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Considering the development of organic farming in Poland at different territorial aggregation levels

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Abstract. The aim of this paper is to show and assess how the level of data aggregation can change the way the development of organic agriculture in Poland in 2014–2021 is perceived. A composite indicator of eco-farming at different levels of territorial aggregation and in different time horizons has been built taking into account sub-components and individual indicators. The performance of organic agriculture with the initial effects of the pandemic (for 2020–2021) was also quantified. The results showed that, in populationally larger territorial units (NUTS-1, NUTS-2, NUTS-3), organic farming characteristics are less variable, whereas the same characteristics show greater variability in smaller territorial units (LAU-1, LAU-2). This reflects the strong regional character of eco-agriculture. It can be observed especially in northern and south-eastern Poland. Moreover, although the highest performance of organic farming was observed in 2021, the effects of the pandemic crisis were highly heterogeneous by location. The results may be crucial for farmers and policymakers in planning sustainable agricultural strategies and building resilient organic regions.

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Contents:

1. Introduction

The newest European Union (EU) regulations (applied from 1 January 2022) define organic farming as a productive system providing for a specific market responding to consumer demand for organic products and delivering goods that contribute to the protection of the environment and animal welfare, as well as to sustainable rural development (EU, 2021). In Poland, organic farming was initiated in the mid-1980s – two decades before 2004 (Poland's accession to the EU) and the adoption of Community legislation governing the system of organic food production (PCOF, 2020).

Accession to the EU significantly strengthened the attractiveness of organic farming in Poland and resulted in a rapid increase in farms converting to organic lands. The percentage of total utilized agricultural area in 2003 was 0.2% in Poland (the EU-28 average being 5.9%), whereas by 2021 it had increased to 3.5% (the EU-28 average being 9.1%) (Eurostat, 2022). Although Polish organic farming experienced stagnation for several years, the number of producers is still above the EU-28 average. Among the EU countries, only Germany, Austria, Italy, Greece and Spain have more agricultural eco-producers. The development of organic farming is favored in Poland by agri-environmental activities and the considerable resources of arable land at its disposal (Stuczyński et al., 2007; Kociszewski, 2022). However, the progress results mainly from relevant and widely distributed subsidies (Wiśniewski et al., 2021). The main incentive has been the financial support of the Rural Development Programme (RDP) (ENRD, 2022). The payment rates for organic farming set by RDP 2014–2020 increased by an average of 30% in March 2021 (to a total of €106 million), although differently for each crop category. The funds allowed farmers to switch from conventional to organic land management (Kobylińska, 2021). Surprisingly, during the initial pandemic years (2020–2021), Polish organic farming registered an increase (of 7.5% on average in the number of farms and the area designated for "bio" cultivation). One of the reasons for the surge was the lockdown, which determined the need to prepare and consume meals at home. There was growing interest in high-quality, pro-health local products (Wojciechowska-Solis et al., 2022). The accelerating eco-agricultural development is also strongly fostered by the new EU Green Deal and Farm to Fork Strategy (EGD), aimed at linking knowledge with action or building a more sustainable, resilient and productive agriculture system (EC, 2019a).

Despite researchers regarding organic farming as a significant factor in development, few studies have taken a synthetic view at a relevant geographical scale and temporal horizon when assessing bio-agriculture (Ilbery & Maye, 2011; Popovici et al., 2021). Some literature identifies commonalities in sustainable trends in eco-agriculture (Mili & Martínez-Vega, 2019; Cataldo et al., 2020). Other studies either assess organic farming with the farm sustainability index based on survey data (Seidel et al., 2019) or employ various separate indicators (Blaće et al., 2020) in order to measure and model the trajectory of organic farming development. Polish studies investigate selected eco-agriculture conditions that affect organic farming efficiency (Stuczyński et al., 2007; Nachtman, 2015; Król, 2016), compare farming types (Podawca & Dąbkowski, 2020; Kociszewski, 2022) and assess the outlooks for development (Jezierska-Thole et al., 2017).

However, due to the subject's complexity, most analyses reported in the organic farming literature examine the subject at the regional level, identify common trends across many separate indicators (Makowska et al., 2015; Szarek & Nowogrodzka, 2015; Pawlewicz et al., 2020; Kobylińska, 2021) or focus only on the number of operators (omitting the surface of organically farmed area or volume of organic harvest) (Jarecki et al., 2020). Few researchers have investigated Polish eco-agriculture synthetically – that is, at various levels of data aggregation (Wiśniewski et al., 2021).

Moreover, the literature on COVID-19's effects on organic agriculture systems includes assessments of the magnitude and longevity of the pandemic. Some researchers observe that the crisis has led to a slowdown in agriculture and services (Aday & Aday, 2020). The pandemic has also changed the functioning of the entire food system, including in Poland (Zielińska-Chmielewska, 2021). Other researchers underline that the magnitude of the pandemic's effects on food systems will prevent them from functioning as they did prior to the pandemic (OECD, 2021). Researchers have also noted that the way Poland's food systems functioned during the pandemic revealed institutions' weaknesses in responding to environmental factors (Dudek & Śpiewak, 2022). But it is underlined that the crisis's effects create opportunities for transformative public policies that build sustainable food systems and innovations that can be maintained and developed further (Hobbs, 2020).

Considering organic farming's substantial contributions to Poland, policymakers, decision-makers, farmers, agricultural authorities and sustainable agricultural strategists must understand how eco-agriculture develops and which sectors affect its regionalization and spatial distribution. Research should therefore enable an improvement of the efficiency with which Polish organic farming's resources are managed, especially since the pandemic, when consumers became more conscious about health and environmental issues. However, such studies remain limited.

The purpose of this article is to show and assess how the level of territorial data aggregation (from local administrative units (LAU) to regional levels (NUTS)) can change how organic farming in Poland develops. Free open-access data from the Inspectorate of Agriculture and Food Quality (IAFQ) were obtained at the lowest possible territorial aggregation (LAU-2) for the years 2014–2021. Actual addresses of the physical location of organic farms are included in the IAFQ database. Based on this information, the indices were constructed and conceptually divided into four sub-groups: agricultural seeds and foodstuffs, plant harvest and crop yield, headage, organic products. This division improved the understanding of the driving forces behind Polish organic farming performance and development. Based on these indices, a composite dynamic measure of the development of organic farming in Poland (CMOF) was devised. The CMOF was calculated at different levels of data aggregation in order to show how the development process of organic farming differs across territorial units and how policy priorities can be better set. This study's methodology is based on the OECD's measure concepts (OECD, 2018), making it replicable in other systems and countries.

This background leads to the research questions:

1. Does analyzing different levels of territorial aggregation contribute to better setting of policy priorities and benchmarking or monitoring of organic farming performance?
2. Is the Polish organic farming sector strongly inter- and intra-territorially varied?
3. Despite the crisis caused by the COVID-19, was the increase in sustainable agriculture recorded in most Polish units for the period 2020–2021?

Providing the overall picture of the phenomena (at different levels of data aggregation) would appear to make it easier for the public to interpret results than would identifying common trends across many separate indicators.

2. Research materials and methods

In this study, various raw data from the IAFQ (IAFQ, 2022) and the Local Data Bank of the Statistics Poland (LDB, 2022) were used. The database was assembled for local administrative land areas (LAU units) and then aggregated to other, larger territorial land areas (NUTS units). The NUTS level for an administrative unit is determined on the basis of demographic thresholds defined by the European Parliament and the Council. The system of LAUs complements the NUTS classification. LAUs are the building blocks of NUTS and comprise the municipalities and communes of the European Union. The political, administrative and institutional situation of NUTS and LAUs also needs to be specified (EP, 2024). Based on the data, 25 indices were constructed for the period 2014–21. The timeframe of the analysis was narrowed down to the above years due to the uniform way databases are built and regularly updated at the local (LAUs) level, containing similar descriptions of organic farm features, unified production categories and the potential impact of support obtained from EU funds in the framework of the Rural Development Programme for the years 2014–2020 at the production level. These indicators are reconstructed and produced in accordance with the relevant literature about the measuring track progress toward organic farming (e.g., MacRae et al., 2007; Antczak, 2021, Popovici et al., 2021) and with proposals of organic agriculture policies (EC, 2019a). Based on a farming system typology (Andersen et al., 2007), subjective measures and qualitative assessment, the individual factors were classified into four sub-groups (Table 1). This diversity is a crucial issue in several studies related to agroecosystem and environmental management, policy implementation and rural development (Mądry et al., 2016). This classification also helps to reveal the existence of individual indicators' clusters and thus is useful in determining the nested structure of the composite measure.

The characteristics that make up the synthetic measure had to meet certain statistical and formal criteria (Kusideł & Antczak, 2014). Variables should be characterized by spatial variation and low correlation. In the analysis, differentiation was investigated using the modulus of coefficient of variation (CV) and the variables that meet the condition of $|CV|>10\%$ were considered (Pélabon et al., 2020). To eliminate the multi-collinearity problem, the Spearman's rank correlation was applied (Gauthier, 2001). To carry out tests of the

Table 1. Characteristics of organic farming in four subgroups (averaged over the years 2014–2021

Variables	Average	Is included in CMOF?
Group 1: Agricultural seeds and foodstuffs		
Fodder crops (maize, fodder beet, dicotyledonous, grass) [tons/hectare of organic area]	1.9	Yes
Harvest of crops from seed plantations [tons/hectare of organic area]	0.02	Yes
Group 2: Plant harvest and crop yield		
Yields of cereals (maize, oats, barley, rye, triticale, wheat) grown for grain (including seed) [kg/capita]	8.3	No
Dry bean harvest [kg/inhabitant]	1.4	Yes
Harvest of root crops (potatoes, sugar beet, and others) [kg/capita]	0.9	Yes
Harvest of industrial plants (hops, rape, colza, sunflower, soybean, flax, medicinal and spice plants) [kg/capita]	0.4	Yes
Harvest of vegetables (brassica, leaf, stem, onion, root, peas, beans, mushrooms) [kg/capita]	1.5	Yes
Harvest of strawberries and wild strawberries [kg/capita]	0.2	No
Harvest from fruit trees and shrubs (fruit and berry crops) [kg/capita]	3.3	Yes
Harvest from vineyards [kg/capita]	0.05	Yes
Harvest of flowers and ornamental plants [kg/1000 population]	0.003	Yes
Group 3: Headage		
Number of cattle kept for meat and milk [per 1000 population]	1.0	No
Number of pigs (fatteners, sows) [per 1000 population]	0.1	Yes
Sheep (ewes and others) [per 1000 population]	0.6	Yes
Headcount of goats (mothers and others) [per 1000 population]	0.1	Yes
Number of rabbits (female and other) [per 1000 population]	0.2	Yes
Poultry (broilers, chickens, ducks, turkeys, geese, ostriches) [per 1000 population]	11.2	Yes
Number of horses (equines) [per 1000 population]	0.03	Yes
Number of deer (noble and sika) and fallow deer [per 1000 population]	0.1	Yes
Group 4: Organic products		
Production of milk and cream [liters/capita]	0.9	Yes
Production of butter and cheese [kg/1000 population]	3.1	No
Egg production (including eggs for consumption) [number/capita]	1.8	Yes
Meat production [kg/1000 population]	0.7	No
Honey production [kg/1000 population]	1.7	Yes
Number of snails [kg/1000 population]	3.5	Yes

Source: own elaboration based on IAFQ and LSO data

significance of correlations between variables, the t-distribution formula for computing the appropriate t-value methods was employed (Kpolovie, 2011). In this case the entire database was resized by eliminating some of the variables that show higher collinearity. Although 25 indicators were preselected to measure and monitor the development of organic farming, only 20 of them met the statistical criteria for the aggregate measure (Table 1).

All the diagnostic variables were stimulants (Karpiński et al., 2015); therefore, to maintain individual indicators' comparability, the characteristics were normalized (1):

where z_{ijt} and x_{ijt} are, respectively, the normalized and observed values of the j^{th} variable in the t^{th} period for the i^{th} land unit (from LAU-2 to NUTS-1), maxi x_{ijt} and mini x_{ijt}, respectively, are the maximum and minimum value of the jth variable over the whole time span $t = 1,2,\dots, l$. The composite sub-measures

$$z_{ijt} = \frac{x_{ijt} - \min_i x_{ijt}}{\max_i x_{ijt} - \min_i x_{ijt}}, (i = 1,2, \dots,n); (j = 1,2, \dots,m); (t = 1,2, \dots,l)\ z_{ijt} \in [0,1], \quad (1)$$

in the period 2014–2021 for the four r sub-groups (Table 1) were built (2):

$$\overline{\text{CMOF}}_{itk} = \frac{\sum_{j=1}^{m_k} z_{ijt}}{m}, (k = 1, \ldots, \text{r}) \quad (2)$$

where: CMOF_{itk} — the value of the synthetic variable for the i^{th} land unit, calculated on the basis of variables belonging to the k^{th} group (k = 1 …, r) (the variables that belong to each of these four groups are defined in Table 1). To account for changes in the state of organic farming, the synthetic variable CMOF was obtained through formula (3):

$$\text{CMOF} = \frac{\sum_{k=1}^{r} \overline{\text{CMOF}}_{itk}}{4}. \quad (3)$$

The dynamic CMOF obtained through formula (3) assumes values in the interval [0,1]. This method makes it possible to rank the land unit with the best (close to 1) and the worst (close to 0) levels of organic farming (OECD 2018). Descriptive statistics (e.g., means, coefficients of variation) and annual growth rates (AGR) were calculated, and data visualization was conducted to provide a complete picture of organic farming in Poland. The analyses were conducted using ArcGIS v.10.6.

3. Research results

For the 2014–2021 period, an AGR increase in organic farming occurred at all levels of data aggregation. However, CMOF rose more rapidly for the more aggregated units examined. The mean values of the index were lower at more disaggregated levels, and the differentiation of CMOF (coefficient of variation) increased with decreasing data aggregation. Moving from LAU-2 to NUTS-1, these regional differences diminished (a yearly decrease in spatial diversity was observed from NUTS-3 to NUTS-1 units). At the onset of the COVID-19 outbreak (2020–2021), all territorial levels registered an increase in organic farming but simultaneously, a rising spatial distortion is noticeable. However, AGR observed for 2020–2021 was faster than for 2014–2019 (0.4 pp on average), Table 2.

The results reveal that areas located in north-eastern, north-western and south-eastern Poland experienced the highest degrees of the phenomena during period 2014–2021 (Fig. 1). However, the territorial disaggregation shows how organic farming differs across units and what the potential "determinants" of this disparity are at particular territorial levels. It should be noted that the higher the level of administration is, the more regionalization (concentration) of organic

Table 2. Composite measure of organic farming (mean and variability) at different levels of data aggregation and various timespans

	2014	2015	2016	2017	2018	2019	2020	2021	2014-2021	2014-2019	2020-2021
	CMOF								AGR [in %]		
NUTS-1	0.157	0.161	0.158	0.157	0.147	0.222	0.233	0.243	7.3	4.3	4.4
NUTS-2	0.111	0.104	0.104	0.108	0.098	0.130	0.135	0.140	4.3	1.9	3.8
NUTS-3	0.031	0.029	0.031	0.029	0.028	0.036	0.039	0.041	3.6	1.7	3.5
LAU-1	0.0119	0.0117	0.0106	0.0118	0.0108	0.0137	0.0146	0.0147	3.5	1.5	0.4
LAU-2	0.0031	0.0027	0.0033	0.0032	0.0029	0.0032	0.0033	0.0034	1.7	1.3	0.3
	|CV| in %								AGR in pp		
NUTS-1	64	68	64	62	53	57	53	51	-3.9	-3.8	-3.8
NUTS-2	53	62	65	60	58	52	55	59	-0.7	-1.1	7.3
NUTS-3	91	98	106	99	96	92	85	88	-1.5	-0.2	3.5
LAU-1	97	109	116	114	112	119	114	118	2.3	3.2	3.5
LAU-2	164	181	196	186	186	196	195	198	2.2	2.7	1.5

Composite measure of organic farming (mean and variability) at different levels of data aggregation and various time spans

Notes: p – percentage points; CV – coefficient of variation (Takeishi & Inoue, 2021), LAU-2: 2,477 communes; LAU-1: 380 counties; NUTS-3: 72 subregions; NUTS-2: 16 voivodships; NUTS-1: 7 macro-regions. The rate of change (AGR) was determined from the exponential trend function AGR = b_0e^mx, where the dependent AGR value is a function of independent x values. The m value is a constant that determines the rate (in percentage, when multiplied by 100%) of growth (the AGR), (Kusideł & Antczak, 2014; World Bank, 2022). To consider the uncertainty and sensitivity inherent in the composite measure, robustness was checked by varying the standardization method, linking the index with previously constructed measure of organic farming (the outcomes are available upon request).

Source: own elaboration

farming is observed. The high intensity of organic farming characterizes NUTS-2 located in the northeastern, north-western, eastern and south-eastern parts of Poland (Fig. 1, maps on the right). In contrast, the LAU-2 units are characterized by larger spatial distortions in the CMOF, which suggests the strongly locally nested (intraregional) character of organic farming development. The results indicate that between 2014 and 2021, the highest positions in the ranking of organic farming development were taken by communes located in the north-western, eastern-central, north-eastern and southern regions. Furthermore, at the regional levels (from NUTS-1 to NUTS-3), the analysis identified no units without organic farming. However, at the LAU levels, some areas located in south-western, central and central-western Poland are deprived of eco-agriculture (200 LAU-2 units are not involved in organic farming; however, “zero” values of CMOF were calculated for 237 LAU-2 units).

Despite the effects of the crisis, the highest eco-agricultural development was, on average, noted in 2021 (Table 2). From a regional perspective, the COVID-19 pandemic had a strong territorial dimension, potentially. Between 2020 and 2021, the CMOF rose in most units in western and south-eastern Poland, whereas there was a marked drop in organic farming in the center and north of Poland. However, analyzing the consequences of COVID-19 only at higher levels of data aggregation can degrade the results for CMOF’s growth rate from low-level data. Nearly half of the units at the LAU levels exhibited decreases in organic farming from 2020 to 2021 (Fig. 1, maps on the right).

Finally, the results show that the LAU levels were characterized by the largest spatial distortions in organic farming (Table 2). The main driving forces behind the CMOF were seeds, foodstuffs and organic products (Spearman’s correlations with CMOF). Moreover, the mean harvests of fodder crops (maize, fodder beet, dicotyledonous crops, and grass) and crops from seed plantations during 2014–21 were the highest in southern and the central Poland (Fig. 2). Areas in the north-eastern part of the country are centers of plant harvests, milk, honey, egg and cream production. In addition, the pandemic resulted in an acceleration of harvests of agricultural seeds, foods and crops (almost half of the units recorded an increase). However, this growth is also strongly territorially varied (Fig. 2).

4. Discussion

In larger units (higher spatial data aggregation levels), organic farming varies less, while in smaller units (lower levels of territorial data aggregation), the phenomena become more divergent. In fact, the aggregation of data included in the CMOF affects the patterns of the geographical distribution of eco-agriculture, as well as the analysis of potential factors that could promote its development. Therefore, the knowledge regarding the distribution of organic farming is essential for policy, to define strategies, to determine whether landscape targeting of lower-intensity farming is worthwhile or to help agricultural policymakers create future pathways to more resilient farms (Feber et al., 2015). The NUTS can be directly affected by national government policies and funds such as the concept of sustainable development or the Green Deal strategy (Kociszewski, 2022), as well as legal acts on the general functioning of the agricultural system, the *Rural Development Plan, the Act on Organic Farming* (NUTS-2 are units at which regional policies apply, i.e., financial support) (Makowska et al., 2015; Wiśniewski, 2021). However, in line with the new “organic” legislation, the EU also aims to foster local and small-scale processing. This is crucial to ensuring organized and efficient supply chains for organic products and ensuring that small producers can find outlets for their production (EU 2021). Smaller units (LAUs) and their local governments must obey national regulations and have less autonomy, but they still make their own investments in organic farmers and consumption budgets that may influence various local aspects: the financing of organic food consumption in kindergartens and schools or organic propagation material (Bańkowska et al., 2020). The outcomes also identified local areas with high potential for organic crop harvest and production (LAU-2 level). This implies that local government stakeholders should consider the potential that agricultural resources can bring to local and regional communities. Local planning and policy can, therefore, play a major role in the capacity to develop strong food systems by reducing zoning and policy barriers and providing tools to support communities in their endeavors. These results correspond to the German and UK studies carried out so far in the literature (Ilbery & Maye, 2011; Schmidtne, 2021).

The intra- and interregional diversification of Polish organic farming poses difficulties in identifying local patterns of regional and global specialization. In terms of the intensity of agricultural

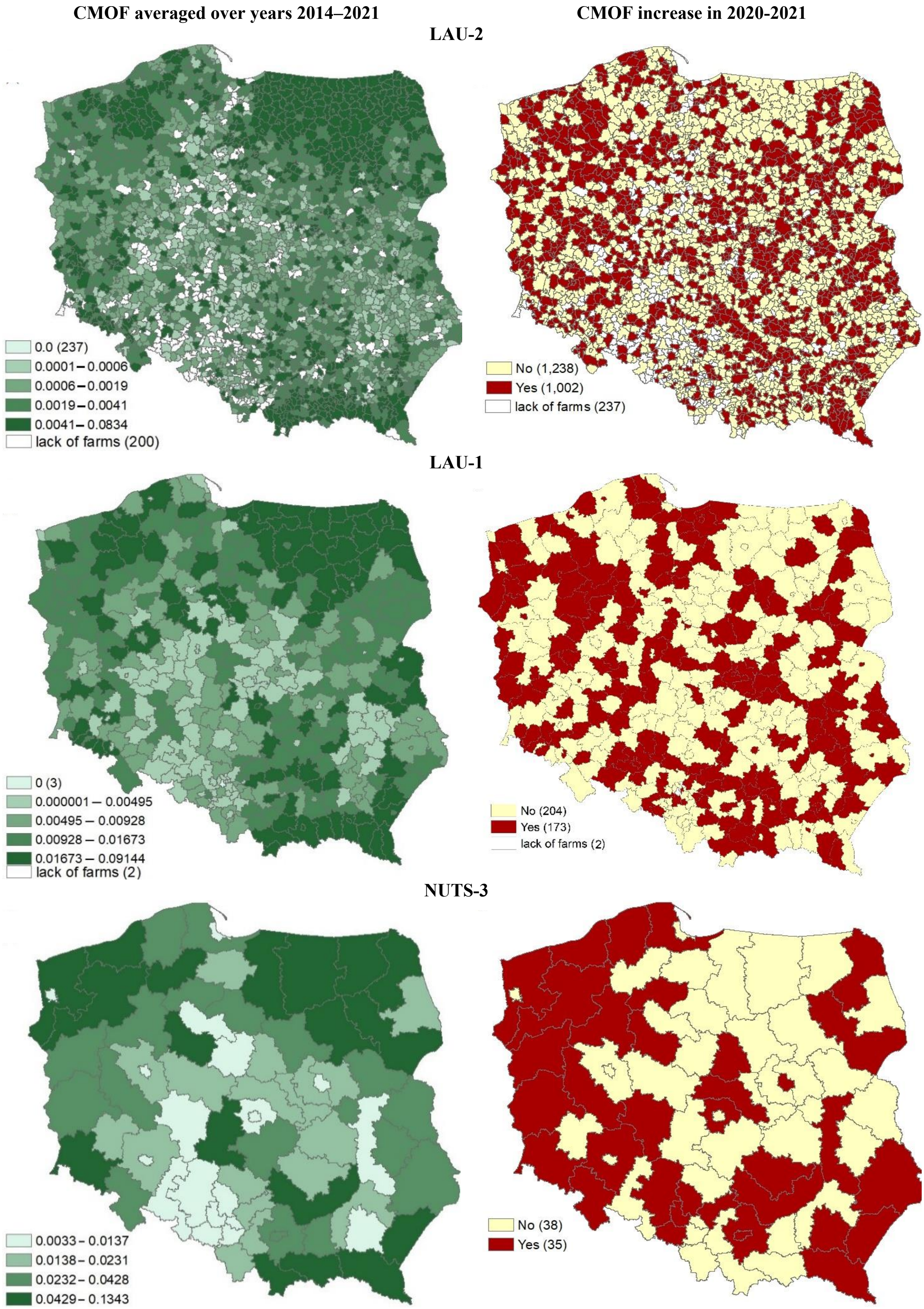

Fig 1. continiue page 58

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NUTS-2

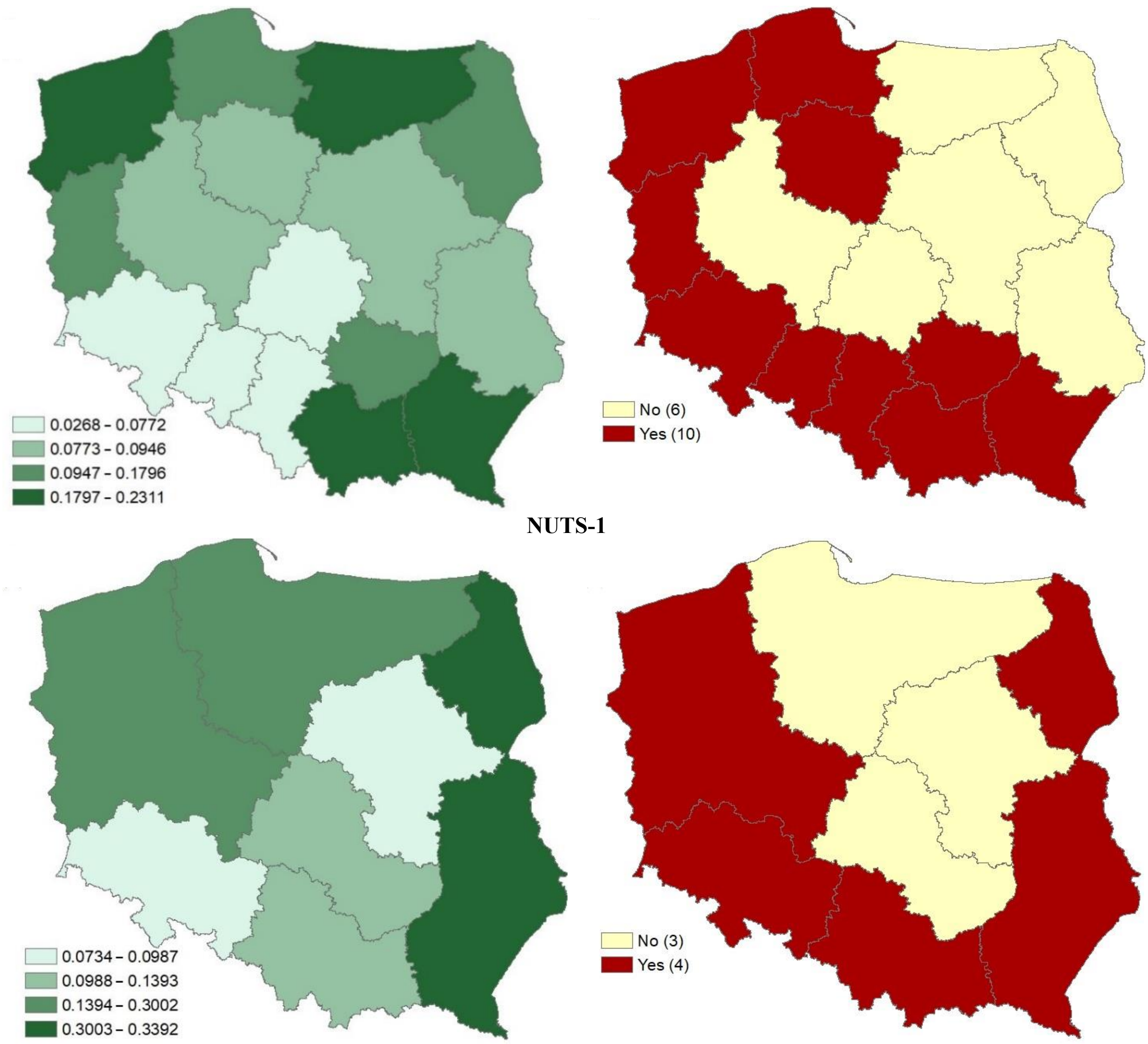


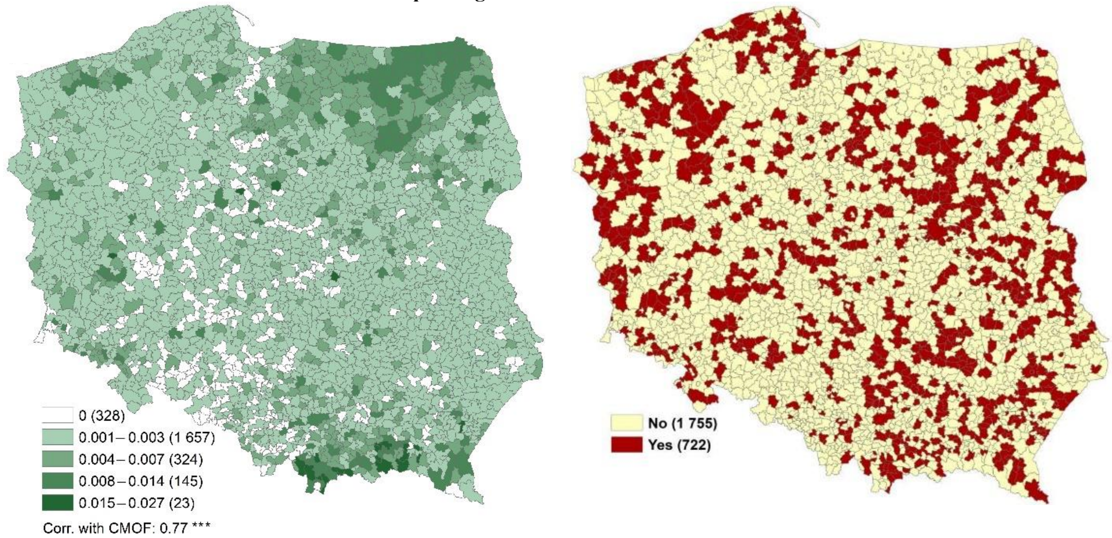
Fig. 1. Mean organic farming during 2014–2021 (left maps) and its change during 2020–2021 (right maps) at different levels of territorial aggregation in Poland

Note: The classification of land areas was carried out on the basis of quartiles, i.e., the fourth class boundaries were determined by the minimum and the first quartile, the third were determined by the first quartile and the median, the second were determined by the median and the third quartile, and finally the first were determined by the third quartile and the maximum (Kukuła & Bogocz, 2014). The minimum numerical value in range was found, while having ignored the 0 value.

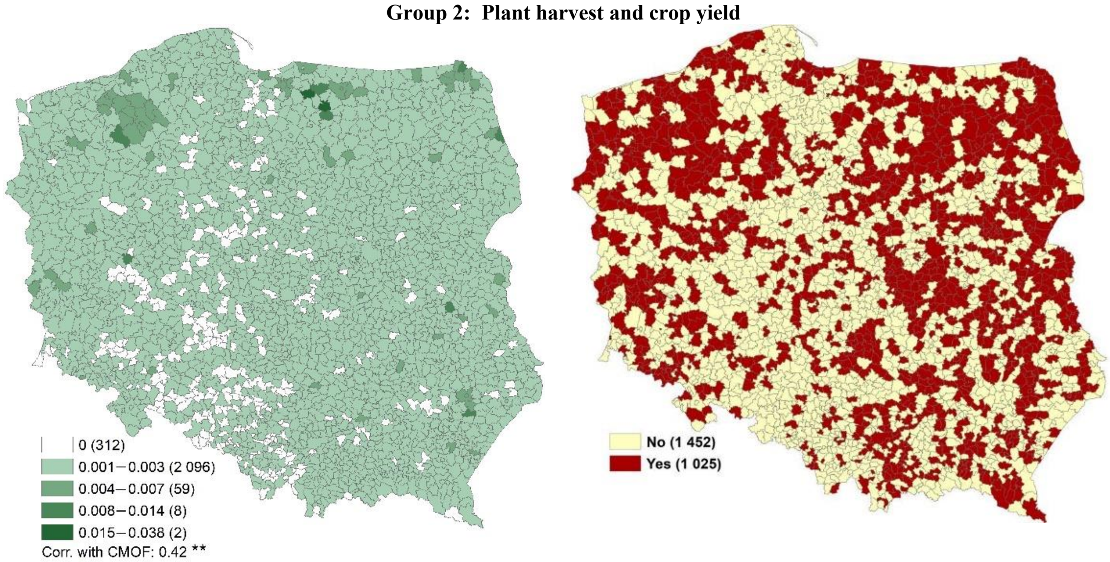
Source: own elaboration in ArcMap v. 10.6.

$\overline{\text{CMOF}}$ averaged over years 2014–2021 **$\overline{\text{CMOF}}$ increase in 2020-2021**

Group 1: Agricultural seeds and foodstuffs



Group 2: Plant harvest and crop yield



Group 3: Headage

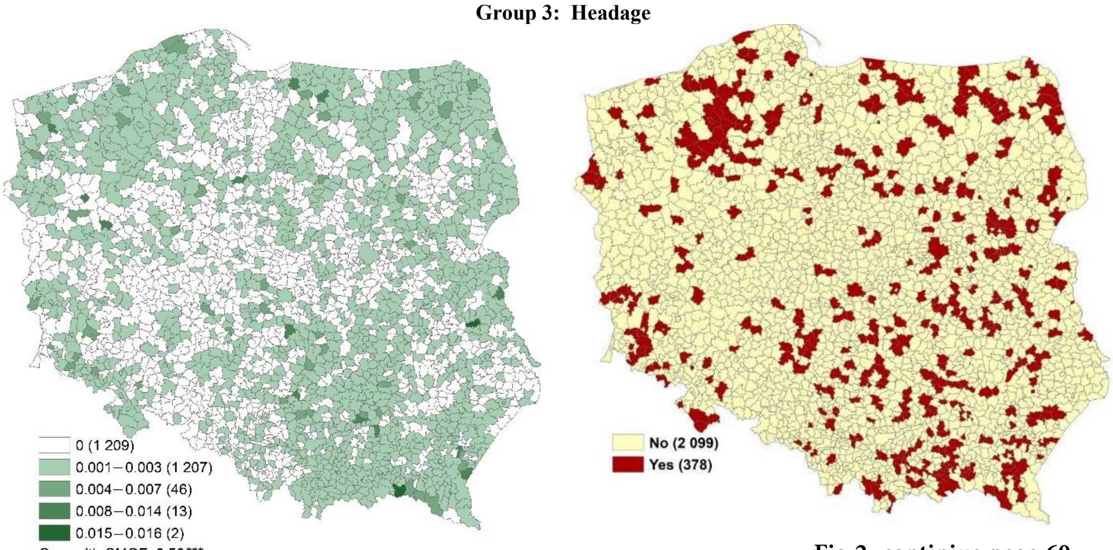


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Fig 2. continiued

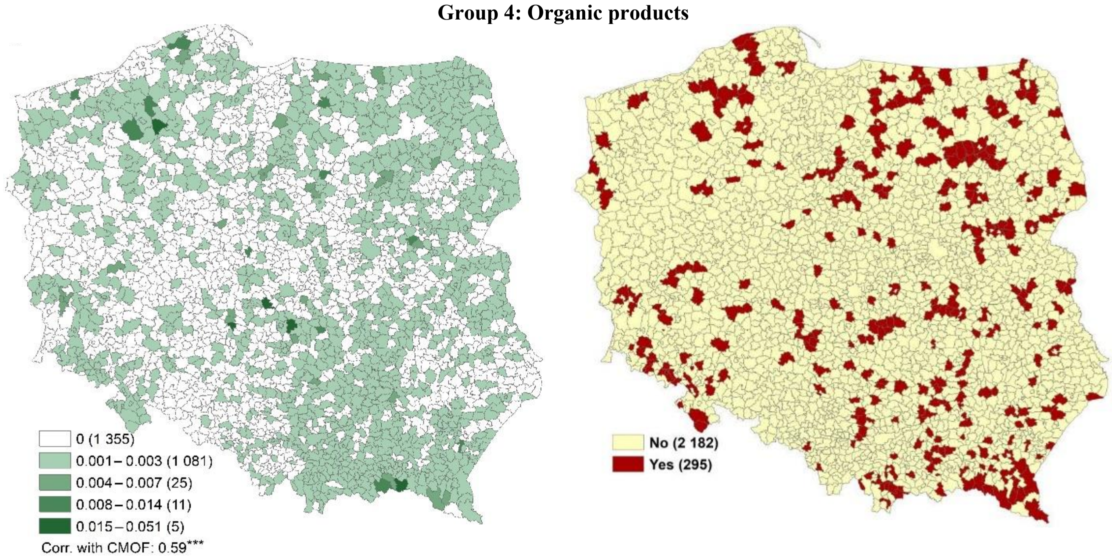

Fig. 2. Sub-groups of CMOF at LAU-2 (averaged for 2014–2021) and its change in 2020-2021

Note: significance levels: * α = 0.10, ** α = 0.05; *** α = 0.01. To compare CMOF in the sub-groups over land units the same class intervals (quintiles) were used. The minimum value in a range was found, having excluded zero value.

Source: own elaboration in ArcMap v.10.6.

production, it was found that the CMOF is low in areas of intensive production (particularly in the south-western and western parts of Poland), which confirms the previous results (Früh-Müller et al., 2019; Luty, 2017; Antczak, 2021). However, the disparities in CMOF are higher at lower levels of data aggregation, indicating increasing local concentration and specialization of a particular eco-agriculture line in certain LAU-2 units (Table 2, Fig. 1, Fig. 2). It seems that at the higher territorial aggregation levels, diversified regional CMOF does not exhibit a spatially uniform local organic farming diversity (Fig. 1). Local development (local leaders or organic farming cores) makes an important contribution to regional and even national organic farming performance (Bańkowska et al., 2020). However, the regions feature many local LAU-2 units with unique specializations that create a diversified agriculture economy. Furthermore, differences between locals were also noted within regions (Fig. 2). Some of the leaders are as diversified as the organic industry and represent the various types of agricultural activity and accompanying businesses: crop harvest, livestock production and organic processors. This finding is in line with those for other countries (Schmidtner et al., 2011; Jaenicke, 2016; Seidel, 2019).

The results also show that the mean values of CMOF are higher for more aggregated regions, which reflects the strong regional character of organic farming (Table 2). Thist can be observed especially in the northern and south-eastern parts of Poland (Fig. 1). This is mainly due to the natural conditions in the region (which is in line with the synthetic indicator of suitability for organic production developed by Institute of Soil Science and Plant Cultivation State Research Institute, Stuczynski et al., 2007). Also important is the fact that organic farming is developing dynamically in the regions that are characterized by a particular richness of environmental resources and are protected under the system of legally protected areas (the northern, north-eastern, eastern and central parts of the country) (Makowska et al., 2015). However, there are studies showing that the natural conditions and suitability of areas for organic production do not have a dominant influence on the level of organic agriculture development in different regions of Poland. The spatial unevenness in the development of organic agriculture in different regions of Poland is also connected with the increase in demand for certified food products as a result of the growing awareness of the positive effects of organic food on health. Consumers' purchase of organic food is most often conditioned by the concern for their own and their family's health. Also important is the belief that organic food is safe and environmentally friendly, as well as the fact that it is food free of genetic modification (Tyburski & Żakowska-Biemas, 2007; Szarek & Nowogrodzka, 2015). This positive trend has been observed during the COVID-19 pandemic.

Although the highest eco-agricultural performance and growth rate were, on average, noted in 2020–2021 (Table 2), the initially assessed impact of the COVID-19 crisis was highly heterogeneous by locality and sectors (Figs. 1 and 2). Especially, during the pandemic, consumers became more aware of health and environmental issues, which stimulated interest in the market for organic (healthier than conventional) food products. The pandemic also relaxed legislation, introducing an opportunity for farmers to obtain additional financial assistance and making it possible to perform remote organic farming inspections using alternative methods and tools, such as Internet-based communication (Wojciechowska-Solis et al., 2021). However, nearly half of all areas in Poland at the LAU levels exhibited decreases in organic farming from 2020 to 2021 (Fig. 1). The closure of the economy, the long-observed deficit of workers, the resultant economic slump, and restrictions on international trade were all factors with negative impacts on domestic agricultural producers, the processing industry, transport, energy and trade businesses (Dudek & Śpiewak, 2022). The import of organic products to Poland is significant in terms of both assortment and volume. Most Polish processors and traders source products originating indirectly from Germany and the Netherlands (Sridhar et al., 2022). In that context, from the end of 2020 onward, food producers might also have been affected by this global crisis. The full impact of the pandemic on organic farming and the demand for this produce is therefore not yet known (Simon, 2023).

5. Conclusions

The paper offers a forward-looking perspective on how the development process of Polish organic farming differs across local and regional territorial units. To better set the policy priorities and benchmark or monitor the organic farming performance, the analysis was conducted at different levels of territorial aggregation and for the dynamic trajectory: 2014–2021. In this study, a dynamic composite indicator in line with OECD methodology based on the raw data divided into four sub-categories was applied.

The territorial disaggregation of composite measure shows how the development process of organic farming differs across Poland, and whether the natural potential of a particular area determines the level of eco-agriculture. The specialization of eco-farming constitutes a strongly territorially differentiated development factor, depending on local determinants; however, overall, ecological farming is strongly regionalized. For this reason, a multi-faceted benchmarking framework carried out at the lower level of data aggregation (LAU-2) is the most valuable. Moreover, the local leaders could play a key role in raising awareness and informing the local community about the positive impact of organic farming. Policy actions should therefore be aimed at developing natural viability, implementing an organic fraud prevention policy, maintaining a robust control system of audits, intensifying the collection of market data, improving the organization of the organic sector supply chains, strengthening the position of organic farmers in the food supply chain, and stimulating organic hotspots throughout the country. Based on the outcomes, it is also postulated that decision-makers preparing action plans dedicated to organic production should take into account the time frame as well as disparities between regions' natural potential for developing modern, effective organic farming. Adequate support will enable the achievement of the ambitious goals set by the EU and the outcomes assumed by the EGD.

Finally, the premise that, despite the global crisis caused by the pandemic, increases in eco-agriculture were recorded in most geographic units in Poland for the period 2020–2021 is not fully supported. Although the highest eco-agricultural performance was, on average, noted in 2021, the impacts of the COVID crisis were highly heterogeneous by locality and sectors. For this reason, a multi-faceted benchmarking carried out at the lower levels of data aggregation is the most valuable. However, more data, e.g. on market power, consumption, imports and sales of agricultural commodities (food and non-food) and processed products (wholesale and retail) before and during pandemic are crucial for further research in this area.

The findings have some limitations that may affect the qualitative inferences made. It must first be stressed that the future availability of individual data is a major concern. As of January 1, 2022, personal data on organic farmers fall under the General Data Protection Regulation. Hence, this new regulation does not allow statistics to be compiled by the degree of urbanization, identifying cities, towns and semi-dense areas, and rural areas at the LAU levels. Future dataset construction and validation processes will, therefore, be more time-consuming. More detailed research should also address the potential impact of eco-funds on the phenomenon. Furthermore, the continuing COVID-19 crisis and the war in Ukraine could result in unevenness in resource requirements and the flow of output of organic farming in Poland. Therefore, in view of the increasing demand for organic products and the opportunities for development, it seems necessary to conduct analyses to support this sector. The approach presented in this article is a starting point for quantifying and modelling the effects of crises currently gripping the world situation.

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