production factors – namely labour, land and capital – which forms the basis of Smith's doctrine. This approach was later developed by J. B. Say, who acknowledge the value-creating roles of capital and land, thereby rejecting theories based solely on labour. This also applies to agricultural products. In lines with these theories, resources determine the value of production. Efficiency, in turn, describes how effectively a company transforms resource inputs into production outputs. Measuring efficiency is essential for assessing a company's economic performance and for comparing its level of efficiency with that of other entities.

DEA (Data Envelopment Analysis) and SFA (Stochastic Frontier Analysis) are two the most important methods for measuring the efficiency of units (e.g. farms, companies), but they differ in their approaches and underlying assumptions. SFA is parametric method, which means it requires specifying a particular functional form of the production function (e.g. Cobb-Douglas). As a parametric technique, it

relies on strict statistical assumptions, such as the normality of the error term distribution and equality of variance (homoscedasticity). If these assumptions are violated, the result may be biased, and in such cases, non-parametric methods may be more appropriate (see also Lambarraa-Lehnhardt *et al.,* 2022). DEA, on the other hand, is a non-parametric method that does not require specifying a production function or meeting strict statistical assumptions. It uses linear programming to construct an 'efficiency frontier' based on observed input-output data. DEA evaluates the relative efficiency of units without assuming a predefined functional form (Engebretsen and Na, 2023; Kang and Kim, 2018). In our study, the data did not follow a normal distribution, as confirmed by the Shapiro–Wilk test. Moreover, the purpose of the analysis was to compare the efficiency of farms participating in SFSCs with those not participating in the SFSCs. These factors justified the use of the DEA method in the analysis.

The DEA method was proposed by Charnes, Cooper and Rhodes in 1978 in the form of the so-called CCR model (Charnes *et al.*, 1978). It is an extension of Farrell's (1957) seminal work on the estimation of technical efficiency. DEA is used to measure the relative efficiency of selected units (e.g., farms) in cases where multiple inputs are used simultaneously to produce multiple outputs. This method enables the calculation of synthetic technical efficiency scores of the examined entities, ranging from 0 to 1, where a higher score indicates the higher technical efficiency (Coelli *et al.*, 2005). This is a major advantage over commonly used partial efficiency indicators, such as fixed asset efficiency, land productivity, or labour productivity.

Another important advantage of DEA in agricultural efficiency analysis is its ability to handle inputs and outputs with different units of measurement. In practice, units are rarely described by just one input and one output, and input and output values are not always expressed in monetary terms. DEA overcomes this challenge by defining relative efficiency as the ratio of the weighted sum of outputs to the weighted sum of inputs. This relative efficiency is calculated within a specific set of units (in our case, farms). The ability to use heterogeneous inputs and outputs expressed in different units is one of DEA's greatest strengths, and this is the reason why it was applied in our analysis.

Research design

In the first stage of the analysis, land, capital, and labour inputs and their productivity were compared between farms participating in SFSCs and those not participating, across two countries simultaneously. The study defined SFSC-participating farms as those employing the following distribution methods: direct on-farm sales, neighbourhood sales, sales at bazaars and markets, home delivery to consumers, own retail outlets, delivery to external entities (such as local shops, restaurants, bars, educational institutions, or hospitals), and box schemes. Farm owners were asked what percentage of their production was sold through these channels. However, the analysis did not differentiate between the specific SFSC channels used. To be classified as participating in SFSCs, a farm had to sell at least 51% of its agricultural production through the aforementioned channels. The production value included both raw and processed goods.

In Poland, as many as 91.49% of farms that declared using various SFSC channels sold 100% of their production via these channels. The remaining farms sold, on average, 88% of their production through SFSCs. In the Czech Republic, the proportion of farms that sold their products exclusively through the aforementioned SFSC channels was lower than in Poland—58.70%. The remaining SFSC-participating farms sold, on average, 83% of their output via SFSC channels. In both Poland and the Czech Republic, direct sales from the farm and neighbourhood sales were by far the most common distribution method, followed by market or bazaar sales. It is also worth noting that in Poland, the farm with the lowest share of SFSC channel sales among those classified as SFSC participants still sold 60% of its production through these channels. The same minimum share was recorded in the Czech Republic—60%. Therefore, it can be concluded that the sample of farms classified as participating in SFSCs in both countries consisted of farms in which SFSC sales clearly predominated.

Table 1: Description of variables used in the study

Variables	Description
Agricultural production	Total agricultural production per year (PLN or CZK); includes both raw and processed agricultural products
Land	Total utilised agricultural area (UAA in hectares); includes both owned and leased agricultural land
Capital	Average annual expenditures on chemical fertilisers (PLN or CZK respectively) + Average annual expenditures on plant protection products (PLN or CZK) + Value of buildings, machinery, tools, etc. (PLN or CZK)
Labour	Total work performed on own farm (related to agriculture) in hours per year = Farmer's agricultural work + Partner's agricultural work + Other family members' work related to agricultural activities

Source: Own elaboration

To determine differences in input productivity between Polish and Czech farms, productivity indicators for Czech farms were expressed in both CZK and PLN. The exchange rate used for the conversion was that of 20 February 2025, i.e., 1 CZK=0.17 PLN. Table 1 provides a detailed description of the variables used in the study. The selection of input and output variables used to measure efficiency was based on a review of previous studies in which authors assessed efficiency in the agricultural sector. For example, Čechura *et al.* (2014) used labour (measured in AWU[1]), land (measured as total utilised agricultural area), and capital (measured as capital depreciation) as input variables to assess the technical efficiency of farms in EU countries. The output variable in their research was the total agricultural production of the farm. The output consisted of the value of pig production, while the inputs variables included labour, buildings and

[1] Annual work unit (AWU) represents full-time equivalent employment, calculated as the total hours worked divided by the average annual hours worked in full-time jobs in the country. One AWU corresponds to the work performed by one person engaged full-time on an agricultural holding. For reference, 1 AWU = 1,800 hours (Eurostat, 2025).

variable inputs (defined as the sum of feed costs—mainly concentrates—and veterinary services). Identical output and input variables to those used in our study were employed by Syp and Osuch (2018) where they used total farm output (in PLN) as the output variable, and the following as inputs: utilised land (in hectares), labour (in hours), intermediate consumptions, and total assets (in PLN).

Because the inputs and outputs were measured in different units (hectares, PLN, hours), and the range of their values varied widely, variable normalisation was applied. The min–max normalisation method was used (see Formula 1), which scaled each variable to a common range between 0 and 1.

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$$x\ norm = \frac{x - x\ min}{x\ max - x\ min} \quad (1)$$

where:
x norm – normalised value
x – original value
x min – minimum value in the data set
x max – maximum value in the data set

The productivity indicators used are partial, attributing all production to a single input (land, capital, or labour), which constitutes a significant simplification of reality. Therefore, in our analysis, we employed the Data Envelopment Analysis (DEA) method to assess the relationship between output and all inputs involved in production. Farm efficiency – separately for Poland and Czechia – was evaluated using input-oriented DEA models with variable returns to scale (VRS). To determine the optimal production technology for the farms, we applied the following formula (Cooper *et al.,* 2007):

$$P\ (x,y) = \{\ x_j \Rightarrow X\lambda_j, y_j \Leftarrow Y\lambda_j, \lambda_j \Rightarrow 0,\ \textstyle\sum_{j=1}^{n} \lambda_j = 1\} \quad (2)$$

where:

P (x,y) – set of production capabilities in the farm samples under study,
x_j – input vector m (labour in hours, land in ha of UAA, total assets in PLN or CZK) on the j-th farm;
X – input matrix (labour in hours, land in ha of UAA, total assets in PLN or CZK) sized (n*m) for all n farms;
y_j – output vector s (agricultural production in PLN or CZK) on the j-th farm;
Y – output matrix (agricultural production in PLN or CZK) sized (n*m) for all n farms;
λ_j – weights, which are the coefficients of the linear combination.

The construction of the production capacities set separately for Polish and Czech farms allowed us to measure the distance between the best-performing farms – representing optimal technology – and the remaining farms. This relationship is reflected by the following formula:

$$E(x_j, y_j) = \min\ \{\theta : \theta x_j,\ x_j\ \in P\ (x,y)\} \quad (3)$$

where:
$E\ (x_j, y_j)$ – function of distance between the point characterising the technology of j-th farm and the optimum technology (envelope);
θ – efficiency coefficient of the j-th farm;
$P\ (x, y), x_j, y_j,$ – as in formula 1.

The calculated technical efficiency indicators express how effectively land, capital, and labour inputs are transformed into final output, measured as total agricultural production. Technical efficiency scores estimated using the DEA method range from 0 to 1 and indicate the extent to which a given farm should proportionally reduce its inputs (i.e., land, labour, and capital) without changing its output (agricultural production), in order to achieve full efficiency (i.e., a score of 1).

In the next stage, farms were divided into four land-size classes separately for Poland and the Czech Republic. The classification was based on quartiles calculated independently for each country (Poland and the Czech Republic), ensuring that each class contained a similar number of farms. Subsequently, we compared the efficiency indicators for farms participating and not participating in SFSCs, both across the entire samples from Poland and the Czech Republic and within each land-size class. This approach allowed us to analyse the relationship between farm size and efficiency of SFSC farms and non-SFSC farms in two countries with different agrarian structure. It is worth noting that in Poland, the minimum and maximum farm size in the sample ranged from 1 to 75 hectares, whereas in the Czech Republic they ranged from 1 to 5,000 hectares. It highlights the significant differences in agrarian structures between the two countries (see section Territorial scope and data set). The land-sized classes for Poland and the Czech Republic are presented in Table 2.

Table 2: Farm area classes* for Poland and Czechia

Size class	Area range (ha of UAA) and number of farms (in brackets)	
	Poland	Czech Republic
Small	1–10 (52)	1–15 (45)
Medium-small	11–15 (46)	16–60 (46)
Medium	16–25 (48)	61–200 (46)
Big	26–75 (46)	201–5,000 (46)

* The classes were established to ensure that each contained a similar number of farms.
Source: Own elaboration

Since the survey samples in Poland and the Czech Republic did not meet the assumption of normality and equality of variances, a non-parametric Mann-Whitney U test was used to assess the significance of differences between the means

of the two independent samples, i.e., SFSC-farms and non-SFSC-farms, and farms across different area classes. STATA software was applied for the calculation.

Results

Inputs and their productivity in farms participating and not participating in SFSCs

We compared the size of inputs and production outcomes between farms participating in short food supply chains and those that do not. In both Poland and Czechia, the average values of agricultural production, capital, and land inputs were lower among SFSC-participating farms. Conversely, labour inputs were higher in SFSC-participating farms. However, statistically significant differences were found only for land and capital inputs (Table 3). This suggests that SFSC-farms operate on smaller areas of agricultural land and utilise lower capital inputs—differences that are statistically significant.

Next, partial productivity indicators were calculated. The data presented in Table 4 reveal significant differences in the types of agricultural intensification between the two countries. In the Czech Republic, both SFSC and non-SFSC farms exhibited higher labour productivity. In contrast, Polish farms demonstrated higher capital productivity. This suggests that agriculture in the Czech Republic is more capital-intensive – requiring substantially higher capital inputs – while being less labour-intensive compared to Poland.

Our research findings are consistent with broader structural trends in European agriculture. Poland is among the EU countries with the highest share of employment in agriculture—more than twice the EU average. At the same time, it ranks among the EU countries with the lowest labour productivity in the sector. In contrast, Czechia is one of the EU countries with the lowest proportion of people employed in agriculture (Ossowska and Janiszewska, 2018). According to Eurostat (2025), in 2022, 8.4% of Poland's total workforce was employed in agriculture. Meanwhile, in 2019, only 2.3% of the economically active population in Czechia worked in agriculture and forestry (Vaishar and Šťastná, 2020). These figures reflect two distinct models of agricultural development: the Czech Republic's model is oriented toward industrial farming, characterised by large-scale operations and high capital investment in machinery and infrastructure. In contrast, Poland's agriculture remains dominated by small-scale, family-run farms (Soliwoda *et al.,* 2017). In general, family farms attach greater importance to the efficiency of labor allocation, while large agricultural corporations focus on improving the efficiency of agricultural capital allocation (Dong, 2023). These structural differences were also confirmed by the results of our study.

In the case of land productivity, SFSC-farms in the Czech Republic recorded higher values, whereas in Poland, non-SFSC farms achieved better results. Thus, the cross-country comparison for this variable yields ambiguous conclusions. However, when comparing SFSC and non-SFSC farms within each country, land productivity was significantly higher among SFSC-farms – this difference was statistically significant in both Poland and Czechia. Labour productivity, on the other hand, was higher in non-SFSC farms, although the difference reached statistical significance only in the Czech Republic. Conversely, capital productivity was higher among SFSC-farms, but this difference was not statistically significant.

The observed differences in efficiency in favour of farms participating in short food supply chains (SFSCs) may stem from the specific economic model underpinning SFSCs, which supports local economies by reducing transportation costs and fostering direct sales – factors that can enhance the profitability of participating farmers (Petropoulou and Paschou, 2022). As highlighted by numerous researchers, co-creation is a key feature of the SFSC model. According to Thomson *et al.* (2023), co-creation within SFSCs involves a transformation of the selling and buying process, whereby participants – including consumers – become "co-producers," actively engaging in the design, planning, retailing, and

Table 3: Inputs and production value for SFSC and non-SFSC farms in Poland and Czechia

Participation in SFSCs	Inputs			Output
	Land (ha of UAA)	Labour (hours)	Capital (PLN)	Agricultural production (PLN)
	Poland			
Yes	14***	5,743	839,278**	209,356
No	20	5,302	1,007,012	225,296
p-value	<0.001	0.210	0.009	0.356
	Czech Republic			
Yes	220***	5,686	6,2196, 405*	2,127,993
No	372	4,286	8,110,819	3,640,011
p-value	<0.001	0.114	0.018	0.102

Note: Significant at: ***p < 0.001; **p < 0.05; *p < 0.10
* The exchange rate used for currency conversion was 1 CZK = 0.17 PLN, based on the rate from 20 February 2025.
Source: Own elaboration based on own survey

Table 4: Productivity of SFSC and non-SFSC farms in Poland and Czechia

Participation in SFSCs	Output per 1 unit of input (productivity)		
	Agricultural production to land (PLN/ha of UAA)	Agricultural production to labour (PLN/1 hour of work)	Agricultural production to capital (PLN/PLN)
	Poland		
Yes	24,973.21**	41.85	2.26
No	13,524.60	60.70	0.29
p-value	0.002	0.158	0.223
			Czech Republic
Yes	8,402.74***	547.63*	0.08
No	12,475.70	961.72	0.06
p-value	<0.001	0.013	0.825

Note: Significant at: ***p < 0.001; **p < 0.05; *p < 0.10
* The exchange rate used for currency conversion was 1 CZK = 0.17 PLN, based on the rate from 20 February 2025.
Source: Own elaboration based on own survey

Table 5: DEA efficiency of SFSC and non-SFSC farms by farm size class in Poland and Czechia (including share of SFSC and non-SFSC farms, %)

Area class:	Poland			Czech Republic		
	DEA efficiency indicators and participation in SFSC (yes/no)					
	Yes	No	p-value	Yes	No	p-value
Small	0.280* (65%)	0.200 (35%)	0.078	0.443 (80%)	0.251 (20%)	0.138
Medium-Small	0.151 (41%)	0.135 (59%)	0.89	0.221 (61%)	0.146 (39%)	0.919 (54%)
Medium	0.379 (42%)	0.300 (58%)	0.727	0.218 (46%)	0.200	0.242
Big	0.130 (26%)	0.218 (74%)	0.826	0.181 (39%)	0.137 (61%)	0.558
Total	0,445*** (44%)	0,310 (56%)	0,002	0.310 (56%)	0.220 (44%)	0.147

Note: Significant at: ***p < 0.001; **p < 0.05; *p < 0.10
Source: Own elaboration based on own survey

collaborative creation of outcomes. Similarly, Umaran *et al.* (2022) emphasise that SFSC participants often engage in the joint definition and planning of services and outputs.

SFSCs represent innovative food systems – such as farmers' markets, on-farm sales, food box delivery schemes, online sales, and pick-your-own arrangements – that are open to collaboration and inclusive of a diverse range of actors, including consumers, retailers, market organisers, and producers (Charatsari *et al.,* 2019). This collaborative nature of SFSCs contributes to increased profitability through co-creation. Moreover, the shortening of food supply chains, as an alternative food practice, aligns with the concept of a "quality turn" (Goodman *et al.,* 2012). This shift reflects a movement away from rigid quality criteria such as price, standards, and trademarks toward softer quality attributes rooted in trust, community, and tradition. These processes collectively contribute to cost reduction and improved efficiency among farms participating in SFSCs.

Efficiency of SFSC and non-SFSC farms and by farm size classes

This section presents the DEA (Data Envelopment Analysis) efficiency results for farms in Poland and the Czech Republic. In both countries, the average efficiency scores were higher for farms participating in short food supply chains (SFSCs) compared to those that were non-participating. However, this difference was statistically significant only in the case of Poland (Table 5). When the analysis was disaggregated by farm size classes, statistically significant differences were observed only among small farms in Poland – defined as those with an area between 1 and 9 hectares.

Additionally, the results indicate that the share of farms participating in SFSCs declined as farm size increased in both countries. This suggests that farmers in both Poland and the Czech Republic tend to view participation in short supply chains as more suitable for smaller farms, likely due to the perceived potential for improving their economic performance. In this context, the decision of small-scale farmers in Poland to engage in SFSCs can be considered economically rational.

Discussion

The work of Chiaverina *et al.* (2021), based on a review of 48 studies examining the impact of SFSCs on farm productivity, found that approximately 54% reported a positive effect on farm economic performance, while 46% observed no effect or, in some cases, a negative impact. In our study, a positive impact of participation in SFSCs was evident primarily among the smallest farms in Poland. For larger farms – those with 11 hectares or more – the relationship was not statistically significant. These results clearly indicate that the beneficial effect of participation in short food supply chains on economic outcomes, measured here by efficiency, is most pronounced for the smallest farms in Poland. Thus, our findings demonstrate that the impact of participation in SFSCs on the efficiency of the smallest farms is influenced by the agrarian area structure. A positive effect was observed in Poland – a country with a highly fragmented agrarian structure – while no such effect was found in the Czech Republic, which has the largest average farm size among all EU member states. For reference, the average farm size in the EU is 12 hectares, with the Czech Republic averaging 152 hectares, and Romania and Cyprus having the smallest farms, averaging just 3 hectares (Popescu, 2013). These differences suggest that the structure of land ownership and farm size plays a crucial role in shaping the relationship between participation in SFSCs and farm economic performance. Therefore, any general assessment of the economic impact of SFSC participation must consider national variations in agrarian structure.

The results of our study can also be compared with findings from other countries. For instance, Cesaro *et al.* (2020) reported a positive relationship between participation in SFSCs and economic performance in countries such as Greece, Slovenia, and Croatia. Notably, these countries – like Poland – are characterised by an agrarian structure dominated by small farms. By focusing on local markets, SFSCs can help mitigate inefficiencies associated with land fragmentation and contribute to the ecological and economic sustainability of farming practices. However, small-scale farmers often face significant challenges, including high transaction costs and production risks, which require cooper-

ative solutions. By fostering collaboration among producers and other stakeholders, SFSCs have the potential to enhance the competitiveness of small farms. This is particularly important for improving efficiency in the agricultural sector in countries with fragmented agrarian structures.

Dries *et al*. (2004) argue that effective participation in long food supply chains requires advanced production knowledge, access to specialised technical equipment, and adherence to private standards imposed by large agribusinesses. These requirements are often difficult for small farms to meet, making participation in SFSCs a more accessible and appealing alternative. Within long supply chains, small-scale producers typically have little or no influence over pricing, with the majority of added value captured by intermediaries. In contrast, short food supply chains offer farmers greater control over pricing and reduce their vulnerability to market volatility. As noted by Berti and Mulligan (2016), SFSCs offer a degree of protection against the negative economic consequences of market volatility, which are often experienced in conventional, intermediary-dominated food supply chains.

Our results align with the findings of Chiaverina *et al*. (2021), who emphasised that farming systems differ across countries and continents, and these structural differences influence the economic performance of farms participating in SFSCs. This highlights the importance of carefully selecting countries for analysis, as the national context may significantly shape the outcomes. Another key factor influencing research results is the duration of the study. Farmers entering SFSCs typically require several years to achieve profitability, as participation involves initial investments and the gradual development of a stable customer base (Dono *et al.,* 2022). According to Chiffoleau and Dourian (2020), farms engaged in short food supply chains can attain higher incomes than those relying solely on long chains, but this advantage tends to materialise only after 5–7 years of participation. Consequently, studies based on short-term data may underestimate the potential benefits of SFSCs. Our findings should therefore be treated as preliminary, and broader generalisations will require longitudinal research extending beyond a single year.

It is also important to note that other researchers, such as Enthoven and Van den Broeck (2021), based on an extensive literature review covering studies from Europe and North America, found that most analyses examined the economic performance of farms that sold at least a portion of their production through SFSCs. However, these studies often lacked direct comparisons with farms that did not participate in short supply chains. As a result, it remains difficult to accurately assess the economic differences between SFSC and non-SFSC farms or to isolate the effect of SFSC participation on farm performance. Our study addresses this gap by directly comparing the two groups, thereby contributing valuable insights to the literature on the economic impacts of SFSCs.

Conclusions

Small farms, measured by area size, tend to achieve higher land productivity and production efficiency through participation in SFSCs in countries with a fragmented agrarian structure, such as Greece, Slovenia, Croatia, and Poland. Therefore, the perspective commonly presented in the literature – that the SFSC model primarily targets smaller farms – should be viewed positively. It enables producers to improve their efficiency alongside conventional, long supply chains that dominate the food market. This dynamic is expected to enhance farm efficiency in countries with fragmented land ownership, thereby contributing to the increased competitiveness of agriculture in these regions.

As noted, SFSCs are closely linked to traditional, local products. Supporting initiatives within the framework of the EU Common Agricultural Policy (CAP) that promote local food, foster cooperation between consumers and producers, and encourage the formation of cooperatives and producer associations can significantly contribute to the expansion of the SFSC model. Such support is likely to enhance the efficiency of smaller farms in rural areas, especially in countries where family farming predominates. Collaboration among stakeholders can be further strengthened through industry meetings, training sessions, exhibitions, and the creation of networking opportunities. By backing these initiatives, EU agricultural policy can facilitate broader adoption of the SFSC model among small-scale farms.

Additionally, local leaders engaged in SFSCs can play a crucial role in promoting this business model within rural communities. By setting a positive example, they can encourage other farmers to adopt the SFSC approach. Financial support for farm visits and meetings with these pioneering farmers – targeted at those interested in joining SFSCs – should be considered under the EU Common Agricultural Policy. Ultimately, fostering participation in SFSCs through such initiatives may enhance the efficiency of smaller, family-owned farms across the EU, aligning with the EU's sustainable development goals.

Institutional support for SFSCs is further justified by the environmental and social benefits for local economy associated with this model. Environmentally, SFSCs contribute to lower greenhouse gas emissions due to shorter transportation distances, reduced packaging, and limited storage requirements. Socially, they promote increased trust between consumers and producers and help preserve and popularise local food traditions and cultural practices, thereby strengthening regional economies.

Acknowledgments

The research was financed by GACR 22-04055L, the Czech Republic and National Science Centre, Poland, under the OPUS-22 LAP call in the Weave programme, grant no. 2021/43/I/HS4/01090 titled "Small farms and short food supply chains under economic crisis - evidence from COVID-19 pandemic".

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Studies in Agricultural Economics 127 (2025) 162-173 https://doi.org/10.7896/j.3123

SCIENTIFIC ARTICLE

Marii JÄRVE and Evelin JÜRGENSON

From Small Farms to Large Holdings: The Growing Land Disparity in Estonian Agriculture

ABSTRACT

Rather than supporting small agricultural households and rural communities, governments frequently prioritise top-down, extractive, and resource-intensive approaches to agricultural development. This tendency promotes the expansion of large agricultural holdings, which increasingly undermines the viability of smaller farms. As access to land becomes more difficult and land-related inequality escalates, concerns regarding the sustainability of rural communities intensify. It is crucial for all stakeholders – policymakers, agricultural economists, researchers, and those involved in rural development and land use policies – to acknowledge their responsibilities and address these urgent issues proactively. This study employs the Gini coefficient to examine the fairness of accessibility to agricultural land use at the county level in Estonia. The findings indicate a decline in the number of agricultural households, coinciding with a rapid increase in the average land utilised per holding. Larger agricultural holdings are expanding their use of agricultural land, while smaller holdings are experiencing a reduction in their share. As of 2023, just 1% of all agricultural holdings in Estonia managed to utilise 31% of the total agricultural land area, whereas 74% of holdings accounted for only 9% of the area. These results underscore the pressing need to address issues of land concentration and inequality, underscoring the necessity for substantial changes in political, economic, and legal frameworks to ensure a fair and sustainable distribution of agricultural land.

ARTICLE INFO

Keywords:
land concentration, agricultural land use, land inequality, Gini, Estonia

JEL classifications:
Q1, R110, R140.

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Received: 11 April 2025; **Revised:** 1 August 2025; **Accepted:** 12 August 2025.

Introduction

Global land prices have doubled over the past 15 years, leading to a substantial increase in land inequality. Currently, the top 1% of farms control 70% of the global farmland, and in most countries, this trend continues to worsen (IPES-Food, 2024). Land is a finite and essential resource that is deeply intertwined with the lives of societies and individuals. Moreover, there is an increasing demand for land that is not related to food production (Alexander *et al.,* 2015). The management and control of land have profoundly shaped economies, political structures, communities, cultures, and beliefs of nations and their people for thousands of years. In rural areas, access to land has historically been – and remains – a crucial factor determining life opportunities (Boberg-Fazlić *et al.,* 2024). Many rural labourers face widespread landlessness, and those who do have access to land often possess insecure land rights (Franco and Borras Jr., 2021). Researchers indicate that regions with greater land inequality tend to experience higher rates of emigration (Boberg-Fazlić *et al.,* 2024).

The finite nature of land supply, which serves as the primary resource for farmers, distinctly sets agriculture apart from other economic sectors. Agricultural land plays a critical role in food production, making land policy decisions pivotal to food security and international competitiveness. Research by Moreno-Pérez *et al.* (2024) indicates that small-scale agricultural producers and local food businesses are particularly effective in enhancing food security by offering high-quality, healthy, and sustainable food options.

Land concentration refers to the accumulation of significant tracts of land under the control of a limited number of entities (Jürgenson and Rasva, 2020). This phenomenon raises critical concerns across social, economic, and environmental dimensions. Socially, land concentration often leads to the displacement of small agricultural households and rural communities, diminishing their access to land and livelihoods (Korthals Altes, 2022). Moreover, as land becomes commodified and comes under the control of absentee owners or corporations, traditional land-based cultures and community ties often weaken (Park and Deller, 2021). High levels of land inequality are associated with decreased access to education, credit, and political representation for marginalised groups, further exacerbating social tensions (Yunus *et al.,* 2024).

Research conducted by Bauluz *et al.* (2020) indicates that land inequality significantly impedes investment in education and financial development, ultimately reinforcing

poverty traps and institutional stagnation. The concentration of landownership curtails access to productive assets, thereby limiting opportunities for entrepreneurship and upward mobility among rural communities (Bauluz *et al.,* 2020). The dominance of large landholders can drive up land prices and create barriers to fair competition, making it increasingly difficult for new entrants to access land (Rasva and Jürgenson, 2022). Furthermore, when land is held by non-local investors or utilised for speculative purposes, local economic development and job creation are adversely affected (European Economic and Social Committee, 2015).

Several environmental risks associated with land concentration must be taken into account. Larger agricultural holdings often prioritise intensive monoculture farming, which can result in a decline in biodiversity and the degradation of ecosystems (Burja *et al.,* 2020). Industrial agricultural practices, characterised by concentrated land use, contribute to soil erosion, water pollution, and deforestation (King *et al.,* 2023). Furthermore, absentee ownership or short-term leasing can hinder sustainable land management, as long-term ecological concerns are often overlooked (Merlet, 2020).

Contemporary agricultural production aims for high efficiency at low cost (Arslan *et al.,* 2019), often resulting in increasing land inequality. The trend, characterised by a diminishing number of households controlling larger tracts of land, poses significant challenges for those dependent on land for their livelihoods (Binswanger-Mkhize *et al.,* 2009). The unequal distribution of agricultural land creates a disconnect between rural communities and their land resources (Korthals Altes, 2022). Research indicates that a more equitable land distribution can foster fairer societies with fewer land-related conflicts, thereby supporting sustained growth and development (Binswanger-Mkhize *et al.,* 2009; Herrera and Guglielma da Passano, 2006; Wegerif and Guereña, 2020). Moreover, when a small fraction of the community controls agricultural land, it diminishes the influence of other community members over its utilisation (Korthals Altes, 2022). Studies reveal that communities with a higher proportion of farmers as a primary occupation tend to experience enhanced overall well-being (Park and Deller, 2021). Even in communities that are less reliant on agriculture, high levels of land inequality can undermine democracy, social cohesion, and environmental health (Binswanger-Mkhize *et al.,* 2009). Recent studies (Bilewicz and Bukraba-Rylska, 2021; Dunlap, 2020; Korthals Altes, 2023; Nowack *et al.,* 2023; Rasva and Jürgenson, 2020) indicate that larger agricultural holdings are expanding, while most small agricultural holdings struggle to access sufficient productive land. Rather than supporting small agricultural households and rural communities, governments worldwide are promoting top-down, resource-intensive development models (IPES-Food, 2024).

Land is essential for the livelihoods of rural communities, with small agricultural households serving as the foundation of rural life (Tomson, 2007). However, as land prices in Central and Eastern Europe have tripled, many of these small agricultural households are rapidly disappearing from the European countryside (IPES-Food, 2024). This situation has raised significant concerns regarding the sustainability of rural communities.

Rural life and agriculture in Estonia are increasingly confronting significant challenges, with recent trends indicating a growing concentration of agricultural land (Jürgenson and Rasva, 2020; Rasva and Jürgenson, 2020, 2022). Consequently, agricultural land prices are rising, and larger companies are progressively acquiring and utilising the land (Rasva, 2023). This trend towards land concentration is resulting in a more polarised land and agri-food system, creating widening disparities between the smallest and largest landholders. Younger generations are encountering considerable obstacles in accessing land and entering the agricultural sector (IPES-Food, 2024). The reluctance of younger individuals to engage in agricultural production is expected to further intensify the trend of increasing farm size and a decline in the number of agricultural households, a pattern that is typical of European and Estonian agriculture as a whole (Raggi *et al.,* 2013; Zagata and Sutherland, 2015). Land, a precious resource and source of sustenance, also carries symbolic meaning for individuals, who often form deep personal connections with it, thereby contributing to the identity of local communities (Jänicke and Müller, 2024).

Understanding agricultural land concentration in Estonia requires an engagement with broader theoretical perspectives on land inequality and rural development. Ricardo's theory of rent highlights the economic power derived from land scarcity and productive differentials, framing rent as unearned income that can exacerbate social stratification. Marx's agrarian critique extends this argument by contending that concentrated land ownership is a fundamental factor that perpetuates rural class divisions and hinders equitable development, thereby advocating for redistributive reform (Finn, 2024). Harvey's theory of accumulation by dispossession elucidates how land becomes concentrated through legal and institutional mechanisms that often marginalise smallholders (Das, 2017). A multidimensional approach to land inequality considers not only land size of the land but also tenure security, land value, access to benefits, and control over its use (Borras Jr *et al.,* 2020). This framework recognises that inequality may persist beneath superficial metrics, such as average plot sizes, and complements the empirical application of Gini coefficients by providing a more nuanced interpretation.

The trajectory of rural development is both influenced by and influences land distribution patterns. Modernisation theory suggests a linear progression from traditional agriculture to industrial productivity; however, its urban-centric assumptions frequently overlook rural agency of rural communities and the context-specific challenges they face (Rostow, 1960). Structural change theory, particularly the Lewis model, anticipates a shift of labour from agricultural activities to higher-productivity sectors (Ansari, 2020). Nevertheless, in the Estonian context, demographic changes and land market dynamics suggest more complex transitions that cannot be explained solely by labour migration.

Dependency theory sheds light on how external economic pressures and historical legacies can shape land concentration (Frank, 1967). Building on this, the sustainable livelihoods approach (Chambers and Conway, 1992)

and the concept of new rurality (Kay, 2008) offer bottom-up perspectives that highlight household strategies, asset portfolios (including land), and adaptive capacities. These frameworks also acknowledge the multifunctionality of rural areas and the increasingly fluid boundaries between urban and rural environments.

Agriculture in Estonia has experienced a significant structural transformation over the years. Since 1919, five major land reforms have profoundly influenced Estonian agriculture. The first reform in 1919 aimed to redistribute land, which was primarily owned and utilised by large farms, predominantly by Baltic Germans, to the peasant class (Jürgenson, 2017). During the interwar period, family farming became increasingly prevalent and played a crucial role in Estonia's agricultural landscape (Grubbström and Sooväli-Sepping, 2012).

In 1940, the Soviet Union occupied Estonia and implemented a new land reform. However, in 1941, Germany took control of Estonia, resulting in the cancellation of the Soviet-initiated reform. After three years, the Soviet Union reoccupied Estonia. It resumed the land reform process, which involved the abolition of private ownership and a shift from small-scale farming to large-scale collectivisation (Hedin, 2005). The prolonged occupation by foreign powers for over fifty years significantly disrupted Estonian rural life prior to 1940, leading to a decline in village communities. During this time, family farming decreased to small-plot farming (Grubbström and Sooväli-Sepping, 2012), which played a crucial role in preserving people's farming experiences during the Soviet period (Abrahams, 1996).

In 1991, Estonia's land reform initiated the dissolution of collective farms, resulting in the distribution of private farmland among numerous landowners, many of whom had little prior involvement in agriculture (Jürgenson, 2017). It was observed that these landowners were committed to preserving family land, despite the impracticality of resuming farming (Holt-Jensen and Raagmaa, 2010). The situation created a divide between commercially focused farms and those farms oriented toward lifestyle or environmental stewardship (Viira *et al.,* 2020). The collapse of the Soviet Union left rural areas with infrastructure poorly adapted for small-scale farming development (Sørensen, 2004), and Estonian village life never fully recovered. Although the trend of migrating to large cities has stabilised in recent years, rural areas have not seen significant benefits from this shift, as families with children increasingly favour small towns on the outskirts of larger cities (Mändmets and Kärk, 2022; Samarüütel *et al.,* 2010).

In the three decades following independence, Estonia has experienced a concentration of agricultural land use within larger households. Monitoring the changes in agricultural land use across Estonia is vital to assess whether the country is moving towards increased inequality in land distribution among agricultural households or if conditions have improved. This paper explores the fairness of agricultural land distribution across various sizes of agricultural households.

Data and Methods

Study Area and Statistical Data

The study area of this research is Estonia, focusing on agricultural land users' holdings, which include all plots utilised for agricultural production across the country. No distinction is made between owned and leased land. Statistical data was sourced from Statistics Estonia[1], while data for agricultural producers' holdings was obtained from the Estonian Agricultural Registers and Information Board (ARIB). Spatial data regarding Estonian counties was obtained from the Estonian Land Board[2]. The data from Statistics Estonia was used to analyse changes in agricultural land use in Estonia, which included details about the number of agricultural households and the area of utilised agricultural land. The dataset spans from 2001 to 2023, covering the years 2001, 2003, 2005, 2007, 2010, 2013, 2016, 2020, and 2023.

The study utilised the data from the Agricultural Registers and Information Board (ARIB) to analyse shifts in agricultural land use across Estonia and its counties between 2011 and 2023. Using GIS software (ArcGIS Pro), agricultural producers were categorised into six groups based on the size of their landholdings: 0–<2 ha, 2–<40 ha, 40–<100 ha, 100–<400 ha, 400–<1000 ha and >1000 ha. The data was analysed according to these size groups. This classification comes from the Farm Accountancy Data Network (FADN), which initially grouped agricultural land area into four size groups (0–<40 ha, 40–<100 ha, 100–<400 ha, >400 ha). To gain a more detailed understanding of the smallest agricultural land users, the FADN size group 0–<40 ha was subdivided into 0–<2 ha and 2–<40 ha. Likewise, the FADN group of >400 ha was split into two groups 400–<1000 ha and >1000 ha to better characterise the largest agricultural land users. This methodology has previously been employed to analyse changes in agricultural land use in Estonia (Rasva and Jürgenson, 2020, 2022).

The ARIB data layer was combined with the county layer from the Estonian Land Board to assess agricultural land use changes at the county level. Spatial information was linked to land plots to investigate structural changes in agricultural holdings categorised by size groups within each county.

Gini Coefficient

Estonia has undergone significant transformations in agricultural land use and ownership, characterised by growing concentration of land in the hands of fewer individuals. Regional inequality can be analysed through various methods. This study explores the disparities in agricultural land utilisation among agricultural households of differing sizes by utilising the Gini coefficient. The Gini coefficient effectively captures these spatial and structural inequalities at both national and county levels. Table 1 presents the criteria used to evaluate land utilisation patterns based on the Gini coefficient.

[1] https://andmed.stat.ee/et/stat
[2] https://geoportaal.maaamet.ee/est/ruumiandmed/haldus-ja-asustusjaotus-p119.html

Table 1: The standard to assess different levels of the agricultural land use structure.

Gini coefficient	<0.2	0.2–0.3	0.3–0.4	0.4–0.5	>0.5
Level	absolutely equal	relatively equal	reasonable	relatively unequal	absolutely unequal

Source: Own composition

The Gini coefficient is a widely recognised statistical measure of inequality, typically used to assess income or wealth distribution. Its application to agricultural land use offers a valuable method for quantifying disparities in land ownership or utilisation across different regions. Facilitating comparison across counties and over time, it reveals important trends. Identifying regions with high levels of land inequality, the Gini coefficient supports evidence-based policymaking, particularly in the context of rural development. Furthermore, this coefficient provides a single, intuitive value that effectively summarises the degree of inequality, making it easily understandable for both researchers and policymakers.

While the Gini coefficient is a valuable tool, it has several limitations when applied to land utilisation. It focuses solely on the quantitative distribution of land, neglecting qualitative factors such as land fertility, location, and productivity. The results are heavily influenced by the accuracy and granularity of the data used; thus, aggregated or outdated records can distort the coefficient. Furthermore, a single Gini value may correspond to multiple distribution patterns; for instance, two counties might exhibit the same coefficient but have significantly different landholding structures. It is also crucial to note that traditional Gini calculations often exclude individuals without land, which may lead to an underestimation of inequality. Additionally, the coefficient does not differentiate between private, corporate, or state-owned land, each of which has distinct implications for rural development.

The Gini coefficient is determined by analysing the agricultural land usage area alongside the number of producers within various size groups. Below are the steps taken to calculate the Gini coefficient:

- *Data collection.* Data for the Gini coefficient, calculation was provided by ARIB, encompassing information about land users and their land use areas. These land users were divided into six groups based on the extent of their agricultural land.
- *Data sorting by county.* Each land user is classified within one of the six size groups, and their land and plots were assigned to one of 15 counties based on geographical location. The information regarding the size group associated with each plot is retained. The data for each county was sorted in ascending order according to the land use area.
- *Cumulative calculation for each county.* Cumulative calculations were conducted for each county, focusing on both the cumulative share of land usage and the cumulative share of land users. It involved aggregating the land usage of each size group with that of the preceding groups. Similarly, each number of users was added to the previous number of users.

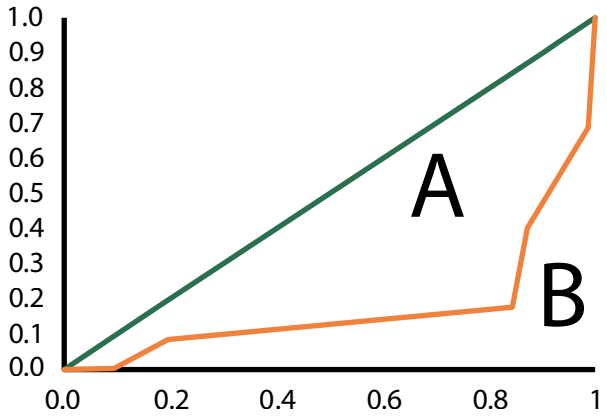

Figure 1: Example of calculating the Gini coefficient according to the Lorenz curve.

Source: Own composition

- *Plotting the Lorenz Curve for each county.* The Lorenz curve was then plotted using these cumulative percentages. The X-axis represents the cumulative share of producers (%), while the Y-axis illustrates the cumulative share of land use area (%). This curve provides a visual representation of the concentration of land usage.
- *Calculating the Gini coefficient for each county*. The Gini coefficient for each county was calculated based on the area between the Lorenz curve and the diagonal line. This coefficient measures the degree to which the Lorenz curve deviates from the "line of equality" by comparing areas A and B (as shown in Figure 1). The Gini coefficient is calculated using the formula: Gini coefficient = A / (A + B)

The Gini coefficient measures inequality, with values ranging from 0 to 1, applicable to a nation or any specific group. In this context, a coefficient of 0 indicates that all size groups share an equal amount of agricultural land, while a coefficient of 1 indicates that a single size group possesses all the agricultural land. However, it is essential to note that this coefficient alone does not provide a comprehensive understanding, and it has its limitations, as previously noted.

Results

The number of agricultural households in Estonia has steadily decreased over the years. In 2001, there were 55,748 agricultural holdings; however, by 2023, this number had dropped to just 10,518 (Figure 2), representing an 81% decrease over 22 years. Interestingly, despite the decline in agricultural households, the extent of utilised agricultural land has increased by 11%, rising from 795,640 hectares in 2001 to 978,364 hectares in 2023.

Over the past 12 years, inequality in the distribution of agricultural land use among different size groups in Estonia has increased. The Gini coefficient rose from 0.30 in 2011 to 0.38 in 2023.

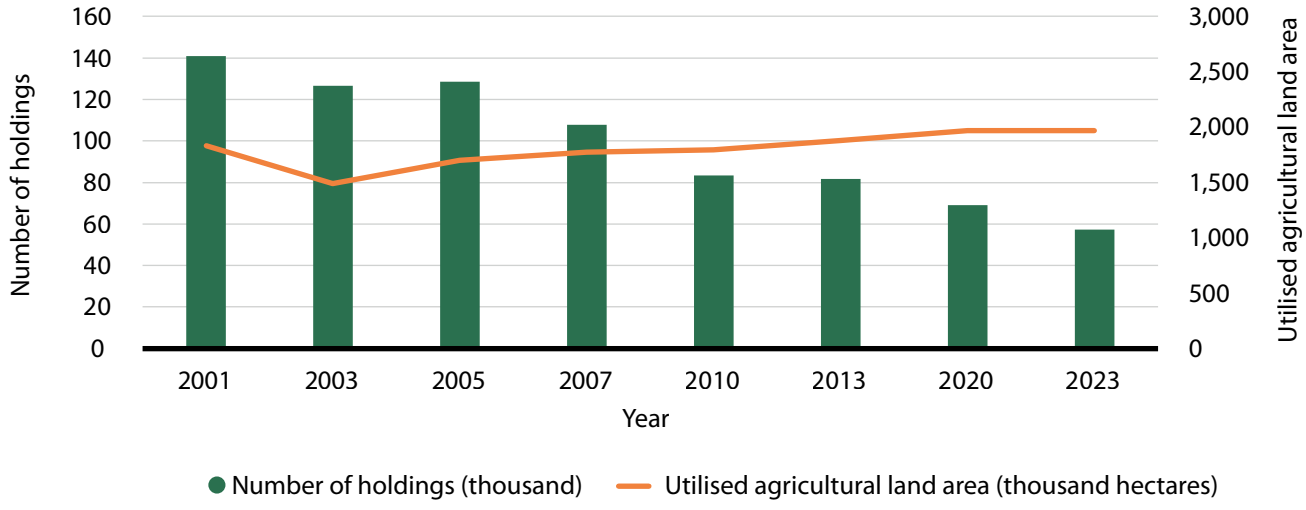

Figure 2: The number of agricultural holdings and area of utilised agricultural land in Estonia between 2001 and 2023.
Source: Own composition based on Statistics Estonia

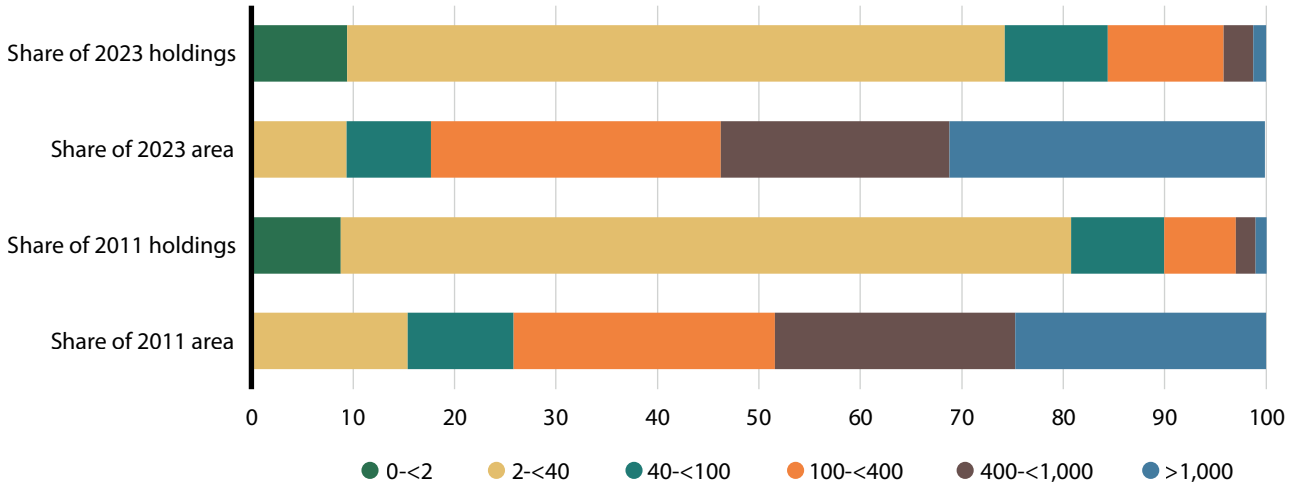

Figure 3. Share of agricultural area and agricultural holdings in size groups in Estonia in 2011 and 2023.
Source: Own composition based on ARIB data

The area of agricultural land utilised by larger groups has expanded (see Figure 3). In 2011, the combined share of agricultural land used by size groups of 400–<1000 hectares and those exceeding 1000 hectares was 49%; by 2023, this figure reached 54%. These larger holdings represented 3% of all agricultural holdings in 2011 and 4% in 2023. Controversially, the share of agricultural land used by smaller groups – those ranging from 0 to <2 hectares, 2–<40 hectares, and 40–<100 hectares – has declined. In 2011, these size groups accounted for 25% of agricultural land use, which decreased to 17% in 2023. These holdings constituted 88% of all agricultural holdings in 2011 and 35% in 2023.

In 2011, the Gini coefficient was highest in the counties of Järvamaa, and Lääne-Virumaa, with values ranging from 0.42 to 0.50 (see Figure 4). In Jõgevamaa, the Gini coefficient was 4.1. In contrast, Raplamaa and Pärnumaa recorded the lowest Gini coefficient, with values between 0.26 and 0.29.

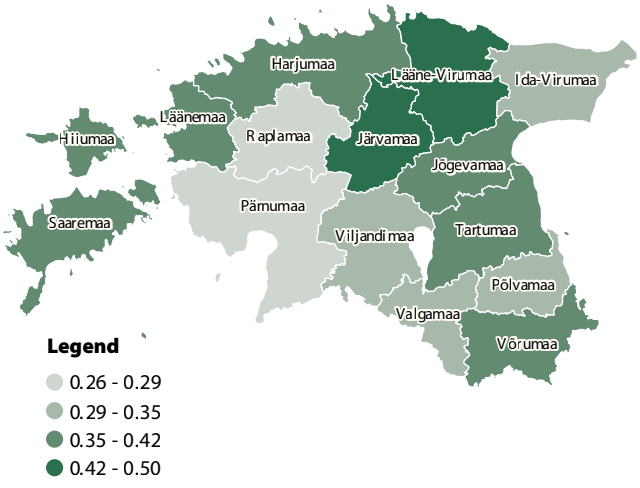

Figure 4: Gini coefficient in Estonian counties in 2011.
Source: Own composition based on ARIB data

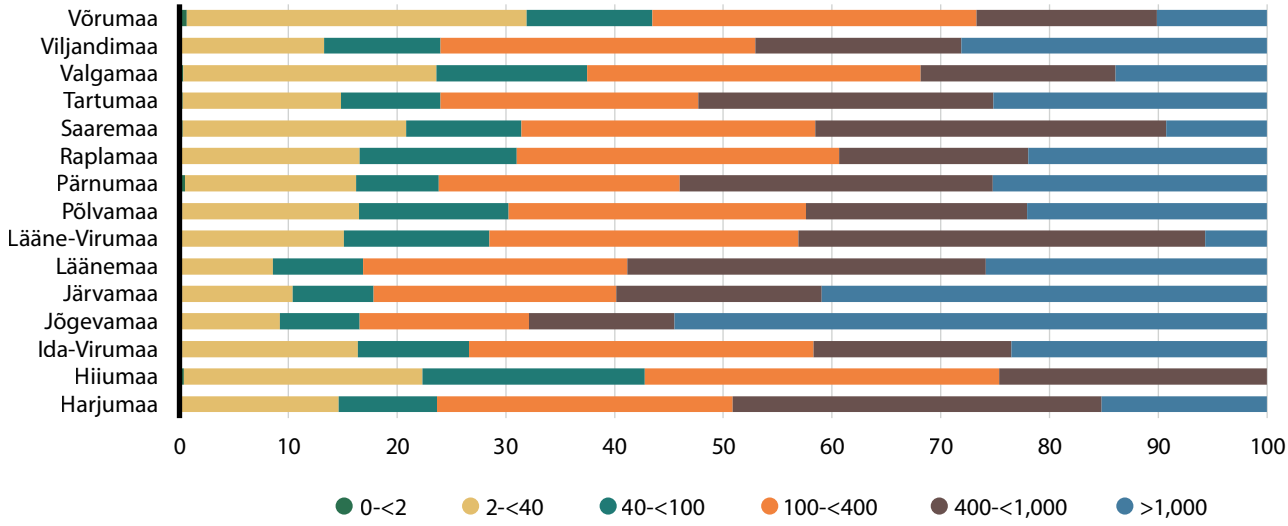

Figure 5: Share of utilised agricultural area in size groups in Estonian counties in 2011.
Source: Own composition based on ARIB data

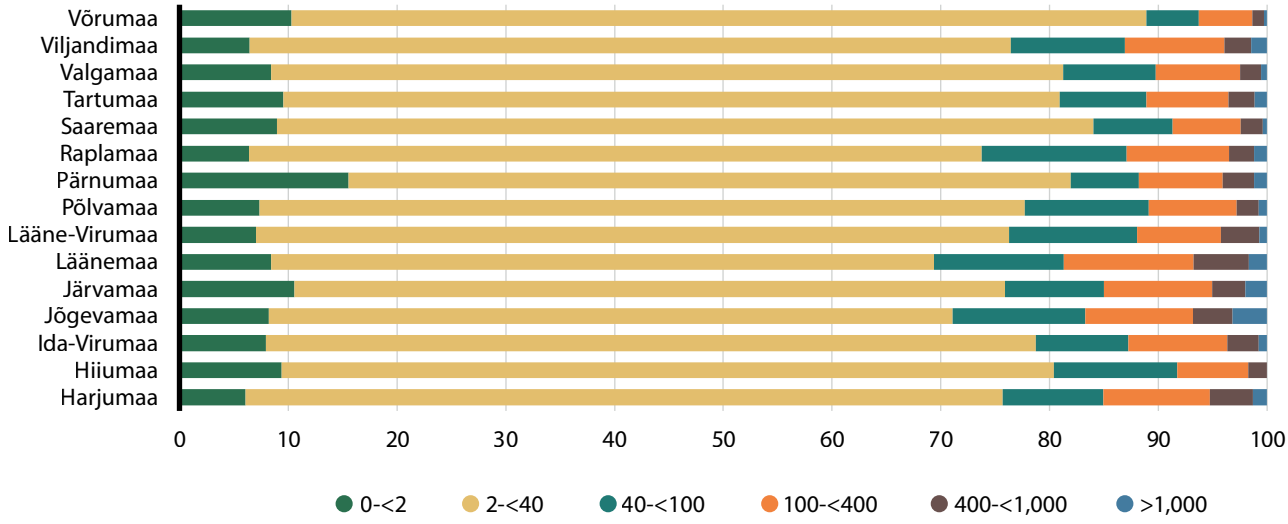

Figure 6: Share of agricultural holdings in size groups in Estonian counties in 2011.
Source: Own composition based on ARIB data

In Järvamaa and Jõgevamaa, large agricultural holdings greater than 1000 hectares represented the largest share of agricultural land in 2011, accounting for 41% and 54%, respectively. Meanwhile, agricultural land in smaller size groups below 400 hectares made up 39% of Järvamaa's and 32% of Jõgevamaa's land (see Figure 5). The notably high Gini coefficient in Lääne-Virumaa for that year can be attributed to the complete absence of producers in the size group of zero to two hectares, resulting in a 0% share of agricultural land use for this category. The size group greater than 1000 hectares made up 6% of Lääne-Virumaa's land. Conversely, agricultural land among the size group 400 to 1000 hectares made up 37% of Lääne-Virumaa's land.

In 2011, the majority of agricultural holdings in Lääne-Virumaa, Jõgevamaa, and Järvamaa were concentrated in the 2–<40 hectares size group, comprising approximately 69%, 63% and 65% of the total, respectively. Only a small percentage of holdings – 3% in Jõgevama, 1% in Lääne-Virumaa, and 2% in Järvamaa – fell into the size group of over 1000 hectares (see Figure 6). Notably, despite their small numbers, these larger holdings accounted for a significant share of agricultural land use, representing 41% of the total in Jõgevamaa and 54% in Järvamaa.

In 2011, in Hiiumaa, 71% of agricultural holdings belonged to the 2 to less than 40 hectares size group, while only 2% were in the 400 to less than 1000 hectares group. Consequently, 71% of agricultural holdings utilised 22% of the agricultural land in Hiiu County, whereas the 2% of larger holdings utilised 25% of the land.

By 2023, the overall Gini coefficient in Estonia had increased, reaching its peak of 0.5-0.55 in Järvamaa (see Figure 7). Following Järvamaa, the highest Gini coeffi-

cients were observed in Jõgevamaa, Tartumaa, and Lääne-Virumaa, ranging from 0.42 to 0.50.

In Järvamaa, holdings larger than 1000 hectares used the largest share of agricultural land usage at 56%, while those smaller than 100 hectares represented the smallest share, ranging from 0% to 5% in 2023 (Figure 8). In Jõgevamaa, the >1000 ha category used 45% of agricultural land, while holdings under 100 hectares made up between 0% and 6%. Similarly, in Tartumaa and Lääne-Virumaa, the >1000 hectares group used 38% of the total agricultural land. In Tartumaa, holdings smaller than 100 hectares utilised between 0% and 8% of the agricultural land, while in Lääne-Virumaa, this group accounted for 0% to 5%. In Hiiumaa, the 100–<400 hectare size group represented the largest share of agricultural land at 40% in 2023, and the holdings smaller than <1000 hectares used 9% of the agricultural land in the county.

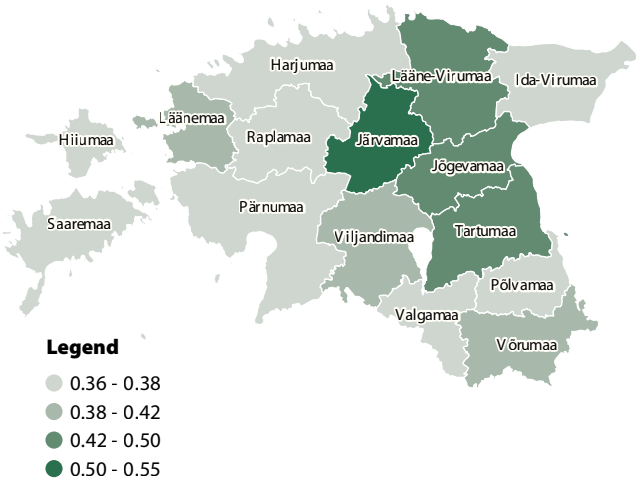

Figure 7: Gini coefficient in Estonian counties in 2023.

Source: Own composition based on ARIB data

In 2023, agricultural holdings exceeding 1000 hectares formed the largest share, representing 37% of all agricultural holdings in Järvamaa. In contrast, the smallest shares were found in the size groups of 0–<2 hectares and 40–<100 hectares, contrivuting only 1% and 9%, respectively (Figure 9). Similarly, in Jõgevamaa, the majority of agricultural holdings (30%) were also over 1000 hectares, with the smallest shares (1% and 9%) being attributed to the size groups of 0–<2 hectares and 40–<100 hectares.

In Tartumaa, the largest share (26%) of agricultural holdings was in the size group of less than 1000 hectares, while the smallest share (1% to 9%) was found in the size groups of 0 to less than 2 hectares and 40 to less than 100 hectares. Similarly

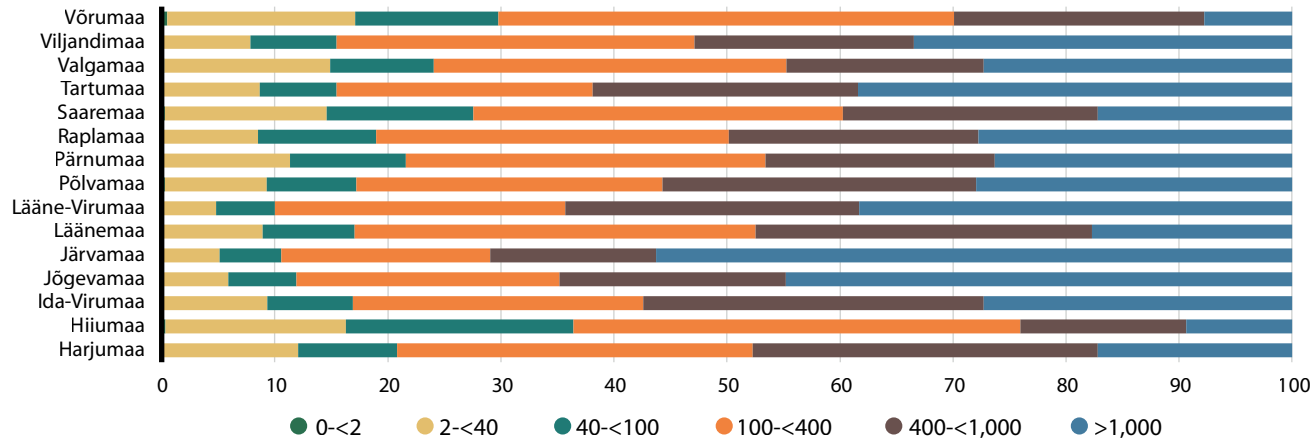

Figure 8. Share of utilised agricultural area in size groups in Estonian counties in 2023

Source: Own composition based on ARIB data

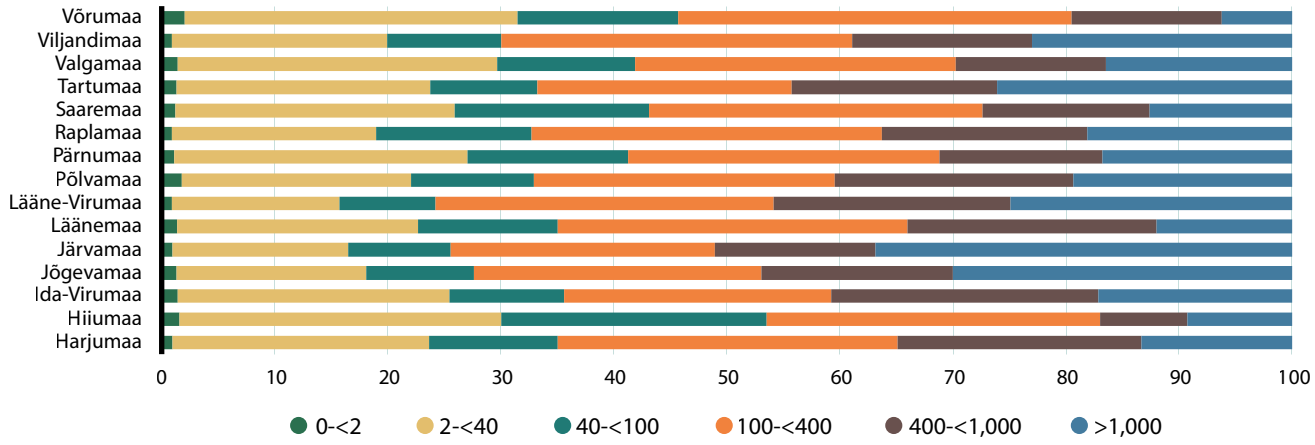

Figure 9: Share of agricultural holdings in size groups in Estonian counties in 2023.

Source: Own composition based on ARIB data

in Lääne-Virumaa, the highest presentage (25%) of agricultural holdings belonged to the size group of less than 1000 ha, with the smallest shares (1% and 8%) attributed to the size groups of 0 to less 2 hectares and 40 to less than 100 hectares.

In 2023, 37% of agricultural holdings in Järvamaa used 56% of all agricultural land in the County. Meanwhile, 30% of agricultural holdings in Jõgevamaa used 45% of the agricultural land in Jõgeva County, and 26% of agricultural holdings in Tartumaa used 38% of the agricultural land in that County.

Discussion

The agricultural landscape in Europe is undergoing significant changes, primarily driven by a rapid decline in the number of agricultural holdings, and the expansion of large enterprises (Joosse and Grubbström, 2017). This concentration of land use and the growing rise in inequality have profoundly affected small agricultural households (Kay *et al.,* 2015) and rural life as a whole. Moreover, the COVID-19 pandemic and the Russia's aggression towards Ukraine have further highlighted the essential role of rural areas in enhancing Europe's resilience (EC, 2024).

Like many other European countries, Estonia is experiencing a rapid concentration of agricultural land. The number of agricultural households is declining, while the average area of land managed by each holding is expanding quickly. Larger agricultural holdings are increasingly acquiring a greater portion of the total agricultural land, resulting in a reduced share of farmland managed by smaller producers. As a consequence, smaller agricultural households in Estonia are gradually closing down, and younger generations face significant challenges in accessing land and entering the farming sector. This process of generational renewal is crucial for fostering innovation and modernisation in agriculture (Daniele, 2024). Maintaining these smaller agricultural households is vital for the sustainability of rural communities, as they provide employment opportunities for locals and help preserve the cultural landscape (Tomson, 2007). However, the concentration of land poses a significant threat to the vitality of rural life. Furthermore, the ageing farming population and limited access to land pose a risk to food security (Põldaru *et al.,* 2018).

Land concentration in Estonia has significant implications that extend beyond the realm of agricultural economics, impacting the social fabric, generational renewal, and balanced regional development. This phenomenon is shaped by a complex interplay of historical, economic, policy, and market dynamics.

Following the restoration of independence in 1991, Estonia implemented land reform aimed at returning property to pre-Soviet landholders. This process resulted in fragmented land ownership and a rise in small farms. However, many of these small farms ultimately proved economically unviable, leading to their consolidation into larger entities (Rasva and Jürgenson, 2020). Larger farms enjoy economies of scale, enhanced access to technology, and increased bargaining power, all of which contribute to the trend of concentration in Estonia's agricultural sector. Additionally, the relatively low land prices in Estonia have attracted both investors and corporate entities, further accelerating land acquisition (Rasva, 2023). The Common Agricultural Policy (CAP) subsidies, which are often proportionate to land area, tend to favour large landholders, facilitating their expansion in Estonia (Jürgenson and Rasva, 2020). Unlike some neighbouring countries, such as Latvia and Lithuania, Estonia imposes few restrictions on the amount of land that one entity can own (Rasva, 2023). In the absence of targeted policies to protect smallholders, market dynamics inherently favour consolidation.

Agricultural land in Estonia is increasingly being acquired by corporate entities (Rasva and Jürgenson, 2022), which possess the resources to manage extensive tracts of land more effectively. Non-local investors and absentee owners may prioritise profit over responsible land stewardship, leading to greater land concentration without reinvestment in rural communities. The migration of younger generations to urban areas has resulted in rural land becoming underutilised or available for purchase by larger corporations. Consequently, many older farmers find themselves without successors, prompting the sales or lease of their land to larger agricultural producers.

Korhals Altes (2023) has pointed out that in situations of land concentration, landowning farmers may be tempted to stop farming and lease their land to the highest bidder. This trend hinders the entry of new farmers and contributes to a significant outflow of people and resources from rural communities. Thus, addressing land use concentration is essential for broader rural development initiatives. The concentration of agricultural land among a selected few individuals carries considerable political, economic, and social implications (Ayaz and Mughal, 2023). Data derived from population censuses and land registers indicate that regions with greater land inequality often experience higher rates of emigration (Boberg-Fazlić *et al.,* 2024). In Estonia, for instance, Statistics Estonia reported the highest emigration rates in 2023 from Ida-Virumaa (-685), Jõgevamaa (-243), and Võrumaa (-236). It supports the notion that areas characterised by greater land inequality may experience increased emigration. Conversely, the emigration rates in Järvamaa (-12) and Lääne-Virumaa (-65) were lower than in many other counties.

One way to assess land inequality is by calculating the Gini coefficient based on agricultural land use area and the number of users within a specific size group. Over the past 12 years, Estonia's Gini coefficient has shown an upward trend; however, it still falls within the higher end of a reasonable range. If this trend continues, the coefficient may soon reach a level that suggests significant inequality.

Over the years analysed, more than half of Estonia's agricultural land is managed by holdings exceeding 400 hectares, and this trend continues to grow. In 2023, 4% of these holdings utilised 54% of the total agricultural land area in Estonia. While larger holdings, particularly those surpassing 1000 hectares, have increased their share of agricultural land, their overall proportion among all holdings has remained unchanged. In 2023, these larger holdings formed 1% of all

holdings, yet utilised 31% of total agricultural land area. In contrast, 74% of all holdings used only 9% of Estonia's total agricultural land area. This data indicates that larger agricultural holdings possess a greater capacity for expansion and tend to expand more than their smaller counterparts, especially when considering the diversity of farm sizes (Korthals Altes, 2023; Zagata and Sutherland, 2015).

Holdings within smaller size groups have experienced a significant decrease in their share of agricultural land, accompanied by a reduction in their numbers. The most significant decrease has been observed in the size group of 2–<40 hectares. While large agricultural households are increasingly gaining a greater share of agricultural land, new entrants, farming successors, and smaller holdings continue to encounter significant challenges regarding land access (Zagata and Sutherland, 2015). When land becomes available, new entrants often find themselves competing with established households for agricultural land in pursuit of economies of scale (Zagata and Sutherland, 2015). This escalating land inequality contributes to an increase in rural poverty and food insecurity (IPES-Food, 2024). In Estonia, the regions exhibiting the most unequal distribution of agricultural land are Järvamaa and Jõgevamaa.

In 2011, a significant disparity was evident in the distribution of agricultural land use among different size groups in Järvamaa and Jõgevamaa. Approximately half of the agricultural land in these counties was utilised by holdings exceeding 1000 hectares, which comprised 63 to 65 per cent of all holdings. In contrast, the highest proportion of agricultural land used by smaller holdings was found in Hiiumaa, Võrumaa, and Valgamaa, where these counties also had the largest share of small holdings.

In 2023, there was a significant increase in the Gini coefficient, indicating a high level of inequality in the distribution of agricultural land in Järvamaa. Large holdings in the county utilised a substantial portion of the agricultural land, with the largest size group making up 56% of the total area. Meanwhile, in Jõgevamaa, there was a slight decrease in the share of agricultural land used by holdings exceeding 1000 hectares; however, this share remained comparatively high relative to other counties. Given the limited availability of local land, accessing agricultural land in both Järvamaa and Jõgevamaa may present challenges for new entrants and smaller agricultural holdings.

Recent years have seen a growing interest in agriculture among individuals and entities not previously involved in farming, as noted by Carolan (2018). Nonetheless, new entrants and younger individuals encounter significant challenges when moving to rural areas to pursue careers in agriculture. It is particularly evident in Estonia, as highlighted by Mändmets and Kärk (2022). The difficulties in acquiring agricultural land, coupled with a lack of investment opportunities, pose substantial obstacles to establishing a farming venture in the country. Raising the necessary capital and achieving profitability can be nearly impossible without prior access to agricultural land and equipment.

Throughout Estonian history, various periods have been characterised by the dominance of large agricultural holdings in the sector (Rasva and Jürgenson, 2020; Reiljan and Kulu, 2002). During its early years of political independence, Estonia was predominantly a rural country (Unwin, 1997). The collective farming era during the Soviet occupation resulted in significant out-migration from rural areas and a shift towards urbanisation (Grubbström and Sooväli-Sepping, 2012). Most investments during this time were focused on the new urban centres and their surrounding villages, lacking in essential services (Raagmaa *et al.,* 2002). Consequently, many villages lost their status as local hubs (Raagmaa *et al.,* 2009), and the rural lifestyle that existed prior to 1940 never fully regained its footing.

The most recent and ongoing land reform has facilitated the resurgence of small holdings in Estonia. The Estonian population shares a profound emotional connection to their land, and small agricultural households are often regarded as an ideal way of life. This model of household was predominant in Estonia's rural areas during the relatively short period of 1919 to 1940, with most agricultural households being small, averaging around twelve hectares. However, in southern and central Estonia, there were also large, well-mechanised cattle-breeding farms, often exceeding 50 hectares (Holt-Jensen and Raagmaa, 2010). Remarkably, both small and large agricultural households coexisted successfully during this time.

Three decades after regaining its independence, Estonia is experiencing a trend of land concentration and growing land inequality. Since joining the European Union in 2004, Estonia has engaged in the CAP support systems, which predominantly benefit the largest agricultural holdings (Holt-Jensen and Raagmaa, 2010; Raggi *et al.,* 2013). Consequently, small agricultural households are facing significant challenges in maintaining their viability as a result of CAP. It has been suggested that these small agricultural households can adapt by either specialising in their operations or exploring alternative rural business ventures (Tomson, 2007).

Addressing the issue of agricultural land concentration and the resulting inequality is crucial. In Estonia, land concentration has significant repercussions that extend beyond agricultural economics; it impacts rural communities, young farmers, and regional development. As land becomes concentrated in fewer hands, small farms and family-run operations are disappearing, leading to depopulation and the erosion of rural traditions and community life (Rasva and Jürgenson, 2022). Absentee or corporate landowners often do not reinvest locally, which weakens rural economies and infrastructure. Smallholders play a vital role in preserving Estonia's rural identity, language, and customs (Rasva and Jürgenson, 2022), and their decline poses a significant threat to cultural continuity.

High land prices and competition from large entities pose significant challenges for young or new farmers looking to acquire land. Moreover, CAP subsidies often favour larger landholders, which leaves emerging farmers with fewer resources to innovate and expand (Rasva and Jürgenson, 2022). Without targeted support, the ageing farming population risks not being succeeded, putting the future of agriculture in Estonia in jeopardy.

The concentration of agriculture in a few regions leads to uneven economic activity across the country, leaving some

areas stagnant or in decline. Many large landholders operate across multiple counties, diminishing the impact of local decision-making and planning (Rasva and Jürgenson, 2020). Furthermore, the intensive land use by these large entities can contribute to soil degradation and biodiversity loss, thereby undermining sustainable regional development goals.

Transitioning to a more equitable agricultural system presents challenges, yet it is indeed achievable. All agricultural holdings should have fair access to agricultural land use and ownership, regardless of size. To address land inequality, a comprehensive set of measures must be implemented. These measures should encompass redistributive programs, regulatory reforms, taxation policies, and accountability initiatives. Furthermore, they should extend beyond land issues to include the entire agri-food sector, from inputs to retail (IPES-Food, 2024).

Land inequality continues to be a substantial barrier to achieving inclusive rural development in Estonia. The increasing concentration of agricultural land undermines the vitality of smallholder farming and poses long-term risks to social cohesion, environmental sustainability, and food security. To address land inequality domestically, Estonia should consider implementing a tiered land value tax designed to discourage excessive land accumulation and generate revenue for grants and support programs aimed at small agricultural producers. In addition to tax reform, it is vital to expand access to agricultural land for new entrants. This can be achieved by establishing a national land bank tasked with redistributing unused and state-owned land, while also offering low-interest loans, start-up grants, and long-term leases to young and emerging farmers.

Establishing prior rights for newcomers and small farms to rent or purchase agricultural land would significantly contribute to a future that is inclusive, resilient, and rooted in the local community (Rasva and Jürgenson, 2022). This policy has the potential to serve as a cornerstone for rural revitalisation, emphasising not only land access but also the involvement of various stakeholders in shaping the agricultural future of Estonia.

Furthermore, implementing an upper limit on the amount of agricultural land that individuals or entities may own in Estonia could lay the foundation for a more equitable and sustainable rural future (Rasva and Jürgenson, 2022). While this regulation would require careful legal design and stakeholder engagement, it represents a powerful mechanism to counteract land concentration. Although land ownership regulation falls within national jurisdiction, it must align with EU principles. Several EU member states have successfully defined such ownership limits on grounds of public interest, rural development, and environmental protection.

There is a pressing need to establish a clear structure of enterprises in Estonia to ascertain the extent of land ownership or rental by each enterprise (Rasva and Jürgenson, 2022). Estonia's e-governance infrastructure already lays a solid foundation for this initiative. The country could mandate the disclosure of beneficial ownership and related entities within the Land Register, link land use data with enterprise registries through digital platforms, and create public dashboards showing land ownership and rental patterns by enterprises.

In the absence of a transparent structure, it becomes challenging to track how much land is controlled by interconnected companies or associated individuals. Ownership and rental information may be obscured by subsidiaries or shell entities, making policy enforcement – such as land ownership limits or sustainability requirements – virtually impossible. Establishing a clear structure of enterprises is a strategic approach to safeguard rural equity, promote environmental sustainability, and ensure market fairness. It would empower regulators, researchers, and citizens alike to understand who controls Estonia's land and how it is managed.

EU strategic plans must also include measurable land equity targets, requiring Member States to define specific objectives and initiatives for inclusive land governance. This approach should be supported by dedicated funding for land tenure reform and participatory planning. The CAP needs to integrate stronger redistributive mechanisms that support small and medium-sized agricultural producers, as it plays a significant role in shaping land distribution patterns in Estonia. Historically, CAP has favoured larger farms due to its area-based structure, which allocates support in proportion to the land owned or cultivated. It has led to the concentration of agricultural land, reinforcing existing inequalities and making it increasingly difficult for small agricultural producers and new entrants to compete.

Estonia's CAP Strategic Plan for 2023–2027 recognises these challenges and includes measures aimed at redistributing a portion of direct payments toward smaller and medium-sized farms ("Estonia – CAP Strategic Plan," n.d.). However, additional reforms could further enhance equity, such as implementing stricter caps on subsidies for large landholders, providing stronger support for young and beginning farmers, and incorporating land inequality indicators into CAP performance monitoring. These adjustments would align CAP implementation more closely with the EU's broader objectives of inclusive rural development and sustainable land governance.

Conclusion

The mechanisation, specialisation, and scale expansion within Estonia's agricultural sector have significantly contributed to land concentration and agricultural inequality. Findings from this study indicate a growing disparity in land use, with just 1% of agricultural holdings accounting for 31% of the total agricultural land area in 2023. New generations now face challenges in accessing land and entering the agricultural sector, while small agricultural holdings have reached a critical tipping point.

Since regaining independence, Estonia's agricultural landscape has undergone considerable transformation, having experienced decades of foreign annexation. Over the years, the country has transitioned through various phases of agricultural production, including manors predominantly owned by Baltic Germans, state farms during the Soviet era, and the current focus on scale expansion. The interwar period marked the most prosperous time for small farms and rural communities in Estonia. Unfortunately, village life has not

fully restored to its pre-1940 state, despite reforms implemented after regaining independence in 1991. These reforms have fallen short in adequately supporting vital rural life and sustainable small-scale agricultural practices, overlooking family and small-scale farming traditions.

It is essential to monitor changes in agricultural land use in Estonia, as a troubling trend has emerged where even landowning farmers are choosing to cease farming and instead lease their land to the highest bidder. This concentration process poses significant challenges, reducing the influx of new entrants into agriculture and contributing to a one-way flow of people and resources out of rural areas. Furthermore, studies have highlighted the growing concentration of land ownership in Estonia. Addressing these issues will necessitate substantial changes to the political, economic, and legal frameworks to reverse the trends of land concentration and inequality.

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Studies in Agricultural Economics 127 (2025) 174-186 https://doi.org/10.7896/j.3118

SCIENTIFIC ARTICLE

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Multidimensional evaluation of Agricultural Knowledge and Innovation Systems

ABSTRACT

The Agricultural Knowledge and Innovation Systems (AKIS) are responsible for the flow of information, knowledge, and innovation between the actors of the agricultural and food sector, as well as between those engaged in education, research, and extension. Strengthening cooperation and interaction between actors has become a cross-cutting objective of the European Union's Common Agricultural Policy (CAP). The CAP Strategic Plans in the Member States aim to develop agriculture through two interventions (support of EIP operational groups and the provision of knowledge exchange and dissemination actions). However, the AKIS goes beyond the CAP support, as several additional actions and incentives under national competence are needed for a modern, knowledge-based agricultural economy and well-functioning AKIS. Each EU Member State has developed its own AKIS, according to its specific conditions and needs. Previous studies on the comparison of AKIS across Member States have attempted to collect and analyse the specificities of each Member State, mainly through primary data collection. These studies are less capable of providing an objective comparison of AKIS systems in the Member States based on a common methodology. Although there are several indicator systems available to measure innovation performance, these indicator systems address the national/regional innovation performance but do not provide an adequate picture of the innovation performance of the agricultural economy. The aim of this study is to develop a framework for objective benchmarking of the Agricultural Knowledge and Innovation Systems supporting the agricultural economy of each EU Member State. To this end, the authors have created the AKIS index.

ARTICLE INFO

Keywords:
innovation, innovation performance, knowledge flow, Agricultural Knowledge and Innovation System, Common Agricultural Policy

JEL classifications:
Q16, Q18.

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Received: 7 April 2025; **Revised:** 21 September 2025; **Accepted:** 25 September 2025.

Introduction

The second pillar of the Common Agricultural Policy was initially governed by Regulation (EC) No 1257/1999, which explicitly prioritised the adaptation of new and innovative technologies. Among the six rural development priorities outlined in Regulation (EU) No 1305/2013, the first priority emphasised knowledge transfer and the promotion of innovation in forestry, agriculture, and rural economies. During the 2014–2020 programming period, the European Commission introduced a new instrument to foster innovation, namely the support for EIP-AGRI operational groups. The EIP (European Innovation Partnership for Agricultural Productivity and Sustainability) serves as a network for innovation projects within individual Member States. The EIP-AGRI brings together the operational groups from Member States, aiming to connect various actors (farmers, advisors, researchers, agribusinesses, NGOs) across different innovation and agriculture sectors, thereby facilitating the development, utilisation and dissemination of new knowledge. The 2014–2020 programming period marked a significant advancement in the development of Agricultural Knowledge and Innovation Systems (AKIS). In addition to measures directly promoting innovation, it also fostered an environment conducive to innovation and networking (Fieldsend, 2020).

The CAP Strategic Plan Regulation for 2020-2027 consolidates the interventions financed under the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD). Council Regulation (EU) 2021/2115 outlines nine specific objectives, along with an additional objective that horizontally integrates goals aimed at modernising agriculture and rural areas. Member States are required to outline the intervention logic they plan to implement in their National Strategic Plans, thereby enhancing coherence among the various subsystems of Agricultural Knowledge and Innovation Systems (AKIS) (Regulation (EU) 2021/2115, p. 9).

AKIS has become an integral part of the Common Agricultural Policy (CAP), facilitating the flow of information, knowledge, and innovation among stakeholders in the agricultural and food economy, as well as partici-

pants in education, research, and advisory services (Röling and Engel, 1991; EU SCAR, 2012). Over the past years, AKIS has undergone significant conceptual and substantive evolution, paralleling its integration into policymaking. Originally, the term AKIS referred to "Agricultural Knowledge and Information Systems" (Fieldsend, 2020). Gradually, the terminology shifted from "information systems" to "innovation systems", reflecting a broader scope. Today, AKIS is understood as "Agricultural Knowledge and Innovation Systems" (EU SCAR, 2012). Extending beyond the framework of CAP, the AKIS approach encompasses the development of relationships among relevant organisations, institutional infrastructures, various incentives, and budgetary mechanisms (EU SCAR, 2012). In the agricultural sector, the notion of a sectoral innovation system can be conceptualised within the AKIS framework: an innovation-generating ecosystem that integrates, within a given sector, the domain of products and technologies together with the relevant actors and institutions – research and higher-education organisations, advisory service providers, companies, producer groups, and public authorities (Malerba, 2002; Wintjes, 2016). Each sectoral system has its own specific knowledge base, technological requirements, network of relations, input structure, and demand side; these elements jointly influence the development of innovation processes. At the same time, the operation of the system is strongly shaped by innovation policy, as well as by various national and international incentives, the main purpose of which is to ensure the diffusion of knowledge and results. In European agriculture, this logic is institutionally framed by the Common Agricultural Policy (CAP).

There are notable differences among Member States concerning the fragmentation of AKIS, the number and diversity of actors, the types of institutions involved, the levels and subsystems of governance, funding schemes, and the characteristics and performance of their agricultural economies (OECD, 2023). Although Birke *et al.* (2022) highlight that no universal blueprint exists for designing an ideal AKIS, this study aims to develop a framework for objectively comparing Agricultural Knowledge and Innovation Systems of EU Member States.

The authors of this paper aim to answer the following research questions:

- How can the available baseline data for the assessment of AKIS be organised systematically?
- What quantifiable indicators can be developed to examine the subsystems of AKIS?
- What relationships exist among these indicators, and how do they influence one another?
- In what ways are the AKIS subsystems of different Member States similar or distinct?
- Can a ranking of Member State AKIS be established, and can the Member States be grouped based on certain characteristics?

Factors determining the performance of agricultural knowledge and innovation systems

Several measurement systems exist for evaluating innovation performance (e.g., BISI, EIS, GII); however, these are less suited for capturing the innovation dynamics of agriculture and the complex structure of Agricultural Knowledge and Innovation Systems (AKIS). Previous comparative studies of AKIS across Member States have primarily focused on identifying and analysing national specificities, relying mainly on primary data collection. In parallel, the literature on innovation systems has developed and employed a variety of analytical approaches for their dynamic examination and assessment (Spielman *et al.,* 2009), among which indicator-based benchmark analysis is most closely aligned with the methodological framework of this study.

Complementing this, guidelines developed for AKIS assessment typically adopt a multi-step diagnostic approach, which relies extensively on the collection and processing of qualitative information (FAO, 2022). However, these studies or guides are less suitable for objective comparison based on a uniform methodology (Birke *et al.,* 2022; Spielman and Birner, 2008; Hall, 2007; Peterson and Perrault, 1998). There is broad consensus in the academic literature and policy analyses that the functioning of the AKIS is fundamentally based on knowledge creation, diffusion, and utilisation (Rivera, 2005; Kountios *et al.,* 2024a). From a functional perspective, these pillars align with the traditional components of education, research, and advisory services.

In recent years, however, digital tools and infrastructures have emerged as a distinct and increasingly essential component of AKIS, now recognised as a key pillar of contemporary frameworks. The European Union's policies place particular emphasis on advancing agricultural digitalisation, aiming to enhance knowledge flows and accelerate the diffusion of innovations across the sector (EC, 2019). Agricultural economic performance is a crucial factor shaping the overall significance of the sector. It directly influences the operational intensity and strategic importance of individual AKIS components. Research evidence from both Europe and beyond demonstrates a strong positive correlation between agricultural performance and the strength of AKIS elements, particularly research and (R&D) investment and advisory services. Farm advisory and extension services also have a clear and measurable impact on farm-level performance (Parikoglou *et al.,* 2023). In constructing the AKIS index, the research dimensions were defined based on these components. Although farm advisory systems could be conceptually treated as a separate dimension within AKIS, the lack of harmonised and comparable quantitative statistical data across EU Member States made this unfeasible. Consequently, available EU-level data on advisory services were integrated under the research dimension, acknowledging the strong functional and institutional overlap between research and advisory systems in several Member States.

Agricultural education

Educational and training institutions play a pivotal role in initiating and fostering agricultural innovation processes. These institutions have the dual capacity to generate new technologies and disseminate them through the development of human resources. Increasing emphasis is being placed on practice-oriented agricultural education and training (AET), which must align labour market needs with the supply of skilled professionals (Kapronczai, 2018). Employers expect graduates to address emerging challenges effectively, making it essential for educational programmes to integrate the latest research findings into the curriculum (EU SCAR, 2012). In addition to the traditionally prioritised technological knowledge, students must develop the ability to understand business processes, interpret market dynamics, prepare and make economic decisions, and identify genuine opportunities for innovation (World Bank, 2012). Thus, the success of innovation processes hinges on the availability of well-trained professionals who combine advanced technological knowledge with up-to-date management expertise (Takácsné, 2015).

On average, only 8.5% of today's European farmers have completed formal agricultural training, while 70% rely solely on practical experience. Since initial training falls under national responsibility, agricultural education systems vary greatly across the EU (Augère-Granier, 2017). Agricultural vocational education and training (VET) is, in most EU Member States, structurally integrated into the general education system. For comparative assessment, Eurostat indicators provide useful reference points – notably the number of individuals holding agricultural qualifications, the share of farm managers with such qualifications, and EU expenditures on training and advisory services (Eurostat, 2020). These metrics, however, yield primarily a quantitative snapshot and do not capture the content, pedagogical approaches, or institutional arrangements that differentiate agricultural VET and higher education across countries. A comprehensive understanding of system performance therefore requires supplementing statistical indicators with qualitative inquiry (e.g., curriculum analyses, case studies, and institutional comparisons). One of the major shortcomings of this dimension is that it fdoes not adequately reflect the availability of advisory services across Member States, as the only available measure is an output indicator based on CAP-funded activities. It provides no information on the quality of the advisory services, the thematic areas they cover, or the farmers who make use of these services.

Agricultural research

To ensure that agriculture keeps pace with global social and environmental challenges, it is essential to generate new knowledge and technologies that create added value in agricultural production and processing (World Bank, 2012). According to Hall (2012), agricultural innovation should not be perceived as a research-driven process but rather as a process of novel application of ideas. In agriculture, the renewal of products and technological procedures is a multifaceted task influenced by socioeconomic conditions, ecological characteristics, and innovations in biology, chemistry, and technology. The complexity and interplay of these factors complicate the identification of agricultural innovations and the evaluation of their outcomes (Huszti, 2013). Agricultural research supports the enhancement of innovation capacity among individuals and organisations, encompassing basic, strategic, and adaptive agricultural sciences, as well as disciplines beyond agriculture (World Bank, 2012).

The Member States consider the ability of the agricultural economy to provide economically, socially, and environmentally sustainable responses to environmental dilemmas as a strategic priority (Leaver, 2010). The allocation of resources for research, development, and innovation (RDI) is critically important for a country's agricultural economy. In their article, Heisey and Fuglie (2018) examine the extent to which publicly funded R&D and other factors have contributed to long-term agricultural total factor productivity (TFP) growth in high-income countries. Countries maintaining high standards in RDI activities have adapted most effectively to global economic challenges (Kapronczai, 2017). In addition to national funding and CAP resources, EU Member States can also leverage the European Regional Development Fund (ERDF) to promote their RDI activities (Läpple *et al.,* 2015). Investments in R&D, whether public or private, often result in tangible outcomes after some delay, with the link between R&D spending and productivity growth typically becoming evident only after several years (Piesse and Thirtle, 2010).

Performance of the agricultural economy

Before introducing the indicators used to measure the performance of the agricultural economy, it is important to clarify the distinction between the concept of national economic and sectoral competitiveness. *National economic competitiveness* refers to a country's ability to produce goods and services that meet the requirements of international trade while increasing the returns on its production factors. In contrast, *sectoral competitiveness* measures the efficiency of a specific sector (Porter, 1985).

A strong correlation can be observed between competitiveness, economic growth, and innovation. Innovation can lead to increased productivity, reduced dependence of agriculture on natural factors, lower production costs in agriculture, and improved environmental performance of firms by promoting resource-saving practices (Coca *et al.,* 2017). Alarcón and Sánchez (2013) stablish a strong connection between the availability of external research, development, and innovation (RDI) resources and economic performance.

Several indicators are available for analysing agricultural performance. One such indicator is the gross value added (GVA) of the agricultural sector relative to total GDP, which highlights the agricultural economy's importance. A low significance of the sector indicates a high level of economic development (Coca *et al.,* 2017). Another commonly used indicator is annual labour productivity, expressed as the agricultural gross value added per annual work unit (AWU). This metric represents the value newly created by a full-time worker (employed or self-employed) in the agricultural sector (OECD, 2022). The competitiveness of countries can

be compared based on the productivity of their economies (Porter, 1985), for which *Total Factor Productivity* (TFP) is commonly used. TFP measures the ratio of total output to total input, providing an aggregate metric of economic performance. An increase in TFP indicates that output growth exceeds the growth of inputs, indicating enhanced economic performance. TFP growth serves as a key indicator of overall agricultural efficiency, resource-use effectiveness, and, consequently, sustainability. These indicators are also employed by Spielman and Mekonnen (2009) in their benchmark analysis, although the use of total factor productivity (TFP) is subject to certain limitations. On the one hand, technological progress and technical efficiency cannot be clearly disentangled (Nowak and Kubik, 2019), while on the other hand, the reliability of data at the EU level remains questionable (Wimmer and Dakpo, 2023).

Potential of the younger generation

Numerous studies have demonstrated that young farmers tend to be more open-minded and possess a higher entrepreneurial inclination, making them more likely to embrace innovation (Yoon *et al.,* 2021; Balezentis *et al.,* 2020). Support mechanisms for strengthening young farmers were already available during the 2014–2020 programming period through targeted schemes for young agricultural producers. On one hand, farmers under the age of 40 could apply for area-based additional support. On the other hand, young farmers also had the opportunity to apply for business plan-based grants under the Rural Development Programme, aimed at encouraging the process of generational renewal in agriculture (Balezentis *et al.,* 2020).

The opportunities available to the younger generation are increasingly shaped by access to digital technologies and the advancement of digital competencies. Consequently, this dimension incorporates indicators related to digitalisation. Information and Communication Technology (ICT) play a key role in fostering innovation by facilitating the transmission of agricultural research results and developments among various stakeholders (Spielman and Birner, 2008; Kiraly *et al.,* 2023). Moreover, it offers opportunities to enhance knowledge flows between knowledge producers, disseminators, and users (Coca *et al.,* 2017). Digital maturity encompasses indicators that not only assess the usage of ICT but also measure the sophistication of digital technologies employed. According to Eurostat, the *Digital Skills Indicators* are composite metrics based on activities performed by individuals in relation to internet or software use in four specific areas: information, communication, problem-solving, and software skills. Collectively, these indicators provide a comprehensive perspective on the integration and application of digital competencies.

Methodology

Determining data and indicators

The conceptual framework for the development of the AKIS index is based on both domestic and international literature (Mutua and Goda, 2021; Mazziotta and Pareto, 2013; Goda, 2012; OECD, 2008). Primary data were obtained from publicly available sources, including EUROSTAT and the AGRI-FOOD PORTAL. When selecting the basic data, an important consideration was that the indicators should be available for all member states, covering several years retrospectively, and that there should be no strong correlation among them. After collecting the raw data, they were cleaned, organised, and standardised. The composite indicator was constructed based on Goda's (2012) doctoral dissertation and the multidimensional evaluation approach of Mutua and Goda (2021). Due to the limited availability of indicators of consistent quality across EU Member States, it was not feasible to apply a principal component analysis

Table 1: Baseline data and indicators used in constructing the AKIS index.

Agricultural Education					
Indicator	**Unit of Measure**	**Reference Basis**	**Interpretation**	**Data Source**	**Period of Study**
Number of Individuals with Agricultural Qualifications	number	Number of Farmers	The ratio of students who completed agricultural training to the total number of agricultural enterprises	EUROSTAT	2014–2020
Farm Managers with Agricultural Qualifications	percentage	–	Expresses the percentage ratio of all managers to agricultural managers	EUROSTAT	2010; 2013; 2016
EU Expenditures on Training and Consulting	million euros	Rural Development Fund (EAFRD)	The amount allocated to Measures 1 and 2 relatives to the total Rural Development Fund of the MS	AGRI-FOOD PORTAL	2014–2020
Agricultural Research					
Indicator	**Unit of Measure**	**Reference Basis**	**Interpretation**	**Data Source**	**Period of Study**
Government Expenditures on Agricultural R&D	percentage	–	Percentage of GDP allocated by the government to agricultural R&D.	EUROSTAT	2014–2020
Agricultural Enterprises ' Expenditures on R&D	million euros	Enterprises' Expenditures on R&D	Expenditures on R&D by agricultural, forestry, and fisheries enterprises in million euros based on NACE Rev. 2 activities	EUROSTAT	2014–2020
Expenditures on EIP	million euros	Rural Development Fund (EAFRD)	The amount allocated to EIP within Measure 16 relative to the total Rural Development Fund of the MS	AGRI-FOOD PORTAL	2014–2021

Performance of the Agricultural Economy					
Indicator	**Unit of Measure**	**Reference Basis**	**Interpretation**	**Data Source**	**Period of Study**
Labour Productivity in Agriculture	euros/AWU	–	Represents total labour productivity in agriculture	EUROSTAT	2014–2020
Total Factor Productivity (TFP)	percentage	–	Provides the total factor productivity of agriculture expressed as a percentage (2005=100%)	EUROSTAT	2014–2020
Potential of the Younger Generation					
Indicator	**Unit of Measure**	**Reference Basis**	**Interpretation**	**Data Source**	**Period of Study**
Young Farm Managers (the proportion of farm managers under 35 years of age relative to all managers)	percentage	–	Indicates the proportion of managers under 35 years of age relative to all managers	EUROSTAT	2010; 2013; 2016
Digital Skills (individuals with above-basic digital skills)	percentage	–	Individuals with basic or above-basic digital skills	EUROSTAT	2014–2020

Source: own composition

in this study. Consequently, all indicators were included with equal weight within each dimension. Similarly, the dimensions themselves were assigned equal weights in the construction of the AKIS index, in line with the approach adopted by Spielman and Mekonnen, (2009) in the measurement of agricultural innovation systems.

The data were compiled based on four key dimensions: agricultural education, agricultural research, agricultural performance, and the potential of younger generations. To prevent outliers from distorting the AKIS index results, multi-year averages of the baseline data were calculated, as outlined in Table 1. Some baseline data do not stem from annual data collection efforts; for these, available data from the study period were utilised. In other cases, the authors used the most recent data available (e.g., data from the General Agricultural Census [ÁMÖ] and Farm Structure Survey [GSZÖ], such as the proportion of farm managers with agricultural qualifications and the proportion of young farm managers).

Standardisation of indicators, sub-indices and creation of the AKIS index

Numerous methodologies are available for constructing sub-indices, among which standardisation is the most employed approach. Using the fundamental formula applied in the calculation of the Human Development Index (HDI), our pre-processed indicators can be rescaled to fall within the range of 0 to 1, rendering the data dimensionless (Goda, 2012). Normalisation of baseline data during the development of composite indices facilitates the transformation of indicators to a unified scale, enhancing comparability (OECD, 2008). In constructing the composite index, the *min-max normalisation method* (rescaling method) proposed by Mazziotta and Pareto (2013) was employed to mitigate the impact of outliers on the index (Mutua and Goda, 2021). This transformation technique scales the values of individual indicators (x_i) within the range of 0 to 1 based on their minimum (x_{min}) and maximum (x_{max}) values. The range and relative range of variation are derived from the basic formulas, as exemplified in the HDI calculation. The formula used is as follows (Goda, 2012; McSweeney *et al.,* 2010):

$$I_i = \frac{X_i - X_{min}}{R} \quad (1)$$

where:
I_i: The i-th sub-index
x_i: The criterion value of the i-th exam
x_{min}: The lower value of the examined indicator
x_{max}: The upper value of the examined indicator
R: The range, calculated as $x_{max} - x_{min}$, representing the difference between the two extreme values of the examined indicator

For certain sub-indices, due to their inherent nature, a lower value is considered preferable (e.g., the age structure of farm managers). Consequently, the results of these sub-indices must be subtracted from one to ensure their comparability with the other sub-index results. This adjustment is performed using the following formula:

$$1 - I_i = \frac{X_i - X_{min}}{R} \quad (2)$$

where:
I_i: The i-th sub-index
x_i: The criterion value of the i-th exam
x_{min}: The lower value of the examined indicator
x_{max}: The upper value of the examined indicator
R: The range, calculated as $x_{max} - x_{min}$, representing the difference between the two extreme values of the examined indicator

The index values of the four determining factors (D_i) were calculated by aggregating the arithmetic mean of the sub-indices:

$$D_i = \frac{Y_jSI_a + Y_jSI_b \ldots + Y_jS_{in}}{n} \quad (3)$$

where:
D_i: The determining factor of the Member State
$Y_jS_{ia\ldots\ldots,n}$: The sub-indices of the specific determining factor

The AKIS index is a composite indicator calculated from the aggregated values of the defined indicators. It was derived as the arithmetic mean of the index values of the key factors, using the following formula:

$$AKIS\ index = \frac{DI_a + DI_b \ldots + DI_n}{n} \quad (4)$$

where:

AKIS index: Agricultural Knowledge and Innovation System index

$DI_{a\ldots\ldots,n}$: The determining factors of the Member States

Classification of AKIS index

The classification of Member States is based on the arithmetic mean of the AKIS index, as well as its upper and lower quartiles, defined as follows. These quartiles serve as the upper and lower boundaries of the index classification.

$$\underline{X}AKIS = \frac{AKIS_a + AKIS_b + \ldots + AKIS_n}{n} \quad (5)$$

where:

$\underline{X}AKIS$: The average AKIS value of the Member States

$AKIS_{i\ldots\ldots,\,n}$: The AKIS value of the Member States

$$Med_{upper}AKIS = \frac{AKIS_{max} - \underline{X}AKIS}{2} + \underline{X}AKIS \quad (5)$$

$$Med_{Lower}AKIS = \frac{\underline{X}AKIS - AKIS_{I_{min}}}{2} + AKIS_{min} \quad (6)$$

where:

$Med_{upper}AKIS$: The median of *AKIS* is higher than the median of $\underline{X}AKIS$

$Med_{lower}AKIS$: The median of *AKIS* is lower than the median of $\underline{X}AKIS$

The Member States were grouped into three clusters based on their *AKIS* index values:

AKIS Leaders: Those Member States that demonstrate outstanding performance across all dimensions of the AKIS. In these countries, research and development expenditures and digital skills play a leading role, complemented by notable achievements in agricultural education. Member States classified as AKIS Leaders have an index value exceeding the upper median ($AKIS > Med_{upper}AKIS$).

AKIS Advancers: Those Member States that make substantial efforts in education as well as in research and development but do not reach the level of AKIS Leaders. In these countries, certain elements of the index demonstrate strong performance, while other dimensions show less remarkable results. ($Med_{upper}AKIS > AKIS > Med_{lower}AKIS$).

AKIS Laggards: This category includes Member States whose AKIS index demonstrates underperformance across nearly all dimensions ($AKIS < Med_{lower}AKIS$).

Results and Discussion

Agricultural Education

The analysis of agricultural education was conducted based on the ISCED classification (from secondary education to doctoral or equivalent levels). This framework provides a standardised and comparable method for categorising the various levels and types of education.

During the analysed period, France (269,608 individuals) and Germany (152,404 individuals) had the highest number of agricultural graduates within the EU in absolute terms. However, when considering the proportion of agricultural graduates relative to the total number of farm managers, the Czech Republic leads the ranking, closely followed by the Netherlands and Belgium. In contrast, Cyprus, Romania, Greece, Malta, Latvia, and Lithuania showed the lowest proportion of agricultural graduates, a trend mainly due to their fragmented farm structures. The Czech Republic's exceptional value is partly linked to the relatively low number of agricultural holdings. According to Eurostat data, the average size of Czech farms in 2016 was 133.0 hectares, significantly larger than the EU average of 16.6 hectares. Furthermore, data from the Czech land identification system in 2017 indicate an even higher average size of 216.6 hectares for arable farms. Additionally, farm managers and employees in the Czech Republic, particularly those in large-scale enterprises, often possess high levels of education and technical competence. In these large farms, agronomists typically conduct experiments with new technologies, underscoring the emphasis on innovation and professional expertise (Mrnuštík and Sutherland, 2022).

The *indicator for farm managers with agricultural qualifications* represents the proportion of managers who completed comprehensive agricultural training relative to the total number of agricultural holdings between 2010 and 2016. According to the indicator, comprehensive training is defined as any programme undertaken after compulsory education that is equivalent to at least two years of full-time study and completed at an agricultural college, university, or other higher education institution in an agriculture-related field. Luxembourg, the Czech Republic, France, Latvia, Poland, Austria, and Estonia reported relative index values exceeding 0.5. In contrast, Romania, Cyprus, and Greece ranked at the bottom of the list. The low positions of Greece and Cyprus can be attributed to the lack of mechanisms for coordinating AKIS in these countries (Birke *et al.,* 2022).

Output indicators have limitations, as they fail to capture the quality of agricultural education or participation in short-term, non-formal training programmes. Although such programmes do not grant formal qualifications, they provide valuable knowledge and foster new perspectives among agricultural workers, thereby promoting lifelong learning. To address this gap, training and advisory activities funded through the EAFRD were included in the analysis. Comparison of expenditure shares reveals that the Netherlands and Denmark allocated the highest proportion to training and advisory services, followed by Slovenia, the Czech Republic, and Finland. In contrast, Croatia, Greece, Cyprus, Hungary, and Romania ranked among the lowest-performing countries.

In the field of agricultural education, the Czech Republic, Luxembourg, the Netherlands, and Belgium showed outstanding performance, while Cyprus, Romania, Greece, and Hungary consistently lagged behind. In countries that joined the European Union in 2004 or later, it is particularly common that practical experience is the sole foundation for farm management (Augère-Granier, 2017). However, business competitiveness can only be ensured by employees with a high level of knowledge, appropriate skills, and access to practice-oriented training (Magda *et al.,* 2008). A moderate correlation has been observed between the proportion of individuals with agricultural qualifications, expenditures on training and advisory services, and labour productivity. This suggests that in countries with higher investment in agricultural education, agricultural labour productivity tends to be more efficient. The authors align with the 2017 policy statement by the SCAR-AKIS Strategic Working Group, which emphasises the need for a new approach to agricultural education. Beyond providing fundamental agricultural knowledge and skills, the focus of education should shift toward making learning techniques more interactive and effective. Vocational training must equip farmers with a broader range of skills while also reinforcing practical knowledge. Additionally, it is essential to create a supportive environment for students that fosters trust-based relationships and ensures broad access to digital skills (Nátz *et al.,* 2022).

Agricultural research

During the 2014–2020 period, German companies allocated the highest absolute amount to agricultural research, spending an annual average of €168.4 million. However, when measured as a share of total corporate research and development (R&D) expenditures, Hungary ranked first with 1.4% during the same period. Latvia, Spain, and Romania also performed strongly, while in contrast, Estonia, Ireland, and Cyprus reported the lowest values, with companies investing only marginally in agricultural research. Notably, despite significant incentives to support educational and R&D activities in Ireland, private investments in agricultural research remain substantially below the EU average (Heisey and Fuglie, 2018). The growth rate of agricultural research in Mediterranean countries, as well as in Central European countries, continues to lag well behind the average of high-income countries (Heisey and Fuglie, 2018).

In the EU, government expenditures on agricultural research and development (R&D) accounted for an average of 2.12% of GDP between 2014 and 2020. The highest proportions of government spending were observed in Bulgaria, Spain, Finland, and Estonia. In Hungary, the share of government expenditures moderately exceeded the EU average. The leading countries during this period emphasised the presence of developments related to the agri-food value chain and agricultural innovation as priority areas in their *Smart Specialisation Strategies (S3)* for 2014–2020. This focus likely explains the prominence of the sector in public expenditures. An examination of the nominal values of R&D expenditures disbursed through the *European Regional Development Fund (ERDF)* during the same period further reveals that Spain allocated substantial resources to this purpose, highlighting its commitment to advancing agricultural research and innovation. There are several reasons why public agricultural R&D has high research intensity. First, it makes up for the relatively low level of private R&D in this sector, even though private research in farming has grown in recent years. Second, agriculture relies heavily on technology, so productivity growth depends more on innovation than on simply using more inputs. Technology-based sectors usually require more research than others. Third, governments invest in agricultural R&D not only to support food production and food security, but also to address broader public concerns, such as the environment, food safety, nutrition, and other social issues (Heisey and Fuglie, 2018).

In nominal terms, Denmark recorded the highest government expenditure on agricultural research and development (R&D), with an annual average of €872 million. This is particularly noteworthy, given that Denmark allocated negligible amounts to AKIS in its CAP Strategic Plan and was among the countries where EIP operational groups were not launched. Furthermore, Denmark spent only a minimal portion of its European Regional Development Fund (ERDF) resources on R&D, relying instead on national funding to support agricultural research. In Denmark, R&D funding is allocated to organisations closely connected to practical applications, primarily universities and the Danish agricultural knowledge centre, SEGES. Universities address the needs for basic and strategic research in agriculture and the food industry, while SEGES contributes through practice-oriented experimental development, advisory services, and implementation efforts (Birke *et al.,* 2022).

According to the aggregated value of the agricultural research index during the analysed period, three countries emerged as leaders: Hungary, Spain, and Latvia. In Hungary, corporate expenditures and their proportion to total corporate spending secured the country's top position. In contrast, in Spain and Latvia, the share of government expenditures on agricultural research and development (R&D) relative to GDP was the dominant factor contributing to their high index scores. In Hungary, corporate R&D expenditures are deductible from the corporate tax base and local business tax base, providing incentives that foster the growth of business-oriented R&D activities.

At the EU level, while the agricultural sector is considered knowledge-intensive, the scale of R&D expenditures remains significantly lower than in other sectors. From a research and development perspective, agriculture is underfunded (Heisey and Fuglie, 2018).

Performance of the agricultural economy

During the 2014–2020 period within the EU, the average Total Factor Productivity (TFP) increased by 108.7% compared to 2005 levels. The most significant productivity growth was observed in Belgium, where TFP rose by 42.7% since 2005. This remarkable increase can be attributed to the intensity of agricultural production in Belgium, which experienced a decline in TFP between 2004 and 2015, followed by substantial improvements in agricultural efficiency (Baráth

and Fertő, 2017). In addition to Belgium, notable progress was achieved in Lithuania, Latvia, and Hungary. This study aligns with the findings of Kijek *et al.* (2019), who noted that in countries such as the Netherlands, France, Luxembourg, and Germany, TFP has remained relatively stable over the past 15 years. These nations are among the most advanced in terms of agricultural development, characterised by high TFP levels. As a result, agricultural productivity growth during the analysed period (2004–2016) was relatively modest in these countries. Nowak and Kubik (2019) highlight in their study that the development of the TFP index in the "new" and "old" Member States follows divergent trends. While agricultural productivity increased in the new Member States, a decline of 1.5% was recorded in the old Member States. The rise in productivity observed in the new member states was primarily attributable to technological changes as well as improvements in technical efficiency.

Another widely used indicator for measuring the economic performance of countries is *labour productivity*, calculated based on agricultural gross value added (GVA) at constant prices. This metric reflects the value of goods or services produced annually by a full-time employee. According to Martin (2001), this indicator highlights differences in economic outcomes across regions, shaped directly by factors that influence regional competitiveness. Productivity growth leads to reduced costs, increased societal welfare, and enhanced purchasing power. During the 2014–2020 period, the labour productivity indicator shows that the Netherlands stood out among EU Member States, achieving nearly €70,000/AWU (Annual Work Unit). Denmark and Belgium also performed strongly in this regard. In contrast, Poland, Latvia, Romania, and Bulgaria ranked among the least productive countries. In Hungary, the average labour productivity was €7,938/AWU, significantly below the EU28 average of €18,120/AWU.

Research by Polozova *et al.* (2021) indicates a correlation between a country's digitalisation index and productivity levels, with higher digitalisation scores corresponding to higher productivity. Correlation analyses confirm this relationship, with Poland, Romania, and Bulgaria consistently appearing among the weakest performers in both digitalisation and productivity metrics. According to Csáki and Jámbor (2019), substantial disparities in labour productivity persist between the "new" and "old" Member States of the EU in the agricultural sector. These differences can partly be attributed to divergent specialisation patterns. Central and Eastern European countries predominantly focus on cereal and raw material production, whereas EU15 countries prioritise the production of animal products and processed goods. Consequently, the added value per worker in agricultural production is higher in Western Europe.

Potential of the younger generation

Eurostat's Digital Skills Indicators are composite metrics based on activities performed using the internet or software, assessing skills in the 16–74 age group across four specific domains: information, communication, problem-solving, and software usage. These indicators provide insights into individuals' digital competencies and how extensively they leverage internet and software opportunities in their daily life. Luxembourg and Denmark have the highest proportion of individuals with above-basic digital skills, at 50% and 48.7%, respectively. Luxembourg leads in overall digital skills scores, followed by Denmark, the Netherlands, Finland, and Sweden. In contrast, Romania, Bulgaria, Poland, Italy, and Cyprus rank lowest in digital skills.

These findings align with Polozova *et al.* (2021), who noted that Romania and Bulgaria consistently score lower on all digitalisation indicators compared to other European countries. However, these countries also hold the greatest potential for improvement. The EU28 average is 30.67%, with Hungary ranking eighth lowest at 24.7%. Achieving high levels of digital skills cannot be attributed solely to economic performance. On the contrary, attaining advanced digital skills requires exceptional economic policies that prioritise human capital development and foster the growth of high-tech enterprises through the creation of an optimal institutional environment (Leogrande, 2022). Cross-country analyses by van Kessel *et al.* (2022) highlight a positive correlation between high capital stocks and income levels and the advancement of digital skills. However, they also emphasise that the cost of internet access has a marginal effect on digital skill levels. These trends extend to agriculture, where high agricultural performance and a well-structured, adequately funded educational system show a strong correlation with the digital skills of sector participants.

In terms of the age structure of farm managers, Austria, Poland, and Slovakia performed best during the 2013–2020 period, while Cyprus and Portugal ranked lowest. This is further supported by the article of Zagata and Sutherland (2015), which highlights Eurostat figures showing considerable national differences in the number of young farmers. The data suggest that there is no shortage of young farmers at the national level in countries such as Germany, France, Switzerland, Finland, Austria, the Czech Republic, and Poland. By contrast, the apparent shortage of young farmers is found mainly in countries with a higher prevalence of small-scale holdings, particularly Portugal, Italy, Romania, and Greece. The statistical analysis also reveals marked differences in farm structures between older and newer Member States, and supports the view that young sole holders are more likely to manage modernised, profitable farms.

Examining the role of the younger generation is essential for understanding how the age of agricultural business managers influences the decision-making processes of farms, particularly from an innovation perspective. Young farmers tend to be more open to comprehensive planning aimed at long-term development and invest more resources in business growth (McKillop *et al.,* 2018). Valliant *et al.* (2019) emphasise that new entrants into agriculture face specific challenges, particularly regarding access to land and land succession. Similarly, Milone and Ventura (2019) highlight that the younger generation possesses the determination necessary to sustain farming operations and introduce innovations essential for launching and managing their businesses. Access to agricultural land is the most widespread challenge faced by young farmers. How-

Table 2: Values of sub-indices of the AKIS index

Country	Agricultural Education			Agricultural Research			Performance of the agricultural economy		Potential of the younger generation	
	Number of Individuals with Agricultural Qualifications	Farm Managers with Agricultural Qualifications	EU Expenditures on Training and Consulting	Government Expenditures on Agricultural R&D	Agricultural Enterprises' Expenditures on R&D	Expenditures on EIP	Labour Productivity in Agriculture	Total Factor Productivity (TFP)	Digital Skills	Age Structure of Farm Managers
Belgium	0.62	0.46	0.45	0.26	0.06	1.00	0.58	1.00	0.55	0.33
Bulgaria	0.04	0.08	0.09	1.00	0.03	0.00	0.03	0.21	0.04	0.53
Czech Republic	1.00	0.74	0.53	0.63	0.23	0.01	0.16	0.26	0.35	0.43
Denmark	0.37	0.11	0.94	0.78	0.17	0.63	0.68	0.35	0.97	0.17
Germany	0.39	0.30	0.26	0.74	0.17	0.15	0.53	0.00	0.67	0.53
Estonia	0.14	0.51	0.40	0.89	0.00	0.39	0.12	0.29	0.65	0.70
Ireland	0.13	0.43	0.26	0.85	0.01	0.56	0.16	0.41	0.47	0.43
Greece	0.01	0.00	0.01	0.56	0.36	0.30	0.12	0.25	0.28	0.23
Spain	0.03	0.03	0.32	1.00	0.75	0.16	0.40	0.26	0.56	0.20
France	0.41	0.57	0.18	0.48	0.45	0.22	0.53	0.11	0.48	0.70
Croatia	0.10	0.04	0.00	0.44	0.10	0.05	0.01	0.09	0.48	0.37
Italy	0.07	0.10	0.28	0.48	0.05	0.14	0.36	0.15	0.26	0.27
Cyprus	0.00	0.00	0.01	0.78	0.02	0.26	0.20	0.10	0.27	0.00
Latvia	0.03	0.57	0.40	0.85	0.76	0.30	0.00	0.52	0.40	0.30
Lithuania	0.03	0.29	0.23	0.52	0.12	0.17	0.04	0.58	0.54	0.47
Luxembourg	0.26	1.00	n/a	0.00	n/a	n/a	0.43	0.21	1.00	0.73
Hungary	0.04	0.07	0.03	0.70	1.00	0.34	0.05	0.51	0.37	0.37
Malta	0.03	0.02	0.43	0.19	0.26	0.01	0.10	0.01	0.67	0.23
Netherlands	0.68	0.15	1.00	0.44	n/a	0.40	1.00	0.09	0.92	0.20
Austria	0.28	0.51	0.25	0.26	0.05	0.32	0.30	0.22	0.66	1.00
Poland	0.04	0.53	0.08	0.37	0.31	0.01	0.00	0.38	0.25	0.90
Portugal	0.04	0.04	0.15	0.26	0.55	0.06	0.10	0.25	0.51	0.03
Romania	0.01	0.00	0.04	0.26	0.61	0.04	0.00	0.19	0.00	0.27
Slovenia	0.08	0.23	0.59	0.59	0.04	0.11	0.02	0.10	0.48	0.30
Slovakia	0.40	0.18	0.30	0.33	0.13	0.02	0.11	0.27	0.49	0.80
Finland	0.45	0.20	0.53	0.89	0.04	0.37	0.20	0.12	0.89	0.53
Sweden	0.25	0.40	0.50	0.26	n/a	0.65	0.37	0.16	0.83	0.37

Source: own calculations

ever, other significant obstacles include the lack of experience, start-up capital, and collateral for loans (Eistrup *et al.,* 2019). These barriers underline the need for targeted policies and support mechanisms to enable young farmers to overcome structural challenges and contribute to the innovation and sustainability of the agricultural sector.

AKIS index

Addressing the methodological aspects of the research questions, indicators are available for characterising the subsystems of AKIS that meet the criteria of availability and accessibility. Consequently, the AKIS index can be constructed and, furthermore, can be recalculated using the available indicators, ensuring its adaptability and reusability for future analyses.

Based on the AKIS index, the countries classified as *AKIS Leaders* include Belgium (0.55), the Netherlands (0.54), Denmark (0.52), and Luxembourg (0.45). These countries have well-functioning and well-supported AKIS systems, as corroborated by the findings of the ProAKIS project. Even in countries where AKIS is less centralised, such as the Netherlands and Belgium, the system remains robust. In these nations, AKIS systems are well-designed and developed with consistently applied incentives, contributing to their effectiveness and sustainability.

The countries classified as *AKIS Advancers* include Sweden (0.43), Finland (0.42), France (0.42), Estonia (0.41), Austria (0.41), the Czech Republic (0.41), Latvia (0.40), Germany (0.38), Ireland (0.37), Spain (0.37), Hungary (0.34), Slovakia (0.32), Lithuania (0.32), Poland (0.30), and Slovenia (0.25). In these countries, certain subsystems of AKIS are well-supported and function effectively. These nations generally coordinate their AKIS systems in an organised manner through established mechanisms. However, the further development of AKIS systems remains necessary to enhance their overall performance and alignment with best practices.

Countries with weaker AKIS development are classified as *AKIS Followers*, including Italy (0.22), Greece (0.21), Bulgaria (0.21), Malta (0.20), Portugal (0.20), Croatia (0.18), Cyprus (0.16), and Romania (0.14). These countries allocate limited resources to AKIS. Although numerous actors participate in their systems, their activities are uncoordinated and exert minimal influence on the system's evolution. Greece, Portugal, and Romania exhibit some of the weakest AKIS structures, primarily due to their high level of fragmentation and the limited strength of linkages among the various actors involved. The Greek AKIS is particularly ineffective, as the absence of effective coordination by national institutions has resulted in weak interconnections between actors. Similarly, the Portuguese AKIS faces significant

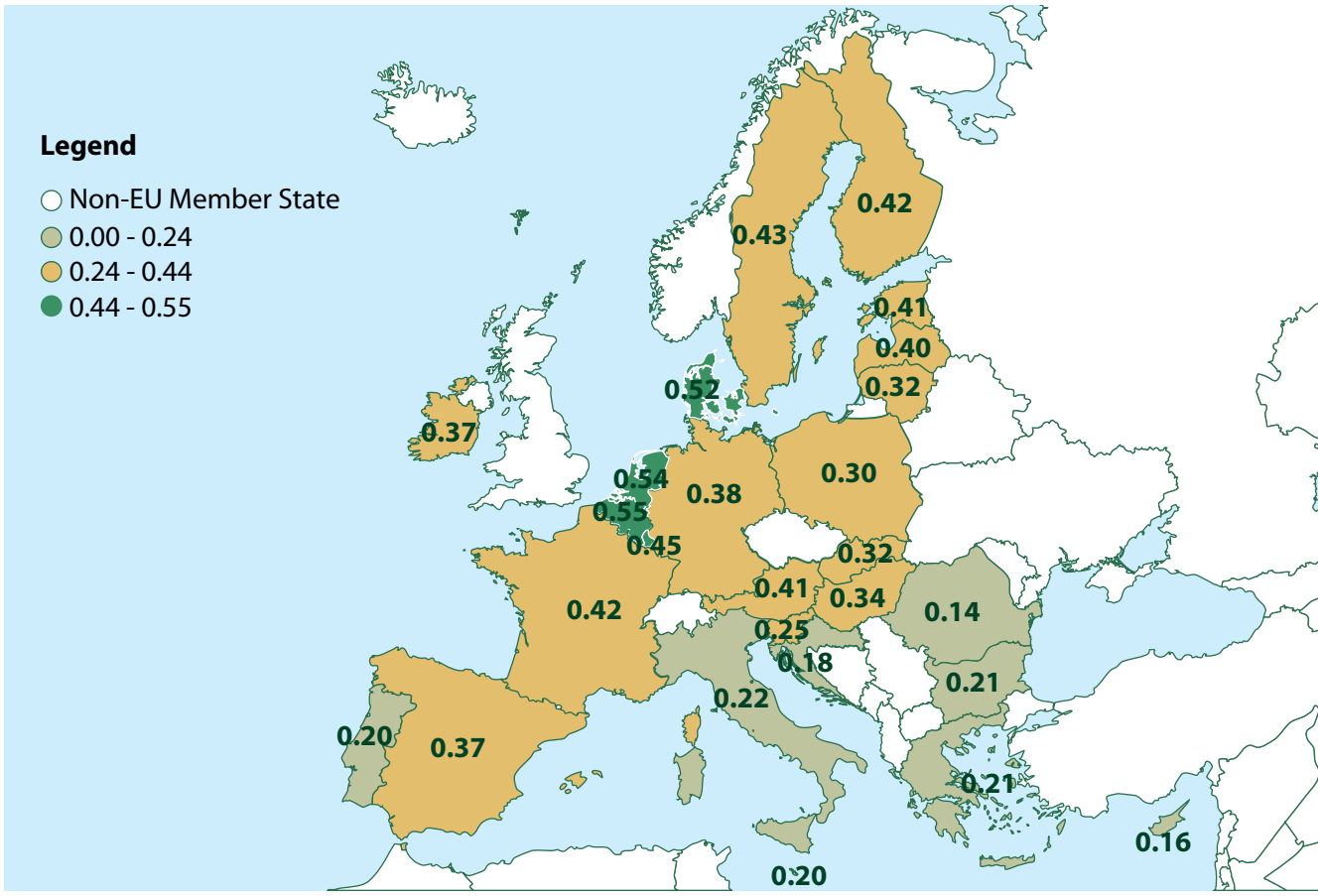

Figure 1: AKIS index according to EU Member States.
Source: Own calculations and editing based on the AKIS index

challenges: despite the presence of a large number of stakeholders, the lack of systematic coordination by public authorities undermines its overall functionality (Kountios *et al.,* 2024b).

Conclusions

Since 2008, the EU has systematically worked on developing the Agricultural Knowledge and Innovation System (AKIS) through various CAP incentives, referred to in the literature as AKIS-related measures. The composite index highlights that factors beyond the CAP also have a significant impact on the development of AKIS in Member States and, ultimately, on the innovation capacity of the agricultural sector. One such factor is the level of government expenditures on research and development, where the European Regional Development Fund (ERDF) plays a pivotal role. In the agricultural education category, formal education determines the qualifications of actors within the sector. Decisions in this area are influenced not only by agricultural administration but also by policymakers in the education domain. Furthermore, private sector investments in agricultural research, training, and other educational measures can be substantial, though official data on these expenditures remain limited. Differences in research intensities may be related to general budgetary constraints, the political-economic characteristics of publicly funded scientific research, or the extent to which certain countries and the private sector rely on adopting research results from elsewhere (Heisey and Fuglie, 2018). The collective performance of AKIS actors influences innovation capacity, while the open sharing of knowledge is essential for fostering innovation.

In summary, the most advanced AKIS systems are found in Western and Northern European countries, which are also considered the most innovative Member States in terms of agriculture. In these countries, active partnerships exist between farming organisations, research institutions, and universities. Additionally, the role of private capital in financing innovation systems is significant and cannot be overlooked.

The index results highlight areas with development potential in certain countries. The McKinsey report underscores significant opportunities for digitalisation in Central and Eastern European countries, supported by high levels of human development and education, advanced infrastructure, and substantial industrial capacities (Novak *et al.,* 2018). However, in Central and Eastern Europe, the diversity of partners involved in innovation systems is low, the intensity of interactions among them is weak, and knowledge flow to farmers is predominantly conducted by public organisations. This is partly because potential AKIS actors in these countries are not incentivised to engage in knowledge transfer, often misunderstand innovation processes, and fail to

perceive the benefits arising from collaborative interactions (Georgieva, 2022).

A critique of the composite index is that, beyond input and output indicators, it has limited capacity to incorporate efficiency metrics, with such measures only applicable in the case of agricultural performance (e.g., FTE and labour productivity). Another limitation of the index is its inability to integrate the advisory services of Member States. In 2003 the European Commission legislated for advisory services within the CAP. The objective was to ensure that all Member States provide farmers with the necessary support to better align production goals with environmental, health, and animal welfare regulations. However, the organisation of these systems remains under the jurisdiction of individual Member States (Labarthe and Laurent, 2013). The assessment of advisory services typically relies on the number of advisors operating in the sector and the number of organisations providing advisory services. These indicators are available through CAP performance and output metrics on the DG AGRI-managed Agri-Food Portal. However, due to incomplete data across Member States, comparative analysis is not feasible. In this study, advisory services and information flows among agricultural actors were analysed using the amount of CAP expenditures allocated to advisory and training services. While this approach provides insights into the role of advisory systems, the lack of comprehensive and comparable data remains a significant limitation.

In recent years, there has been significant progress in the understanding, funding, and support of AKIS, with Member States adopting a more structured approach than before. However, the AKIS approach is primarily interpreted at the level of CAP Strategic Plans. The authors of this study emphasise that substantial resources and numerous policy incentives influencing AKIS extend beyond the scope of the CAP and agricultural administration.

Thus, aligning AKIS strategies with various support policy instruments is essential for achieving tangible innovation and knowledge transfer outcomes in agriculture. The composite index is a valuable tool for measuring the extent of changes driven by coordinated incentives, providing policymakers with critical feedback on the effectiveness of efforts to advance AKIS development.

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https://doi.org/10.7896/j.3093 Studies in Agricultural Economics 127 (2025) 187-195

SCIENTIFIC ARTICLE

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Impact of Basic Human Values on Alcohol Use as a Coping Strategy During Chronic Stress: Insights for Sustainable Health Behaviours

ABSTRACT

Alcohol misuse has been a persistent challenge in Hungary, and the COVID 19 pandemic intensified the complexities of how people respond to collective stress. This study offers several new insights into the problem. First, drawing on a nationally representative survey of Hungarian adults, we move beyond broad patterns to pinpoint which demographic and social factors most influenced alcohol consumption during the pandemic. The analysis shows that increased drinking was more common among older adults and women, and among those experiencing financial hardship, while caregiving responsibilities (children under 14 in the household) were associated with a greater likelihood of increase rather than protection. Second, this research deepens understanding by applying Schwartz's Theory of Basic Human Values in combination with a Heckman selection model. This approach distinguishes not only who drinks, but also how intrinsic values shape drinking behaviour under stress. Disaggregating the ten basic values reveals that Power (status/dominance) was a robust predictor of increased alcohol use across models; Achievement (competence/goal attainment) showed a modest protective tendency; and Hedonism, net of thrill seeking and status, was negatively associated with escalation. In contrast, social focus values (e.g., benevolence, universalism, tradition) did not consistently predict change once other values and covariates were considered. Finally, the study provides practical guidance for policymakers. The findings suggest that reducing alcohol misuse will require more than rules or information campaigns: value tailored strategies (e.g., framing moderation as professionalism for Power oriented groups, emphasising performance for Achievement, and promoting mindful "savouring" for Hedonism) should be paired with supports that mitigate economic stress. Attention must also be given to the ways risk behaviours cluster and how financial strain can make communities more vulnerable.

ARTICLE INFO

Keywords:
sustainable health; Schwartz Theory of Basic Human Values; COVID-19; psychology copying strategy; Hungarian consumers

JEL classifications:
D12; I12; P46; Q11.

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Received: 11 March 2025; **Revised:** 12 September 2025; **Accepted:** 15 September 2025.

Introduction

Alcohol use – and misuse – touches nearly every aspect of social and economic life. In Hungary, as in much of the world, it is both common and consequential: when alcohol consumption rises, the toll is felt in health care systems, family wellbeing, workplace productivity, and public safety. Yet despite decades of research and intervention, the drivers behind why some individuals turn to alcohol – especially during periods of collective crisis – remain surprisingly puzzling. The COVID-19 pandemic, with its cocktail of stress, isolation, and uncertainty, brought this puzzle into sharper focus. Why did some Hungarians respond to the pandemic by drinking more, while others drank less or not at all? And what does this say about the deeper psychological and socio-demographic forces that shape our coping behaviours?

Recent Hungarian research has also emphasised the broader importance of value-driven behaviours in food and health-related contexts. For example, Török *et al.* (2022) highlight how short food supply chains create business opportunities by leveraging consumer trust and local embeddedness, while Nagy-Pető *et al.* (2023) segment consumers based on their commitment to local products, revealing strong links between personal values and purchasing decisions. These studies reinforce the idea that underlying value orientations shape not only economic and consumption

behaviours but also broader lifestyle and coping strategies. By situating our analysis within this emerging body of work, we recognise that understanding the role of values is essential for designing effective interventions, whether in public health, sustainable consumption, or resilience-building during periods of societal stress.

This paper addresses the question: How do basic human values influence alcohol consumption as a coping strategy during chronic societal stress? More specifically, do the ten basic Human Values as defined by Schwarz (1992) give explain on why some individuals turn to alcohol during hard times, increasing vulnerability? By combining a nationally representative survey with state-of-the-art statistical methods, this study seeks to provide a clear, evidence-based answer to this question – one that has both scientific and policy significance.

Much of the existing literature has explored the effects of demographic, economic, and psychological factors on alcohol use (Dawson *et al.,* 2005; Pollard *et al.,* 2020; Oroszi *et al.,* 2021). While important, these papers often treat individual values as secondary or assumes their influence is uniform across contexts. Recent advances, including those using Schwartz's theory of basic human values (Nordfjærn and Brunborg, 2015; Paramita *et al.,* 2023), suggest that values may matter greatly for coping behaviours. However, prior studies are typically limited by small or selective samples, a narrow focus on specific subgroups, or simplistic value frameworks that fail to capture the complexity of real-world behaviour during acute, society-wide stress.

This paper makes three contributions relative to this prior work. First, it leverages a large, representative sample of Hungarian adults collected during the COVID-19 pandemic – an extraordinary natural experiment in chronic societal stress. Second, it applies a rigorous Heckman selection model, allowing us to distinguish not only who drinks but how different values shape changes in consumption, while correcting for selection bias between abstainers and drinkers. Third, it moves beyond descriptive associations to offer concrete, policy-relevant insights about how certain human values can be fostered to reduce harmful alcohol use, especially in times of crisis.

Literature Review

The COVID-19 pandemic has significantly impacted global alcohol consumption patterns, highlighting the intricate interplay between stress, behavioural adaptations, and health outcomes. There is robust evidence linking chronic stress to increased alcohol use, as individuals often turn to alcohol as a coping mechanism (Dawson *et al.,* 2005; Becker, 2017; Paramita *et al.,* 2023). Pandemic-related stressors – social isolation, economic uncertainty, and health-related anxiety – have further intensified these tendencies (Bridgland *et al.,* 2021; Taylor *et al.,* 2021). However, epidemiological data also reveal considerable heterogeneity, with some populations reporting increased alcohol consumption and others reporting reductions or no change (Pollard *et al.,* 2020; García-Cerde *et al.,* 2021).

To understand these patterns, it is essential to consider the psychological and motivational determinants of health behaviours. Theories such as the Health Belief Model (HBM), Theory of Planned Behaviour (TPB), and Lazarus and Folkman's Stress and Coping Theory have provided crucial insights into why individuals engage in specific health behaviours in response to stress. For example, Lazarus and Folkman's framework posits that stress responses, including alcohol use, are shaped by both individual appraisals of stressors and available coping resources. TPB and HBM highlight the role of beliefs, intentions, and perceived behavioural control in shaping actions like substance use.

Compared with the HBM, TPB, or Lazarus–Folkman's stress–coping theory, Schwartz's Theory of Basic Human Values (Schwartz, 1992; Schwartz *et al.,* 2012) hereon BHV, is more general for alcohol research since it captures universal, transsituational motivations with demonstrated crosscultural measurement invariance (Schwar and Cieciuch, 2021) enabling comparable inference across populations. BHV offers a robust framework for examining the motivational basis of health behaviours, including alcohol consumption. The theory encompasses ten basic values, which empirical research has consistently grouped into higher-order dimensions, four or two. The four dimensions are openness to change (self-direction, stimulation, hedonism), self-enhancement (hedonism, achievement and power), conservation (security, tradition and conformity) and self-transcendence (benevolence, universalism). Further aggregations are possible, for instance the binary grouping of social focus (conservation plus self-transcendence) and personal focus (openness to change plus self-enhancement). Numerous empirical studies in psychology, sociology, and public health have utilised BHV to examine the relationship between values and health-related behaviours, including substance use (Nordfjærn & Brunborg, 2015; Dollinger and Kobayashi, 2003; Corti *et al.,* 2024). The basic values, and components of higher order dimensions are best emphasised by the BHV wheel (see Figure 1.)

Figure 1: The circumplex model of basic human values.
Source: Schwartz (2012)

In this paper we use a mix of the most detailed groupings of BHV, namely the aggregation into four groups to explain the determinants of whether the respondent is abstinent or not, and further, the ten BHV themselves, as determinants of change in alcohol consumption during a period of stress. Within Hungary, with its unique sociocultural and economic landscape, the detailed, ten value framework seems to be the most relevant. Marked regional disparities, strong cultural traditions, and the intensification of stressors during the pandemic all interact with population-level value orientations. Our approach is intended as a pragmatic and theoretically informed starting point, suitable for identifying population-level patterns and generating hypotheses for more detailed future research. This approach provides a clear, evidence-based lens for investigating the interplay between values, stress, and alcohol use, and offers valuable guidance for public health strategies in Hungary and beyond.

Materials and Methods

This cross-sectional study utilised data collected from a representative survey of the Hungarian adult population (aged 18 years and older) during the third wave of the COVID-19 pandemic in June 2021. Data collection adhered to the STROBE guidelines for observational studies (Von Elm *et al.,* 2007) and was conducted via structured telephone interviews by a professional survey company. When structured telephone interviews are employed to collect quantitative data within a cross-sectional framework, STROBE guidelines are appropriate for survey studies as well (Von Elm *et al.,* 2007). The sample (N=1031) was stratified to reflect demographic characteristics, including gender, age, education level, type of settlement, and regional distribution, as recorded in the 2016 Hungarian Microcensus.

Ethical approval was obtained from the Ethical Committee of the HUN-REN Centre for Economic and Regional Studies, Hungary. Participants provided informed consent prior to participation, and their involvement was voluntary, with the option to withdraw at any stage without justification.

The primary outcome variable was self-reported changes in alcohol consumption during the COVID-19 pandemic. Respondents were classified into four categories: abstinent, decreased consumption, no change, and increased consumption. Abstainers comprised 53% of the sample, while the remaining respondents provided detailed information on their alcohol use, capturing a range of behavioural responses to pandemic-related stress.

Psychological mechanisms underpinning these behaviours include coping strategies, emotional regulation, and social support. Chronic stress often drives individuals to rely on alcohol to alleviate negative emotions. Concurrently, basic human values – core beliefs that guide behaviour – may moderate or mediate these coping responses. Schwartz's (Schwartz, 1992) circumplex model of human values provides a framework for understanding how these values influence health behaviours.

Data on BHV was collected using the Portrait Value Questionnaire (PVQ), adapted from (Pascucci *et al.,* 2016) As discussed earlier, this versatile tool evaluates ten value dimensions that may be aggregated into four, and further to two overarching categories**.**

We further included well-established predictors of alcohol use – age, gender, education, household composition (presence of children under 14), smoking status, and physical activity – based on extensive prior research on substance use and coping (Pollard *et al.,* 2020; Oroszi *et al.,* 2021).

In addition, dietary and lifestyle variables such as fast food and soft drink consumption were incorporated. These variables are relevant given growing evidence of clustering of health-related risk behaviours (e.g., poor diet, smoking, alcohol use), which often share common psychosocial and economic drivers, especially under chronic stress (Paramita *et al.,* 2023). Including these factors helps capture broader lifestyle patterns that may confound or mediate the relationship between stress and alcohol consumption. Data were electronically recorded and reviewed for completeness. The alcohol consumption variable was analysed as an ordered response, with sociodemographic and psychological variables serving as covariates. The dependent variable, alcohol consumption, was categorised into four groups: abstinent, decreased consumption, no change, and increased consumption.

Table 1 illustrates the distribution of alcohol consumption changes among respondents. The majority (53%) reported abstaining from alcohol, while 36% indicated no change in their drinking habits. A smaller proportion reported either decreased (8%) or increased (3%) alcohol consumption. These results suggest that while a significant portion of the population abstained, a notable subset exhibited changes potentially linked to stressors arising from the pandemic. Conversely, the low percentage of increased consumption points to resilience among most individuals, although this group's vulnerability to stress-induced drinking behaviours warrants targeted public health interventions.

Table 1: The dependent variable.

Alcohol consumption	Observations	Per cent
Abstinent	546	53
Decreased	79	8
Did not change	370	36
Increased	27	3
Total	1,022	100

Source: Own estimations

Table 2 presents the key explanatory variables resulting from BHV of our models. As discussed earlier, along the use of the ten original values, four and two group aggregations are also suitable. There is of course a trade-off in the use of ten, four or two value/group specifications. The use of higher order aggregation generates more compact results – that is, fewer variables and thus less collinearity – yet more difficult interpretation. In the selection equation we will use the four groups of HBV (lower panel of Table 2) whilst in the outcome equation the ten HBV (upper panel of Table 2) are used. The rather high mean scores for BHV 10 and BHV 4 variables

values underscore the variability in psychological orientations, which are key determinants of health behaviours.

Table 3 provides descriptive statistics for the study's core independent variables. The mean age of respondents was 51.89 years, reflecting a predominantly middle-aged population. Gender distribution showed a slightly higher representation of females (56.6%) compared to males (43.4%). Educational attainment varied, with 22.2% holding higher education degrees, indicative of a diverse socioeconomic background. Households with children under 14 years accounted for 20.4% of the sample, suggesting a subset with additional caregiving responsibilities that may influence stress and coping mechanisms. Behavioural characteristics, such as smoking prevalence (29%) and engagement in light physical activity (83.2%), provide insight into lifestyle factors that may interact with stress and alcohol consumption. These findings highlight the interplay between demographic, psychological, and lifestyle variables, forming a comprehensive basis for analysing alcohol consumption patterns during the pandemic.

Table 2: Descriptive statistics of the Schwartz's Theory of Basic Human Values independent variables.

Variables	N	Mean	SD	Min.	Max.
BHV 10					
Universalism	1,024	5.19	0.72	1.33	6
Benevolence	1,029	5.10	0.77	1	6
Tradition	1,027	4.63	0.99	1	6
Conformity	1,029	4.91	0.94	1	6
Security	1,015	5.18	0.84	1	6
Power	1,029	3.66	1.14	1	6
Achievement	1,028	4.25	1.19	1	6
Hedonism	1,031	4.84	0.89	1	6
Stimulation	1,030	4.02	1.13	1	6
Self-direction	1,030	4.92	0.88	1	6
BHV 4					
Openness to change	1,029	4.59	0.75	1	6
Self-enhancement	1,026	4.25	0.85	1	6
Conservation	1,009	4.91	0.72	1	6
Self-transcendence	1,022	5.15	0.65	1.5	6

Note: BHV 10 emphasises the 10 basic values, whilst BHV 4 the four composite value aggregation
Source: Own estimations

Table 3: Descriptive statistics of the common independent variables.

Variable		N	Frequency /mean	SD	Min.	Max.
Age		1,031	51.89	17.31	18	91
Gender*		1,031		–	–	–
	0: Male	448	43.4%	–	–	–
	1: Female	583	56.6%	–	–	–
Education		1,031		–	–	–
	1: primary	153	14.8%	–	–	–
	2: vocational	288	27.9%	–	–	–
	3: secondary	361	35%	–	–	–
	4: higher education	229	22.2%	–	–	–
Kids (children under 14)		1,028		–	–	–
	0: none	818	79.6%	–	–	–
	1: minimum 1	210	20.4%	–	–	–
Light activity		1,031				
	0: otherwise	173	16.8%	–	–	–
	1: at least once a week	858	83.2%	–	–	–
Smoking		1,021		–	–	–
	0: otherwise	725	71%	–	–	–
	1: yes	296	29%	–	–	–

* The questionnaire presented the following options: male, female, rather not say. All responses were of the first two categories.
Source: Own estimations

Several additional variables were used to give a more detailed aspect to our estimations. Thus, chronic stress indicators, including financial burden and caregiving responsibilities, were also integrated into the analysis to capture their influence on drinking behaviours. Further variables proxying various unhealthy diet and lifestyle variables were also employed. Since the descriptive statistics of these additional categorical variables are of low importance, to save space these are available in (Table 4). These variables are:

Table 4: Descriptive statistics of the additional independent variables.

Variable	N	Mean	SD	Min.	Max.
Extra burden	1,024	3.25	1.36	1	5
Worsen finance	1,021	2.19	1.37	1	5
Fast food restaurant	1,030	5.99	1.3	1	7
Convenience food	1,031	4.32	1.86	1	7
Soft drinks	1,031	4.26	2.31	1	7
Health status	1,031	2.26	0.64	1	3
Budapest	1,031	0.3	0.45	0	1

Source: Own estimations

In order to better capture the broader psychosocial and lifestyle context of alcohol use during the pandemic, several additional explanatory variables were included in the analysis. These comprised both stress-related and behavioural factors. The variable Extra burden reflects respondents' perceived increase in responsibilities and everyday challenges due to COVID-19 restrictions, measured on a five-point Likert scale ranging from "Strongly disagree" to "Strongly agree." Worsen finance captures the extent to which individuals reported a deterioration in their financial situation as a result of the pandemic, also on a five-point agreement scale. To assess pre-pandemic dietary habits that may correlate with health-related coping strategies, we included three variables based on frequency of consumption: Fast food restaurant refers to how often respondents ate at fast food outlets before the pandemic; Convenience food captures the frequency of consuming ready-made or processed snacks; and Soft drinks measures the consumption of sugary beverages, excluding plain or carbonated mineral water but including flavoured waters. All three variables were coded on a seven-point categorical scale from "Daily" to "Never." In addition, Health status was assessed through a self-reported measure with three categories: poor, satisfactory, and excellent. Finally, a binary (dummy) variable was used to account for a relevant contextual factor: Budapest indicates whether the respondent lives in the capital city.

A key methodological challenge in analysing alcohol consumption is that detailed drinking patterns are only observed among those who consume alcohol, while a large share of respondents are abstainers. This raises a selection bias issue: drinkers may systematically differ from abstainers not only in observed characteristics, but also in unobserved factors (e.g., health status, risk aversion, value orientation). Failing to account for this could bias estimates of the effects of values and other covariates on alcohol use.

There are several methodological solutions to address this issue. One could use Propensity Score Matching (PSM), a popular technique for reducing selection bias in observational studies. The method however is primarily designed for binary treatment effects (e.g., treatment vs. control) and does not directly address situations where the outcome is only observed for a selected subpopulation. PSM would also require strong assumptions about overlap and ignorability, and may result in information loss due to matching and sample reduction. In contrast, the Heckman selection model (Heckman, 1976; 1979), is specifically designed to correct for selection in models with censored or conditional outcomes – making it the most appropriate and theoretically justified choice for our research question. The Heckman selection model explicitly models the two-step process: (1) the likelihood of being an alcohol consumer (selection equation), and (2) the determinants of changes in alcohol use among drinkers (outcome equation), while correcting for potential correlation between the two stages. This approach is particularly appropriate for our data because: the distinction between abstainers and drinkers is sharp, and a large portion of the sample abstains (53%). Key independent variables (including value orientations) may influence both selection into drinking and subsequent changes in consumption. The model enables us to utilise information from the full sample, increasing statistical efficiency and minimising bias from non-random selection. The Heckman model was implemented using the semi-nonparametric estimator proposed by (De Luca and Perotti, 2011). This advanced method accommodates complex error term distributions often present in behavioural data, thereby reducing the risks of misspecification associated with traditional parametric models. The flexibility of this estimator allowed for the accurate modelling of non-standard distributions and improved the reliability of the results. The *snpopsel* command in STATA facilitated the application of this technique, ensuring precision and robustness in the analysis. Likelihood-ratio tests confirmed the model's overall fit, providing confidence in the robustness of the findings.

Results

Our analysis begins with the selection equation, which differentiates between respondents who drink and those who abstain (lower panel of Table 5). The results confirm familiar patterns from the literature on alcohol use: younger age and male gender significantly increase the likelihood of alcohol consumption, while the presence of children under 14 in the household reduces it. More education is positively related to alcohol use, indicating that drinking in Hungary is not simply a marker of disadvantage but part of the social practices of middle-class and professional life. Smoking is also strongly associated with drinking, showing that health-risk behaviours often appear together.

Value orientations already play a role at this first stage. Individuals with high Openness to Change scores – covering

Table 5: The impact of factors on alcohol use during chronic stress.

Variable	Model 1	Model 2	Model 3
Outcome equation			
Age	0.020***	0.024***	0.018***
Gender	0.618***	0.599***	0.483**
Education	–0.065	–0.038	–0.022
Kids	0.929***	0.897***	0.871***
Universalism	–0.12	–0.15	–0.171
Benevolence	0.13	0.07	0.138
Tradition	0.006	–0.031	–0.025
Conformity	0.077	0.122	0.061
Security	–0.075	–0.081	–0.092
Power	0.155*	0.172**	0.130*
Achievement	–0.112	–0.137*	–0.081
Hedonism	–0.177*	–0.138	–0.144
Stimulation	0.122	0.074	0.114
Self-direction	–0.111	–0.062	–0.083
Extra burden		–0.009	0.024
Worsen finance		0.232***	
Fast food restaurant		–0.075	
Convenience food		–0.044	
Soft drinks		0.079**	
Health status			–0.125
Budapest			0.220
Openness to change		0.265**	0.225*
Self-enhancement		0.03	0.05
Conservation		–0.243**	–0.231**
Self-transcendence		0.064	0.077
Age		–0.014***	–0.013***
Gender		–1.086***	–1.008***
Education		0.227***	0.235***
Kids		–0.374**	–0.340**
Light activity		0.034	0.042
Smoking		0.505***	0.551***
Statistics			
N		980	982
p (chi2)		0.000	0.000

Note: *, **, ***: significant at 1%, 5%, 10%, respectively.
Source: Own estimations

self-direction, stimulation, and hedonism – are more likely to drink, consistent with alcohol being part of a lifestyle of novelty-seeking and sociability. In contrast, those who place more weight on Conservation – tradition, conformity, security – are significantly less likely to consume alcohol. This result suggests that drinking decisions are not purely driven by circumstances but also by deep-seated preferences and moral frameworks.

The outcome equation (upper panel of Table 5) sheds light on which drinkers change their behaviour under stress. Age remains significant, but its role reverses: while younger respondents are more likely to drink at all (based on the selection equation), it is older respondents who are more likely to report an increase in their drinking during the pandemic. Women also report more increase than men, consistent with greater sensitivity to stress or more willingness to acknowledge behavioural adjustments. Interestingly, the presence of children, which reduced the probability of drinking in the first stage, becomes positively associated with increased drinking among those who do drink. This may reflect the heavy burdens placed on parents during lockdown – home-schooling, reduced childcare options, and work-family conflict – pushing some to rely on alcohol as a coping tool.

Among the ten basic human values, Power is by far the most consistent and significant predictor across models. Respondents who value status, control, and influence are systematically more likely to report increasing alcohol use. This is consistent with the interpretation of drinking as part of status-laden social rituals – networking dinners, client entertainment, or celebratory events – where abstaining could even signal disengagement. For those in power-oriented roles, drinking may reinforce social belonging and signal success.

Other value effects enrich this picture. Hedonism becomes negatively related to increased drinking (Model 1), implying that these individuals prefer fewer but more pleasurable drinking occasions rather than more frequent or heavier use. Achievement is negatively associated with increased drinking in Model 2, suggesting that people focused on performance and goal-attainment protect their time and energy, keeping alcohol consumption under control.

Economic stress intensifies these dynamics. Those who reported a worsening financial situation during the pandemic were significantly more likely to increase their alcohol use. This finding fits the idea that economic hardship drives some people toward maladaptive coping behaviours. Lifestyle indicators tell a similar story: soft-drink consumption is positively related to alcohol use, hinting at a pattern of less healthy dietary choices.

Overall, the results provide a consistent picture. Demographic factors define who is likely to drink, but changes in consumption during crises are strongly shaped by values and situational pressures. Power heightens the probability of increasing drinking, while Achievement and "pure" Hedonism tend to hold behaviour in check. The presence of children and financial stress tilt the balance toward higher alcohol use, while access to green space has a calming effect.

Discussion

This study provides new evidence on how demographic, psychological, and economic factors shape alcohol consumption under chronic stress, using Hungary during the COVID-19 pandemic as a natural experiment. The results confirm several well-established patterns: younger age and male gender are risk factors for drinking (Dawson *et al.,* 2005; Pollard *et al.,* 2020; Oroszi *et al.,* 2021), while caregiving responsibilities reduce the probability of drinking. At the same time, among those who do drink, the presence of children is associated with higher odds of increasing alcohol use. This contrast is important: caregiving may deter some from drinking altogether, but for those who drink, the additional pressures of home-schooling and work-family conflict may push them toward higher consumption. This finding mirrors earlier research showing that stress affects men and women differently, and that family context plays a key role in shaping coping strategies (Hendriksen *et al.,* 2022; Boncz *et al.,* 2020).

Perhaps the most striking result is the consistent role of value orientations. Power emerges as the most robust predictor of increased drinking, even after adjusting for sociodemographic factors, lifestyle variables, and economic stress. This is more than a statistical finding: it reflects the way alcohol is integrated into status-driven social life. In many Hungarian business and professional settings, drinking is not just tolerated but encouraged – networking events, client meetings, and celebrations often involve alcohol. For individuals who seek influence and status, participation in these rituals can reinforce their position, making abstention costly in social terms. This finding is consistent with Nordfjærn and Brunborg (2015), who found that self-enhancement values were associated with heavier drinking in Norway.

Other values also matter. Achievement is weakly protective, suggesting that those focused on goal attainment restrain drinking to safeguard productivity. Hedonism shows a negative relationship once thrill-seeking and status motives are taken into account, meaning that hedonists may be more selective about drinking occasions and substitute toward other pleasures, such as food, travel, or cultural activities. These results add depth to theories such as the Health Belief Model, Theory of Planned Behaviour, and Lazarus and Folkman's Stress-Coping Theory, which emphasise how motivations interact with perceived norms and coping resources (Bridgland *et al.,* 2021).

Situational pressures also shape behaviour. Respondents who reported a deterioration in their financial situation were significantly more likely to increase their alcohol consumption, confirming meta-analytic evidence that stress and anxiety raise the risk of alcohol use (Paramita *et al.,* 2023). The positive association between soft-drink consumption and alcohol use points to a clustering of less healthy dietary habits, a pattern well documented in public health research (Taylor *et al.,* 2020).

These findings have direct implications for public health policy. First, alcohol consumption under chronic stress is not only about price, availability, or generic information campaigns. Thus, interventions should be targeted toward groups most likely to increase drinking under stress – including financially strained households, parents under heavy caregiving burden, and individuals with strong power motives. For the latter group, messaging that frames moderation as professionalism may be more effective than warnings about health risks.

Second, policies should consider how social norms interact with drinking. For those high in Power, moderation can be framed as professionalism and self-control. Supporting parents and reducing financial stress would have a double dividend – lower stress levels and less need for coping through drinking. In workplaces and professional settings, encouraging alcohol-free networking events or providing non-alcoholic but high-status beverage options could help decouple status signalling from drinking. Community-level interventions, such as supporting sports clubs, or cultural programmes, may also create alternative outlets for coping with stress, consistent with evidence that outdoor activity and social engagement reduce risky health behaviours.

Finally, the results support a broader agenda that integrates value-based approaches into health promotion. Programmes that build social values – benevolence, solidarity, community – through education, volunteering, and inclu-

sive storytelling could gradually shift behavioural norms, as suggested by Schwartz's (1992) value framework and later empirical studies (Schwartz et al., 2012; Schwartz and Cieciuch, 2021). Over time, such interventions can help create a culture where drinking is less tied to status display and more aligned with deliberate, moderate enjoyment.

Some limitations must be acknowledged. As in many surveys, alcohol consumption is self-reported and may be underestimated due to social desirability bias (Grossman et al., 2020). Future research could combine survey data with biomarkers, time-use diaries, or administrative records to strengthen measurement validity (Schecke et al., 2021). Moreover, the cross-sectional design does not allow for causal inference: value orientations may themselves evolve in response to stress and drinking behaviour (Paramita et al., 2023). Longitudinal research could clarify these feedback loops.

In sum, our findings show that alcohol use under chronic stress is shaped not only by who people are but also by what they value and the social contexts they inhabit. This makes a strong case for multi-layered interventions — economic, cultural, and psychological — that address both the pressures that push people toward drinking and the motives that make them more likely to increase their consumption. By combining economic support, value-based education, and opportunities for healthier coping, policymakers can reduce the risk of harmful drinking not only in future crises but in everyday life.

Several limitations should be acknowledged. First, the reliance on self-reported data for sensitive behaviours such as alcohol consumption raises the possibility of social desirability bias. Respondents may underreport or selectively recall their drinking behaviour (Grossman et al., 2020), potentially attenuating or distorting associations. While assurances of confidentiality and validated survey instruments (e.g., PVQ) help mitigate this risk, future research could enhance validity by incorporating alternative data sources – such as biomarkers, collateral reports, or time-use diaries (Bridgland et al., 2021; Schecke et al., 2021). Somewhat the same possible caveat applies to self-reported health status data.

Second, our cross-sectional design precludes any definitive statements about causality or the directionality of observed associations. It remains plausible, for example, that changes in alcohol use or chronic stress exposure might themselves shape value orientations over time (Paramita et al., 2023). Longitudinal studies would be better suited to capture these temporal dynamics and disentangle reciprocal effects between values, stress, and behaviour.

A further limitation concerns the generalisability of our findings beyond the Hungarian context. While Hungary provides a salient case study, with high prevalence rates of alcohol use disorder and pronounced regional and social disparities (WHO, 2019; Oroszi et al., 2021), cultural norms and value hierarchies may differ elsewhere. Cross-national comparative research would help clarify the extent to which these value–behaviour relationships are universal or contextually contingent.

In conclusion, our findings confirm and extend existing knowledge about the motivational underpinnings of alcohol use under chronic stress. While social focus values can serve as a buffer, and personal focus values as a risk factor, these effects are shaped by wider social, economic, and psychological contexts. Addressing these complexities will require future research designs that are longitudinal, multimethod, and culturally sensitive. Such efforts will provide a richer foundation for evidence-based interventions and more targeted public health strategies – both in Hungary and beyond.

Conclusions

This study confirms that alcohol consumption during periods of chronic stress is shaped by a mix of demographics, economic pressures, and deeper motivational drivers. In Hungary, the pandemic did not lead to a uniform rise in drinking, but it did expose clear fault lines: parents under stress, financially strained households, and individuals with strong Power values were most likely to increase consumption. At the same time, Achievement and Hedonism values acted as moderating forces, supporting more deliberate and restrained drinking patterns.

These findings have direct implications for policy. Traditional instruments – taxes, availability restrictions, and information campaigns – remain important, but they are not enough on their own. Value-sensitive approaches are needed: for those motivated by status, moderation should be framed as professionalism and self-control; for those seeking excitement, safe and engaging social alternatives must be made available. Support for families and targeted relief for financially vulnerable groups can reduce the economic stress that fuels risky coping.

Ultimately, addressing harmful alcohol use is not simply about regulating a product but about shaping the social and cultural environment in which drinking takes place. By combining economic support, education, and community-based initiatives, policymakers can create conditions where alcohol is consumed in ways that strengthen social ties rather than undermine them – building resilience not only for the next crisis, but for everyday life.

Acknowledgements

This research was funded by the Hungarian National Research, Development and Innovation Office in the form of grants [Z. Benedek (143247), Z. Bakucs (NKFI-1, Advanced-150850)].

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Studies in Agricultural Economics 127 (2025) 196-210 https://doi.org/10.7896/ j.3252

SCIENTIFIC ARTICLE

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Social embeddedness and consumer preferences for farmers' markets: Evidence from three European countries

ABSTRACT

The study aims to explore the role of social embeddedness in consumer shopping behaviour across different retail environments, with a particular focus on farmers' markets. Drawing on a sample of 1,800 European consumers from Hungary, Italy, and the United Kingdom, the study examines apple purchase preferences regarding different product attributes (e.g., price, origin, quality certification) using a discrete choice experiment. A hybrid logit model is estimated to capture the impact of social embeddedness on purchase decisions. The results show that, across the three countries, farmers' markets are the preferred outlet, more so than supermarkets or greengrocers, especially by those consumers who are most embedded in community relations. For Italian consumers, community and cultural aspects are key drivers of purchasing behaviour, while health and quality attributes are the most significant for their British counterparts. Hungarian respondents' decisions are mostly influenced by price factors, although community-driven considerations also matter. The research confirms that farmers' markets are not just places to buy food, but also community spaces where trust, personal connections, and local identity play a significant role. The findings have important theoretical, managerial, and policy implications, particularly for promoting more sustainable, community-based food systems, including short food supply chains.

ARTICLE INFO

Keywords:
social embeddedness; farmers' markets; consumer preferences; consumer behaviour; short food supply chain; sustainable consumption.

JEL classification:
Q13.

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Received: 22 July 2025; **Revised:** 14 October 2025; **Accepted:** 18 October 2025.

Introduction

In an era characterised by rapid globalisation, and in some cases, deglobalisation, technological advancement, pandemics, and shifting political landscapes, the interaction between social relationships and economic systems has never been more crucial (Hamid and Mir, 2021; Kornprobst and Paul, 2021; Maró *et al.,* 2025). Markets are deeply enmeshed in the social and cultural fabric of society. The concept of social embeddedness challenges the notion that economic activities are purely driven by profit-maximising motives or impersonal decisions (Granovetter, 1985; Hunt, 2007). Instead, it focuses on how cultural values, social networks, and trust influence the functioning of these systems and markets and the actors operating within them. Whether related to the informal exchanges of international supply chains or local markets, the social ties that bind individuals and communities play an important role (Heidenreich, 2012; Hunt, 2007; Kirwan, 2004).

The concept of social embeddedness has attracted increasing attention in the context of the food sector, particularly in relation to short food supply chains (SFSCs) (Chen and Scott, 2014; Sonnino, 2007). The latter support alternative and more direct sales from farmers to end-consumers, offering a more localised option than more conventional and globalised food systems. For instance, in the case of farmers' markets (FMs), the close geographical and social connection between producers and consumers not only fosters economic transactions but also strengthens and relies on social relationships and community-building (Migliore *et al.,* 2014). Social embeddedness within FMs is beneficial for several reasons, and its advantages affect multiple stakeholder groups, including consumers, vendors, market managers, and the wider community. The concept of social embeddedness, where economic actions are grounded in social relationships and trust, has been central to understanding the unique dynamics of FMs (Chen and Scott, 2014; Hunt, 2007; Kirwan, 2004). For many people, social embeddedness has come to represent the idea of social connections that shape and enrich the way people engage in economic activities such as FMs (Hinrichs, 2000).

The contribution of this paper is thus threefold. First, to the best of one's knowledge, social embeddedness has not yet been examined using a discrete choice experiment (DCE), particularly in a context involving three different countries where the role of FMs is crucial. Despite various studies on the topic (see e.g.,Chen and Scott, 2014; He and Morales, 2022), the literature either discusses FMs in general

or focuses on a specific region or social aspect. The application of DCE enables a more thorough examination of the role that social factors play in consumers' decisions (e.g., interaction with producers, the influence of values, and community relations). For the study, apples were the subject of investigation, as they are one of the most widely consumed fruits available in various retail outlets across the selected countries. Second, the analysis, conducted on a large sample of European consumers, provides a more reliable context for cross-country comparisons and permits the drawing of generalisable conclusions and policy implications. In the three examined countries (Hungary, Italy, and the UK), distinct regulatory and cultural contexts exist that may significantly impact the role of social embeddedness in FMs. Third, the trend in Europe is to place significantly more emphasis on SFSCs, including FMs. Several EU policies and support programmes, such as the Farm to Fork Strategy and rural development measures supporting short supply chains, explicitly encourage direct contact between producers and consumers. In addition, the COVID-19 pandemic has also focused attention on the resilience of local food systems, further strengthening the demand for and political support of SFSCs (Török *et al.,* 2024). Thus, the findings may be of interest to policymakers who want to strengthen and enhance local food markets and develop more sustainable food systems.

Theoretical background and literature review

Short food supply chains and the characteristics of FMs and their consumers

Since the appearance of modern and longer supply chains in the 20th century, the relationship between producers and consumers has weakened, e.g., in terms of communication and information exchange, which has often led to an increase in information asymmetry and a decrease in consumer trust (Bildtgård, 2008; Török *et al.,* 2022; Török *et al.,* 2024). Conversely, the food safety scandals at the end of the 20th century and the beginning of the 21st century, consumers' commitment to healthier, more sustainable food, and an appreciation of the value of social interaction have strengthened the role of SFSCs again (Basil, 2012; Luo *et al.,* 2022; Marsden *et al.,* 2000; Renting *et al.,* 2003), as they are perceived to be able to help solve these issues and provide an alternative to LFSCs.

Food quality (e.g., healthier and tastier food) (Byker Shanks *et al.,* 2013; Gillespie *et al.,* 2007; Larimore, 2018; Török and Tóth, 2013), food price (Baker *et al.,* 2009; Bullock, 2000; Conner *et al.,* 2010), and market atmosphere (e.g., social interaction, meeting places) (Charatsari *et al.,* 2018; Conner *et al.,* 2009; Holloway *et al.,* 2007; Zepeda and Leviten-Reid, 2004) are the main reasons why individuals purchase food through SFSCs. According to the literature, there are many types of SFSCs that may be classified based on the number of intermediaries, organisational links, and physical distance (Marsden *et al.,* 2000; Michel-Villarreal *et al.,* 2019); e.g., box schemes, community-supported agriculture (CSA), cooperatives, farm-based butchers' shops, farm shops and FMs. FMs were selected for analysis as they represent the most popular and widespread form of SFSCs, especially in the studied countries (Maró *et al.,* 2022; Michel-Villarreal *et al.,* 2019; Murphy, 2011).

Consumers of FMs have some well-defined characteristics. According to the systematic summary of Maró *et al.* (2023), the typical FM customer, with few exceptions, is a middle-aged or older, highly educated woman with 1-2 children in the household and a higher-than-average income. However, there is no consensus in the literature as to what the typical type of residence of an FM buyer is. FMs are visited mainly by residents of small and large cities, as urban people are looking for fresher, tastier, better-quality products (Youngs, 2003). Supporting local farmers and the local economy is important for FM consumers, who prioritise health, quality, and sustainability in their consumption choices (Bazzani and Canavari, 2013; He and Morales, 2022; Malak-Rawlikowska *et al.,* 2019; Shahu *et al.,* 2023)

There are other ways of interpreting the buyer segments of FMs. Classifications identify product-oriented, socially responsible, and entertainment-oriented consumers. This latter segment seeks experiences beyond purchasing and often spends the most, reflecting the attraction of social and community engagement in these spaces (Pilař *et al.,* 2019). Hughes (1992) highlights that middle- and high-income retired people and active professionals are the primary target groups at FMs, with less access for low-income individuals, inadvertently creating a customer base that aligns with the middle-class preference for embeddedness within local food systems. Manalo *et al.* (2003) reveal similar trends: customers who buy directly from farmers often express a willingness to pay a premium for local products, driven by the motivation to preserve farmland and support local agriculture.

Social embeddedness at farmers' markets: a consumer perspective

Social embeddedness in the context of FMs involves the formation of trust, personal connections, and community bonds. This embeddedness creates a shared space that emphasises community and trust, but remains grounded in commercial relations, and this dynamic contributes to social cohesion within local food systems (Hinrichs, 2000). In the case of FMs, the connection between social embeddedness and human values is particularly evident (Benedek *et al.,* 2018; Sonnino, 2007). Such markets are often sustained by support for community cooperation and collective values, rather than a motivation for profit. These factors strengthen the effect of social embeddedness, which has not only an economic but also an ethical and cultural dimension. In the case of local food systems, social embeddedness not only generates economic benefits, but also represents values such as a desire to contribute to strengthening communities (e.g., preferring community, local markets over large stores), sustainability (e.g., choosing environmentally-friendly products), or local identity (supporting local

producers) (Carson *et al.,* 2016; Maró, *et al.,* 2023; Nagy-Peto *et al.,* 2023; Sonnino, 2007). These aspects distinguish FMs from conventional retail environments by fostering direct, face-to-face interaction. Consumers frequently visit FMs not only for high-quality, locally sourced products but also to support sustainable practices and build a connection with local producers (Feagan *et al.,* 2004; Kirwan, 2004). Social embeddedness is beneficial for consumers who seek authenticity in their purchases, as well as for producers who value customer loyalty based on shared values (Chen and Scott, 2014; Feagan *et al.,* 2004; Grashuis and Su, 2023; Kirwan, 2004)

Research has identified that FMs strongly attract a significant number of retired individuals and active professionals who appreciate the community's social aspects (Hughes, 1992). By connecting directly and sharing information with vendors, consumers participate in a form of economic activity that fosters a sense of community and mutual support, thereby enhancing their satisfaction and trust. Similarly, Hunt (2007) describes how customer-vendor interactions at FMs foster mutual relationships that influence vendor practices, prompting vendors to adopt and maintain ethical and high-quality production standards in response to consumer expectations. In contrast, focusing on young adults' expectations and experiences at FMs, Oths *et al.* (2016) reveal that the latter often prefer markets with a lively, festival-like atmosphere, which may, however, risk creating exclusionary spaces. Young adults value variety, green practices, and social experiences, which support a sense of belonging and embeddedness within the community.

Further, the concept of social embeddedness takes on cultural dimensions in various global contexts. Kopczyńska (2017) discusses Polish open-air markets, emphasising how cultural familiarity and local traditions contribute to trust and continuity, while Oñederra-Aramendi *et al.* (2018) highlight similar dynamics in Spain's Gipuzkoa region. Focusing on Central and Eastern Europe, Benedek *et al.* (2018) found that FM consumers are primarily those interested in fresh, high-quality food and are supportive of local farmers. Pilař *et al.* (2019) further identifies consumer segments, noting that entertainment-oriented consumers who seek social and emotional experiences alongside their purchases are among those who spend the most.

Empirical evidence from the literature

Concerning the research area regarding the social embeddedness of FMs, most studies have focused on the United States and Latin America (Hughes, 1992; Hunt, 2007; Kaufmann *et al.,* 2023; Oths *et al.,* 2016; Schoolman *et al.,* 2021), with a growing body of work emerging from Asia (Tsai *et al.,* 2019), while the situation in Europe remains underexplored (Benedek *et al.,* 2018; Kirwan, 2004; Kopczyńska, 2017; Oñederra-Aramendi *et al.,* 2018; Pilař *et al.,* 2019). Based on the literature, Southern and Eastern Europe are underrepresented, with a limited number of cross-country studies that compare the dynamics of FMs across different cultural and regulatory environments. European studies provide some insights but often focus more on the general structure of alternative food networks, in most cases from the producers' perspective, rather than on embeddedness-specific themes (Benedek *et al.,* 2018; Kopczyńska, 2017).

The methodological approaches used in FM and social embeddedness research generally fall into the following categories: Qualitative studies, including ethnography and case studies, capture the lived experiences and social interactions within markets. For instance, Oths *et al.* (2016) employed ethnographic methods to explore young adults' preferences for lively, festival-like market environments, which, while appealing, may risk creating exclusionary spaces. Both Hunt (2007) and Oñederra-Aramendi *et al.* (2018) analysed consumer-farmer interactions and explored social embeddedness through case study analysis with interviews and observations as data sources. In addition, the ethnographic method appears to be based on qualitative interviews when exploring social dynamics in FMs (Kopczyńska, 2017). In terms of quantitative analysis, studies like Pilař *et al.* (2019) and Tsai *et al.* (2019) have used structural equation modelling (SEM) to analyse the relationship between product performance, relational capital, and consumer well-being, emphasising the economic and social impact of FM experiences on repurchase intentions and satisfaction. In addition, several studies have combined qualitative and quantitative approaches, using surveys, interviews, and statistical models (He and Morales, 2022; Hinrichs, 2000; Hughes, 1992; Kaufmann *et al.,* 2023).

Despite the valuable contributions of such research (see more details above), significant research gaps are identifiable that are related to methodology, sample size, and area of research. First, DCE, a method often used in consumer behaviour studies to quantify the impact of different factors on decision-making (see e.g., Lockshin *et al.,* 2006; Maró, Balogh, *et al.,* 2023), has not been applied in the context of social embeddedness and the consumers of FMs. Employing DCE could generate a nuanced understanding of the specific attributes and characteristics, both intrinsic and extrinsic (e.g., product origin, price, or farmer interaction) that influence consumer choices at FMs. The application of this model could clarify the relative importance of social embeddedness elements in purchasing decisions and allow for a more quantitative analysis of consumer motivations. Second, the sample size in FM studies, with some exceptions (Pilař *et al.,* 2019; Schoolman *et al.,* 2021; Tsai *et al.,* 2019), is often limited, resulting in less robust statistical power and generalisability. Conducting larger-scale surveys could improve the validity of findings and provide more statistically significant insight into the sociodemographic characteristics and preferences of FM consumers. Third, there is a lack of comparative, cross-country research in Europe. As most studies are conducted within a single country or region (Benedek *et al.,* 2018; Pilař *et al.,* 2019; Schoolman *et al.,* 2021; Tsai *et al.,* 2019), a cross-European study could address unique regulatory, cultural, and economic variations across markets in different regions. This approach would not only fill the geographic gap in the literature but also reveal how national policies and cultural values shape social embeddedness within markets.

Materials and methods

Research process, description of the sample

This study builds on Török *et al.* (2025), and examines the interaction between the point of sale and the social embeddedness of the FM. To investigate consumer preferences for apples, a discrete choice experiment was conducted with the attributes and levels presented in Table 1.

After defining the attributes (and their levels), the design of the discrete choice experiment was tested through a pilot survey. This was conducted with 120 participants ($n_{British}$=40, $n_{Hungarian}$=40, $n_{Italian}$=40) in October 2023. The design of the experiment was based on the parameter combination 16-3-7 (number of decision situations, number of alternatives included in decision situations, number of attributes characterising the alternatives) in the context of a D-efficient experimental design (Rose and Bliemer, 2009). Due to the large number of choice situations, the pilot survey was blocked, with 16 choice situations arranged in 2 blocks, so that respondents were faced with only 8 choice situations. In addition, in order to reduce the bias caused by the hypothetical situation, a *"no choice"* option was included in all decision alternatives.

Data from the pilot survey were analysed by performing conditional logit (CL) model estimations by country. Based on this, it was considered to be necessary to revise the way decision situations were presented. A kind of mixed approach was applied, often used in discrete choice experiments: i) presentation of the decision situations in tabular form without image illustration or ii) presenting decision situations with pictorial alternatives. This was achieved by presenting the alternatives to the decision situations to the participants, primarily in a tabular format (without illustrations). However, when participants approached the alternative (e.g., using the computer's cursor or its smart device equivalent), they were presented with a picture of it. An example is shown in Figure 1. The decision situations were introduced with the following text: "*Please imagine a situation in which you want to buy apples. Let's say you have to choose between three types of apples, all of which are the same size, but differ in some of their product attributes. Please decide which of the three options you would select, or mark 'no choice' if you would not buy any of them. You will be presented with eight different FICTITIOUS decision scenarios. Please consider each decision scenario to be completely independent from the others!*".

The experimental design in the final survey was also of D-efficient type, again with three apple options (with seven traits) and one 'no-choice' option. The only difference from the pilot survey design was that the number of choice situations was increased from 16 to 32 to generate more variability in the data. Accordingly, the number of blocks was doubled (4). Descriptive details of the sample are presented in Table 2. The sample is representative in all three countries in terms of gender and age distribution.

Table 1: Attributes of discrete choice experiment.

Attributes	Level of attributes	Description of attributes	Supporting literature
Point of sale	Farmers' market	Place where the product was purchased.	Maró, Maró, *et al.* (2023); Platania *et al.* (2015); Vermeir *et al.* (2023)
	Supermarket		
	Grocery store		
Aesthetic appearance	Perfect	The appearance and perfection of the product can be determined by visual inspection.	Aschemann-Witzel *et al.* (2021); Ceschi *et al.* (2018); de Hooge *et al.* (2017)
	Slightly imperfect		
	Fully imperfect		
Organic	Yes	Whether the product has an organic certified label.	Akpinar *et al.* (2009); Massaglia *et al.* (2019); Meyerding and Merz (2018)
	No		
Geographical indication	Yes	Whether the product has a Geographical Indication label.	Maró, Balogh, *et al.* (2023); Massaglia *et al.* (2019); Török and Jámbor (2013); Török *et al.* (2020)
	No		
Origin	Local	Local, domestic, or imported product.	Kim and Kim (2022); Massaglia *et al.* (2019)
	National		
	Imported		
Colour	Red	Product colour is red, green, yellow, or mixed.	Ceschi *et al.* (2018); Moser and Raffaelli (2012); Skreli and Imami (2012)
	Green		
	Yellow		
	Mixed colours		
Price	329 Ft / 1.49 € / 1.99 £	Different product price HUF, EUR, or GBP (based on the surveyed country).	Ceschi *et al.* (2018); de Hooge *et al.* (2017); Vermeir *et al.* (2023)
	659 Ft / 2.39 € / 3.39 £		
	989 Ft / 3.29 € / 4.69 £		
	1,299 Ft / 4.19 € / 5.99 £		

Source: Own composition

Figure 1: Example of a decision situation.

Source: Own composition

Table 2: Sample structure across the three countries.

	UK (*n*=600)	Hungary (*n*=614)	Italy (*n*=600)
Gender (%)			
Female	52.17	50.33	51.00
Male	47.50	49.51	49.00
Other/Prefer not to say	0.33	0.16	0.00
Age category (%)			
18–24	11.67	10.10	8.17
25–34	21.67	18.08	14.83
35–44	19.33	20.85	18.00
45–54	20.17	23.29	23.33
55–64	17.83	15.96	25.83
65–70	9.33	11.73	9.83
Education level (%)			
Lower secondary education or below	16.33	2.77	9.50
Upper secondary education or a college qualification below degree level	37.67	59.45	57.00
Higher education	46.00	37.79	33.50
Residence (%)			
City	39.50	41.53	36.17
Medium/Large town	44.83	39.25	52.00
Village	15.67	19.22	11.83
Household size (%)			
1 person	16.50	12.54	13.00
2 persons	32.00	39.74	25.00
3 persons	19.67	23.13	28.17
4 or more persons	31.83	24.59	33.83
Subjective income level category (%)			
Very low	38.17	32.74	39.67
Low	13.67	14.33	14.67
Medium low	14.33	14.01	16.83
Medium high	12.67	14.82	11.83
High	6.83	8.96	5.83
Very high	14.33	15.15	11.17

Note: The subjective income categories were constructed based on the five statements of the Consumer Financial Protection Bureau (2024), measured on a 7-point agreement scale (where '1' indicated strong disagreement and '7' indicated strong agreement): (1) *A large, unexpected expense would be difficult for me to handle*; (2) *I'm just getting by financially*; (3) *In a given month, a gift intended for a wedding, birthday, or other event will burden me financially*; (4) *By the end of the month, I have no money left to spend*; (5) *Sometimes I have unpaid bills.* In order to create subjective income categories from the scores given to the statements, the categorisation of the CFPB was used after converting the aggregate scores into percentages (e.g., the highest aggregate score for a respondent was 35 points, which represented the highest level of income sensitivity): (1) 0-29–very low; (2) 30-37–low; 38-49–medium-low; 50-57–medium-high; 58-67–high; 68-100–very high. It is important to note that, for ease of interpretation, the category names have been reversed (since, in this case, a high score indicated a worse income situation), so "very low" refers to the weakest income situation, while "very high" refers to the most stable income situation.

Source: Own composition

Methodology

Discrete choice modelling is based on random utility maximisation (RUM) within the framework of random utility theory (RUT). This assumes the utility maximisation of the individual and decomposes the total utility into an observable and an unobservable (random) part according to Equation (1) (Ben-Akiva and Lerman, 1985).

$$U_{n,i,t} = V_{n,i,t} + \varepsilon_{n,i,t} \quad (1)$$

where U denotes the total utility, V the observable part of utility, ε the random part of utility, n the individual, i the alternative and t the decision situation.

One of the oldest RUT-based model types that is used is the conditional logit (CL) specification (McFadden, 1972). Despite the many advantages of the CL specification, several disadvantages exist, one of the most crucial being the assumption of homogeneous preferences. To overcome this limitation, there are both simpler solutions (e.g., creating and modelling interactions) and more complex ones (e.g., creating latent classes, including random parameters) (Mariel *et al.,* 2021). Among the latter, in the case of so-called random parameter logit (RPL) modelling, the coefficients of the attributes under study are no longer treated as fixed but are defined as distributions (along which they are allowed to vary among the respondents), and then their parameters are estimated (McFadden and Train, 2000; Train, 2009). In the case of RPL modelling, the specification of the utility function could be defined (focusing on the systematic part) according to Equation (2).

$$V_{n,i,t} = \beta'_n X_{n,i,t} \quad (2)$$

where β'_n denotes the parameter vector estimated for the observed attributes for the n-th decision maker, and X indicates the vector of observed attributes.

For the modelling, the utility function in Equation (3) can be derived from Equation (2).

$$\begin{aligned} V_{n,i,t} = {} & ASC_i + \\ & + \beta_{Farmers'market,n_{Point\ of\ sale}} Farmers'\ market_{Point\ of\ sale_{n,i,t}} + \\ & + \beta_{Supermarket,n_{Point\ of\ sale}} Supermarket_{Point\ of\ sale_{n,i,t}} + \\ & + \beta_{Perfect,n_{Ugliness}} Perfect_{Ugliness_{n,i,t}} + \\ & + \beta_{Slightly\ perfect,n_{Ugliness}} Slightly\ perfect_{Ugliness_{n,i,t}} + \\ & + \beta_{Organic,n_{Label}} Organic_{Label_{n,i,t}} + \\ & + \beta_{GI,n_{GI\ indication}} GI_{GI\ indication_{n,i,t}} + \\ & + \beta_{Local,n_{Origin}} Local_{Origin_{n,i,t}} + \\ & + \beta_{National,n_{Origin}} National_{Origin_{n,i,t}} + \\ & + \beta_{Red,n_{Colour}} Red_{Colour_{n,i,t}} + \\ & + \beta_{Green,n_{Colour}} Green_{Colour_{n,i,t}} + \\ & + \beta_{Yellow,n_{Colour}} Yellow_{Colour_{n,i,t}} + \\ & + \beta_{Price,n} Price_{n,i,t}, \end{aligned} \quad (3)$$

where ASC_i denotes the alternative-specific constant estimated for the i-th alternative and β-s denotes the random parameters estimated for the attributes (except for price, where a lognormal distribution was used, a normal distribution was applied for all attributes, with 500 MLHS throws (Hess *et al.,* 2006)). In the modelling, a dummy specification for categorical attributes was used, so for these attributes, one category was always treated as a base reference: namely, grocery store (point of sale), fully imperfect (Aesthetic appearance), no organic (organic label), no GI (GI indication), imported (origin), mix of colour (colour).

To examine the interaction between the location of FM and social embeddedness, hybrid choice modelling (HCM) was employed, supplemented by the previously described random parameter approach (hereafter, the HRPL model). The empirical framework allows to incorporate factors that are not directly quantifiable through hybrid modelling – in this study, social embeddedness is approximated using 10 Likert-scale items (as outlined below) (McFadden, 1986). In addition to extending the choice model (by integrating the latent variable(s)) in the HCM, two further components are added to the standard structure. On the one hand, structural equation(s) (the latent variable(s) are described as a function of certain explanatory variables) were defined and on the other hand, measurement equation(s) (the latent variable(s) are related to certain indicator(s) measuring the attitude(s) under study) were developed (Bolduc *et al.,* 2008; Mariel *et al.,* 2015). The extended structure for the HCM is shown in Figure 2 (Walker and Ben-Akiva, 2002).

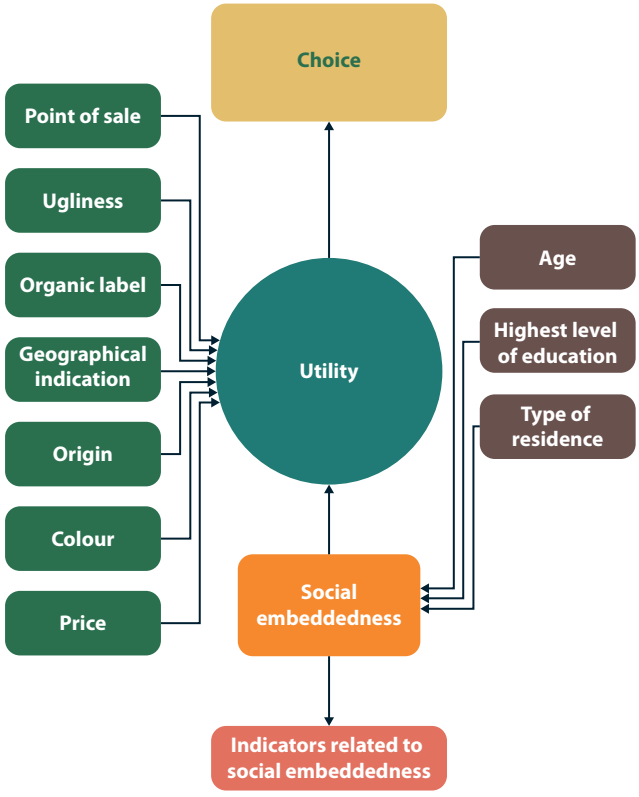

Figure 2: The study's hybrid choice modelling approach.
Source: own composition

The interaction with the latent variable (integrated in the choice model) and the structural and measurement equations are defined according to Equation (4), Equation (5), and Equation (6).

$$\beta_{Farmers'market,n_{Point\ of\ sale_{New\ term}}} = \\ = \beta_{Farmers'market,n_{Point\ of\ sale}} + \lambda LV_n \quad (4)$$

where λ denotes the coefficient representing the interaction effect of the latent variable of FM and social embeddedness.

$$LV_n = \gamma_{Age_{Level\ 1}} Age_{Level\ 1_n} + \gamma_{Age_{Level\ 2}} Age_{Level\ 2_n} + \\ + \gamma_{Age_{Level\ 3}} Age_{Level\ 3_n} + \gamma_{Age_{Level\ 4}} Age_{Level\ 4_n} + \\ + \gamma_{Age_{Level\ 5}} Age_{Level\ 5_n} + \\ + \gamma_{Education_{Lower\ secondary}} Education_{Lower\ secondary_n} + \\ + \gamma_{Education_{Upper\ secondary}} Education_{Upper\ secondary_n} + \\ + \gamma_{Residence_{Village}} Residence_{Village_n} + \\ + \gamma_{Residence_{Town}} Residence_{Town_n} + \eta_n \quad (5)$$

where γ indicates the parameter vector of the structural model explanatory variable, and η_n denotes the random term, and

$$ME_{k,n} = \zeta_k LV_n + \sigma_{k,n} \quad (6)$$

where ζ_k denotes the estimated coefficient on the latent variable for the k-th statement, while $\sigma_{k,n}$ indicates the random member of the measurement model.

The latent variable (social embeddedness) was measured by using a 7-point Likert scale (1: totally disagree to 7: totally agree) for various statements derived from previous studies (Hunt, 2007; Oths *et al.,* 2016; Tsai *et al.,* 2019):

1. The direct relationship with the producer is an important reason for me to buy at farmers' markets.
2. I like/love purchasing food at farmers' markets.
3. My purchases at farmers' markets might influence the producers' production decisions.
4. At the farmer's market, I not only buy products but also talk with the producers.
5. At the farmer's market, I can get additional information about the production methods of specific products.
6. I trust the producer from whom I buy at farmers' markets (in terms of product quality, standards, etc.).
7. The farmers' market creates a closer connection with agriculture and food for consumers.
8. Shopping at farmers' markets is more pleasant than at other grocery stores.
9. Time spent at farmers' markets is valuable to me because it means time spent with friends/family.
10. I feel that time slows down a bit when shopping at farmers' markets.

With the Likert-scale statements, the measurement equations were created based on the so-called ordered structure (Daly *et al.,* 2012); i.e., for each statement, a threshold parameter l-1 (where l is the number/level of categories of statements) was estimated. The D-efficient experimental design was generated using Ngene 1.2 software, while the model estimations were carried out using the Apollo package within the R programming environment (Daly *et al.,* 2012; Hess and Palma, 2019; Hess and Palma, 2021; Ngene, 2018). To assess the perceptions of the statements, a one-way ANOVA was conducted to evaluate significant differences across countries, with Bonferroni post-hoc tests applied for the pairwise comparisons (Field, 2005).

Results

Descriptive statistics associated with the examined statements regarding social embeddedness

Table 3 compares consumer attitudes towards FMs in Hungary, Italy, and the UK, based on the aforementioned ten statements. The statements examined consumer attitudes in terms of experience, trust, social connections, and interaction

Table 3: Descriptive statistics associated with the statements examined by country.

Statement	UK			Hungary			Italy		
	Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.
Statement 1	4.79	5.00	1.46	4.40	5.00	1.80	4.86	5.00	1.33
Statement 2	4.86	5.00	1.47	4.96	5.00	1.67	4.97	5.00	1.34
Statement 3	4.68	5.00	1.34	4.57	5.00	1.67	4.78	5.00	1.22
Statement 4	4.58	5.00	1.58	4.49	5.00	1.84	5.04	5.00	1.32
Statement 5	5.00	5.00	1.39	4.91	5.00	1.66	5.10	5.00	1.18
Statement 6	5.26	5.00	1.22	5.02	5.00	1.51	5.11	5.00	1.18
Statement 7	5.41	6.00	1.25	5.23	5.00	1.41	5.26	5.00	1.22
Statement 8	5.15	5.00	1.33	4.65	5.00	1.72	5.00	5.00	1.29
Statement 9	4.56	5.00	1.58	4.19	5.00	1.89	4.68	5.00	1.44
Statement 10	4.70	5.00	1.43	4.35	5.00	1.78	4.80	5.00	1.30

Note: S.D. denotes the standard deviations.
Source: Own composition

Table 4: Examination of differences in the strength of agreement with statements by country.

Statement	Country		UK	Hungary	Italy
	F-value	p-value	Mean	Mean	Mean
Statement 1	15.50	<0.01	4.79[a]	4.40[b]	4.86[a]
Statement 2	0.95	0.38	4.86	4.96	4.97
Statement 3	3.45	0.03	4.68[ab]	4.57[a]	4.78[b]
Statement 4	20.65	<0.01	4.58[a]	4.49[a]	5.04[b]
Statement 5	2.73	0.07	5.00[ab]	4.91[a]	5.10[b]
Statement 6	5.39	<0.01	5.26[a]	5.02[b]	5.11[ab]
Statement 7	3.48	0.03	5.41[a]	5.23[b]	5.26[ab]
Statement 8	18.68	<0.01	5.15[a]	4.65[b]	5.00[a]
Statement 9	14.64	<0.01	4.56[a]	4.19[b]	4.68[a]
Statement 10	14.50	<0.01	4.70[a]	4.35[b]	4.80[a]

Note: The Bonferroni post-hoc test was used for pairwise comparisons. Different superscripts (a, b) indicate statistically significant differences in the respondents' agreement with the statements in the respective countries. Identical superscripts indicate no differences between those countries. The lack of superscripts indicates that there is no significant difference among any of the three countries examined.
Source: Own composition

with farmers. Overall, consumers in all three countries have a positive attitude towards FMs, with Italy scoring particularly high on the areas of interaction (Statement 4), information (Statement 5), and a sense of time slowing down (Statement 10). UK respondents show particularly high levels of trust in farmers (Statement 6, mean: 5.26) and a stronger connection to agriculture (Statement 7, mean: 5.41).

In Hungary, respondents also hold a positive opinion of FMs, but the standard deviation is consistently higher, indicating greater differences among respondents. Interestingly, Hungarian respondents like these points of sale the most (Statement 2, mean: 4.96), but they award slightly lower values in terms of experiential and social values (Statements 8–10). The results clearly show that FMs are not only shopping venues but also social and cultural meeting places, especially in the case of Italian respondents, where the role of interaction and information gathering is even more pronounced. The data from these three countries suggest that, although the motivations are similar, their intensity may vary from country to country, influenced by cultural habits and shopping preferences.

Based on the ANOVA analysis and post-hoc procedure, significant differences were found between countries for nine out of the ten statements (Table 4). The largest differences apply to the statements related to interaction. Italian respondents are much more likely to talk to farmers (Statement 4) and to gather information about production methods. It is also notable that Italian consumers perceive that time 'slows down' at FMs (Statement 10), with time spent there perceived as more valuable, especially from a social perspective (Statement 9). UK respondents value shopping at FMs for providing them with a stronger connection to agriculture (Statement 7) and associate them with a high level of trust in producers (Statement 6). In contrast, Hungarian respondents' ratings are lower for several statements, especially in relation to social and emotional factors. Although their attitudes are generally positive, there is less emphasis on the social experience, the value of time, or the sense of customer influence on production. Overall, British and Italian consumers have a more intense, emotional connection with FMs, while Hungarian respondents have a more rational, moderate attitude towards them.

Consumer preferences and the impact of social embeddedness

Table 5 presents the results of the HCM model estimated with these conditions augmented with random parameters (hereafter referred to as the hybrid random parameter logit model – HRPL). The model estimates presented in Table 5 highlight interesting trends in the purchasing preferences of the three countries. "No choice", i.e., when the customer would not choose any of the product options, was significantly less preferred than making any purchase decision in all countries, suggesting that consumers are fundamentally open to making decisions and purchasing products if there is an option that suits them. The point of sale also plays an important role. In all of the countries investigated, FMs were significantly preferred by consumers over traditional grocery stores. This is likely due not only to the quality of the food but also to the shopping experience and the connection with the producers, as previously discussed. In contrast, shopping at a supermarket was not associated with a statistically significant effect, suggesting that this is perceived as a rather neutral, routine shopping location not associated with any preference. The appearance of the apple, especially its perfection, had varying effects across different countries. Among British consumers, appearance had only a limited influence on the purchase decision, with slightly imperfect apples eliciting a small positive reaction (10% significance level). In contrast, Italians and Hungarians clearly prefer perfect apples, and Hungarians even judged slightly imperfect apples more favourably than fully imperfect ones. This may indicate that Hungarian and Italian consumers place more emphasis on aesthetics, while British consumers may be more concerned with naturalness cues or food waste.

The model results further highlight interesting differences in consumer preferences. In the case of the organic attribute, British and Italian consumers clearly prefer products with a certified organic label, while for Hungarian consumers, this

Table 5: Preference-space estimates by HRPL specification.

Attributes and Model Details	UK	Hungary	Italy
	HRPL	HRPL	HRPL
	Coeff.	Coeff.	Coeff.
ASC no choice	−4.07*** (0.21)	−2.60*** (0.16)	−3.58*** (0.18)
Farmers' market	0.33*** (0.09)	0.56*** (0.10)	0.27*** (0.07)
Farmers' market (S.D.)	−0.62*** (0.11)	−0.67*** (0.10)	0.72*** (0.09)
Supermarket	−0.01 (0.08)	−0.09 (0.08)	0.01 (0.08)
Supermarket (S.D.)	−0.48** (0.21)	0.67*** (0.13)	−0.64*** (0.17)
Perfect	0.06 (0.12)	0.59*** (0.13)	0.36*** (0.11)
Perfect (S.D.)	1.42*** (0.13)	−1.47*** (0.15)	−1.24*** (0.15)
Slightly imperfect	0.10* (0.07)	0.22*** (0.07)	0.04 (0.07)
Slightly imperfect (S.D.)	<0.01 (0.13)	−0.21* (0.16)	0.12 (0.18)
Organic	0.13*** (0.05)	−0.05 (0.05)	0.33*** (0.06)
Organic (S.D.)	0.52*** (0.13)	−0.60*** (0.11)	−0.87*** (0.08)
GI	0.26*** (0.06)	0.48*** (0.06)	0.53*** (0.06)
GI (S.D.)	−0.29** (0.17)	0.54*** (0.11)	−0.60*** (0.09)
Local	0.47*** (0.09)	0.56*** (0.08)	0.59*** (0.08)
Local (S.D.)	0.44*** (0.10)	0.34*** (0.14)	−0.25** (0.12)
National	0.20** (0.11)	0.36*** (0.09)	0.39*** (0.10)
National (S.D.)	0.10 (0.22)	<0.01 (0.21)	0.03 (0.14)
Red	0.06 (0.05)	0.23*** (0.06)	−0.06 (0.05)
Red (S.D.)	−0.36** (0.16)	0.19 (0.19)	<0.01 (0.24)
Green	0.06 (0.07)	−0.06 (0.08)	0.05 (0.08)
Green (S.D.)	−0.49*** (0.18)	−0.02 (0.39)	−0.35** (0.20)
Yellow	−0.05 (0.08)	−0.16** (0.08)	0.03 (0.09)
Yellow (S.D.)	0.32 (0.42)	−0.26 (0.39)	0.78*** (0.13)
Price	−0.92*** (0.07)	−0.40*** (0.05)	−1.24*** (0.07)
Price (S.D.)	0.97*** (0.14)	0.46*** (0.15)	1.20*** (0.11)
Λ (social embeddedness – farmers' market)	0.36 (0.07)	0.37*** (0.09)	0.27 (0.06)
Observations	4,800	4,912	4,800
PsR-squared	0.24	0.22	0.23
Log-likelihood (0) (for choice model)	−6,654.21	−6,809.48	−6,654.21
Log-likelihood (final) (for choice model)	−5,023.94	−5,325.41	−5,149.65
AIC	27,946.58	29,372.77	26,676.21
BIC	28,626.60	30,055.21	27,356.23

Note: The robust standard errors are shown in parentheses below the parameter estimates; S.D. denotes the standard deviations; ASC represents the alternative-specific constant; ASC choice, Grocery store, Fully imperfect, No organic label, No Geographical Indication, Imported, Mix of colour were defined as the base levels in the estimates; ***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively; λ denotes the effect of the latent variable in the choice model. AIC denotes the Akaike Information Criterion; BIC denotes the Bayesian Information Criterion.
Source: Own composition

label does not have a significant influence. This may indicate that in Western Europe, organic certification already enjoys strong consumer confidence, while in Hungary, it is even less seen as a guarantee of quality or healthiness. The existence of a GI label has a significant impact on decisions in all three countries. This suggests that authenticity associated with place of origin and the quality associated with a geographical region is a valued attribute everywhere. Consumers likely perceive such products as representing uniqueness, tradition, and a controlled origin. Specifically in terms of origin, similar trends exist across the three countries: consumers prefer local and national products over imported goods. The colour of the apple does not generally significantly influence choices, i.e., only red, green, or yellow apples are not significantly pre-

ferred over a colour mix (the exception is the Hungarian sample, where red apples are significantly preferred and yellow apples are significantly less preferred than the colour mix). The effect of price, on the other hand, is quite clear. There is a significant negative relationship between the price of the product and purchasing preferences. The higher the price, the weaker the preference for the product; this follows classical economic logic and clearly reflects that price remains a decisive consideration for consumers, regardless of the location of purchase or other product characteristics.

The effect of the latent variable measuring social embeddedness is positive and significant in all three countries, showing that the more embedded a consumer is in community and social networks, the more they prefer FMs over traditional grocery stores. This finding supports the idea that FMs are not just shopping venues, but also social spaces where people build relationships, experience community, and, as a result, develop stronger attachments to this form of shopping. The results, therefore, paint a complex picture. In addition to product characteristics, personal and social background have a significant impact on how and where people shop.

Understanding social embeddedness across consumer groups

The estimated coefficients for the two additional components of the model structure in Figure 2 are presented below, focusing first on the structural equation by country in Table 6. Based on the estimated coefficients in Table 6, age and education have a significant impact on the level of social embeddedness in all three countries. Certain demographic characteristics can determine the extent to which a consumer feels connected to their community and social networks, which, as previously discussed, also influence preferences related to FMs, which, as previously discussed, also influence preferences related to FMs. In the UK, younger consumers and particularly those in the 35-44 age bracket display higher social embeddedness than their older counterparts. This may be surprising at first, as it is often assumed that older people are more strongly connected to local communities. However, based on the British sample, the middle-aged generation appears to be more socially active. At the same time, compared to those with a higher level of education, respondents with a secondary education level have significantly lower social embeddedness.

In Hungary, other types of age differences can be observed. Respondents aged 45–65 and under 25 appear to be less socially embedded than those over 65. This may indicate that members of the oldest age group in the country are still more strongly connected to communities – perhaps they live in rural environments where relationships are more long-lasting and rooted in the local territory. A similar pattern can be observed in the case of Italy. The social embeddedness of the younger age group (under 25) is significantly less than that of those over 65. It should also be noted that consumers with a lower (only primary) education feel less socially connected than those with a higher education.

Table 7, which presents the structure of the hybrid model, contains the estimated ζ coefficients of the measurement equations for the latent variable (social embeddedness) broken down by country. These coefficients show the extent to which the latent variable explains the responses to the different attitude statements. Based on the results, all estimated coefficients are positive and significant, indicating that, on average, the higher the respondent's level of social embeddedness, the higher the rating they give to the attitude statements. This supports the notion that social connectedness

Table 6: Estimated coefficients associated with the structural equation regarding the hybrid model structure.

Structural equation parameters	UK	Hungary	Italy
	Coeff.	Coeff.	Coeff.
$\gamma_{Age_{Level\ 1}}$	0.27 (0.22)	–0.53* (0.35)	–0.20* (0.13)
$\gamma_{Age_{Level\ 2}}$	0.35* (0.25)	–0.26 (0.23)	0.04 (0.14)
$\gamma_{Age_{Level\ 3}}$	0.44** (0.20)	–0.28 (0.23)	–0.11 (0.15)
$\gamma_{Age_{Level\ 4}}$	0.33* (0.21)	–0.31* (0.22)	0.01 (0.18)
$\gamma_{Age_{Level\ 5}}$	0.10 (0.31)	–0.49** (0.24)	0.15 (0.15)
$\gamma_{Education_{Lower\ secondary}}$	–0.18 (0.16)	0.19 (0.39)	–0.49* (0.33)
$\gamma_{Education_{Upper\ secondary}}$	–0.23* (0.16)	0.01 (0.13)	–0.02 (0.09)
$\gamma_{Residence_{Village}}$	<0.01 (0.50)	0.14 (0.14)	0.17 (0.24)
$\gamma_{Residence_{Town}}$	–0.08 (0.11)	0.10 (0.13)	0.05 (0.13)

Note: The robust standard errors are shown in parentheses below the parameter estimates. ***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.
Source: Own composition

Table 7: Estimated coefficients associated with the measurement equation regarding the hybrid model structure.

Measurement equation parameters	UK	Hungary	Italy
	Coeff.	Coeff.	Coeff.
ζ_{k1}	1.07*** (0.09)	1.49*** (0.12)	1.41*** (0.13)
ζ_{k2}	1.20*** (0.09)	1.44*** (0.13)	1.58*** (0.16)
ζ_{k3}	0.82*** (0.07)	1.07*** (0.10)	0.85*** (0.10)
ζ_{k4}	1.07*** (0.09)	1.49*** (0.14)	1.41*** (0.14)
ζ_{k5}	1.06*** (0.09)	1.40*** (0.11)	1.32*** (0.12)
ζ_{k6}	1.14*** (0.10)	1.30*** (0.12)	1.24*** (0.11)
ζ_{k7}	0.98*** (0.09)	1.05*** (0.10)	1.18*** (0.12)
ζ_{k8}	1.17*** (0.11)	1.89*** (0.13)	1.47*** (0.13)
ζ_{k9}	1.00*** (0.10)	1.55*** (0.13)	1.11*** (0.11)
ζ_{k10}	0.82*** (0.09)	1.09*** (0.10)	0.73*** (0.09)

Note: The robust standard errors are shown in parentheses below the parameter estimates. ***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively; The parameters of the three highest and most influential statements are highlighted in bold.
Source: Own composition

and attachment to the community play a significant role in fostering positive perceptions of FMs.

Country-specific differences can also be observed: in the UK and Italy, the latent variable is most strongly correlated with Statement 2 ("I like to shop at farmers' markets"), indicating that in these countries, emotional attachment and experience with markets are particularly closely related to social embeddedness. In Hungary, however, Statement 8 ("Shopping at farmers' markets is more pleasant than at other grocery stores") shows the strongest relationship with the latent variable. This means that for Hungarian respondents, perceiving the FM as a positive experience and form of recreation is the one that best reflects the level of social connections.

Discussion

The results of this research highlight that the choice of FMs is closely related to the level of social embeddedness. This means that consumers' purchasing decisions are not simply the result of isolated, impersonal preferences, but are deeply embedded in social networks. The study confirms that FMs have a function well beyond their role as mere food sources; they are social spaces where trust, personal contact, and community experience play a significant role. Several previous studies have emphasised that FMs allow for direct, personal encounters between producers and consumers. As a result, consumers visit these markets not only for local, high-quality products, but also to support sustainable practices and build relationships with local producers (Feagan *et al.,* 2004; Kirwan, 2004). The literature has suggested that economic exchanges in such markets are embedded in social networks and are not independent of cultural values, social connections, and trust (Granovetter, 1985). FMs simultaneously support community cohesion and economic transactions, connecting ethics, culture, and business in a single space (Hinrichs, 2000). In line with this, the results suggest that high levels of social embeddedness significantly increase the likelihood of purchasing at FMs; that is, consumers seeking a social experience and connections prefer FMs over other shopping venues.

The results are also consistent with Chen and Scott (2014) findings that consumers' sense of embeddedness positively influences their spending at FMs. Research by Kirwan (2004) and Feagan *et al.* (2004) has previously shown that consumers desire authentic experiences and trust-based relationships when shopping for food, while producers value customer loyalty based on shared values. The results also suggest that social embeddedness has a dual benefit. It provides consumers with a more authentic, community-based shopping experience, and producers with a more committed customer base who stick with them because of the personal connections. Based on the literature, it can be clearly established who constitutes the majority of the shoppers at FMs (Maró, *et al.,* 2023; Török *et al.,* 2025). A similar trend is identifiable from this research. In all three countries, those with higher education are more strongly connected to their community. Moreover, in Hungary and Italy, the older age group (over 65) proved to be the most embedded in local society. This explains why they prefer FMs to a greater extent, since tradition and community support play an important role in their lifestyles and value systems. Interestingly, in the UK, the middle-aged group (35-44) displayed the strongest social embeddedness. A possible explanation for this is that the new-wave, festival-like atmosphere of British markets mainly attracts the younger-middle-aged, active generation, while older individuals may feel less at home in this environment. This dynamic is also reflected in the literature. For example, Oths *et al.* (2016) have shown that young adults prefer lively, festival-like markets, which in turn involves the risk that such an atmosphere may exclude certain social groups (if a market is too focused on encouraging a youthful, festival-like experience, older or more conservative buyers may be averse to it). All this highlights that the emergence of social embeddedness is culturally and demographically context-dependent (Kopczyńska, 2017; Oñederra-Aramendi *et al.,* 2018).

In addition, the strongest social embeddedness effect was identified in Italy. This can be explained by the traditions of Southern European food culture and strong regional cohesion (Oñederra-Aramendi *et al.,* 2018; Vittersø *et al.,* 2019). In contrast, in the UK, consumer preferences were dominated by the health characteristics and general quality of products, and the impact of community aspects was relatively smaller. Perhaps due to modern consumer trends and a wider range of products, the price-value ratio is considered of particular importance in British markets (Guthrie *et al.,* 2006; McEachern *et al.,* 2010). Although Hungarian consumers also perceived some advantage in terms of community embeddedness, their decisions were more often influenced by the usual market logic, such as price sensitivity. This can be partly attributed to the fact that Hungarian markets are a relatively new and rapidly developing phenomenon, where community ties have not yet matured uniformly (Maró *et al.,* 2022). The differences between countries highlight the role of cultural and market-specificities: while in Italy, a strong local tradition enhances the importance of community ties, in the British and Hungarian cases, other factors also prevail in purchasing decisions.

It is also important to compare how social embeddedness influences the behaviour of market participants. Hunt (2007) showed that buyer–seller interactions at FMs build mutual expectations and trust, which results in practical changes on the part of producers. As a result, they place greater emphasis on ethical, high-quality production methods. The positive embeddedness effect measured (that is, consumers who are more integrated into the community are more likely to shop at FMs) also illustrates this pattern. The results, therefore, provide empirical evidence that socio-social factors indeed shape economic preferences, as suggested by previous research (e.g., Hunt, 2007; Kirwan, 2004; Oñederra-Aramendi *et al.,* 2018). Furthermore, Benedek *et al.* (2018) highlighted that buyers at FMs are primarily those who seek fresh, high-quality food and are also committed to supporting local producers. This trend can also be observed in the research. For consumers, choosing an FM is often a value-based decision, driven by solidarity with local producers,

sustainability, and local identity (e.g., a preference for local products and designations of origin). This is reflected in the fact that groups that are more open to community experiences and more embedded preferred the FM in the survey. The results of this study reinforce the primary findings of the literature, which suggest that the success and specific role of FMs are influenced by community embeddedness (Granovetter, 1985; Hinrichs, 2000; Kirwan, 2004).

Theoretical, policy, and managerial implications

The research offers theoretical insights into the link between social embeddedness and consumer decision-making. It empirically supports the theory of Granovetter (1985) that economic action is embedded in social networks, showing that consumers more active in community relations make different market choices. Thus, traditional models of consumer behaviour can be expanded to include sociological dimensions, where preferences are shaped by community values. Following Hinrichs (2000), producer markets can be seen as "hybrid" spaces combining business and social interaction. This study shows that consumer choices are influenced not only by product characteristics (e.g., price, quality, certifications) but also by social factors (e.g., community ties, trust), bridging economic and social science perspectives.

Second, the results point to the differentiated nature of social embeddedness. The comparison of the three countries, employing a novel methodology in this field, suggests that although the effect of embeddedness is universally positive regarding the perception of FMs, the social patterns (e.g., the role of local communities, the degree of urbanisation and mobility, and the tradition of markets) may differ. The context of social embeddedness varies from culture to culture (Kopczyńska, 2017; Oñederra-Aramendi *et al.,* 2018). The research deepens this idea by demonstrating that the effect of community integration on consumer behaviour is general, but its specific manifestations (e.g., which age group, according to which values) may differ from country to country. Strengthening the relationship between sustainable food consumption and social capital is an important element. The results suggest that the success of SFSCs is not only based on the mere communication of sustainability benefits (e.g., smaller ecological footprint, better quality), but also on community experience and identity. Some consumers, especially those more deeply embedded in their communities, also seek to support moral and community goals through their purchases (e.g., supporting the local economy, preserving traditions). This observation, by considering value-driven and community motivations in addition to or instead of the utility-maximising model when explaining sustainable consumption, may contribute to the theory of consumer behaviour.

Based on these findings, the research yields several policy and managerial implications. First, the results support the claim that FMs are not only economic spaces but also community institutions; thus, their support can serve economic, environmental, and social goals at the same time. In light of the results, public policy should also treat these markets as community spaces. For example, it could provide infrastructural and financial support to establish new markets or develop existing ones in a way that they also function as community meeting places (e.g., creating covered market spaces with spaces suitable for community events). Local governments and decision-makers can plan urban and rural development programmes around markets, recognising that a vibrant FM increases community cohesion and the multiplier effects of the local economy.

Second, strengthening consumer communities may be a key policy objective in supporting a sustainable food supply. As people living in closer social networks are more likely to choose sustainable, locally sourced food, public policy can focus on increasing community participation and awareness. This can be achieved through, for example, social campaigns and educational programmes that draw attention to the values of local food and FMs. In addition, by supporting local food movements and civic initiatives (e.g., community gardens or food communities), decision-makers can help more consumers establish personal contact with local producers. Third, a crucial lesson for policy is to acknowledge the differences between generations and social groups. The research has highlighted that certain groups (e.g., younger generations in some countries, or those with a lower level of education) are less connected to local communities and are therefore less likely to visit FMs. This suggests the need for targeted public policy measures. For example, launching youth programmes at FMs (FMs at universities, educational activities, volunteering) to involve young people in local food systems (see e.g.,Maró *et al.,* 2022). The current customer base of FMs tends to be skewed towards the middle class, while poorer segments have less access. Public policy can address this as an equity issue. For example, social programmes can encourage the participation of disadvantaged groups (such as how SNAP/EBT programmes were included in markets in the US). In the European context, this could involve providing discount coupons or vouchers to those in need, which they can redeem for healthy food at FMs.

The research also provides practical lessons for organisers of FMs, operators, and market participants (e.g., producers and vendors). The results confirm that the power of an FM lies in the community experience, so organisers should consciously cultivate the community function of such markets. Personal relationships between buyers and vendors can enhance the shopping experience and foster customer loyalty. Accordingly, market managers should encourage active and direct communication and trusting relationships. In practice, this could mean organising community programmes at markets (tastings, cooking, children's programmes) that encourage customers to spend time on site and talk informally with vendors and each other. The more consumers view the market as a meeting place, the stronger their attachment will be, and the more likely they are to become permanent customers. Moreover, market organisers need to know their target audience and tailor their strategies accordingly. Based on the findings and other research (Maró, Maró, *et al.,* 2023), the typical FM customer is often an older, middle-class, well-informed woman who values quality and a connection to local produc-

ers. Meeting the needs of this group is essential for success. At the same time, attracting younger generations and other underrepresented groups will be important for future growth and market sustainability. From a practical perspective, this can be achieved by alternating events with different profiles. Lastly, it is worth emphasising the benefits of social embeddedness in the marketing and communication of FMs. Since supporting local producers and a sense of belonging to the community are the main attractions for many customers, communication can highlight the stories associated with the market. For example, presenting the personal background of the vendors, the origin of the products, and the values of the market community. This storytelling approach will strengthen the emotional connection with customers.

Conclusions

Research shows that the future of farmers' markets depends greatly on their social embeddedness. Sustainable food systems succeed not only when people buy products but also when they seek community experiences. Based on empirical data from the UK, Hungary, and Italy, the study suggests ways to strengthen social embeddedness in consumer choices, public policy, and market operations. Unlike most research focused on single countries – mainly the US or Western Europe – this cross-country comparison reveals both general trends (the positive impact of social embeddedness on FM choice) and local specificities (e.g., generational differences). The findings fill a geographical and cultural research gap, confirming that FMs function as both economic spaces and community arenas, and that recognising this dual role is vital for sustainable food systems.

However, the study's limitations include its sample of only three countries, which restricts generalisability due to cultural and economic differences. The cross-sectional design also limits insights into long-term trends. Future research should include more countries to examine European-level patterns and use longitudinal and qualitative methods to explore causal links and evolving network dynamics. Extending the focus to other stakeholders – such as farmers, FM organisers, and policymakers – would also provide a more comprehensive understanding of how social embeddedness shapes market sustainability.

Acknowledgement

The research has received funding from the National Research, Development and Innovation Office project under the grant agreement FK137602 "The economics of farmers' markets - economic, environmental and social sustainability".

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https://doi.org/10.7896/j.3283 Studies in Agricultural Economics 127 (2025) 211-219

SCIENTIFIC ARTICLE

Anett ZANOCZ[A]

Sustainability reporting in the Hungarian agricultural sector: an exploratory qualitative study

ABSTRACT

This study examines the organisational readiness of the Hungarian agricultural and food industry to introduce and implement effective sustainability reporting regimes from a supply chain perspective, with a focus on knowledge exchange and practical partnerships with regulators and academic institutions. The methodology for this qualitative study was designed to capture the complexity of evolving sustainability reporting practices and organisational responses in Hungary's agri-food sector. Semi-structured interviews were conducted with twelve companies, specifically selected as they are subject to the CSRD and EU Taxonomy. The findings reveal a dynamic and rapidly evolving landscape in the approach to sustainability and ESG reporting within the Hungarian agro-food industry, underscoring its practical impact on corporate strategies and reporting. By embracing standardised measurement systems and supporting public-private collaboration, Hungarian agricultural companies – and the rural communities that depend on them – can achieve measurable, internationally-respected progress in sustainability, resource use, and market resilience. This study provides practical guidance for companies and policymakers, prioritising comprehensive data models for supply chain disclosures and planning for multi-year capabilities development.

ARTICLE INFO

Keywords:
qualitative interview, sustainability reporting, agricultural sector

JEL classification:
Q01.

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Received: 15 August 2025; **Revised:** 12 November 2025; **Accepted:** 17 November 2025.

Introduction

The agricultural sector, which is fundamentally dependent on natural resources and has a significant impact on ecosystems, is increasingly facing the need for sustainability (Máté *et al.,* 2022, Török *et al.,* 2023). This escalating pressure stems from several factors, including changing regulatory frameworks, heightened consumer awareness, and investor demands for transparent environmental, social, and governance (ESG) performance (Setyaningsih *et al.,* 2024). Furthermore, due to the global challenges of climate change and ongoing social inequalities, agricultural businesses in particular need to integrate long-term, sustainable decision-making into their core operations and strategies (Rushchitskaya *et al.,* 2024). Within this perspective, comprehensive and transparent sustainability reporting is not only a compliance exercise but also a strategic tool to demonstrate responsibility and promote resilience in the agricultural supply chain (Jindřichovská *et al.,* 2020, Freund, 2023). Despite its crucial role, the agricultural sector often underperforms other industries in terms of implementing and maturing sustainability reporting practices, especially in the Hungarian context (Fiore *et al.,* 2022, Török and Jámbor, 2013).

This research aims to explore, through in-depth sectoral dialogue, the preparedness of Hungarian agricultural companies to introduce and implement effective sustainability practices and reporting mechanisms, with a focus on knowledge exchange and practical partnerships with regulators and academic institutions. Specifically, it examines how Hungarian agricultural companies are dealing with the complexities imposed by the latest European Union directives, such as the Corporate Sustainability Reporting Directive (hereinafter referred to as: CSRD) and the EU Taxonomy, which introduce stricter non-financial and financial disclosure requirements for selected companies. Currently, there is a significant research gap due to the lack of qualitative research examining the practical implementation and strategic use of sustainability reports in this niche sector, particularly concerning preparedness for changing regulatory requirements (Gombkötő *et al.,* 2025).

This qualitative study intends not only to fill the knowledge gap by gathering first-hand experiences from key stakeholders but also to contribute to a shared understanding and collective problem-solving through university-led dialogue initiatives. The study employs a semi-structured qualitative interview methodology to capture the experiences and observations of these companies across all their various aspects, thereby providing novel insights into sustainability and non-financial reporting. A thorough examination of the agricultural sector is vital, as it is a sector particularly vulnerable to climate change and crucial for addressing global food security and environmental challenges (Jámbor and Gorton, 2025). Understanding the motivations and challenges behind sustainability and its

integration is therefore fundamental to developing effective strategies to promote a more sustainable agricultural future (Pupo D'Andrea *et al.,* 2025).

This paper also contributes to the broader academic discussion on the development of a more sustainable economic paradigm by exploring the integration of sustainability into reporting and the disclosure of non-financial information, particularly in the agricultural sector (Gombkötő *et al.,* 2025). This research provides a comprehensive insight into the performance of sustainability frameworks in the Hungarian agrarian industry, highlighting their practical impact on corporate strategies and reporting (Máté *et al.,* 2022). All this is presented from a supply chain perspective to obtain the broadest possible picture of the operating mechanisms of agricultural companies. Additionally, it identifies the most significant factors and barriers influencing the adoption of sustainable practices and subsequent reporting, thereby providing actionable recommendations for policymakers and industry stakeholders.

This study aims to go beyond superficial evaluations of technical readiness by revealing deeper and often overlooked challenges to the effective implementation of the CSRD. The research question posed is:

What are the real experiences, regulatory adaptation, and principal challenges encountered by the Hungarian agricultural sector and its value chain in preparing for sustainability reporting in compliance with CSRD standards?

The article is consequently structured as follows. After the introduction, Section 2 synthesises the burgeoning body of literature on sustainability within the agricultural sector alongside pertinent regulatory advancements. Section 3 delineates the qualitative, interview-based research methodology and elucidates the sampling procedures. Section 4 presents the empirical findings, organised thematically to examine the current status of sustainability reporting, the key organisational and strategic challenges, and the integration of ESG considerations into governance frameworks; it also provides comparative analyses between local and multinational entities. It is important to note that this project contributes empirical, qualitative insights to the broader academic and policy dialogues concerning sustainability regulation. Section 5 examines the policy and practical implications of these findings, while Section 6 concludes with recommendations and propositions for future research directions. This study seeks to improve both academic comprehension and regulatory development by capturing grounded, practitioner-level insights.

Literature Review

The global agri-food sector, and specifically its European branches, faces intensifying pressure to adapt to complex sustainability challenges. Drivers include climate change, market volatility, regulatory innovation, and societal demand for transparency (Paredes-Rodríguez *et al.,* 2024). Hungary, as a significant agricultural producer in the EU, is not exempt from these trends – industrialisation, market integration, and recent production volatility have rapidly transformed its agricultural and food landscape (Török and Jámbor, 2013; Jámbor and Gorton, 2025). As a result, sustainability and resilience have become twin pillars of both academic debate and practical supply chain management.

Traditionally, agri-food sustainability research has centred on operational efficiency (e.g., yield maximisation), but recent work increasingly advocates for "whole value chain" and multi-stakeholder approaches (Paredes-Rodríguez *et al.,* 2024; Fragoso and Viera, 2024). Knowledge exchange – across enterprises, regulators, and academic institutions – is recognised as critical to effective sectoral transformation. This shared learning is particularly necessary for SMEs, which often lack the internal resources or networks to systematically respond to new reporting regimes (Setyaningsih *et al.,* 2024).

Key recent EU legislative initiatives – most notably the Corporate Sustainability Reporting Directive and the EU Taxonomy Regulation – set stricter non-financial and financial disclosure requirements for selected companies (European Parliament & Council, 2022; European Commission, 2025). The CSRD, in particular, has expanded the breadth and detail of sustainability reporting well beyond previous Non-Financial Reporting Directive (hereinafter referred to as: NFRD) regimes, while ESRS (hereinafter referred to as: European Sustainability Reporting Standards) defines standardised metrics, materiality assessments, and third-party assurance systems for sustainability data (European Commission, 2025).

These regulatory changes are further complicated by the complexity and uncertainty inherent in the evolving EU legal landscape. The 2025 Omnibus amendments have deferred implementation deadlines – large Hungarian agri-food companies are required to report from 2028 – and narrowed the field of immediate obligation by raising company-size thresholds (European Parliament & Council, 2025). In parallel, ESRS standards have reduced the number of compulsory disclosure items, allowing for a more targeted and materiality-led approach (European Commission, 2025). These developments create both time for adjustment and new risks of fragmentation or uneven compliance, especially for smaller actors with less institutional knowledge (Setyaningsih *et al.,* 2024).

Research indicates that Hungarian companies often perceive sustainability reporting as a strategic opportunity rather than a compliance burden – especially when requirements seem to outpace sectoral readiness or practical capability (Setyaningsih *et al.,* 2024; Hossain *et al.,* 2025). As Gombkötő *et al.* (2025) and Setyaningsih *et al.* (2024) emphasise, a critical qualitative gap persists: there are few in-depth, ground-level studies exploring the lived experiences and pragmatic adaptation strategies of Hungarian agri-food firms in response to EU mandates. Particularly lacking are studies on how knowledge flows, dialogue with public authorities, and collaboration with academic partners equip firms to meet new compliance challenges.

Effective navigation of the new regime requires more than technical compliance; Hungarian agri-enterprises are increasingly turning toward strategic alliances with professional bodies, digital service providers, and universities to co-design

reporting templates and exchange best practices (Paredes-Rodríguez *et al.,* 2024; Hossain *et al.,* 2025). Knowledge-sharing platforms and cross-sectoral roundtables are emerging as crucial venues for translating complex regulatory norms into practical templates for real-world businesses. This is especially true now that Hungarian law enables voluntary, streamlined ESG reporting for SMEs using the "VSME" guidance and defers mandatory disclosures for the smallest entities until 2027 (European Commission, 2025).

Despite advancements, scholarship continues to highlight persistent "implementation gaps", especially regarding motivations for voluntary adoption, the internalisation of sustainability as a business asset, and a holistic understanding of value chain risk. More qualitative, participatory research is needed to reveal how firms interpret regulatory ambiguity, negotiate compliance with multiple authorities, and capitalise on regulatory postponements for capability-building (Setyaningsih *et al.,* 2024).

In conclusion, the literature acknowledges that the Hungarian agri-food sector faces both operational and strategic challenges in preparing for transitions driven by the CSRD and EU Taxonomy. The sector's successful adaptation hinges upon cross-sectoral knowledge exchange, effective public-private partnership, and qualitative inquiry into the lived, practical realities of regulatory adaptation. The current research thus responds to an urgent gap by investigating not only technical compliance but also the strategic, dialogic, and capacity-building processes through which sustainability reporting readiness is being negotiated along the Hungarian agri-food value chain.

Research Design and Methodology

The research employed a qualitative design, conducting semi-structured interviews with twelve companies operating within the Hungarian agricultural and food sectors, which were selected as they are subject to the CSRD and Hungarian regulatory frameworks. The methodology for this qualitative research was designed to capture the complexity of evolving sustainability reporting practices and organisational responses in Hungary's agri-food sector. To provide a rigorous and detailed perspective, a combination of document analysis and semi-structured interviews was employed, ensuring data validity and facilitating in-depth thematic analysis in accordance with established academic standards (Ruslin *et al.,* 2022).

Prior to the interviews, a comprehensive document review was conducted to provide context and background for each participant organisation. Reports, company profiles, and regulatory disclosures were examined to understand how participating companies have dealt with sustainability and non-financial reporting in recent years, and to inform the development of targeted interview protocols (Natow, 2019). This preparatory step enabled the interviewers to approach discussions with a nuanced understanding of each organisation's strategic integration of sustainability, the level and format of prior ESG reporting, and the extent of involvement by internal and external auditors.

A two-stage methodology structured the empirical work. First, potential companies were identified and assessed for inclusion based on objective criteria: revenue ranking within the Hungarian agribusiness and food sectors and representation across value chain segments. The value chain was mapped according to input suppliers (plant protection, genetics and breeding, seeds, fertilisers, equipment, logistics, capital), primary producers and service providers (including animal husbandry, grain/feed, vegetables/fruits, animal products, tobacco), processors (food, beverage, milling, feed, biofuel and biogas, waste), and distributors (retail and wholesale). A minimum of three companies per value chain segment was targeted to ensure feedback depth and sector representativity. This approach aligns with existing best practices in qualitative research, which employ purposeful sampling to ensure diversity and insight into patterns across sub-sectors (Patton, 2014). The final sample was further refined according to the company's willingness and availability, resulting in a cohort of organisations listed in Appendix 1.

Interviews lasted between 45 and 60 minutes and were conducted in Hungarian to maximise the expressiveness and communicative accuracy of responses (Truant *et al.,* 2017). The semi-structured format balanced a focus on predefined thematic areas, formulated based on prior document analysis and regulatory context, with scope for respondents to expand on emerging and organisation-specific topics. This structure encouraged interviewees to reflect openly on historical developments, current challenges, and future goals, resulting in responses that were both context-specific and sufficiently detailed for cross-case analysis (Ruslin *et al.,* 2022).

The interview guide was organised in both chronological and thematic order. Chronologically, the questions evolved from retrospective experiences and established practices, through current relevance and regulatory adaptation, to anticipated future changes and organisational strategies. Thematically, questions were grouped to address: (1) company characteristics and sector specificity, (2) historical and present sustainability reporting practices, (3) challenges and compliance with CSRD and related assurance processes, (4) stakeholder pressures (including regulatory, supply chain, and insurance factors), (5) pillar-specific ESG issues (environmental, social, governance), (6) technology and digitisation (impact of AI, digital solutions), (7) effects of company size and scale, and (8) recommendations for sectoral sustainability improvements (Lozano *et al.,* 2018). Open-ended questions fostered an atmosphere where respondents could articulate their perceptions and strategic decisions freely, while the structure ensured that all major research areas were covered.

Triangulation was a central component of quality control throughout the methodology (Natow, 2019). Along with the preliminary document review, data from interviews were cross-checked using multiple methods: transcripts were reviewed independently by both researchers; company representatives were asked to validate completed transcripts to confirm interpretative accuracy and eliminate potential misunderstandings (Bowen, 2009). The combination of these techniques enhanced the study's validity by reducing bias and capturing organisational perspectives comprehensively.

For data analysis, thematic coding was employed. Interview transcripts were transcribed in full and entered into NVivo software for qualitative analysis and subsequent methodological literature (Braun and Clarke, 2006). The coding process began with broad deductive codes based on the literature and regulatory context but was refined iteratively as new themes and patterns emerged from the interview data (Lozano *et al.,* 2018). Topics were further synthesised and compared across participant organisations and value chain segments, supporting the interpretive depth required in ESG research.

Ethical considerations were embedded throughout all stages of the research. Participation was voluntary, and informed consent was obtained prior to the participant's involvement. Each participant was assured of confidentiality in accordance with general qualitative research standards and sectoral research standards (Truant *et al.,* 2017). Research reflexivity was actively encouraged to minimise the impact of researcher biases on data analysis (Bowen, 2009). This methodological approach is underpinned by a recognition of the dynamic and evolving regulatory landscape in Hungary and across the EU, particularly in relation to the transition from NFRD to CSRD regulation (Lippai-Makra *et al.,* 2024). By combining rigorous sampling and triangulation with structured yet flexible interview design and systematic coding, the study delivers comprehensive and nuanced insights into the ESG adaptation processes underway in Hungary's agri-food sector.

Results

The findings of this study show a dynamic and rapidly changing landscape in the approach to sustainability and ESG reporting within the Hungarian agri-food sector. The sample covered a heterogeneous cross-section of the value chain, from crop cultivation and animal husbandry to feed production, food processing, wholesale and retail, and financial services. Despite notable differences in company size, ownership structures, and market embedding, several recurring patterns emerged: maturity in sustainability strategy, data-driven operations, supply-chain engagement, and the handling of local impacts are central across most interviews.

A consistent finding is that the majority of companies have surpassed the initial "reporting threshold." Sustainability concerns are increasingly integrated into executive decision-making, and earlier ad-hoc activities have evolved into systematic approaches. However, critical constraints remain – fragmented data, definitional uncertainties, and supplier-side capacity gaps continue to limit the broader effectiveness of ESG initiatives. The following section highlights the main strategic considerations expressed by companies during the interviews.

Sustainability and competitiveness

Companies increasingly treat sustainability as inseparable from business life. Integrating ESG into business risk management and value creation reduces exposure to input price volatility (such as energy, water, and fertiliser), strengthens supply security, and improves brand and product positioning in both consumer and B2B markets. Interviews reveal that dual return logic is increasingly common in investment decisions: alongside financial indicators, risk reduction and reputation effects are now highly valued. "No-regret" interventions, such as energy efficiency, water reuse, and loss reduction, are prioritised in tandem with preparations for larger, mid-term transformations, including precision and regenerative practices, circular resource flows, and product-level carbon footprint reduction. Thus, the competitiveness narrative reframes sustainability as a question of efficiency and risk management – not merely as a cost increase. The FirstFarms interview demonstrated that *"Sustainability is an organic part of FirstFarms' corporate strategy, where circular resource reduction is essential. ... For us, one of the main tasks in the coming years is to create and introduce a data management and reporting system that fully satisfies both group and business partners' and regulators' expectations".*

Market-based thinking with public-private cooperation

Interviews indicate that the rapid adoption of solutions depends on aligned market incentives and public policy tools. Companies find financing arrangements useful that reduce transaction costs and risks, such as green loans, guarantee programmes, and targeted subsidies for irrigation development, soil renewal, and bioenergy investments. Insurance products are also critical for managing climate risks. This approach is most efficient when public funds address genuine market gaps, cover part of the initial surplus costs, and allow space for competition and innovation. Successful programmes align support conditions with actual investment schedules, while financial actors clearly and uniformly articulate ESG data expectations upfront. The MBH Bank said, *"It is possible for us as a bank to actively support the green transition of the agri-food sector through financing. We finance practices such as organic farming, agroforestry, and water-efficient irrigation systems ... and development of agricultural risk mitigation and insurance programmes is a good direction for proactive resilience development".*

Supply chain perspective over point solutions

Environmental and social impacts in the agri-food value chain are heavily concentrated on the supplier side. Companies are increasingly moving beyond internal improvements to launch sustainability programmes that span the entire supply chain. They set expectations for suppliers, provide detailed guides, organise targeted training, and run joint field pilot projects – scaling up proven approaches. Long-term procurement contracts are increasingly stipulating sustainability requirements. Lidl Magyarország mentioned that "*For critical raw materials, we require our partners to hold recognised sustainability certifications".*

Short supply chains and transparency

Companies emphasise the business and sustainability benefits of local embeddedness and short supply chains. Regional collaborations – including producer groups and cooperative landscape programmes – simultaneously reduce logistics and supply chain risks, increase social acceptability, and localise environmental interventions (such as water retention, soil management, and biodiversity conservation). The "start local" approach does not diminish the significance of strategic goals but brings them to the operational level – making interventions more measurable, better adapted to the landscape's ecological and social conditions, and centring execution on rapid, practical problem-solving. Stated in the interview with representatives of Első Pesti Malom, *"It is not rare today to see local produce become local feed and then return to local livestock, ultimately resulting in local meat consumption ... the short supply chain and trust-based, long-term relationships are invaluable for sustainability".*

Measurability and continuous monitoring

Data is the engine of progress. Companies are increasingly instituting site-, product-, and process-level measurements. Quarterly ESG KPI reports, Scope 1–2–3 emissions measurements, and comprehensive energy, water, soil, and waste monitoring are proliferating. Sensor-based and remote (IoT, satellite, drone) solutions are increasingly used for field data, alongside formally validated measurement protocols (such as sampling, frequency, and thresholds). UBM mentioned that *"We have established our quarterly ESG reporting system, with various departments involved in measuring and evaluating our most important sustainability KPIs ... We track our CO_2 emissions at the site level and calculate our feed GHG-intensity".*

Balancing short and long-term objectives

Short-term profitability pressures often collide with longer sustainability transitions. According to interviews, change proceeds fastest where management sets clear goals and accountability, with annual, measurable targets driven by strategy (energy, water intensity, loss rates, supplier coverage). These targets are linked to executive and shop-floor KPIs, which in turn are linked to compensation. Első Pesti Malom stated, *"The key to a sustainable transition is clear management commitment – where management is committed, everything is easier ... Sustainability is not just an idea for the distant future, but a daily reality in the sector today".* Shifting responsibility is only avoided when bigger players support capacity building and transition, such as via training, pilot projects, joint investments, while financiers offer predictable transitional risk management (grace periods, targeted pricing). As GALLICOOP said, *"The key to our company's resilience is supporting professional development, ongoing education and training, and deploying dedicated ESG expert roles to coordinate the transition".*

Heatmap of operational sustainability activity

Some companies have several years of reporting experience, internal controls in place, and independent assurance, while expanding supplier data coverage. Elsewhere, voluntary reporting processes and pilot measurement initiatives are just beginning, supported by evolving IT solutions. Increasing data maturity and broadening supplier coverage are the key operational challenges. The overarching goal is methodological consistency and auditability, which provide a stable basis for executive decisions. Lidl mentioned that *"At Lidl Magyarország, we feel fully prepared to compile sustainability reports. We have already completed three national-level sustainability reports, utilising the Global Reporting Initiative (GRI) standard. Our reports have been assured by an external independent body, providing us with substantial experience with sustainability assurance".*

At the same time, most companies call for a sectoral data dictionary and uniform reporting templates. On the financing side, this demand converges on standardised bank ESG surveys: unified data fields, methodological guidance, and formats readable by machines. Outcomes include a reduced administrative burden, faster financing decisions, and the ability for banks to price measured performance comparably.

Digital traceability plays a vital role in enhancing transparency. It encompasses the use of site and field identifiers, electronic waybills, and product "passports", all of which contribute to a more informed and trustworthy supply chain. The calculation of product-level carbon footprints is on the rise and is gradually being integrated into corporate routines. For many, mapping multiple supplier tiers remains an early-stage process, but large companies have begun introducing unified methodologies and reporting systems, thereby accelerating learning and tangibly reducing administrative burdens on smallholders. Skills shortages are apparent everywhere; rapid advance depends on internal training, university-corporate partnerships, and supplier education. Several firms have created dedicated ESG co-ordinator roles bridging production, quality, finance, and procurement. Gallicoop mentioned that "*With hundreds of partners, suppliers, and buyers – managing their data is challenging. We plan to introduce software solutions for more efficient data collection and partner evaluation".* Firms increasingly strive for auditability, as robust internal control points and independent third-party assurance not only enhance the credibility of reports but also improve the quality of internal decision-making. This is particularly crucial for supplier data and product-level metrics, where methodological consistency is key.

Key ingredients of successful practice include good data governance – responsible staff, consistent definitions and units, traceable calculation logic, control points, and auditability. Companies begin by focusing on indicators that have the greatest impact on decisions and financing, gradually expanding their coverage. Major buyers are increasingly requesting specific, verifiable indicators (methane intensity, responsible sourcing certificates, animal welfare standards).

Transparency becomes a market advantage, as measurable and audited performance earns better supplier positions and longer contracts.

Companies typically follow a staged process – fast, easily implemented measures (such as energy and water savings) are followed by mid-term technological changes (precision, regenerative practices, and digital traceability), capped by longer-term infrastructure projects (biogas/biomethane, irrigation, and logistics). As UBM mentioned, *"The introduction of carbon footprint calculation at the product level will allow us to map the highest emission points from raw material sourcing to logistics to end use. Based on these data, we can develop new product formulas that have equal or better utilisation but a lower environmental footprint"*.

In the following, a heat map was created based on the maturity of agricultural companies' ESG reporting. The ESG maturity assessment framework for agricultural supply chain analysis is structured to provide a multidimensional view of companies' sustainability integration. The practice-based rows reflect increasing levels of ESG sophistication, as *Reporting* evaluates the thoroughness and auditability of disclosures, ranging from basic voluntary statements to internationally recognised frameworks such as GRI and CSRD. *Data coverage* addresses the comprehensiveness of sustainability measurement, including greenhouse gas emissions (Scope 1, 2, and 3) and supplier compliance. *Assurance* measures the extent to which ESG data and reports are externally validated, whether by third-party audits or formal certification. *Training* captures systematic efforts to build sustainability awareness and competence, both internally and among partners, through educational programmes and ongoing engagement. Lastly, *Pilots* recognise experimental and innovative activities, including digital solutions and novel integrations, that help propel new practices and enhance adaptability within agricultural supply chains.

The columns in the heatmap define the major segments of the agricultural supply chain. *Input companies* supply the foundational materials and technologies for farming – such as seeds, fertilisers, and machinery – setting the baseline for sustainable transformation. *Producers* span those who cultivate crops and rear livestock, forming the operational core of agricultural production. *Processors* represent organisations responsible for transforming raw agricultural materials into finished goods, driving value creation and compliance with sustainability demands. The *Distributor and Financing* sectors play a crucial role in ensuring the smooth operation of companies, the timely delivery of products to consumers, and the provision of financing. Segmenting by supply chain role allows researchers to distinguish where sustainability strengths and developmental needs lie, providing targeted insights for policy and industry advancement in a context where comprehensive regulatory standards are rapidly evolving (Table 1).

Table 1: Companies included in the supply chain segments of the ESG heatmap.

Supply chain segment	Companies included[a)]
Input	IKR Agrár Kft. KITE Zrt. UBM Group
Producer	FirstFarms Hungary Kft. GALLICOOP Zrt. Zwack Unicum Nyrt.
Processor	Coca Cola HBC Magyarország Kft. Első Pesti Malom- és Sütőipari Zrt. Nestlé Hungária Kft.
Distributor and financing	MBH Bank Nyrt. Lidl Magyarország Kereskedelmi Bt.

[a)] Magyar Élelmiszerbank Egyesület was excluded from the heat map because this non-profit organisation is not required to report on sustainability and has other priorities to consider as a member of the supply chain.
Source: Own composition based on interview data

The heatmap (Figure 1) visually displays ESG maturity gradients across both supply chain roles and ESG practices, identifying leaders (blue and green with higher scores) and highlighting areas for improvement with lower scores. This helps clarify which companies excel in specific supply chain functions and which ESG dimensions (such as training or assurance) require further development for sustained compliance and impact.

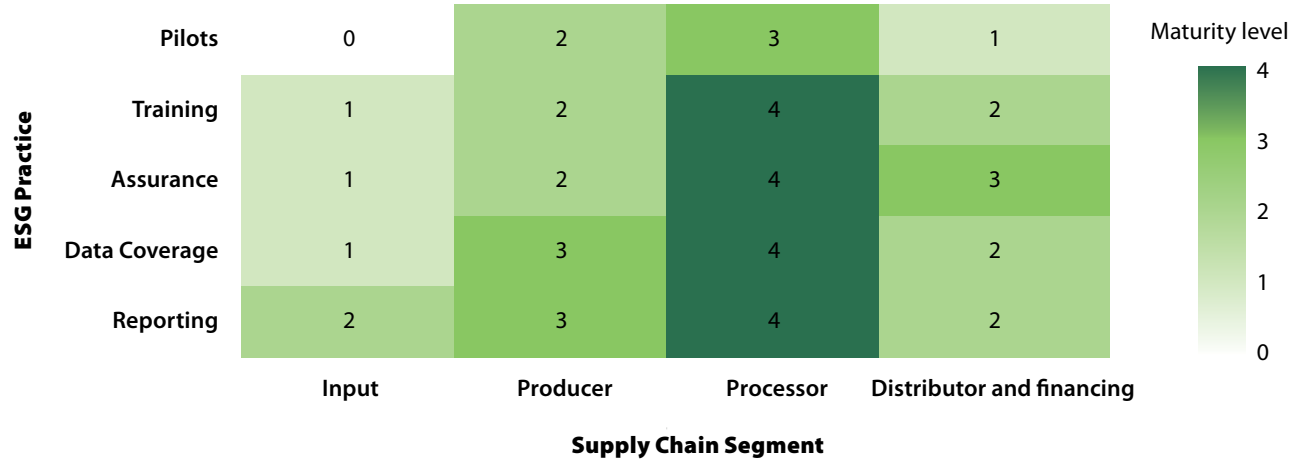

Figure 1: ESG maturity by supply chain segments.
Source: Own composition based on interview data

Conclusions

This research highlights that sustainability and competitiveness are not mutually exclusive but mutually reinforcing objectives for the Hungarian agri-food sector. The study demonstrates that true progress in sustainability will be achieved not merely through compliance or isolated initiatives, but through holistic supply chain thinking, measurable outcomes, and the establishment of standardised data infrastructure. If these conditions are met – particularly with agrifood-specific data standards, field-based measurement templates, and harmonised banking surveys that incentivise companies – the sector could achieve substantial and verifiable improvements both locally and nationally. Although the new regulatory changes can reduce short-term administrative efforts, industry stakeholders warn that the narrower reporting basis may hinder data transparency and comparability, especially for investors and international stakeholders. The competitiveness of Hungarian companies may ultimately depend on proactive capacity building and voluntary commitment, even in a less stringent regulatory environment.

These findings can inform not only individual company strategies but also the design of targeted support programmes and the evolving regulatory approach, helping to bridge the knowledge and capability gap across the Hungarian agri-food value chain. Such advancements would yield tangible results, including improved resource efficiency, more resilient supply chains, and stronger market positions that reinforce the long-term vitality of rural communities and ecosystems. Importantly, these benefits are not abstract; they are shown to be locally measurable, nationally comparable, and internationally recognised, confirming the sector's potential for both domestic leadership and international benchmarking.

These results also highlight the crucial role of knowledge exchange and capacity building, facilitated by partnerships among agri-food companies, regulators, and academic institutions. The companies interviewed demonstrated that proactive engagement with public policy forums, sector associations, and higher education maximised their ability to interpret regulatory demands and adapt reporting practices efficiently. Importantly, such collaborations not only improved technical compliance but also fostered a more holistic and strategic view of sustainability, transforming external pressure into a driver for internal learning, innovation, and long-term value creation. Future efforts should focus on expanding these networks, developing sector-specific guidance for SMEs, and encouraging continuous learning to ensure that Hungarian agriculture's progress in ESG reporting remains robust, inclusive, and internationally benchmarked.

Nevertheless, the research is subject to several limitations. First, data were gathered exclusively through semi-structured interviews with twelve Hungarian companies, which may limit the generalisability of the findings to the broader and more diverse Hungarian agri-food sector, as well as to different regulatory or market environments. The relatively small sample size may underrepresent certain subsectors or regions within Hungary. Moreover, the qualitative nature of the research provides depth and context but may not capture the full spectrum of sustainability performance nor the rapidly evolving compliance environment outside the period of study. While the methodology provides rich, nuanced insights into organisational practices and perceptions, it is less equipped to measure actual, quantitative performance outcomes across the sector. Additionally, the evolving regulatory landscape, including the adoption of CSRD and ESRS frameworks, means that company preparedness and industry pressures may shift significantly in the immediate future, underscoring the need for continuous, longitudinal research and sector-wide dialogue.

In summary, this study confirms that sustainability and competitiveness in Hungarian agriculture can only be advanced concurrently, by aligning market incentives, policy tools, and data-driven operational frameworks. By embracing standardised measurement systems and supporting public–private collaboration, Hungarian agri-food companies – and the rural communities that depend on them – can achieve measurable, internationally-respected progress in sustainability, resource use, and market resilience. Ultimately, the pathway to transformation is rooted in recognising sustainability not as an external obligation but as the foundation of long-term value creation, social trust, and rural prosperity.

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Appendix

Appendix 1: Main activities of the companies involved in the research.

Company	Introduction of the company's main activity
Coca-Cola HBC Magyarország Kft.	Hungary's Coca-Cola bottler is part of Coca-Cola HBC AG (serving approximately 750 million consumers in 29 countries). It operates two bottling plants in Hungary, employs approximately 1,000 people, and exports to 14 countries, offering a comprehensive beverage portfolio that includes soft drinks, waters, juices, teas, sports and energy drinks, coffee, and premium spirits.
Első Pesti Malom- és Sütőipari Zrt.	A historic Budapest-based milling and baking company and a key player in Hungary's grain-to-bread value chain, operating modern facilities and emphasising quality, traceability, and responsible supply in cereal processing.
FirstFarms Hungary Kft.	The Hungarian subsidiary of Denmark-based, Copenhagen-listed FirstFarms A/S. In Hungary it operates through FirstFarms Hungary Kft. (pig production) and FirstFarms HunAgro Kft. (arable farming). ESG reporting is prepared at group level, with the Hungarian entities providing data; the group transitions to CSRD-based reporting from 2025.
GALLICOOP Zrt.	One of Hungary's leading poultry integrators and processors, active across breeding, feed, and meat processing. Its scale enables dedicated sustainability expertise and longer-term planning to embed ESG in operations.
IKR Agrár Kft.	A nationwide inputs and services provider for crop producers, supplying fertilisers, seeds, and plant-protection products, plus precision-ag solutions (e.g., mapping, drone surveys, soil sampling), financing, insurance, and grain trading. Part of the AGROFERT Group since 2012, it discloses sustainability performance within the group's reporting framework.
KITE Zrt.	A major Hungarian agribusiness integrator and distributor of agricultural inputs, machinery, and precision-farming solutions. Beyond compliance, it invests in efficiency and environmental performance (e.g., fleet upgrades) and supports farmers with training and technology for more sustainable practices.
Lidl Magyarország Kereskedelmi Bt.	The Hungarian subsidiary of the Schwarz Group's Lidl discount chain, part of one of the world's largest food-retail networks (31 countries, 12,600+ stores, around 200 logistics centres, and 595,000 employees). Lidl Hungary has published multiple GRI-based sustainability reports, underlining transparency and commitment to ESG.

Company	Introduction of the company's main activity
MBH Bank Nyrt.	A leading Hungarian banking group financing the agri-food sector among others. It is building ESG capabilities and processes across the organisation, aligning with evolving regulation and supporting clients' sustainability transitions
Magyar Élelmiszerbank Egyesület	A nonprofit focused on food rescue and prevention of food waste, the Association engages agricultural producers and supply-chain partners to redirect edible surplus to those in need, while running awareness and training campaigns to build environmental, social, and governance awareness.
Nestlé Hungária Kft.	The Hungarian arm of the world's largest food company. Nestlé integrates ESG into strategy, focusing on sustainable sourcing, resource protection, and community support; in Hungary it reports sustainability achievements via its "Creating Shared Value" summary rather than a standalone report.
UBM Group	A prominent Hungarian feed, grain trading, and food-industry group with vertically integrated activities across the agri-food chain. UBM emphasises scalable, data-driven operations and continuous strengthening of sustainability management and disclosures.
Zwack Unicum Nyrt.	One of Hungary's most renowned heritage spirits producers for over two centuries, maker of Unicum and other premium beverages. The company combines tradition with innovation and sustainability in production and market engagement at home and internationally.

Source: Own composition

Studies in Agricultural Economics 127 (2025) 220-227 https://doi.org/10.7896/j.3313

MARKET ANALYSIS

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Chicken meat production in global comparison – production systems and economics

ABSTRACT

Global chicken meat production has continued to expand, reaching a record 103.8 million tons in 2023, representing a 1.6 percent increase compared to the previous year. Benchmarking and comparative farm-level analyses provide valuable insights for assessing performance at national, regional, and global levels. The agri benchmark Poultry Network applies the typical farm approach, working in collaboration with international research partners, producers, and local experts to collect and validate standardised farm-level data using harmonised procedures and a simulation model. This study analyses global chicken meat production systems and the conditions shaping them. It examines their economic aspects and identifies key critical success factors influencing production efficiency. The study reveals that high feed-use efficiency and farm performance in broiler production is often attributed to a combination of three factors which include: the rearing of high-quality chicks, the use of high-quality feed, and good animal husbandry practices. The study identifies feed and day-old chicks' costs as the most important cost components for all typical farms included in the agri benchmark poultry network. A farm's competitiveness in terms of production costs is therefore heavily dependent on its ability to effectively manage feed and day-old chick costs.

ARTICLE INFO

Keywords:
poultry production, agri benchmark, broiler production, modelling, production costs, profitability, benchmarking, animal husbandry

JEL classification:
Q13.

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Received: 10 September 2025; **Revised:** 6 October 2025; **Accepted:** 8 October 2025.

Introduction

Poultry production has evolved rapidly in recent decades, becoming a cornerstone of global agriculture. In 1961, global poultry meat production was approximately 8.04 million tons (FAO, 2025). By 2024, this figure had risen to an estimated 141.42 million tons, surpassing both pork and beef to become the world's most consumed meat (FAO 2023; FAO, 2025). This growth is driven by advances in breeding, shifting consumer preferences, and economic factors making poultry an affordable protein source (OECD-FAO, 2021).

According to recent FAO statistics, the USA, Brazil and China are expected to maintain their dominant positions in the poultry international market despite facing country-specific challenges. Over the past decade, Europe has experienced a significant increase in production levels, with particularly notable growth observed in Poland and Hungary (FAO, 2025).

The relatively affordable consumer prices of poultry meat compared to beef and sheep meat increases its attractiveness as a cost-effective source of animal protein, particularly during periods of economic strain (Thobe *et al*., 2024). Moreover, rapid population growth coupled with urbanisation have boosted the global demand for poultry, rendering it the most widely traded livestock commodity worldwide in terms of volume (Farris *et al*., 2024).

Historically, Asian countries have represented the largest import market for chicken meat. With consumption growing much faster than production in China, chicken meat imports from Brazil reached unprecedented heights in 2023 – more than treble from 2013 levels (Figure 1). Exports from Brazil, as the world's largest chicken meat exporter, to the UAE and Saudi Arabia, as key importers in the Middle East, have reached 818,000 tons in 2023 – 17 percent of total Brazil's production.

Among the top 10 chicken meat trade flows in the year 2023, the traditional trade flow from the USA to Mexico comes first in with a 6 percent increase year-on-year, but still in line with the last 10-year average.

Despite poultry production's global expansion, each production region presents unique economic and structural challenges, making it essential to develop sustainable, region-specific practices and policies (Menghi *et al*., 2014). Production systems vary widely, from large-scale industrial farms to small backyard operations (Chibanda *et al*., 2024a). Given the rapidly increasing global demand for poultry meat, understanding how different poultry production systems across diverse regions can effectively respond to this growing demand is a critical issue for farmers, policy makers and agribusinesses. Central to this discussion are questions related to the underlying causes of limited competitiveness in some production systems worldwide, the most effective

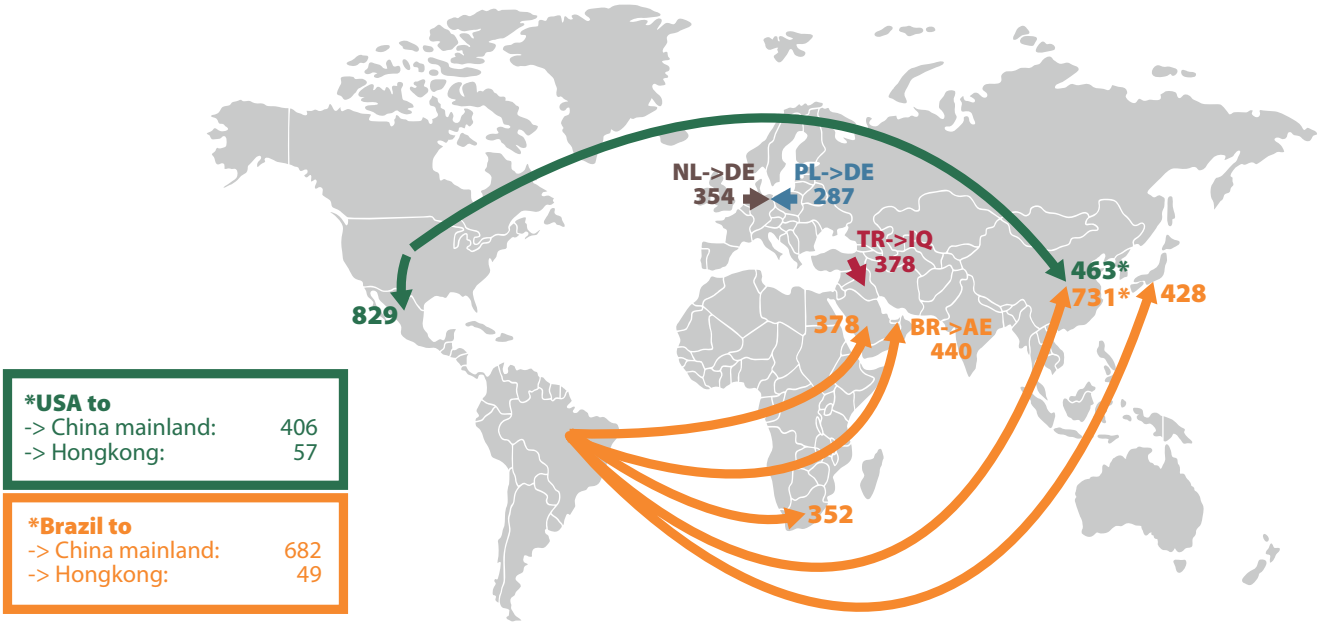

Figure 1: Top 10 chicken meat export flows 2023 ('000 tons).

Source: Own illustration based on UN Comtrade 11.2024, * China mainland, Hongkong and Macao.1

strategies to enhance the performance of domestic production, the environmental implications of various production systems across regions and the extent to which government regulations shape international competitiveness.

Extensive research exists on the economics of poultry farming at the national level investigating country-specific aspects (Adaszyńska-Skwirzyńska *et al*., 2025; Chen *et al.,* 2020; Chibanda *et al*., 2022, 2024b; Cobanoglu *et al*., 2014; Elmelegy et al., 2025; Kamruzzaman *et al*., 2021; Kawsar *et al.,* 2013; Mansour and Elsebaei, 2020; Marmelstein *et al.,* 2024; Verspecht *et al.,* 2011; Zamani *et al*., 2022). Recently, Chibanda et al. (2024a) evaluated the competitiveness of broiler production systems in west Africa (Ghana and Senegal), relative to systems in European countries (Germany and the Netherland). Such focus on single country assessments has left a gap in systematic cross-country comparisons of efficiency, cost structures, profitability, and competitiveness of different poultry production systems worldwide. Addressing this gap is essential for understanding the underlying drivers of poultry production systems, the factors shaping differences in efficiency and economic performance, the structural developments of poultry production across countries, the adaptive strategies farms are likely to adopt under changing framework conditions, and the geographical shifts in where poultry meat will be produced in the future.

This study aims to introduce comparative insights into the economics of global poultry production systems and the structural conditions influencing their development. The primary focus is on assessing the economic performance of these systems and identifying key factors that drive production efficiency and profitability. The analysis is based on an international comparison of typical broiler farms across countries participating in the agri benchmark Poultry Network. The Network was established in 2023 as a global, non-profit network of producers and agricultural experts representing major poultry production systems worldwide. In total, 21 typical broiler production systems from 11 countries - Austria, China, Finland, Ghana, Germany, Hungary, Iran, Senegal, South Africa, Spain, and the Netherlands - are examined. The typical farms are constructed as "virtual" farm datasets that represent the predominant production systems in each region employing the typical farm approach (Chibanda *et al*., 2020). These datasets are developed through expert-based interviews conducted in accordance with the *agri benchmark* Network's Standard Operational Procedure (Chibanda *et al*., 2020), thereby ensuring comparability across regions. To understand the framework conditions shaping broiler production, additional expert interviews, stakeholder consultations and conferences were conducted.

The structure of this article is organised into four main sections. Following this introductory section, Section 2 outlines the methodological framework, emphasising the application of the typical farm approach for constructing the typical broiler farms used in the analysis. Section 3 presents the empirical findings, providing a comparative assessment of production costs, returns, and profitability across diverse broiler production systems. This section also identifies key internal and external drivers of economic performance, that influence the success of broiler farming systems. The final section explores how country-specific conditions – such as institutional frameworks, market dynamics, and policy objectives – shape the structural characteristics and operational practices of typical broiler farms. Moreover, it examines the ways in which these contextual factors influence the economic performance of poultry production systems. By addressing these interdependencies, the study contributes to the broader discourse on optimising poultry production systems in a manner that reconciles economic efficiency with environmental sustainability and social responsibility.

Methodology

The agri benchmark SOP

This study employed the typical farm approach to compare the technical and economic performance of broiler farms across 13 countries (Austria, China, Finland, Ghana, Germany, Hungary, Iran, Senegal, South Africa, Spain, and the Netherlands). The typical farm approach is a structured methodology for constructing "synthetic" farms, commonly referred to as "typical" or "representative" farms, that reflect prevailing production systems in a given region. The methodology was implemented in accordance with the *agri benchmark* Standard Operating Procedure (SOP), as outlined by Chibanda *et al*. (2020). The SOP consists of five key steps (see Figure 2): Step 1 and Step 2 involve identifying key broiler production regions (hotspots) and determining the most prevalent production systems within these regions; Step 3 entails the collection of farm-level data; Step 4 entails the processing and validation of data through cross-checking procedures; and Step 5 involves the annual updating of farm data.

Step 1 and Step 2: Identifying key broiler production regions and the most prevalent production systems

Key broiler-producing regions and prevalent production systems were identified in each country through literature reviews, stakeholder workshops, or expert consultations, depending on the availability of national and regional farm-level data. Experts consulted included extension agents and academic researchers with local knowledge.

Step 3: Data collection and construction of typical farms

Farm-level data were collected through semi-structured interviews with producers operating in the previously identified regions. A standardised questionnaire, developed by the *agri benchmark* Poultry Team, guided the data collection process. Farm selection was undertaken in collaboration with regional extension officers and consultants familiar with local production practices. These individual farm data were then used to construct typical farms via a "typification" process. This involved reviewing the data point by point and substituting farm-specific figures with values representative of the broader production system. This process was conducted through either focus group discussions (as in Ghana and Senegal) with producers or expert consultations to ensure that the final figures were truly reflective of regional norms.

Step 4: Processing and cross-checking

The Technology Impact Policy Impact Calculations (TIPI-CAL) model was employed for data analysis. As described by Chibanda *et al.* (2024b) and Deblitz (2024), TIPI-CAL is a comprehensive farm-level production and economic simulation model, useful for cross-country benchmarking, practice change analysis, and policy impact assessment. In this study, the model facilitated the estimation and comparison of key performance indicators such as the feed conversion ratio (FCR), cost structures, and profitability. The model allows for profitability assessments across three-time horizons:

- Short-term profitability was calculated by subtracting cash expenses from total returns.
- Medium-term profitability included both cash and depreciation costs.
- Long-term profitability further incorporated opportunity costs into the analysis.

Step 5: Updating

To maintain the relevance and accuracy of the typical farm data, annual updates are performed. These include adjustments to input and output prices (e.g., feed, labor, manure, and broiler meat) based on current market conditions.

Figure 2: Overview of the typical farm approach (agri benchmark SOP)
Source: Chibanda *et al.* (2020)

Limitations

While the typical farm approach is a valuable methodology for comparative farm-level analysis, especially in international contexts, it is not without limitations. A significant constraint is the absence of statistical representativeness, as typical farms are not derived from stratified or random samples. Consequently, the findings should be interpreted with an understanding that they reflect typical – not average or median – conditions within a production system. Nonetheless, the methodology remains robust for benchmarking and policy analysis due to its standardisation and expert-based validation.

Comparison of feed-use efficiency

The result section analyses global poultry production systems and the conditions shaping them. It examines their economic aspects and identifies key factors influencing efficiency and sustainability. Results are displayed by key determinants reflecting the efficiency of a system.

The feed conversion ratio (FCR) is one of the primary cost drivers in broiler production and was utilised to assess the feed use efficiency of the typical farms (Figure 3). Two key determinants influenced feed use efficiency among these farms: the quality of inputs (i.e., day-old chicks (DOCs), feed) and poultry husbandry practices. Consequently, farms located in countries with well-developed hatchery and feed sectors, coupled with farmers practicing effective poultry husbandry, generally demonstrated lower FCRs, thereby achieving greater feed use efficiency. However, it is important to note that the length of the feeding period also affects FCRs, as farms with extended feeding periods typically were found to have higher FCR values across the typical farms derived from the collected data.

Due to the standardisation of poultry practices and the use of high-quality inputs such as day-old chicks and feed, typical farms in European countries generally exhibit high and consistent feed use efficiency. However, among all farms analysed, the South African farm (ZA_2.2M) emerged as the most efficient in terms of feed use. This is most likely attributed to a combination of a well-developed hatchery and feed sector, as well as consumer preferences for lighter-weight chickens that are slaughtered at a live weight of approximately 1.8 to 1.9 kg, which results in a relatively short feeding period of 31 days. In contrast, feed use efficiency in Ghanaian and Senegalese farms tends to be lower and exhibits considerable variation between typical farms within the same country. This disparity can be attributed to differences in poultry husbandry practices and varying levels of access to high-quality inputs. The Iranian farm also reported a relatively high FCR due to a prolonged feeding period of 49 days, and final live weight of 2.6 kg. Due to culinary traditions, consumer preferences in Iran tend to lean toward heavier birds, especially in the context of whole chickens.

Comparison of production costs

As illustrated in Figure 4, the primary cost drivers for all typical farms included in our network are feed and day-old chicks (DOCs). Therefore, a farm's competitiveness in terms of production costs is heavily dependent on its ability to effectively manage feed and day-old chick costs. Among the studied farms, the typical farm from Iran exhibits the lowest production costs, which resulted by subsidised feed programs for poultry producers in Iran (IR_143k), particularly regarding energy and imported feed. Consequently, feed prices in the Iranian farm were the lowest in the network countries. In contrast, Ghana and Senegal have the highest

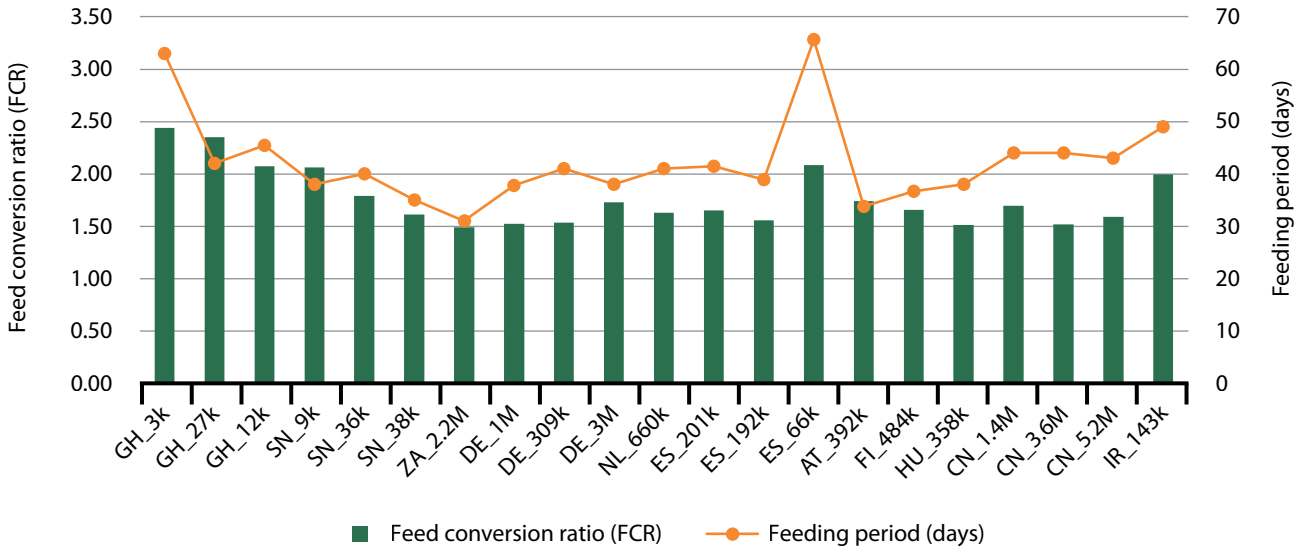

Figure 3: Comparison of feed use efficiency.

Countries: GH= Ghana, SN= Senegal, ZA= New Zealand, NL= The Netherlands, ES= Spain, AT= Austria, FI= Finland, HU= Hungary, CN= China, IR= Iran. Explanation of the names of the farms on the x-axes: Country Number of broilers sold per year. Examples: DE_1M: German farm with 1 million broilers sold per year.
Source: Own calculations

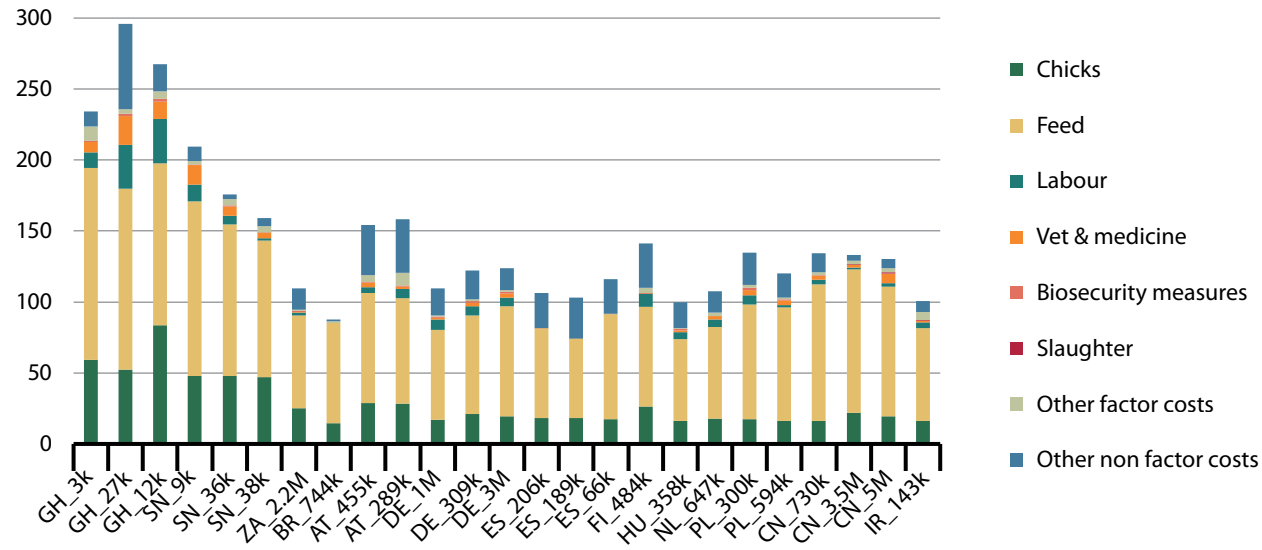

Figure 4: Comparison of production costs (US Dollar/100 kg live weight).
Countries: GH= Ghana, SN= Senegal, ZA= New Zealand, NL= The Netherlands, ES= Spain, AT= Austria, FI= Finland, HU= Hungary, CN= China, IR= Iran.
Explanation of the names of the farms on the x-axes: Country Number of broilers sold per year. Examples: DE_1M: German farm with 1 million broilers sold per year.
Source: Own calculations

production costs due to substantially higher feed and day-old chicks' prices.

The production costs of European farms can be considered to be relatively moderate, positioning them between the highest-cost and lowest-cost groups. The Austrian (AT_436k) farm has the highest costs among the European farms. Increased culling of parent stocks due to Salmonella resulted in a shortage of high-quality Ross 308 brother cocks on the Austrian market. The Salmonella outbreaks in Austria over the past few years was serious at the national level (Kornschober and Pekard-Amenitsch, 2023). Problems with parent stocks result in poor chick quality and overall poorer fattening performance. The typical Finnish broiler farm performs better than most in terms of feed-use efficiency (FCR). Although the typical Finnish farm (FI_484k) has the highest mortality rate among European farms – primarily due to the non-use of antibiotics and the strict culling of herds infected with salmonella, as well as the avoidance of thinning as a biosecurity measure – it still ranks among the top farms in terms of total production per square metre. This strong performance is attributed to the use of high-quality chicks and feed, along with excellent animal husbandry practices. Among the German farms, the production costs are higher for DE_3M as compared to DE_1M and DE 309k. The costs of feed and day-old chicks are also the most important cost items for the typical German broiler farms. Feed costs are quite similar between the three German farms and represent 69 to 72 percent of the total cash costs being the lowest for DE_3M and the highest for DE_309k. DE_3M has the highest mortality rate among the German farms, primarily due to structural deficiencies in the pens, such as old floors and inadequate climate control systems. In north-eastern Germany, broiler barns are often repurposed cattle sheds or outdated facilities from the former agricultural production cooperatives of the German Democratic Republic (GDR) era. In contrary, poultry farmers in north-west Germany (DE_1M) often operate in modern facilities which results in risk reduction of disease outbreaks, lowering treatment costs and production losses. North-west Germany is a highly specialised cluster region for livestock farming, which is characterised by a high density of specialised companies, concentrated expertise, high capital intensity and short transport distances.

Due to the sharp increase of energy prices in Europe (EUROSTAT, 2025), the share of energy costs in total cash costs have gained in significance. In modern poultry farming, energy is essential for heating, ventilation, lighting, and the automation of feeding and drinking systems. Rising energy prices therefore have a direct impact on production costs and can affect profitability. In recent years, energy prices have been subject to considerable fluctuations due to geopolitical crises, changes in energy policy, and the growing importance of renewable energy sources. Many broiler farms are responding by investing in energy-efficient technologies or renewable energy systems such as photovoltaics and biogas plants to reduce their dependence on fossil fuels and lower costs.

The typical farms are using breeds like Cobb and Ross, that grow rapidly and have high meat yields – especially in the breast and thighs – and show good feed efficiency. These hybrids are created through selective crossbreeding and are widely used in industrial poultry farming to reach market weight quickly.

Comparison of returns and profitability

In terms of the profitability of the typical farms, Figure 5 indicates that all farms, with the exception of two in China (CN_1.4M and CN_5.2M), are profitable in the short term. Hence, all other farms, with the exception of these

two Chinese farms, are able to cover their cash costs. In addition to the relatively high feed prices, the unprofitability of CN_1.4M and CN_5.2M is mainly attributed to high one-day-old chick prices in the smaller farm (third highest prices after Ghana and Senegal), and the low selling prices for the larger one (the lowest among the farms analysed). In contrast, farms in Ghana and Senegal achieve significantly higher selling prices compared to the other typical farms. Thus, despite facing the highest production costs, these farms have higher profit margins per production cycle due to their elevated selling prices. Ghanaian farms are able to obtain high selling prices because they market their chickens during festive seasons, when demand for live domestic chicken surges. However, it is important to note that broiler production in Ghana is typically seasonal (production targeting the festive season). Therefore, the typical farms are only profitable when production is seasonal. Farms in Senegal benefit from high selling prices due to a ban on poultry meat imports, which fosters favourable market conditions.

In contrast, European farms typically have lower selling prices, leading to significantly reduced profit margins compared to farms in other regions. Bonus payments vary depending on the country and applicable standards. For the Hungarian farm (HU_358k), renting is economically advantageous. This practice is common in Hungary due to various factors – such as limited capital – and is also frequently observed among affiliated companies. Among the German farms, DE_1M is the most profitable, primarily due to lower cash, depreciation and opportunity costs. This concentration of expertise, infrastructure, and capital not only boosts current efficiency and productivity but may also facilitate future investments in capital-intensive, modern animal welfare stables. The supportive environment and close collaboration among specialised stakeholders create favourable conditions for adopting innovative housing systems that meet higher welfare standards while maintaining economic viability.

Discussion and Conclusions

High feed efficiency and overall farm performance in broiler production is often attributed to a combination of factors, including rearing high-quality chicks, using high quality feed and good animal husbandry practices (Thobe *et al*., 2024). Consequently, the results (Figures 4 and 5) suggest that the best performing farms have better access to these critical success factors.

Several factors contribute to the observed differences in feed and day-old chick costs. First, the level of development within a country's domestic feed sector and its capacity to locally produce key feed ingredients, such as maize, wheat, and soybeans, play a significant role in determining feed prices. A comparative example is evident among the three African countries. Unlike Ghana and Senegal, South Africa has a more developed feed sector, with substantial domestic production of feed ingredients (e.g., maize). Consequently, South African farms benefit from lower feed prices, positioning their feed costs among the lowest compared to other typical farms.

At the European level, the Spanish farms showed relatively low feed costs. This is mainly attributed to the highly integrated production system, where feed is provided by integrator companies at prices which are the lowest among the network farms in Europe. In contrast, the growing demand on feed ingredients from livestock producers in China (mainly beef and pig) pushed up feed prices in China's farms to be among the highest among the network farms (second highest prices after Ghana). Second, low feed -use efficiency, as reflected by a high feed conversion ratio (FCR), also affects feed costs. Farms with lower efficiency require more feed than necessary, as observed in Ghanaian farms, which results in elevated feed costs. Third, the level of development within the hatchery sector influences day-old chicks' prices. Countries with less developed hatchery sectors often

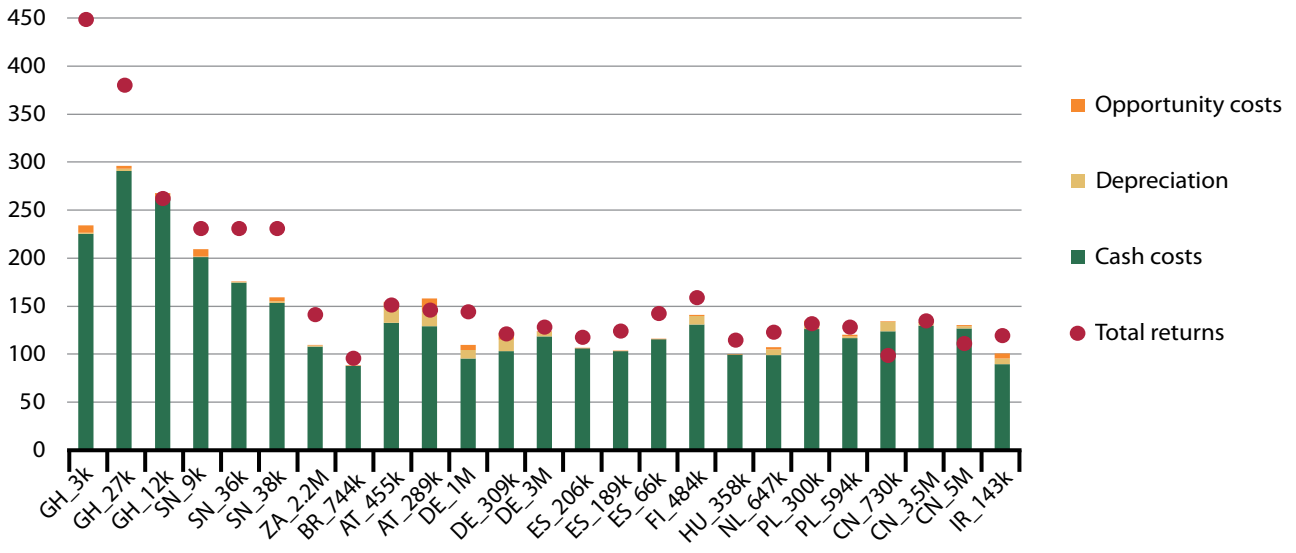

Figure 5: Comparison of total returns and profitability (US Dollar/100 kg live weight).
Countries: GH= Ghana, SN= Senegal, ZA= New Zealand, NL= The Netherlands, ES= Spain, AT= Austria, FI= Finland, HU= Hungary, CN= China, IR= Iran
Explanation of the names of the farms on the x-axes: Country Number of broilers sold per year. Examples: DE_1M: German farm with 1 million broilers sold per year.
Source: Own calculations.

rely on importing day-old chicks, hatching eggs, or breeder stocks, all of which can be costly.

Further the results prove, that the economic performance is highly dependent on securing high selling prices for their production. Further, the farm´s profitability is sensitive to market dynamics, including consumers´ demand and willingness to pay higher prices for broiler meat. Further classification of results based on system characteristics such as integration level, breed used, market access, and management practices provides deeper insights. For example, the analysis reveals correlations between higher costs and stronger biosecurity measures, offering evidence of the trade-offs involved in achieving higher performance.

This study highlights the interplay between country-specific conditions, policy objectives, and the structure and practices of typical broiler farms worldwide. The study demonstrates how these factors collectively influence economic farm performance. The diversity in national priorities – whether rooted in consumer demand, legal frameworks, or institutional settings – creates distinct operating environments for poultry producers across countries.

A key finding is the significant role of consumer preferences in shaping production practices. In South Africa, where there is a pronounced preference for lighter broilers, producers tend to adopt shorter feeding periods. This leads to relatively favourable feed conversion ratios (FCRs), since broilers are harvested before reaching a physiologically less efficient growth phase. In contrast, Iranian consumers demand heavier birds, resulting in extended fattening periods and consequently higher FCRs. These divergent preferences illustrate how market-driven parameters can directly affect farm-level efficiency metrics, often in ways that reach further than purely technical or biological optimisation.

Beyond demand driven market forces, the regulatory environment profoundly influences farm structures and cost structures. In Germany, strict environmental and animal welfare regulations impose higher compliance costs on producers. These may include investments in enriched housing systems, manure management technologies, or reduced stocking densities – all of which influence operational efficiency and profitability. Conversely, in Iran, state subsidies for animal feed mitigate some of the variable costs associated with broiler fattening, allowing producers to maintain profitability even under less efficient technical conditions. This disparity underscores the importance of policy instruments in shaping not only cost structures but also incentives for innovation and sustainability in the sector.

Slaughterhouse requirements, particularly those concerning the handling of flocks infected with pathogens such as Salmonella spp., add an additional layer of complexity. While such regulations are primarily designed to safeguard public health, their implications for producers are often indirect yet substantial. For instance, the categorisation of flocks based on pathogen load may affect marketability and pricing, while necessitating changes in on-farm management and biosecurity. However, the degree to which farmers can directly control these outcomes is limited, highlighting the need for better integration and communication between production and processing stages.

Furthermore, the emergence of specialised cluster regions for broiler production within countries influences the structure and performance of typical farms. In Germany, for example, regions such as Northwest-Germany have evolved into centres of intensive poultry farming due to favourable infrastructure, agglomeration effects, and historical policy support. These areas benefit from economies of scale, access to specialised labour and services, and logistical advantages. However, such regional concentration may also exacerbate environmental pressures and increase vulnerability to market or disease shocks. The variation in farm structures across different regions within the same country underscores the importance of spatially sensitive policy-making and the typical farm approach (Chibanda *et al*., 2020).

The results of this study illustrate that optimising broiler production requires a nuanced understanding of the interconnected drivers that shape farm-level outcomes. Efforts to enhance economic viability must therefore be aligned with broader societal goals, including animal welfare, environmental protection, public health and food security. Future research should further investigate how integrated policy frameworks can harmonise these often-competing objectives, especially in light of evolving consumer expectations and climate challenges.

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