

GRADATION OF EUROPEAN UNION MEMBER STATES IN TERMS OF ORGANIC FARMING DEVELOPMENT IN THE LIGHT OF A MULTIVARIATE COMPARATIVE ANALYSIS

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Abstract

The main objective of the paper is to attempt to analyse the regional diversity of organic farming in EU Member States in 2015 in terms of selected characteristics. There were used such characteristics as: average surface area of organic cultivations, share of the surface area of organic cultivations in the total area of arable lands, value of retail sale, expenses for organic food per capita. Using the selected linear ordering method of a set of objects, a ranking of states was drawn up. The ordering procedure was selected using an auxiliary procedure, based on the similarity measure of ordinal systems.

Keywords: linear ordering methods, multivariate comparative analysis, organic farming

JEL Classification: Q10, Q12, Q15, C2, C4

1 Introduction

The modern food sector is dominated by highly efficient production techniques offering mass products on the global market (Bareja-Wawryszak & Gołębiewski, 2014). Intensive production, as well as transportation possibilities, guarantee great availability of food products from all over the world.

Zegar (2012) claims that society is paying significant costs for devastating industrial food systems. In his opinion, the environmental and social costs of globalised agriculture are substantial and cover loss of fertile soil, air and water pollution, loss of biodiversity, dependence on non-renewable resources, and food quality deterioration. However, recent observation shows that consumers have started to show interest in alternative food networks supporting local production. Organic agriculture is being developed as a response to the chemicalisation of agriculture (Paull, 2011).

Organic farming can be defined by the proactive, ecological management strategies that maintain and enhance soil fertility, prevent soil erosion, promote and enhance biological diversity, and minimise risk to human and animal health and natural resources (Organic Farming Research Foundation [OFRF], 2018). A modern definition of organic farming, provided by Lampkin (1994), states that the aim is: "to create integrated, humane, environmentally and economically sustainable production systems, which maximise reliance on farm-derived renewable resources and the management of ecological and biological processes and interactions, so as to provide acceptable levels of crop, livestock and human nutrition, protection from pests and disease, and an appropriate return to the human and other resources".

The reason for the focus on organic agriculture is the rapid development of the organic sector in Europe. Organic agriculture is gaining popularity in the perspective of the concept of sustainable consumption. From the sustainability perspective, most of the policy and research attention concentrates on shifts toward more sustainable food products and on food losses (Ratinger, Hebaková, Michálek, Tomka, Mrhálková & Stiková, 2014). This development has resulted in the growth in consumer demand for environmentally friendly, "green" or chemical-free food products. It has led to an expansion of organic farms in Europe.

Many authors emphasise that the organic way of production is an important feature of plant cultivation and animal husbandry. To breed animals on an organic farm means either to feed them with the farmer's own silage and hay, or to purchase organic concentrate feeds (Ratinger, Abrahamová, Boudný, Foltýn, Hruška, Pražan & Voltr, 2013), (Flaten, Lien, Koesling, Valle & Ebbersvik, 2005). If you want to have your own organic forage, it will cause the increase of the area of organic farms, which can be seen nowadays in countries of the European Union. It is also important to fertilise crops with natural fertilisers, which is noted by Tiedemann and Latacz-Lohmann (2012).

The production of organic food has been developing both in well-developed countries as well as in developing countries, which see export possibilities in the development of this type of production. It is also a chance to manage workforce

surpluses, increase in income and development of fragmented farms (Willer & Yussefi, 2007).

The first principles of functioning of organic farming, which have become the basis for the first international regulation on organic farming and labelling of its products, were created by the International Federation of Organic Agriculture Movements established in 1972 (IFOAM, 2007). The underlying principles, on which organic agriculture is based, adopted by IFOAM are: health, ecology, fairness, and care. Currently, the framework for all levels of production, distribution, control, and labelling in the European Union is determined by the Council Regulation (EC) No. 834/2007, which is continuously updated in the form of regulations amending this Regulation. In Europe, all countries have an organic regulation or are drafting one. The EU Common Agricultural Policy (CAP) and similar programmes in other countries remain a key policy for the development of agriculture in Europe, including organic farming. Under the current CAP for the period of 2014-2020, organic farming is supported by Pillar1 (direct payments) and Pillar2 (Rural Development Programmes).

The main objective of the paper is to attempt to analyse the regional diversity of organic farming in EU-28 states in 2015 in terms of selected characteristics. The paper consists of three main parts. The first one presents the selected definitions of organic farming and changes in the surface area of organic cultivations in Europe, as well as the development of the healthy food sales market. Then, it describes the selected linear ordering methods and selected formulas used for variable standardisation. The final part presents the ranking of European countries in terms of the development of organic farming, which will enable assignment of particular countries to groups with well-developed, poorly developed and developing organic agriculture.

Data presented in this paper come from the study of literature as well as contain information presented by The World of Organic Agriculture, Eurostat and European Commission reports.

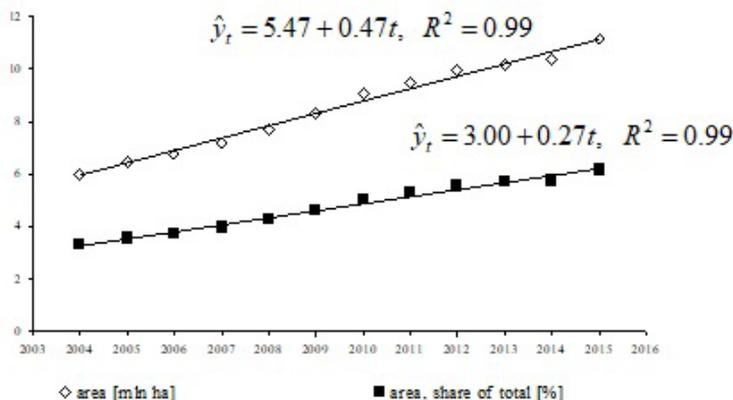
1.1 Development of organic area and retail sales

The demand for organic products mainly concentrates in Europe and North America. In most countries, only a small consumer base is responsible for most organic food purchases. The challenge of organic food marketing lays in adjusting to consumer preferences in the various countries and the concern about supplies of organic products. In 2015, the countries with the biggest organic markets were the United States (35.8 billion euros, 47% of the global market) followed by the European Union (27.1 billion euros, 35%), especially Germany (8.6 billion euros) and France (5.5 billion euros).

The highest per-capita consumption, with more than 170 euros, was found in Switzerland, Denmark, Luxembourg, and Sweden. The highest organic market shares were reached in Denmark (8.4%), Switzerland (7.7%), and Luxembourg (7.5%) (FiBL 2018).

In 2015, as compared to 2004, both the surface area of organic cultivations and the share of arable lands of organic farms in the total area of arable lands in the European Union were systematically growing (Figure 1), as evidenced by the matching trend lines, with the surface area of organic cultivations increasing in this period by 85.34% and the share of the surface area of organic cultivations in the area of arable lands increasing from 3.28% in 2004 up to 6.17% in 2015.

Figure 1 The course of changes in the surface area of organic farms and the share of arable lands of organic farms in the total area of arable lands in the EU in the period of 2004-2015

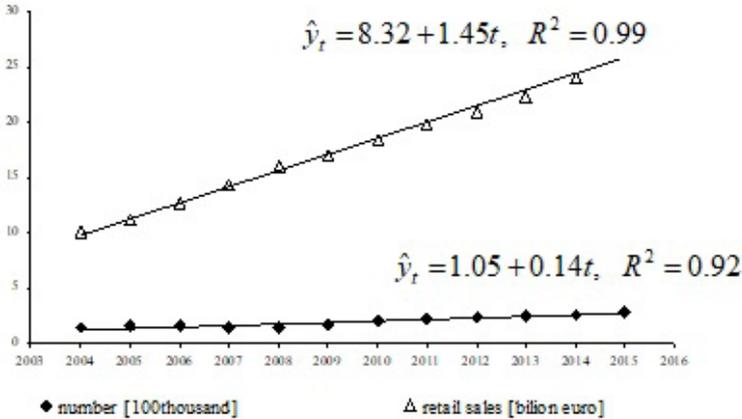


Note: Designated trend lines: $t = 1, 2, \dots, 12$.

Source: own calculation based on FiBL survey 2017 www.organic-world.net retrieved 20.01.2017.

Buying organic food has become very popular over the past 10 years, especially in well-developed countries, hence the growing interest in organic production among farmers and the increasing number of farms involved in farming and breeding in the organic system, and thus an increase in sales of organic products (Figure 2).

Figure 2 The course of changes in the number of organic producers, the value of retail sale of organic products in the EU in 2004-2015



Note: Designated trend lines: $t = 1, 2, \dots, 12$.

Source: Prepared by the authors on the basis of: www.organic-world.net Retrieved 20.01.2017.

The number of organic producers in 2015, as compared to 2004, increased by 129.85%. The value of sales of organic products on the European market in 2015, as compared to 2014, increased by 11.8%, and it was the highest growth since the financial crisis of 2008. Throughout the entire analysed period, the value of sales of organic products increased by 171%.

The value of expenses for organic products per capita also increased. Thus, the consumers' demand for high-quality products has been increasing. However, it should be noted that it is very diverse in particular EU Member States. In old states of EU-15, it amounted to EUR 65.9 on average, while among countries that joined the European Union after 2004 - only EUR 5 per year. Switzerland, Denmark and Sweden, with expenses at the level above EUR 150, are the leaders in consumption of organic products. While in countries such as Slovakia, Lithuania or Latvia, the expenses for organic products amounted to EUR 2 per capita (Willer & Lernoud, 2017).

The purpose of the article is to attempt to analyse the regional diversity of organic farming in EU-28 states in 2015 in terms of selected characteristics. The linear ordering method was used to describe the examined phenomenon. The purpose of these methods is to arrange objects from the best to the worst one in terms of a defined criterion. The results obtained using several linear ordering methods

frequently vary among each other. In some comparisons of pairs of methods, the differences are very clear. Consequently, a dilemma appears: which ordering method should be chosen. The article uses an auxiliary procedure of selection of the linear ordering method. This procedure is based on the similarity measure of rankings obtained as a result of applying several linear ordering methods.

The synthetic measure, selected from the initial list of methods, allowed for arranging EU Member States in terms of the level of development of organic farming.

2 Data and Methods

The analysis was conducted on the basis of the data originating from Reports of The World of Organic Agriculture and the database of EUROSTAT.

The choice of variables was guided by the substantive analysis and the availability of data. When preparing characteristics in the form of indicators, the impact of the size of the examined objects was excluded.

The diagnostic variables adopted for the analysis are as follows: X_1 - average surface area of organic cultivations [ha], X_2 - share of the surface area of organic farms in the total surface area of agricultural farms [%], X_3 - the annual amount allocated on organic food [EUR/inhabitant], X_4 - the sale of organic products in the total sale of food products, X_5 - the percentage of food processors among organic producers.

The statistical data, on the basis of which the analysis was conducted, form a matrix:

$$[X_{ij}]_{\substack{i=1,2,\dots,n \\ j=1,2,\dots,m}} = \begin{matrix} X_{11} & X_{12} & \dots & X_{1,m} \\ X_{21} & X_{22} & \dots & X_{2,m} \\ \dots & \dots & \dots & \dots \\ X_{n,1} & X_{n,2} & \dots & X_{n,m} \end{matrix} \quad (1)$$

where: X_{ij} - value of the feature X_j for the i country, m - number of diagnostic variables, n - number of states.

In the first stage of the research, four linear ordering procedures were selected (Table 2). Then, four rankings of the examined objects were drawn up on their basis.

Table 2 Selected linear ordering methods

Method	Synthetic variable	
Hellwig's	$Q_i = 1 - \frac{d_i}{d_0}$	$d_i^+ = \sqrt{\sum_{j=1}^m (Z_{ij} - Z_j^+)^2}$, $Z_j^+ = \max_i \{Z_{ij}\}$, $Z_{ij} = \frac{X_{ij} - \bar{X}_j}{S_j}$, $d_0 = \bar{d}$ $\bar{d} + 2S_{d^+}$, $\bar{d} = \frac{\sum_{i=1}^n d_i^+}{n}$, $S_{d^+} = \sqrt{\frac{\sum_{i=1}^n (d_i^+ - \bar{d})^2}{n}}$
TOPSIS	$Q_i = \frac{d_i^-}{d_i^- + d_i^+}$	$d_i^+ = \sqrt{\sum_{j=1}^m (Z_{ij} - z_j^+)^2}$, $Z_j^+ = \max_i \{Z_{ij}\}$, $d_i^- = \sqrt{\sum_{j=1}^m (Z_{ij} - z_j^-)^2}$, $Z_j^- = \min_i \{Z_{ij}\}$, $Z_{ij} = \frac{X_{ij} - \bar{X}_j}{S_j}$
MUZ	$Q_1 = \frac{1}{m} \sum_{j=1}^m z_{ij}$	$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}$
SSW	$Q_1 = \frac{1}{m} \sum_{j=1}^m z_{ij}$	$z_{ij} = \frac{x_{ij} - \bar{X}_j}{S_j}$

Note: X_{ij} - value of the j variable for the i object; Z_{ij} - normed value of the j \bar{X}_j, S_j variable for the i object; \bar{z}_j is, respectively, the arithmetic mean and the standard deviation of the j variable; Q_i - value of the synthetic variable for the i object

Source: Prepared by the authors: (Perkal, 1953); (Hellwig, 1968); (Hwang & Yoon, 1981); (Kukuła, 2000).

At the second stage of the analysis, from among the prepared rankings (and thus the used methods), we selected one that was the most similar to the others, namely the one for which is the highest (Kukuła & Luty, 2015, 2017), when:

$$\bar{u}_p := \frac{1}{v-1} \sum_{\substack{q=1 \\ p \neq q}}^v m_{pq}$$

$$p, q = 1, 2, \dots, v$$

Where: v – number of rankings:

$$m_{pq} = 1 - \frac{2 \sum_{i=1}^n |c_{ip} - c_{iq}|}{n^2 - z}$$

(Kukuła, 1989), so that:

c_{ip} , c_{iq} - respectively, the position of the i object in the ranking with the number p , q ;

$$z = \frac{0, n \in P}{1, n \in P}, \text{ and } P - \text{a set of natural even numbers; } m_{pq} \in [0, 1]$$

The method selected in the manner described above is the basis for preparation and interpretation of the ranking of European Union Member States.

3 Results and Discussion

In the countries of the European Union we are observing dynamic growth of organic farming. Shows it an increase in both the area of organic farming and the number of organic farms. Consumers, especially in highly developed countries, also more often reach for organic products, what shows the increasing percentage of sales of organic products in the sale of food products.

An important determinant of production capabilities and specialisation of organic production is taken into account in the analysis of the average size of organic farms, which in the countries of the EU in 2015. developed at 62.75 ha (Table 1).

Table 1 **Basic characteristics of the adopted diagnostic variables**

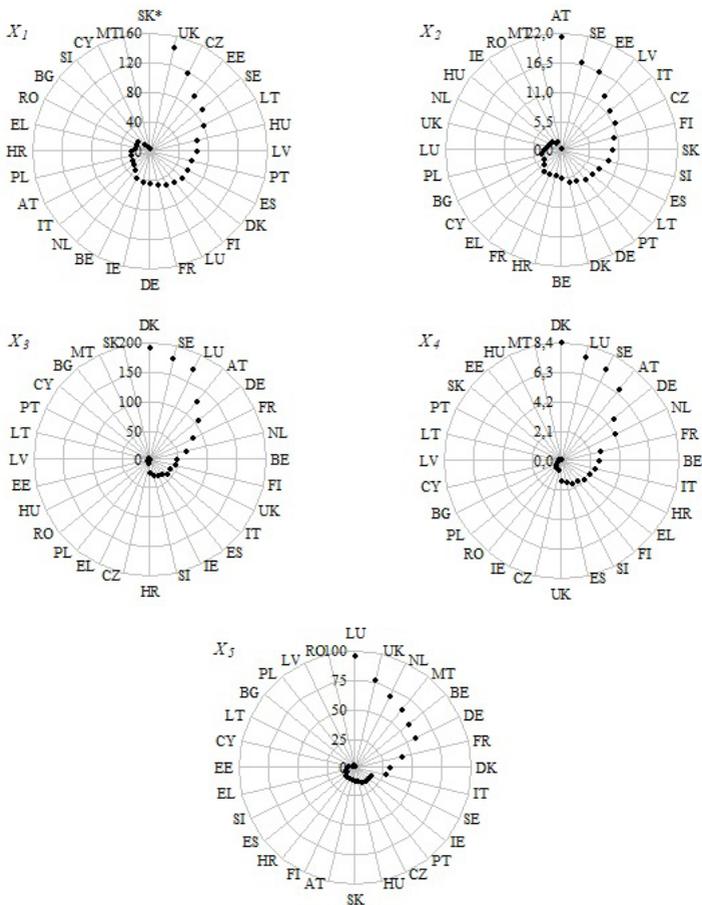
Numeric characteristics	Diagnostic variables				
	X ₁	X ₂	X ₃	X ₄	X ₅
max	433.05	21.30	190.70	8.40	95.18
min	2.73	0.30	0.70	0.10	1.17
average	62.75	7.21	44.08	2.21	24.30
median	45.52	5.75	25.00	1.45	11.68
standard deviation	79.75	5.09	58.06	2.51	26.37

Source: Own calculations on the basis of Eurostat organic farming. Retrieved Jan. 3, 2018, from Eurostat database.

The largest average surface area were recorded in Slovakia (433.05ha), where the number of organic farms is one of the smallest in Europe (Figure 1). The largest share of agricultural land certified organic farms in the agricultural land of the total holdings were reported in Austria, which in this respect, significantly overtook other analyzed countries. Expenditure on organic food are highest in Denmark, Sweden and Luxembourg, where also share of sale of organic products in the sale

of food products in total is very high. In the 1/3 of analyzed countries the percentage of processors of organic products in a group of organic producers exceeds 24.30%, of which the largest is in Luxembourg.

Figure 3 Rankings of countries due to adopted diagnostic variables in 2015



Note: * value for SK is 433.05ha.

Source: Own calculations based on Eurostat organic farming. Retrieved Jan. 3, 2018, from Eurostat database.

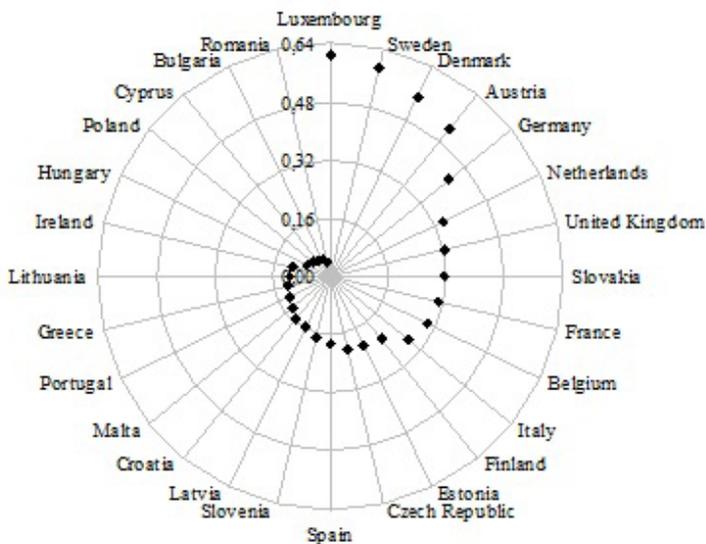
The highest value of the presented variables was obtained by Denmark, Sweden, Luxembourg, Austria and Germany, countries in which the

government's environmental policy plays a significant role, and the public interest in healthy food is high. In the case of these countries, the indicators included in the analysis exceeded the average values determined for all countries also reaching in relation to two indicators (X_3 - amounts allocated for the purchase of organic food, X_4 - percentage of sales of organic products in total sales) the highest values. Slovakia is noteworthy, where the average area of an organic farm is the highest among the countries presented. It was also characterized by a high share of organic farms in the total area of farms. Slovakia is therefore a leader among European countries that joined the EU after 2004. On the other hand, the lowest values of selected indicators were achieved by countries included in the group of developing countries where ecological awareness of society is just developing and legal acts supporting the development of organic farming are introduced. Farmers from countries that joined the EU after 2004 mainly deal with the production of organic products while countries from the old EU are processing these products, what we can observe by analyzing the indicator X_5 -percentage of processors among organic producers.

As a result of applying the aforementioned methods, on the basis of the selected set of features, we hierarchised states according to the synthetic measures. The ordinal systems differ significantly. Extreme points in the rankings differ by eleven items. The largest similarity can be seen in a pair of rankings obtained with the use of two ordering methods: MUZ and SSW ($m_{pq}=0.95$). On the other hand, the largest can be seen in the case of TOPSIS and MUZ ($m_{pq}=0.83$).

In the concerned problem, the ranking of UE Member States obtained on the basis of the synthetic variable set out using the MUZ method is the closest to all \bar{m}_p the other designated rankings ($=0.90$).

Figure 3 Ranking of UE Member States in terms of organic farming in 2015 with the use of the MUZ linear ordering method



Source: Own calculations on the basis of Eurostat organic farming. Retrieved Jan. 3, 2018, from Eurostat database.

In the ranking prepared using the MUZ linear ordering method (Figure 3), the top place is occupied by Luxembourg, where the percentage of organic producers per the number of farms is the highest. The share of the sale of organic products in the total sale of food products is also relatively high, just like in Denmark (8,4%), Sweden (7,3%) and Austria (6,5%). Additionally, the four countries ranked at the top are characterised by the highest expenses for organic products per capita. The largest consumers of organic food are the Danes (EUR 191), the Swedes (EUR 177), the Luxembourgers (EUR 170), the Austrians (EUR 127), and the Germans (EUR 106). In countries that joined the EU after 2004, the inhabitants spent on the purchase of organic food no more than EUR 5 per year, on average. It is worth paying attention to Slovakia, which occupied a very high position in all rankings (3rd, 1st, 8th, and 5th place) and is the leader among European countries that joined the EU after 2004. Similarly to the Czech Republic, Sweden and the UK, the Slovaks have the greatest average surface area of organic cultivations from among all the analysed countries.

The lowest ranks were occupied mainly by countries classified as developing countries, where the environmental awareness of the society is only now developing, and where legal acts supporting the development of organic agriculture are being introduced. Countries with the lowest level of development of organic production include Romania, Bulgaria, Poland, Hungary, and Cyprus.

4 Conclusion

The development of organic agriculture in EU Member States is affected by many factors, among which emphasis should be put on the legal conditions of the functioning of organic farming at the community and national level, but also on the greater ecological awareness of consumers. Member States not only use the support programmes offered by European institutions, but also need to respect the guidelines concerning environmentally-friendly methods of production. An important role in the creation of this development is played by state institutions of Member States. Their goal should not lay in financial support using the national budget, but also in constant expansion of ecological knowledge, both among producers and consumers, as well as in organisation of cooperation between producers and institutions that distribute and promote organic food.

The level of production of organic food has been increasing both in well-developed as well as in developing countries. Countries that joined the EU after 2004, by increasing the outlays on organic farming, seek opportunities for increasing export possibilities, increasing income, above all, in the case of significantly fragmented farms.

The development of organic farming in EU Member States in 2015 was characterised by a growth in the sales market of organic products and a slightly less dynamic increase in the surface area of organic arable lands.

The share of the surface area of farms growing organic crops in the overall area of arable lands was constantly growing - the average value for the EU Member States in 2015 was 5.8%.

The value of expenses for organic products per capita was also systematically growing, however, it should be noted that it is very diverse in particular EU Member States, and the consumption of these products in countries of the old European Union exceeds thirteen times the expenses for the purchase of healthy food in countries that joined the EU after 2004.

The use of multivariate statistical analysis methods enabled preparation of a ranking of European Union Member States in terms of the development of organic farming. The highest positions in the ranking were occupied by the countries of the old European Union.

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