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Assessing of cereal production in Lithuania using sustainable economic competitiveness index

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Abstract

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This paper analyses the sustainable economic competitiveness of cereal farms in Lithuania relative to selected European Union (EU) Member States (MS). The paper proposes and empirically tests an aggregated measure of Sustainable Economic Competitiveness Index (SECI) for agriculture from a production perspective. Based on a literature review on sustainability and competitiveness assessment in agriculture, the SECI was constructed for a selection of the 13 top cereal (wheat)-producing EU countries. The calculations were based on data taken from two EU FADN (European Union Farm Accountancy Data Network) standard results databases: the Public Database and the Cereal Farm Report, for an average cereal farm in the case of the 2010–2020 period. The sustainable competitive advantage of cereal farms in terms of economic aspects was assessed and compared based on nine selected indicators: gross margin, total costs, yield, wheat price, energy use intensity, water use intensity, nitrogen (N) use intensity, investment capacity, and farm net income. The study revealed that Lithuanian cereal farms ranked 5th on average in 2010–2020 after Germany, Denmark, Italy, and France among the selected MS. Lithuanian cereal farms ranked 1st in 2015 and 2nd in 2017 and 2020 throughout the analysed period. Lithuania's competitive advantage in cereal production stems from its relatively high gross margin per hectare of wheat and relatively low total costs per hectare of wheat. Denmark and Italy held the 1st place for four years each between 2010 and 2020.

Keywords: sustainable economic competitiveness; agricultural production; European Union countries; index
Abbreviations: AV, average value, AWU, Annual Work Units; CV, coefficient of variation; CAP, Common Agricultural Policy; EI, energy use intensity; EU, European Union; F2F, Farm-to-Fork; FADN, Farm Accountancy Data Network; FNI, Farm net income; GM, gross margin; GR, growth rate; IC, investment capacity; MS, Member States; N, nitrogen, NI, N use intensity; P, Wheat price; SAW, Simple Additive Weighting; SECI, Sustainable Economic Competitiveness Index; SO, Standard Output; TC, total costs; WI, water use intensity; Y, Yield

Introduction

Competitiveness and sustainability are multidimensional concepts that are often evaluated separately. As noted by Möbius & Althammer (2020), despite the frequent use of the concept of competitiveness, it remains ambiguous, leading to difficulties in its operationalization. Moreover, the concept has a distinct notion when applied to an enterprise, regional or national level (Bilbao-Terol et al., 2019), or specific economic sectors (Constantin et al., 2023). A country exhibits a comparative advantage in a product when it can produce it at a lower opportunity cost or delivers a higher-quality product than other countries (Gorton & Davidova, 2001). According to Porter et al. (2004), leaders demonstrate strong productivity, with productivity growth indicating competitiveness. Baudoin Farah & Gómez-Ramos (2014) identify two main approaches of the competitiveness concept. The first focuses on competition in national or international markets and pertains to the capacity to maintain a determined market share. The second relates to the competition among production factors to achieve profitability at the minimum opportunity cost. In both approaches, competitiveness is relative and expressed through benchmarking. According to Iversen et al. (2020) "the cost level is the main indicator of the competitiveness of the industry in a specific country". Sarris et al. (1999) emphasize technical efficiency as one component of competitiveness and a necessary condition for being competitive. Möbius & Althammer (2020) highlight that the core of competitiveness, i.e., its measurement in terms of prices and costs, market share, or productivity, has remained largely unchanged over time. However, Chebba et al. (2020) underscore the necessity to define concepts such as "sustainable competitive ability or "ability to compete in a sustainable manner" and "sustainable position of competitiveness".

The authors propose the concept of sustainable competitiveness as "the sum of the country's ability to compete in a sustainable manner and its competitive position". According to Mitiai et al. (2015), the competitiveness of agriculture determines its long-term sustainability. Aiginger & Firgo (2017) introduce a new perspective on the concept of competitiveness as the sustainability–competitiveness nexus, shifting from an input-oriented to an output-oriented assessment, linking competitiveness to objectives beyond gross domestic product. Constantin et al. (2023) present the concept of sustainable economic competitiveness for agriculture at the intra-industry scale, stating that it can be achieved through strategic actions by decision-makers, based on a strong factor endowment foundation and an effective trade specialization policy. The authors emphasize that economically sustainable competitiveness does not necessarily focus on the quantity of production but rather on increasing the added value of the product.

Nowadays, sustainable development is the dominant paradigm of agricultural policy in the European Union (EU). An important challenge for the EU Common Agricultural Policy (CAP) post-2020 is to achieve a long-term sustainable development objectives outlined in the European Green Deal, the Farm-to-Fork Strategy (F2F), and the 2030 Biodiversity Strategy. It aims to lead to sustainable agriculture, combining economic, social, and environmental sustainability. There is a wide range of methods and tools capable of assessing agricultural sustainability (Chopin et al., 2021). Indicators and composite indicators are utilized as a useful tools for policy-making and public awareness (Singh et al., 2009). Among the most well-known and comprehensive tools for assessing sustainable agricultural practices are SAFA (FAO, 2014), RISE (Hani et al., 2003), IDEA (Zahm et al., 2008), and INSPIA (Trivino-Tarradas et al., 2019). Although several studies have examined the sustainable competitiveness of agriculture at a broader scale (Kucher, 2019; Pimenova et al., 2020; Constantin et al., 2023), there is a notable lack of research specifically addressing sustainable competitiveness at the farm level.

In Lithuania, cereal production is a key sector of agricultural output. In 2020, cereal crops accounted for 63.9% of all cultivated crops, with wheat alone comprising 41.3%. Cereal production contributed to 36.4% of total agricultural production (Statistics Lithuania, 2023). Foreign trade data for cereals in 2020/2021 indicated that Lithuania ranked as the 4th largest EU country in terms of wheat exports, representing 11.5% of total EU wheat exports (DG AGRI, 2023). Furthermore, according to FAOSTAT (2023) data for 2021, Lithuania was the 15th largest wheat exporter globally.

Taking into account the aforementioned facts, the aim of this paper is to evaluate the sustainable competitiveness of Lithuanian cereal farms, reflecting economic pillar within the context of selected EU Member States (MS) that are major cereal producers and exporters. This objective will be achieved by developing the Economic Sustainable Competitiveness Index (SECI).

Data and Method

Data

The indicators for assessing SECI in cereal farms were based on previous sustainability assessment initiatives (INSPIA and SAFA) and the concept of competitiveness, which focuses on price and input costs (Table 1). The data were obtained from two EU Farm Accountancy Data Network (FADN) sources: the FADN Public Database (FADN, 2023) and the EU Cereal Farms Report (further – Cereal Report) (Cereal Report, 2023). Wheat is the dominant cereal crop on Lithuanian cereal farms. Consequently, the Cereal Report was used as the source for data on gross margins for wheat and the farm costs allocated to wheat production. The report includes data from farms where the Standard Output (SO) of the given crop constitutes over 40% of the total SO. In the FADN Public Database, research results are presented for specialist farms focused on cereals, oilseeds, and protein crops, where cereals account for more than two-thirds of the total SO.

The FADN database reflects the performance of countries at the farm (micro) level. However, it should be noted that the results are presented using stratified FADN sample weights, which ensure that the results represent the population of farms in each EU country. The time frame selected for the study is determined by data availability. The Cereal

Report covers data from 2010 to 2020.

The SECI for Lithuanian cereal farms is calculated in the context of other major EU wheat producers, namely France, Germany, Poland, Romania, Spain, Bulgaria, Italy, Hungary, Czechia, Denmark, Sweden, and Latvia. The selected countries together generated 91.6% of EU-27's wheat production in 2020 (FAOSTAT, 2023).

Method

For the comparative analysis of the economic performance of sustainable competitiveness among the selected EU countries, the SECI for each individual EU country was calculated using the Simple Additive Weighting (SAW) method. The SECI comprises nine selected indicators. However, data on fertiliser N use quantities on cereal farms are available for most analysed countries starting from 2014 (Denmark, Italy, Latvia, Lithuania, Hungary, and Poland), in Czechia and Sweden from 2016, and in Spain, France, Germany and Romania from 2017. Consequently, in this study, the index is composed of 8 indicators up to 2013 and 9 indicators from 2014 onwards. The 2014, 2015 and 2016 values for the missing N fertiliser indicator were imputed using the first available country-specific values.

To ensure a consistent comparative benchmark for each indicator, normalisation was applied following the Joint Research Centre-European Commission (JRC-EC) (2008) methodology. The min-max normalization approach allows the data to be ordered on a scale from zero to one. The SECI comprises five indicators with a direct relationship to the index (direct indicators) and four indicators with an inverse relationship to the index (inverse indicators) (Table 1). Carrying out the normalization the direct indicators are rescaled following equation (1) and indicators with an inverse relationship to the index are rescaled via equation (2).

$$X_n = \frac{X_i - X_{min}}{X_{max} - X_{min}}; \quad (1)$$

$$X_n = \frac{X_{max} - X_i}{X_{max} - X_{min}}. \quad (1)$$

where X_n is the normalized value; X_i is the initial value, X_{max} is the maximum value, and X_{min} is the minimum value for an indicator *i* of the SECI, across the selected EU MS.

The normalisation process allows the SECI indicator values to be combined into a single SECI score. The indicators used to produce the SECI were treated as equally important, with the sum of the scores for each indicator representing the final SECI. Therefore, the SECI is calculated as the sum of eight (2010–2013) and nine (2014–2020) normalised indicator values for each EU country. This results in a maximum possible index score of 8 or 9, assuming a country achieves the highest score (one) for all normalised indicator values. The index is calculated annually to reflect changes over time.

The statistical characteristics of the variables, as averages for the whole period 2010–2020, are discussed using compound annual growth rates and the coefficients of variation (CV). The CV is expressed as the ratio of the standard deviation to the mean, enabling us to identify the country with the highest variation in the values of the composite indicator over the period under analysis.

Descriptive Statistics Analysis

The average values and compound annual growth rates of the SECI indicators, along with two structural indicators (wheat area and economic size of farm), are presented in Table 2, while the coefficients of variation (CVs) are provided in Table 3. During the period 2010–2020, the largest average wheat area among the analysed countries was recorded in

Table 1. SECI indicators selected for the analysis

Indicator	Data	Direct/Inverse	Abbreviation	Description
Gross margin	Cereal Report	D	GM	Receipts from wheat minus wheat production operating costs per wheat area (EUR/ha)
Total costs	Cereal Report	I	TC	Total costs per wheat area (EUR/ha)
Yield	Cereal Report	D	Y	Wheat production per wheat area (t/ha)
Wheat price	Cereal Report	D	P	Common wheat price (EUR/t)
Energy use intensity	Cereal Report	I	EI	Energy costs for wheat per wheat production (EUR/t)
Water use intensity	Cereal Report	I	WI	Water costs for wheat per wheat production (EUR/t)
N use intensity	FADN	I	NI	Fertilizers N per cereal output (kg/EUR)
Investment capacity	FADN	D	IC	Investment to depreciation ratio (EUR/EUR)
Farm net income	FADN	D	FNI	Farm net income per annual work unit (thsd. EUR/AWU)

AWU – Annual Work Units; N – nitrogen

Latvia (108 ha), followed closely by Bulgaria (100 ha). In contrast, Italy had the smallest average wheat area, at just 10 ha. For most of the countries studied, the average wheat area per farm showed a downward trend over the analysed period, with exceptions in countries such as Spain, Italy, Sweden, and Denmark. The most significant variation in wheat area during the period was observed in Romania (CV, 43.7%), while the smallest variation was found in Sweden (CV, 9.1%).

The economic size of agricultural entities/farms, expressed in thousand euros of standard output (SO), showed significant variation among the countries analysed. The average economic size of a cereal farm in the countries analysed over the period 2010–2020 was the highest in Czechia, with a value of 178.6 thousand EUR, followed by Latvia with a value of 142.7 thousand EUR. At the other end of the spectrum was Poland with the lowest average per farm economic size of 24.5 thousand EUR. The economic size of cereal farms showed an upward trend in all countries. The most significant variation in economic size over the period was in Romania (CV, 43.6%).

Gross margin across the cereal farms in the countries studied exceeded 400 EUR/ha in Germany, Italy, and Denmark. At the other end of the range, gross margin was below 200 EUR/ha in Latvia, although the annual growth rate and variation were the highest in Latvia during this period.

The highest total costs (the sum of operating, total external factors, and depreciation) on average per cereal farm were recorded in Denmark (1,534.4 EUR/ha), followed by Germany (1,415.2 EUR/ha), while the lowest were in Romania (547.8 EUR/ha) and slightly higher in Spain (573.5 EUR/ha). The annual growth and variation of these costs over the period 2010–2020 were highest in Bulgaria, +4.7% per year and 15.6% respectively.

Harvest yields averaged more than seven tonnes per hectare during the analysed period in Germany (7.7 t/ha), Denmark (7.4 t/ha), and France (7.3 t/ha), while the lowest yield was recorded in Spain at 3.5 t/ha. Wheat yields on cereal farms in all countries exhibited an upward trend over the analysed period, except in France. The coefficient of variation (CV) indicates the variability of yields among the analysed farms, with the least stable yields observed in Latvia (19.0%) and Lithuania (17.1%).

Within the EU, among the major wheat producers analysed, prices ranged from 152 EUR/t in Romania to 207 EUR/t in Italy during the period 2010–2022. The highest price variation at the country level was observed in Sweden (CV, 16.6%), while the lowest was recorded in Italy (CV, 7.4%).

An analysis of energy costs per tonne of wheat production

Table 2. The average values and growth rates of SECI components and structural variables in average cereal farms in selected EU countries (2010–2020)

EU MS	Wheat area, ha		SO, thsd. EUR		GM, EUR/ha		TC, EUR/ha		Y, t/ha		P, EUR/t		EI, EUR/t		WI, EUR/t		NI, kg/EUR	IC, EUR/EUR		FNI, thsd. EUR/AWU	
	AV	GR	AV	GR	AV	GR	AV	GR	AV	GR	AV	GR	AV	GR	AV	GR	AV	AV	GR	AV	GR
Bulgaria	100	-1.8	142.7	5.3	278.6	2.7	732.0	4.7	4.3	1.6	154	1.6	18.9	-1.0	0.00	–	0.20	1.50	-1.3	6.7	-5.3
Czechia	86	-2.1	178.6	5.1	227.6	5.9	955.5	2.2	5.6	2.6	159	0.1	20.5	-2.3	0.00	–	0.24	1.28	3.4	12.7	8.8
Denmark	52	2.9	106.2	7.7	430.4	3.3	1,534.4	-0.4	7.4	2.2	170	-0.3	11.7	-3.2	0.00	–	0.13	0.90	-6.2	30.4	1.0
Germany	68	-3.8	181.4	0.4	444.5	0.3	1,415.2	0.8	7.7	0.3	177	0.3	15.8	-1.4	0.00	–	0.17	1.48	0.1	22.4	-0.8
Spain	31	0.2	40.6	4.8	204.2	1.9	573.5	3.5	3.5	1.9	179	1.0	18.1	-0.4	3.21	-0.8	0.13	0.63	-0.6	18.1	1.8
France	60	-0.8	138.9	2.8	373.4	-5.0	1,326.5	1.3	7.3	-0.4	171	0.3	9.9	1.3	0.01	-6.9	0.19	0.85	4.6	20.8	-7.8
Italy	10	0.3	35.0	4.4	437.6	-0.5	1,050.3	-1.6	5.7	0.3	207	0.0	25.8	-0.3	0.36	-11.1	0.09	0.62	–	18.3	4.8
Latvia	108	-3.4	85.7	0.1	195.4	14.6	831.0	3.4	4.6	5.2	169	0.4	20.3	-8.0	0.00	–	0.23	1.78	3.0	11.8	4.4
Lithuania	58	-3.1	49.6	1.5	334.3	8.3	771.7	3.7	5.2	5.3	167	0.4	15.7	-6.8	0.00	–	0.25	1.53	-0.8	13.9	3.0
Hungary	27	-3.2	49.6	0.9	243.5	9.9	627.9	1.5	4.6	5.0	155	-0.5	24.3	-4.6	0.01	-48.4	0.15	1.39	9.7	21.2	8.5
Poland	17	-2.1	24.5	0.5	336.2	1.1	893.6	2.1	5.8	2.1	170	-0.4	17.7	-1.9	0.00	–	0.24	0.92	-5.1	7.3	-2.6
Romania	35	-0.6	35.0	5.3	252.3	2.0	547.8	1.9	4.1	0.7	152	0.5	17.7	1.4	0.03	-39.6	0.36	1.02	7.0	12.1	0.6
Sweden	56	1.2	91.9	3.1	208.2	7.3	1,311.6	2.7	6.4	3.1	173	0.5	26.5	-2.8	0.00	–	0.18	1.52	3.0	14.4	-1.3

MS – Member States; SO – standard output; AV – average value, GR – growth rate per year, %

Source: Author calculations on FADN data

Table 3. The CV values of SECI components and structural variables in average cereal farms in selected EU countries (2010–2020), %

EU MS	Wheat area	SO	GM	TC	Y	P	EI	WI	NI	IC	FNI
Bulgaria	17.4	17.3	19.4	15.6	15.6	12.8	18.0	331.7	139.0	25.2	33.0
Czechia	15.4	19.8	21.3	6.7	11.4	12.3	15.4	–	116.1	22.0	28.3
Denmark	12.0	24.0	38.4	4.4	9.9	14.5	19.5	108.2	80.5	78.9	117.7
Germany	15.2	4.8	26.9	3.9	8.3	12.8	13.1	-	139.6	11.6	39.7
Spain	9.1	16.8	35.5	11.8	9.6	10.7	18.5	24.3	140.6	36.5	19.6
France	6.6	10.3	47.5	9.3	10.2	12.1	11.2	92.3	139.1	15.9	71.2
Italy	11.3	21.3	15.9	13.3	3.3	7.4	22.2	51.0	79.5	75.7	22.2
Latvia	20.7	5.5	49.7	9.8	19.0	11.3	28.2	–	79.7	19.4	39.6
Lithuania	14.6	6.4	36.4	11.7	17.1	12.1	25.4	–	82.8	21.2	39.7
Hungary	13.7	5.6	23.4	7.3	16.8	14.0	22.9	321.9	79.8	23.7	20.3
Poland	12.6	8.6	21.6	6.2	8.8	13.1	15.8	222.5	80.2	63.1	36.9
Romania	43.7	43.6	21.5	8.3	16.7	12.9	11.6	131.5	147.6	21.1	37.1
Sweden	9.1	16.1	35.3	14.8	16.4	16.6	19.0	144.2	116.4	45.1	69.0

Source: Author calculations on FADN data

(EUR) revealed significant variation among countries, with Italian cereal farms reporting the highest cost (25.8 EUR) and French farms the lowest (9.9 EUR). Notably, in most of the countries analysed, energy costs followed a downward trend, except in Romania and France. The largest decreases in energy consumption were observed in Latvia (-8.0%) and Lithuania (-6.8%).

Water irrigation costs for cereal crops was registered in five of the countries analysed, namely, in Spain, France, Italy, Hungary and Romania, with Spain registering the highest costs (EUR) per tonne of wheat (3.21).

Nitrogen (N) fertilisers are vital for wheat growth, but excessive use and/or insufficient uptake by plants makes these nutrient losses one of the sources of environmental pollution. The reduction of excessive use of N fertilisers is one of the objectives of the EU F2F strategy. As regards N fertilizer use intensity, Romanian cereal farms used the highest amount of N fertiliser per euro of cereal production (0.36 kg) on average in 2010–2020 among all the EU countries examined.

The ratio of investment to depreciation reflects the growth potential of a business or agricultural entity (e.g., a farm). A high ratio indicates significant investment in long-term assets, signalling expectations of future growth or development. In four of the countries analysed—Latvia, Lithuania, Sweden, and Bulgaria—investment exceeded depreciation by 50% or more. The highest variation in investment capacity on cereal farms during 2010–2020 was observed in Denmark (78.9%) and Italy (75.7%).

Net farm income is a key indicator in the EU FADN database (2023) and is equal to the net value added of farm – total external factors (wages, rent and interest paid) + balance subsidies and taxes on investments. This measure indicates the ability of an agricultural entity to remunerate all the factors of production involved in the production process. The average farm net income per Annual Work Unit (AWU) over the 2010–2020 period ranged from 6.7 (in Bulgaria) to 30.4 thousand EUR (in Denmark). For Lithuanian cereal farms, this income was almost twice as high as in Bulgaria or twice as low as in Denmark. It should be noted that in Bulgaria the FNI per AWU of the farms showed a decreasing trend over the period analysed (growth rate 5.3%), while in Denmark it was the most variable (CV, 117.7%).

Results and Discussion

Table 4 presents the aggregate SECI values for Lithuanian cereal farms from 2010 to 2020 relative to the top cereal-producing countries in the EU. The normalized SECI indicator values are approached by country and each year in Annex Table A1. It should be considered that, due to the absence of data regarding the quantities of N fertilizers used in farms, the maximum possible score for a country is 8 for the period 2010–2013 and 9 for the period 2014–2020.

The eleven-year average SECI for Lithuania from 2010 to 2020 is 4.9, placing Lithuanian cereal farms in 5^{th} position among the EU's largest cereal producers (Figure 1). It is noteworthy that Lithuanian cereal farms ranked highest in 2015 and achieved 2^{nd} highest ranking in 2017 and 2020. Throughout the analysed period, Lithuanian farms attained their highest score in 2020 (6.3). This achievement was attributed to some of the highest normalized values for water consumption (1.0), gross margin per wheat area (0.96), and

Table 4. SECI values in average cereal farms in selected EU countries (2010–2020)

EU MS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010–2020
Bulgaria	3.5	4.0	3.3	3.6	4.1	3.9	4.6	4.5	5.7	4.7	3.7	4.1
Czechia	2.9	3.7	3.0	3.8	4.9	3.9	4.8	3.1	5.0	3.9	3.9	3.9
Denmark	5.3	5.7	5.8	5.7	5.1	5.8	3.9	5.0	5.0	5.8	6.5	5.4
Germany	5.4	5.0	5.3	5.5	6.4	5.6	6.1	5.2	6.4	5.4	5.6	5.6
Spain	3.1	3.3	2.1	2.1	2.6	3.0	4.4	3.6	4.7	3.7	4.3	3.3
France	6.0	5.6	5.1	4.2	4.7	4.8	4.2	5.3	6.5	5.4	5.1	5.2
Italy	4.3	3.7	3.5	3.2	5.5	5.9	6.2	6.1	7.4	5.9	5.3	5.2
Latvia	2.9	3.2	3.7	3.9	3.6	5.0	5.0	4.5	4.7	4.9	5.1	4.2
Lithuania	4.4	4.6	4.2	4.2	4.6	5.9	4.6	5.3	5.0	4.4	6.3	4.9
Hungary	2.5	3.7	2.8	3.3	4.9	4.9	5.8	5.1	5.9	5.7	4.9	4.5
Poland	4.5	4.3	4.7	3.7	4.2	4.0	4.3	3.9	5.1	3.9	4.6	4.3
Romania	3.2	3.6	2.9	3.3	4.0	3.7	5.2	4.9	5.2	4.3	2.9	3.9
Sweden	4.0	4.1	2.9	3.1	3.7	3.4	4.5	3.6	4.0	4.6	4.7	3.9

Source: Author calculations on FADN data

energy costs per wheat area (0.93). However, relatively low normalized values were still obtained for wheat price (0.33), FNI per AWU (0.51), and investment capacity (0.56).

Although Germany holds the 1st position in terms of the average SECI value over the period 2010–2020, it is important to note that countries such as Denmark and Italy led for four years during this period. Danish cereal farms were at the forefront for three consecutive years from 2011 to 2013 and in 2020, despite having the highest (2011, 2012 and 2020) or one of the highest (2013) total costs per hectare of wheat. Italian cereal farms led for four years in a row from 2016 to 2019, albeit in 2016, 2017 and 2019, the energy intensity of these farms was relatively the highest among the selected countries.

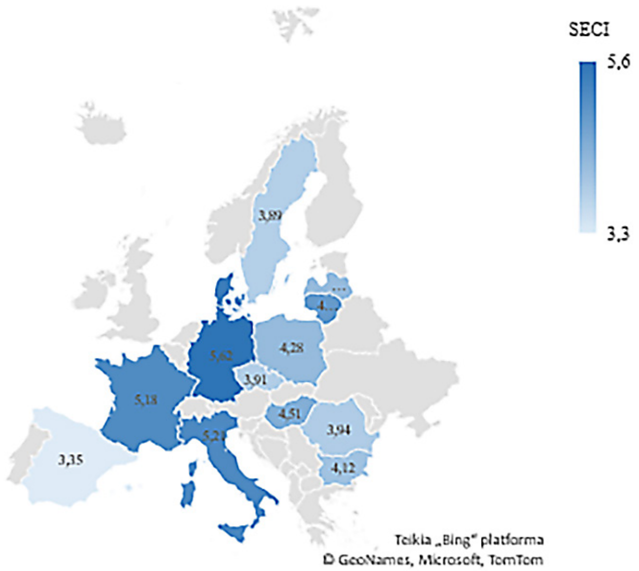

Fig. 1. Ranking of selected EU countries based on SECI on average in 2010–2020
Source: Author calculations on FADN data

A more in-depth analysis of the SECI indicators of Lithuanian cereal farms uncovers disadvantages in the sustainable economic competitiveness in a certain year of analysis over the 2010–2020 period related to:

- Relatively low yield in 2010 (0.15), 2011 (0.15), 2018 (0.28) and 2019 (0.34).
- Relatively low wheat purchase price in 2012 (0.00), 2016 (0.03), 2017 (0.18).
- Relatively high use of N fertilizer for wheat production in 2016 (0.00), 2017 (0.01).

The advantages of Lithuanian cereal farms were also revealed, such as:

- Relatively high gross margin per hectare of wheat in 2015 (1.00), 2017 (0.80), 2020 (0.96).
- Relatively low total costs per hectare of wheat in 2010 (0.88), 2011 (0.87), 2012 (0.80), 2013 (0.77), 2016 (0.78), 2019 (0.75).

A study by Constantin et al. (2023) on the sustainable economic competitiveness of the cereal sector at the macro level (including cereals and cereal preparations) in the EU highlighted Lithuania's low economic competitiveness compared to other EU countries. This was attributed to factors such as the relatively low volume of cereal production, low yields, and the lack of a robust sustainable strategy for trade flows of cereals and their products. In contrast to Constantin et al. (2023), the present research evaluates sustainable competitiveness of the cereal sector at the production/farm level. Nonetheless, similar findings were observed, particularly regarding low wheat yields as a competitive disadvantage. These findings align with the authors' recommendation for the Lithuanian cereal sector to "deliver smart, no more!"

It is evident that Lithuania produces a smaller quantity of cereals relative to other EU analysed countries, yet it faces challenges with excessive production or low levels of domestic consumption, indicating an imbalance in the agricultural structure of agriculture, with other products (fruit, vegetables, pork) being insufficiently produced in Lithuania. These issues are being addressed through CAP measures for 2023–2027 (Melnikienė et al., 2022). On the other hand, the study highlights that selecting appropriate indicators for assessments is a critical step. The choice between relative or absolute indicators, whether based on value or quantity, remains a topic of debate. In this study, efforts were made to identify suitable data sources to achieve the research objectives, and some indicators were used as proxy equivalents, drawing on previous sustainability studies. Since costs in this study were allocated per hectare of wheat, it was also considered whether income per annual work unit (as is standard in FADN) would be the most appropriate measure for the analysis, or whether to adopt the approach proposed by Cardillo & Cimino (2022), which presents indicators such as investment per hectare, revenue, or work units per hectare as alternative measures.

Conclusions

This study introduces a tool for measuring the sustainable competitiveness of farms: the Economic Sustainable Competitiveness Index. Consisting of nine indicators, the index utilizes data from two FADN public databases. It is calculated for major wheat-producing EU countries, enabling the identification of key competitiveness factors and the establishment of a ranking among these countries. Over the period 2010–2020, Germany, Denmark, and Italy ranked as the top three countries in terms of farms' economic sustainable competitiveness, while Spain, Sweden, and Czechia were the lowest-performing countries.

The findings of this research indicate that the sustainable economic competitiveness of Lithuanian cereal farms, compared to the top wheat-producing countries in the EU, ranked 5th on average during the period 2010–2020. In 2015 and 2017, they ranked 1st, while in 2020, they ranked 2nd.

It is important to note that this study has limitations, as it focuses solely on the economic dimension of sustainability. In the future, once the FADN database is complemented with additional sustainability indicators and converted into the Farm Sustainability Data Network, it will be possible to conduct a study encompassing all dimensions of sustainability.

Future research could also expand this scoring tool by broadening the scale of assessment. This could involve integrating farm-level assessments with those of other stakeholders in the sector chain, combining micro- and macro-level data analysis, and examining the entire cereal supply chain perspective.

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Annex A.

Table A1. Normalized values of SECI components in average cereal farms in selected EU countries (2010–2020)

EU MS	GM	TC	Y	P	EI	WI	NI	IC	FNI
2010									
Bulgaria	0.27	0.99	0.03	0.00	0.53	1.00	–	0.51	0.14
Czechia	0.12	0.69	0.31	0.16	0.40	1.00	–	0.22	0.00
Denmark	0.71	0.00	0.82	0.55	0.87	1.00	–	0.45	0.95
Germany	0.78	0.20	1.00	0.54	0.67	1.00	–	0.65	0.56
Spain	0.37	0.99	0.03	0.49	0.76	0.00	–	0.03	0.42
France	1.00	0.31	0.99	0.55	1.00	1.00	–	0.18	1.00
Italy	0.92	0.39	0.59	1.00	0.40	0.75	–	0.00	0.30
Latvia	0.00	0.80	0.05	0.35	0.17	1.00	–	0.41	0.17
Lithuania	0.35	0.88	0.15	0.35	0.58	1.00	–	0.78	0.35
Hungary	0.08	0.89	0.00	0.28	0.00	0.97	–	0.12	0.21
Poland	0.60	0.72	0.45	0.55	0.59	1.00	–	0.43	0.12
Romania	0.18	1.00	0.01	0.08	0.67	0.98	–	0.14	0.18
Sweden	0.08	0.44	0.49	0.33	0.17	1.00	–	1.00	0.50
2011									
Bulgaria	0.41	0.89	0.16	0.00	0.52	1.00	–	1.00	0.00
Czechia	0.36	0.53	0.56	0.23	0.43	1.00	–	0.49	0.11
Denmark	0.77	0.00	0.88	0.36	0.81	1.00	–	0.91	1.00
Germany	0.77	0.15	0.95	0.57	0.62	1.00	–	0.62	0.28
Spain	0.49	1.00	0.08	0.47	0.74	0.00	–	0.23	0.26
France	1.00	0.32	1.00	0.41	1.00	1.00	–	0.27	0.65
Italy	0.91	0.21	0.66	1.00	0.00	0.83	–	0.00	0.12
Latvia	0.00	0.78	0.00	0.43	0.28	1.00	–	0.70	0.07
Lithuania	0.42	0.87	0.15	0.50	0.54	1.00	–	0.92	0.20
Hungary	0.41	0.87	0.21	0.36	0.12	1.00	–	0.49	0.29
Poland	0.67	0.63	0.55	0.50	0.54	1.00	–	0.35	0.02
Romania	0.32	0.98	0.12	0.02	0.66	0.98	–	0.41	0.11
Sweden	0.41	0.36	0.54	0.57	0.23	1.00	–	0.67	0.37
2012									
Bulgaria	0.16	0.81	0.12	0.14	0.45	1.00	–	0.61	0.00
Czechia	0.08	0.60	0.35	0.12	0.42	1.00	–	0.41	0.08
Denmark	1.00	0.00	0.96	0.59	0.84	1.00	–	0.45	1.00
Germany	0.84	0.17	0.94	0.76	0.70	1.00	–	0.49	0.41
Spain	0.00	0.90	0.00	0.63	0.48	0.00	–	0.00	0.12
France	0.87	0.26	1.00	0.35	1.00	0.99	–	0.15	0.45
Italy	0.61	0.37	0.57	1.00	0.00	0.89	–	0.03	0.05
Latvia	0.20	0.70	0.39	0.01	0.48	1.00	–	0.75	0.13
Lithuania	0.53	0.80	0.52	0.00	0.68	1.00	–	0.53	0.15
Hungary	0.05	0.95	0.07	0.15	0.20	1.00	–	0.26	0.16
Poland	0.45	0.70	0.45	0.50	0.54	1.00	–	1.00	0.05
Romania	0.10	1.00	0.02	0.12	0.62	0.97	–	0.06	0.03
Sweden	0.19	0.17	0.70	0.34	0.17	1.00	–	0.14	0.22
2013									
Bulgaria	0.17	0.79	0.14	0.10	0.55	1.00	–	0.80	0.00
Czechia	0.20	0.67	0.38	0.21	0.51	1.00	–	0.74	0.13

Table A1. Continued

EU MS	GM	TC	Y	P	EI	WI	NI	IC	FNI
Denmark	0.61	0.11	0.80	0.36	0.98	1.00	–	0.83	1.00
Germany	1.00	0.19	1.00	0.46	0.80	1.00	–	0.71	0.35
Spain	0.00	0.91	0.00	0.40	0.60	0.00	–	0.10	0.13
France	0.48	0.16	0.86	0.38	1.00	1.00	–	0.23	0.10
Italy	0.51	0.44	0.43	0.85	0.16	0.76	–	0.00	0.07
Latvia	0.05	0.75	0.13	0.50	0.47	1.00	–	1.00	0.02
Lithuania	0.32	0.77	0.31	0.36	0.71	1.00	–	0.68	0.08
Hungary	0.07	0.90	0.23	0.00	0.36	1.00	–	0.54	0.16
Poland	0.30	0.67	0.44	0.28	0.63	1.00	–	0.35	0.01
Romania	0.17	1.00	0.08	0.10	0.72	0.97	–	0.24	0.04
Sweden	0.16	0.00	0.53	1.00	0.00	1.00	–	0.41	0.05
2014									
Bulgaria	0.39	0.85	0.18	0.06	0.43	1.00	0.29	0.84	0.05
Czechia	0.56	0.58	0.61	0.08	0.51	1.00	0.00	0.91	0.64
Denmark	0.65	0.02	0.84	0.10	0.96	1.00	0.88	0.00	0.61
Germany	1.00	0.00	1.00	0.43	0.73	1.00	0.36	0.85	1.00
Spain	0.00	0.98	0.00	0.30	0.40	0.00	0.62	0.01	0.29
France	0.60	0.04	0.87	0.25	1.00	1.00	0.30	0.32	0.35
Italy	0.65	0.57	0.44	1.00	0.00	0.83	1.00	0.26	0.76
Latvia	0.00	0.73	0.20	0.24	0.24	1.00	0.17	1.00	0.06
Lithuania	0.52	0.75	0.43	0.19	0.60	1.00	0.32	0.47	0.29
Hungary	0.32	1.00	0.25	0.01	0.14	1.00	0.59	0.81	0.74
Poland	0.66	0.62	0.61	0.16	0.62	1.00	0.05	0.32	0.14
Romania	0.30	1.00	0.18	0.00	0.42	1.00	0.41	0.47	0.22
Sweden	0.35	0.03	0.73	0.41	0.06	1.00	0.42	0.72	0.00
2015									
Bulgaria	0.38	0.78	0.20	0.04	0.34	1.00	0.28	0.84	0.00
Czechia	0.44	0.53	0.59	0.07	0.49	1.00	0.00	0.46	0.34
Denmark	0.77	0.00	0.96	0.00	0.95	1.00	0.80	0.29	1.00
Germany	0.92	0.12	1.00	0.24	0.73	1.00	0.35	0.61	0.63
Spain	0.00	0.98	0.00	0.52	0.35	0.00	0.61	0.00	0.53
France	0.67	0.11	1.00	0.11	1.00	0.99	0.30	0.24	0.43
Italy	0.93	0.64	0.46	1.00	0.00	0.93	1.00	0.19	0.75
Latvia	0.42	0.71	0.48	0.06	0.65	1.00	0.15	1.00	0.52
Lithuania	1.00	0.74	0.60	0.22	0.82	1.00	0.43	0.65	0.48
Hungary	0.34	0.87	0.35	0.06	0.15	1.00	0.53	0.91	0.69
Poland	0.72	0.60	0.64	0.20	0.61	1.00	0.08	0.17	0.00
Romania	0.41	1.00	0.19	0.03	0.33	1.00	0.40	0.24	0.09
Sweden	0.18	0.14	0.85	0.04	0.21	1.00	0.42	0.43	0.10
2016									
Bulgaria	0.56	0.81	0.16	0.11	0.54	1.00	0.47	0.40	0.54
Czechia	0.47	0.61	0.60	0.07	0.51	1.00	0.24	0.51	0.75
Denmark	0.29	0.00	0.76	0.25	0.87	1.00	0.72	0.00	0.00
Germany	0.90	0.10	1.00	0.44	0.72	1.00	0.52	0.58	0.81
Spain	0.45	1.00	0.00	0.47	0.46	0.00	0.73	0.39	0.94
France	0.00	0.39	0.35	0.34	1.00	1.00	0.48	0.24	0.36
Italy	1.00	0.59	0.48	1.00	0.11	0.97	1.00	0.09	0.98

Table A1. Continued

EU MS	GM	TC	Y	P	EI	WI	NI	IC	FNI
Latvia	0.33	0.74	0.25	0.28	0.61	1.00	0.31	0.84	0.69
Lithuania	0.35	0.78	0.34	0.03	0.88	1.00	0.00	0.64	0.61
Hungary	0.61	0.99	0.36	0.00	0.49	1.00	0.71	0.65	1.00
Poland	0.49	0.70	0.43	0.24	0.62	1.00	0.17	0.12	0.57
Romania	0.60	0.96	0.18	0.21	0.47	1.00	0.56	0.52	0.68
Sweden	0.21	0.24	0.62	0.40	0.00	1.00	0.57	1.00	0.49
2017									
Bulgaria	0.78	0.67	0.45	0.02	0.56	1.00	0.34	0.59	0.06
Czechia	0.04	0.56	0.47	0.14	0.12	1.00	0.00	0.62	0.14
Denmark	1.00	0.00	1.00	0.23	0.84	1.00	0.81	0.00	0.14
Germany	0.76	0.17	0.90	0.28	0.50	1.00	0.41	0.56	0.63
Spain	0.00	1.00	0.00	0.55	0.03	0.00	0.66	0.51	0.80
France	0.49	0.34	0.81	0.15	1.00	1.00	0.35	0.36	0.80
Italy	0.93	0.48	0.55	1.00	0.02	0.96	1.00	0.29	0.90
Latvia	0.23	0.70	0.36	0.21	0.42	1.00	0.11	1.00	0.51
Lithuania	0.80	0.71	0.55	0.18	0.72	1.00	0.01	0.84	0.51
Hungary	0.38	0.88	0.39	0.03	0.19	1.00	0.62	0.63	1.00
Poland	0.54	0.62	0.56	0.25	0.44	1.00	0.16	0.30	0.00
Romania	0.72	0.95	0.37	0.00	0.51	1.00	0.46	0.51	0.38
Sweden	0.07	0.33	0.74	0.06	0.00	1.00	0.49	0.43	0.46
2018									
Bulgaria	0.76	0.76	0.33	0.22	0.73	1.00	0.66	0.61	0.58
Czechia	0.27	0.58	0.48	0.33	0.51	1.00	0.48	0.62	0.69
Denmark	0.76	0.00	0.78	0.81	0.81	1.00	0.88	0.00	0.00
Germany	0.72	0.18	0.88	0.62	0.68	1.00	0.71	0.86	0.76
Spain	0.33	0.98	0.00	0.54	0.77	0.00	0.92	0.24	0.93
France	0.73	0.24	1.00	0.55	1.00	0.99	0.69	0.37	0.90
Italy	1.00	0.61	0.54	1.00	0.45	0.91	1.00	1.00	0.93
Latvia	0.00	0.65	0.06	0.71	0.39	1.00	0.47	0.96	0.51
Lithuania	0.37	0.70	0.28	0.54	0.64	1.00	0.27	0.69	0.55
Hungary	0.45	0.88	0.39	0.13	0.43	1.00	0.83	0.77	1.00
Poland	0.55	0.64	0.50	0.53	0.61	1.00	0.56	0.17	0.53
Romania	0.63	1.00	0.32	0.00	0.76	1.00	0.00	0.56	0.95
Sweden	0.00	0.50	0.21	0.67	0.00	1.00	0.62	0.51	0.53
2019									
Bulgaria	0.45	0.72	0.34	0.14	0.55	1.00	0.67	0.79	0.05
Czechia	0.01	0.52	0.45	0.30	0.26	1.00	0.57	0.55	0.28
Denmark	1.00	0.00	1.00	0.28	1.00	1.00	0.93	0.34	0.29
Germany	0.45	0.06	0.82	0.44	0.56	1.00	0.78	0.68	0.57
Spain	0.00	1.00	0.00	0.64	0.46	0.00	0.89	0.00	0.68
France	0.33	0.08	0.93	0.34	0.97	1.00	0.73	0.41	0.61
Italy	0.77	0.63	0.42	1.00	0.14	0.94	1.00	0.24	0.79
Latvia	0.15	0.67	0.35	0.35	0.54	1.00	0.59	0.81	0.39
Lithuania	0.31	0.75	0.34	0.42	0.57	1.00	0.37	0.37	0.26
Hungary	0.36	0.94	0.37	0.17	0.18	1.00	0.84	1.00	0.89
Poland	0.31	0.63	0.53	0.30	0.48	1.00	0.55	0.07	0.00
Romania	0.32	1.00	0.28	0.00	0.52	1.00	0.00	0.57	0.61

Table A1. Continued

EU MS	GM	TC	Y	P	EI	WI	NI	IC	FNI
Sweden	0.19	0.24	0.88	0.07	0.00	1.00	0.79	0.47	1.00
2020									
Bulgaria	0.19	0.80	0.09	0.22	0.32	1.00	0.68	0.40	0.00
Czechia	0.13	0.54	0.51	0.03	0.31	1.00	0.72	0.38	0.30
Denmark	1.00	0.00	1.00	0.36	1.00	1.00	0.94	0.23	1.00
Germany	0.69	0.05	0.87	0.53	0.58	1.00	0.83	0.54	0.47
Spain	0.30	0.89	0.12	0.71	0.63	0.00	0.96	0.15	0.51
France	0.36	0.12	0.75	0.55	0.91	1.00	0.75	0.39	0.32
Italy	0.77	0.57	0.50	1.00	0.00	0.91	1.00	0.00	0.59
Latvia	0.43	0.57	0.49	0.34	0.70	1.00	0.70	0.52	0.36
Lithuania	0.96	0.70	0.65	0.33	0.93	1.00	0.65	0.56	0.51
Hungary	0.34	0.88	0.38	0.00	0.13	1.00	0.89	0.54	0.73
Poland	0.55	0.59	0.59	0.34	0.53	1.00	0.72	0.25	0.05
Romania	0.00	1.00	0.00	0.03	0.25	1.00	0.00	0.44	0.20
Sweden	0.14	0.10	0.78	0.34	0.06	1.00	0.86	1.00	0.39

Source: Author calculations on FADN data.

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