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SUSTAINABILITY OF FARMS OF VARIOUS PRODUCTION TYPES: ECONOMIC AND ENVIRONMENTAL ASSESSMENT – EVIDENCE FROM POLAND AND LITHUANIA

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ABSTRACT: A farm plays the role of both a custodian of natural resources and a workplace. They are responsible for the quality of food produced and, on the other hand, for the standard of living of the farming family and the quality of the environment. The aim of the study is to examine the relationships between ecological and economic indicators at the farm level of various production types in Poland and Lithuania. The research covered farms participating in the FADN for the years 2015-2022. The results obtained from the analysis showed interdependencies between the parameters studied. Milk farms successfully implemented the economic goal, which is usually associated with a high environmental impact of production factors. In fieldcrops farms, degradation of organic matter and lack of ability to reproduce assets were observed. Differences between Lithuanian and Polish farms are visible in the economic and ecological results. Traditionally formed property rights cause Polish farmers to take measures to protect agricultural land economic goals. The situation was different in Lithuanian farms. They were mainly described by economic indicators. This can be explained by the fact that Lithuanian farms are still at the stage of organising themselves and care more about economic effects, but they have difficulties in implementing environmental requirements.

KEYWORDS: farm, income, organic matter, sustainability

Introduction

Agriculture is strongly linked to the natural environment. Modern technologies ensure high technical and economic efficiency of agricultural production, but at the same time, they strongly interfere with the environment. The growing world population, and therefore the increased demand for food, puts pressure on the rising volume of agricultural production. With current technologies, obtaining greater production is possible. However, increasing the size of production has limitations due to environmental requirements. The environmental effects of the agri-food system are multifaceted and wide-ranging. The negative ones include primarily greenhouse gas (GHG) emissions, loss of biodiversity and deterioration of water and soil quality (Testa et al., 2022). GHG emissions are the cause of climate change (Emmerling et al., 2020; Tongwane&Moeletsi, 2018). In 2019, agriculture in Poland was responsible for 8.4% of GHG emissions (Ministerstwo Klimatu I Środowiska, 2021). In the EU-28, this was 10% of total carbon dioxide emissions (Solazo et al.,2016). It is essential to take action to reduce the risk of irreversible impacts of climate change. This is a huge challenge, given that the earth responds to increased GHG emissions long after emissions have been reduced (Kancelaria Senatu, 2020).

The fight against limiting the negative impact of agricultural production on the environment is a priority for the EU. The document called the European Green Deal (EGD) assumes climate neutrality will be achieved by 2050. One of the pillars of the EGD refers to the production of safe food using sustainable practices (Vanham & Leip, 2020; Taning et al., 2021; Riccaboni et al., 2021). It includes a "Farm to Fork" strategy, which envisages the allocation of at least 25% of arable land for organic farming by 2030 (Purnhagen et al., 2021). The basic link in the food chain is the farm, which is responsible for the production of healthy food. Agricultural production is a source of GHG emissions. Therefore, changes in production technology must be made to reduce these emissions. Hence, efforts are being made, among others, to reduce the level of use of mineral fertilisers and pesticides.

A low-emission economy is a chance to improve the quality of the natural environment and economic prosperity (Gao et al., 2018). This is in line with the concept of sustainable development, which considers ecological, economic and social aspects. Combining these three aspects is a big challenge. A farm plays the role of both a custodian of natural resources and a workplace. It is responsible for the quality of the food produced and, on the other hand, for the standard of living of the farm family. Regardless of how high the ecological awareness of the farmer is, the economic aspect always remains in the background. Therefore, interdisciplinary research is important, seeking answers to the question of how to combine economic goals with ecological goals in agriculture. Research on this topic has already been undertaken, and their results are ambiguous (Zafeiriou et al., 2018; Khan et al., 2018).

The aim of the study is to examine the relationship between ecological and economic indicators at the level of a farm of different production types in Poland and Lithuania. The choice of two neighbouring countries seems to be justified because, as studies show, agro-environmental practices and the economic situation of farms are regionally diversified (Cortignani & Dono, 2019; Wu et al., 2019; Sieczko & Kołoszko-Chomentowska, 2023). In addition, farmers in both countries use similar farm support instruments. Therefore, the comparative analysis is also relevant from the point of view of the effectiveness of these instruments in supporting sustainable development.

The presented study expands knowledge on the impact of farms on the natural environment depending on the direction of production and region.

Methodology

The model was developed based on data from farms in the FADN system [FADN]. The database is unified and allows for the comparison of results from different EU countries. The collected data are used for economic and environmental analyses (Wilk, 2007; Piekut&Machnacki, 2011; Syp & Osuch, 2017; Koloszko-Chomentowska et al., 2021; Sieczko & Kołoszko-Chomentowska,2023). Various indicators are used to assess ecological balance, and their selection depends on the availability of data (Castoldi & Bechini, 2010; Belanger et al., 2015; Escribano et al.,2014; Paracchini et al.,2015; Prus, 2017; Harasim,2013). Based on FADN data, only some environmental indicators can be calculated. For the purposes of achieving the research objective, the following agroecological indicators were

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adopted: animal density (LU·ha^{-1}), soil organic matter balance (t·ha^{-1}) and the consumption of mineral fertilisers and plant protection products (PLN·ha^{-1}).

The indicator of the costs of mineral fertilisers and plant protection products can have limited application in evaluating the sustainability of farms. However, it may have diagnostic value and serve as a criterion for trend evaluation (Sobczyński, 2008).

Livestock density is an indicator of the organisation of animal production from the perspective of mineral fertiliser use. Organic matter is of significant importance in shaping the fertility of soils. The balance of soil organic matter was estimated based on organic matter degradation and reproduction coefficient (after Harasim, 2013). The value of the indicator signifies how many tons of dry organic mass is lost (-) or gained (+) annually per 1 ha of soil under theinfluence of a specific species or group of plants, depending on soil type. Coefficients for average soils were adopted for analysis purposes.

The following indicators were applied for evaluation of the economic situation of agricultural holdings: net value added (PLN AWU^{-1}), family farm income per 1 ha of farmland (PLN), financial surplus (PLN) and rate of property reproduction (%). Farms' capabilities of self-financing development are evaluated based on the financial surplus (Sobczyński, 2008). It is the sum of family farm income and depreciation.

The surplus was calculated in two variants: surplus I account for subsidies to farms, and surplus II – is corrected by subsidies from public funds under the Common Agricultural Policy.

To determine the prospects of farms' operation, the fixed assets reproduction rate was calculated. This is one of the methods of evaluating the reproduction of fixed assets and the development of farms. This indicator was calculated according to the formula: *(net investments/fixed assets) ×100%*, which, according to FADN, takes the form of (SE521/SE441)x 100%. It informs of the type of reproduction occurring on the farm (expanded, simple, narrow). According to the authors, the assessment of farm development opportunities is important for the future of agriculture. Data comes from the years 2015-2022. Fieldcrops and milk farms from Lithuania and Poland were taken into account in analyses.

In order to examine the behaviour of the fieldcrops and milk farm holdersin Poland and Lithuania and whether they consider the same economic and ecological issues at the farm level, we employed Principal Component Analysis (PCA) widely used in agricultural research for data analysis (Koloszko-Chomentowska et al., 2021; Lamichhane et al., 2021; Salata & Grillenzoni,2021; Coppola et al., 2022; Sieczko&Kołoszko-Chomentowska, 2023). PCA enablesto reduce the dimensions of the data set while preserving the most important information describing the original data set by identifying a set of orthogonal axes – principal components – that capture the maximum variance in the dataset (Nanga et al., 2021; Salata & Grillenzoni, 2021). PCA analysis was carried out using the computer package RStudio version, 4.3.1starting with the standardisation procedure, followed by calculation of the covariance matrix of the data, then decomposing the covariance matrix into the eigenvalues and eigenvectors to identify principal components. For our further analysis, we use two principal components with the highest eigenvalues.

Results

Income from a family farm is an important economic category. It is treated as remuneration for the work of the farmer and his family, as well as for the risk associated with the involvement of one's own production factors. In terms of the income achieved, Polish farms stand out, especially farms specialising in milk production (Table 1). They achieve more than twice as much income (per agricultural area) as fieldcrop farms. Despite the differences between the groups, the level of income increased significantly in both groups during the research period. This had an impact on the development possibilities of the farms, which is reflected in the financial surplus. In both groups of farms, the value of the financial surplus (I and II) was positive. However, it should be added that the financial surplus II (without subsidies) should cover at least the labour costs. This was indeed the case in milk farms, with the exception of 2018–2019. This means that the farms were able to finance their development without external support. In fieldcrop farms, the situation was different. Financial surplus II was not even enough to cover the costs of the farmer's own and his family's labour. There were even fewer funds for investments, as evidenced by the negative rate of reproduction of fixed assets.

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In the case of Lithuanian farms, higher income per 1 ha was achieved by milk farms than by field farms, and the difference was about 27%. On the other hand, the value of financial surplus II was higher in fieldcrops farms. This situation can be explained by the fact that depreciation is a component of the financial surplus, and in these farms, the value of depreciation was much higher than in milk farms. This is the result of better equipping fieldcrops farms with fixed assets (the value of fixed assets was twice as high as in milk farms). Hence, the financial surplus with subsidies exceeded the costs of own labour. The same situation was observed in milk farms.

The financial surplus indicates the development possibilities of farms and is usually analysed together with the rate of reproduction of fixed assets. In the case of Lithuanian farms, in both types of farms this indicator was positive. The negative value of the rate of reproduction of fixed assets (fieldcrops in Poland) indicates that in the analysed period, the investments made did not cover the loss of value of assets due to their exploitation. It can, therefore, be assumed that, most likely, at least part of the surplus was intended for consumption purposes. In general, in all farms in Lithuania and Poland, the value of the financial surplus showed an upward trend. It should be mentioned that the financial surplus has only an informational (theoretical) value. Therefore, the development possibilities of farms could be greateras in reality, its purpose depends on the individual decision of the farmer.

One of the ecological indicators is the stocking density. The farms studied differed significantly in terms of this attribute. The lower stocking density was characteristic of fieldcrop farms (0.21 LU·ha^{-1} in Poland and 0.36 LU·ha^{-1} in Lithuania). In the case of milk farms, the stocking density was very diverse, from 0.71 LU·ha^{-1} in Lithuania to 1.91 LU·ha^{-1} in Poland. This is related to the scale of production. At the same time, a positive balance of soil organic matter was monitored in all the farms. In Lithuanian farms, it amounted to 0.15 t·ha^{-1}, while in Polish farms, it was 1.25 t·ha^{-1}. Polish farms, due to their large herd of animals, have large resources of natural fertilisers, which is why the balance of soil organic matter is higher.

In fieldcrops farms, a negative balance of soil organic matter was recorded, which amounted to (-) 0.26 t·ha^{-1} in Lithuania and (-) 0.33 t·ha^{-1} in Poland. This means that the amount of plant material used (as green manure) was insufficient to cover the losses of organic matter caused by plant cultivation. This is confirmed by the results of research by other authors (Kopiński & Witorożec, 2022; Kopiński & Wach, 2023). Farms achieving high economic results burden the environment, as evidenced by the consumption of mineral fertilisers and plant protection products. Particularly high consumption of these products is visible in milk farms. In Polish farms, this consumption was more than three times higher (Table 1). Lithuanian farms used technologies that were more economical in the use of production means.

Table 1. Mean values of variables along with standard deviation (SD) and standard error of the mean (SEM)

Specification	Fieldcrops			Milk		
	Mean	SD	SEM	Mean	SD	SEM
Poland						
Economic indicators						
X1- Utilised agricultural area (ha)	22.37	0.616	0.218	22.84	1.258	0.445
X2- Farm Net Value Added (EUR AWU-1)	9225	4111	1454	13429	6033	2133
X3- Family Farm Income (EUR·ha-1)	440	222	78.60	1001	468	166
X4- Financial surplus I (EUR)	14342	4845	1713	29542	11356	4015
X5- Financial surplus II (EUR)	7856	4369	1545	20938	10427	3687
X6- The rate of re-investment of assets (%)	-0.71	0.489	0.173	0.02	0.604	0.214
X7- Total fixed assets (EUR·ha-1)	7386	564	199	10149	743	263
Ecological indicators						
Y1- Stocking density(LU·ha-1)	0.21	0.027	0.010	1.91	0.082	0.029
Y2- Fertilizers and crop protection (EUR·ha-1)	272	67.00	23.69	170	63.18	22.34
Y3- Soil organic matter balance (t ·farm-1)	-7.51	0.379	0.134	28.65	2.659	0.940

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Specification	Fieldcrops			Milk		
	Mean	SD	SEM	Mean	SD	SEM
Lithuania						
Economic indicators						
X1- Utilised agricultural area (ha)	71.98	4.583	1.620	31.40	2.955	1.045
X2- Farm Net Value Added (EUR ·AWU-1)	17708	8817	3117	8666	5114	1808
X3- Family Farm Income (EUR·ha-1)	312	177	62.46	398	164	57.90
X4- Financial surplus I (EUR)	33543	10800	3818	20460	7182	2539
X5- Financial surplus II (EUR)	17649	12566	4443	10830	5797	2049
X6- The rate of re-investment of assets (%)	4.91	2.498	0.883	4.00	1.480	0.523
X7 – Total fixed assets (EUR·ha-1)	1820	391	138	2193	136	48
Ecological indicators						
Y1- Stocking density(LU·ha-1)	0.36	0.057	0.020	0.71	0.044	0.016
Y2- Fertilizers and crop protection (EUR·ha-1)	251	54.25	19.18	50	16.89	5.97
Y3- Soil organic matter balance (t farm-1)	-18.63	1.162	0.411	4.57	0.919	0.325

Source: authors' work based on European Commission (n.d.).

Despite the fact that we analysed the farms of neighbouring countries, the results revealed large differences between them. Both crop and dairy farms appeared to be very different in Lithuania and Poland.As can be seen from Figure 1, the economic indicator "Total fixed assets" (X7) and ecological indicator "Soil organic matter balance" (Y3) are more strongly expressed in fieldcrops farms in Poland – "Utilised agricultural area" (X1) and "The rate of re-investment of assets" (X6)– mainly describe Lithuanian farms.

As a result of PCA analysis, two principal components were distinguished for both countries. The first one accounts for 55.1% of the variability and is mostly determined by these indicators: "Soil organic matter balance" (Y3), "Financial surplus I" (X4) and "Utilised agricultural area" (X1). The second component accounts for 36.7% of the variability and is mostly determined by these indicators: "Family Farm Income" (X3), "Farm Net Value Added" (X2) and "Stocking Density" (Y1).

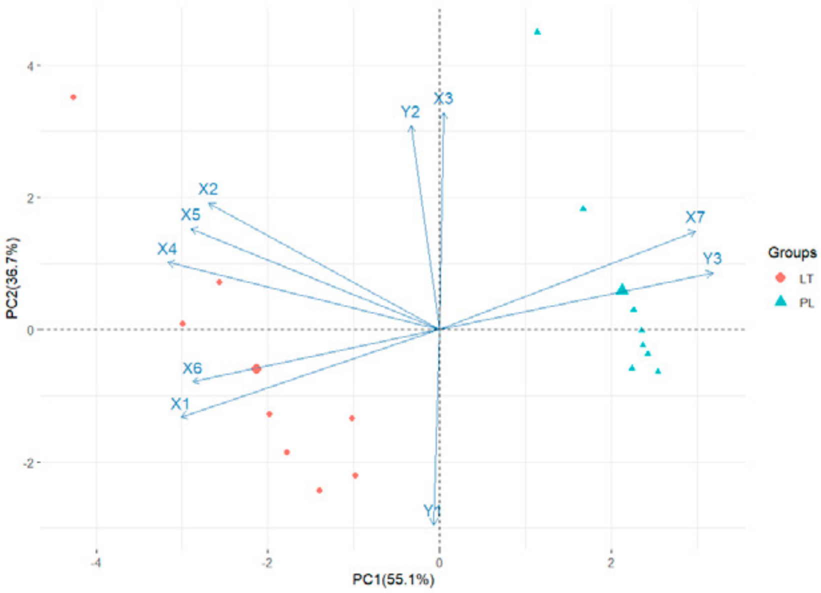

Figure 1. Indicators describing Lithuanian and Polish farms with field crop production in 2015–2022 in the space of the first two components, PC1 and PC2

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Analysing milk farms, we can see similarities with field crop farms, but there are also differences (Figure 2). Milk farms, as well as field crop farms in Poland, are focused on the economic indicator "Total fixed assets" (X7) and ecological indicator "Soil organic matter balance" (Y3). Additionally, milk farms in Poland consider the ecological indicator "Stocking density" (Y1). Milk farms in Lithuania consider the same economic indicators as field crop farms – "Utilised agricultural area" (X1) and "The rate of re-investment of assets" (X6), but do not consider any ecological indicator.

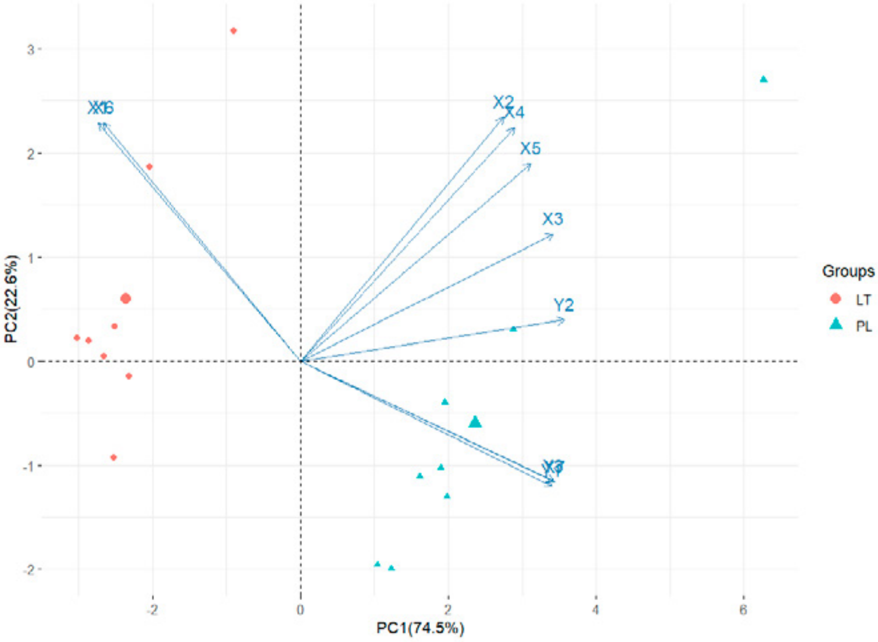

Figure 2. Indicators describing Lithuanian and Polish farms with field milk production in 2015–2022 in the space of the first two components, PC1 and PC2

In the case of dairy farms, two main components were distinguished (Figure 2). The first one accounts for 74.5% of the variability and is mostly determined by these indicators: "Fertilizers and crop protection" (Y2), "Total fixed assets" (X7) and "Soil organic matter balance" (Y3).

The second component accounts for 22.6% of the variability and is mostly determined by these indicators: "Farm Net Value Added" (X2), "Utilised agricultural area" (X1) and "The rate of re-investment of assets" (X6).

Dairy farms in Lithuania are extensive, so milk producers pay less attention to environmental indicators. In EU countries, dairy farms that develop intensive production are usually more likely to face ecological problems. These are countries such as the Netherlands, Denmark, Ireland and Belgium, which are dominated by large, intensive specialized dairy farms with the highest milk production per hectare of forage area and the highest number of cows per AWU. Such farms are economically efficient but face difficulties in implementing environmental requirements (especially N and P limits per hectare).

Conclusions

Reducing the negative impact of agricultural production on the environment is an important goal and a necessity to mitigate climate change. Promoting the benefits of using environmentally friendly practices will help to achieve both economic and ecological goals. Methods of GHG emission from animal production include the use of a high-starch diet, exogenous enzymes, or supplementation with fats. Increasing the milk yield of cows leads to a reduction in methane emissions per agricultural production unit. In this way, economic and ecological goals are achieved. Agriculture requires innovative technologies to reduce emissions without reducing productivity. Above all, good agricultural practices are important, including breeding progress and effective fertiliser management.

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Ecological indicators allow to assess the implementation of environmental objectives, which is a necessary condition for achieving production and economic objectives with respect for nature. The results of this study indicate that farms specialising in milk production achieve higher economic effects. A high level of economic indicators value is usually associated with a high burden of production means on the environment. This happens in farms using high-input technologies. In addition, there is a high concentration of animals here. The stocking density is associated with environmental restrictions, primarily concerning potential threats resulting from the agricultural disposal of animal manure. The average stocking density did not pose a threat to the natural environment because it did not exceed the permissible level of 1.5 LU·ha^{-1} (Duer et al., 2002). However, taking into account the diversity of farms in terms of herd size, it can be assumed that at the level of an individual farm, environmental requirements were not always observed. There are some concerns about dairy farms in Poland. The solution to the problem would be to reduce the number of animals in the herd while increasing production efficiency. This would allow for reconciling economic and ecological goals. In the case of fieldcrop farms, more intensive actions related to soil protection could be taken.

In the case of Lithuanian farms, actions are visible and aimed primarily at building production potential, while less attention is paid to ecological aspects.

We consider that traditionally formed property rights cause Polish farmers to take measures to protect agricultural land along side economic goals. The situation was different in the analysis of Lithuanian farms. They were mainly described by economic indicators. This can be explained by the fact that Lithuanian farms are still forming and seek to accumulate sufficient assets through reinvestment.

The authors are aware of the limitations of this study. The main limitations are insufficient data availability or the problem of determining the limit values of many indicators of the degree of equilibrium, especially for farms of different countries. Further research should be extended to other indicators, depending on the availability of data and other types of farms.

The contribution of the authors

Establishing the concept, Z.K.-C.; establishing research methods, Z.K.-C., A.G. and V.N.; literature review, Z.K.-C.; text creation, Z.K.-C.; analytical description of the phenomenon, Z.K.-C., A.G. and V.N.; critical evaluation, Z.K.-C.; data collection, Z.K.-C.; development of research results, Z.K.-C., A.G. and V.N.

References

Belanger, V., Vanasse, A., Parent, D., Allard, G., & Pellerin, D. (2015). Delta: an integrated indicato – based self-assessment tool for the evaluation of dairy farms sustainability in Quebec Canada. Agroecology and Sustainable Food Systems, 39(9), 1022-1046. https://doi.org/10.1080/21683565.2015.1069775

Castoldi, N., &Bechini, L. (2010). Intergated sustainability assesment of cropping systems with agro-ecological and economic indicators in northern Italy. European Journal of Agronomy, 32(1), 59-72. https://doi.org/10.1016/j.eja.2009.02.003

Coppola, A., Amato, M., Vistocco, D., & Verneau, F. (2022). Measuring the economic sustainability of Italian farms using FADN data. Agricultural Economics / Zemědělská Ekonomika, 68(9), 327-337.https://doi.org/10.17221/169/2022-AGRICECON

Cortignani, R., & Dono, G. (2019). CAP's environmental policy and land use in arable farms: An impacts assessment of greening practicieschanges in Italy. Science of The Total Environment, 647, 516-524. https://doi.org/10.1016/j.scitotenv.2018.07.443

Duer, I., Fotyma, M., & Madej, A. (2002). *Kodeks Dobrej Praktyki Rolniczej.*Warszawa: MRiRW-MŚ-FAPA. (in Polish).

Emmerling, Ch., Krein, A., & Junk, J. (2020). Meta-Analysis of Strategies to Reduce NH_3 Emissions from Slurries in European Agriculture and Consequences from Greenhouse Gas Emissions. Agronomy, 10(11), 1633. https://doi.org/10.3390/agronomy10111633

Escribano, A. J., Gaspar, J. P., Mesias, F. J. D., Moreno, A. F. P., & Escribano, M. (2014). A sustainability assesment of organic and conventional beef cattle farms in agroforestry system: the case of the „dehesa" rangelands. ITEA – InformacionTecnicaEconomicaAgraria, 110(4), 343-367.

European Commission. (n.d.). *FADN database.*https://agridata.ec.europa.eu/extensions/FarmEconomyFocus/FADNDatabase.html

Gao, J., Hou, H., Zhai, Y., Woodward, A., Vardoulakis, S., Kovats, S., Wilkinson, P., Li, L., Song, X., Xu, L., Meng, B., Liu, X., Wang, J., Zhao, J., & Liu, Q. (2018). Greenhouse gas emissions reduction in different economic sectors: Mitigation measures, health co-benefits, knowledge gaps and policy implications. EnvironmentalPollution, 240, 683-698. https://doi.org/10.1016/j.envpol.2018.05.011

Harasim, A. (2013). Metoda oceny zrównoważonego rozwoju rolnictwa na poziomie gospodarstwa rolnego. Studia i Raporty IUNG-PIB, 32(6), 25-75. https://iung.pl/wp-content/uploads/2009/10/zesz32.pdf (in Polish).

Kancelaria Senatu. (2020). *Emisja gazów cieplarnianych. Wybrane zagadnienia dotyczące emisji CO_2 w Polsce.* https://www.senat.gov.pl/gfx/senat/pl/senatopracowania/192/plik/ot-683.pdf (in Polish).

Khan, M. T., Ali, Q., &Ashfag, M. (2018). The nexus between greenhouse gas emission, electricity production, renewable energy and agriculture in Pakistan. Renewable Energy, 118, 437-451. https://doi.org/10.1016/j.renene.2017.11.043

Koloszko-Chomentowska, Z., Sieczko, L., & Trochimczuk, R. (2021). Production Profile of Farms and Methane and Nitrous Oxide Emissions. Energies, 14(16), 4904. https://doi.org/10.3390/en14164904

Kopiński, J., & Wach, D. (2023). Management of nutrients derived from natural fertilizers (manures) in the Polish agriculture – selected issues. Polish Joural of Agronomy, 52, 1-13. https://doi.org/10.26114/pja.iung.506.2023.52.01

Kopiński, J., &Witorożec, A. (2022). Assessment of soil organic matter management in Polish agriculture. Annals of the Polish Association of Agricultural and Agribusiness Economists, 24(2), 44-54. https://doi.org/10.5604/01.3001.0015.8593

Lamichhane, S., Eğilmez, G., Gedik, R., Bhutta, M. K. S., & Erenay, B. (2021). Benchmarking OECD countries' sustainable development performance: A goal-specific principal component analysis approach. Journal of Cleaner Production, 287, 125040.https://doi.org/10.1016/j.jclepro.2020.125040

Ministerstwo Klimatu i Środowiska. (2021). *Krajowy Raport Inwentaryzacyjny. Inwentaryzacja gazów cieplarnianych w Polsce dla lat 1988-2019*. https://www.kobize.pl/uploads/materialy/materialy_do_pobrania/krajowa_inwentaryzacja_emisji/NIR_2021_raport_syntetyczny_PL.pdf (in Polish).

Nanga, S., Bawah, A. T., Acquaye, B. A., Billa, M. I., Baeta, F. D., Odai, N. A., & Nsiah, A. D. (2021). Review of dimension reduction methods. Journal of Data Analysis and Information Processing, 9(3), 189-231. https://doi.org/10.4236/jdaip.2021.93013

Paracchini, M. L., Bulgheroni, C., Borreani, G.,Tabacco, E., Banterle, A., Bertoni, D., Rossi, G., Parolo, G., Origgi, R., & De Paola, C. (2015). A diagnostics system to assess sustainability at a farm level: The SOSTARE model. Agricultural Systems, 133, 35-53. https://doi.org/10.1016/j.agsy.2014.10.004

Piekut, K., & Machnacki, M. (2011). Ocena ekologiczno-ekonomiczna gospodarstw rolnych na podstawie danych FADN. Woda-Środowisko-Obszary Wiejskie, 11(1), 203-219. http://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech-article-BATC-0007-0013 (in Polish).

Prus, P. (2017). Sustainable farming production and its impact on the natural environment – case study based on a selected group of farms. *Proceedings of the International Scientific Conference Rural Development Bioeconomy Challenges,* 1280-1285. http://doi.org/10.15544/RD.2017.226

Purnhagen, K. P., Clemens, S., Eriksson, D., Fresco, L. O., Tosun, J., Qaim, M., Visser, R. G. F., Weber, A. P. M., Wesseler, J. H. H., & Zilberman, D. (2021). Europe's Farm to Fork Strategy and its Commitment to Biotechnology and Organic Farming: Conflictingor Complementary Goals? Trends in Plant Science, 26(6), 600-606. https://doi.org/10.1016/j.tplants.2021.03.012

Riccaboni, A., Neri, E., Trovarelli, F., & Pulselli, R. M. (2021). Sustainability-orientedresearch and innovation in „farm to fork" valuechains. Current Opinion in Food Science, 42, 102-112. https://doi.org/10.1016/j.cofs.2021.04.006

Salata, S., &Grillenzoni, C. (2021). A spatial evaluation of multifunctional Ecosystem Service networks using Principal Component Analysis: A case of study in Turin, Italy. Ecological Indicators, 127, 107758. https://doi.org/10.1016/j.ecolind.2021.107758

Sieczko, L., & Koloszko-Chomentowska, Z. (2023). Relationship between economic and ecological indicators and greenhouse gas emissions: The perspective of farms in Poland at the regional level. Economics and Environment, 86(3), 382-395. https://doi.org/10.34659/eis.2023.86.3.612

Sobczyński, T. (2008). Zmiany poziomu zrównoważonego gospodarstw rolnych UE w latach 1989-2005. Roczniki Naukowe Ekonomii Rolnictwa I Rozwoju Obszarów Wiejskich, 94(2), 106-114. https://doi.org/10.22630/RNR.2008.94.2.28 (in Polish).

Solazzo, R., Donati, M., Tomasi, L., & Arifini, F. (2016). How effective is greening Policy in reducing GHG emissions from agriculture? Evidence from Italy. Science of The Total Environment, 573, 1115-1124. https://doi.org/10.1016/j.scitotenv.2016.08.066

Syp, A., & Osuch, D. (2017). Szacowanie emisji gazów cieplarnianych na podstawie danych FADN. Studia i Raporty IUNG-PIB, 52(6), 69-82. http://www.iung.pl/sir/zeszyt52_6.pdf (in Polish).

Taning, C. N. T., Nezzetti, B., Kleter, G., Smagghe, G., & Baraldi, E. (2021). Does RNAi-Based Technology Fit within EU Sustainability Goals? Trends in Biotechnology, 39(7), 644-647. https://doi.org/10.1016/j.tibtech.2020.11.008

Testa, S., Nielsen, K. R., Vallentin, S., & Ciccullo, F. (2022). Sustainability-oriented innovation in the agri-food system: Current issues and the road ahead. Technological Forecastingand Social Change, 179, 121653. https://doi.org/10.1016/j.techfore.2022.121653

Tongwane, M. I., & Moeletsi, M. E. (2018). A review of greenhouse gas emissions from the agriculture sector in Africa. Agricultural Systems, 166, 124-134. https://doi.org/10.1016/j.agsy.2018.08.011

Vanham, D., & Leip, A. (2020). Sustainable food system policiesneed to addressenvironmentalpressures and impacts: The example of wateruse and waterstress. Science of The Total Environment, 730, 139151. https://doi.org/10.1016/j.scitotenv.2020.139151

Wilk, W. (2007). Wykorzystanie danych statystycznych i wyników rachunkowości rolnej do oceny wpływu rolnictwa na środowisko w ujęciu makro- i mikroekonomicznym. Studia i Raporty IUNG-PIB, 4, 59-67. https://doi.org/10.26114/sir.iung.2007.04.05 (in Polish).

Wu, H., Huang, H., Tang, J., Chen, W., & He, Y. (2019). Net greenhouse gas emissions from agriculture in China: estimation, spatial correlation and convergence. Sustainability, 11(18), 4817. https://doi.org/10.3390/su11184817

Zafeiriou, E., Mallidis, I., Galanopoulas, K., & Arabatzis, G. (2018). Greenhouse Gas Emissions and Economic Performance in EU Agriculture; An Empirical Study in a Non-Linear Framework. Sustainability, 10(11), 3837. https://doi.org/10.3390/su10113837

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ZRÓWNOWAŻONY ROZWÓJ GOSPODARSTW ROLNYCH O RÓŻNYM TYPIE PRODUKCJI: OCENA EKONOMICZNO-ŚRODOWISKOWA – PRZYKŁAD Z POLSKI I LITWY

STRESZCZENIE: Gospodarstwo rolne pełni rolę zarówno powiernika zasobów naturalnych jak i warsztatu pracy. Odpowiada za jakość produkowanej żywności, a z drugiej strony, za poziom życia rodziny rolniczej i jakość środowiska. Celem opracowania jest zbadanie zależności między wskaźnikami ekologicznymi i ekonomicznymi na poziomie gospodarstwa rolnego o różnym typie produkcyjnym w Polsce i Litwie. Badaniami objęto gospodarstwa rolne uczestniczące w FADN za lata 2015-2022. Uzyskane wyniki analizy wykazują współzależności między badanymi parametrami. Gospodarstwa typu bydło mleczne z powodzeniem realizują cel ekonomiczny, co na ogół wiąże się z dużym obiążeniem środowiska środkami produkcji. W gospodarstwach typu uprawy polowe zaobserwowano degradację materii organicznej i brak zdolności do reprodukcji aktywów trwałych. Tradycyjnie ukształtowane prawa własności sprawiają, że polscy rolnicy obok celów ekonomicznych podejmują działania związane z ochroną gruntów rolnych. Sytuacja była inna w litewskich gospodarstwach rolnych. Były one opisywane głównie przez wskaźniki ekonomiczne. Można to wyjaśnić faktem, że litewskie gospodarstwa rolne wciąż są na etapie organizowania się i dbają bardziej o efekty ekonomiczne, natomiast mają trudności z wdrażaniem wymogów środowiskowych.

SŁOWA KLUCZOWE: gospodarstwo rolne, dochód, materia organiczna, zrównoważenie