THE DIVERSITY OF EUROPEAN UNION COUNTRIES ACCORDING TO EQUIPMENT WITH AGRICULTURAL TRACTORS

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Abstract: The research of taxonomic structure of holdings owning agricultural tractors in EU countries was conducted on the basis of statistical information from EUROSTAT database, for 2013 year. The purpose of this article was to present level of equipment of holdings in European Union countries in agricultural tractors in the spatial aspect. The method of vector elimination was used in the analysis. Apart from the analysis concerning the fact of the possession of agricultural tractors according to areal groups of arable land in the European countries, the groups of countries with similar structure were distinguished. Percentage of holdings possessing tractors was related with the number of holdings in each groups of areal groups of arable land.

**Keywords:** agricultural tractors, European Union, additive structures

INTRODUCTION

Technical equipment of farms within the area of agricultural machines and devices is one of the fundamental factors influencing effective agricultural production. The level of this equipment in the countries of European Union (EU) depends mainly on the agrarian structure of the region, crop structure and productivity of farms. Technical equipment of agriculture of Middle-East countries has been undergoing dynamic changes.

In spite of the fact that old machinery allows for performing basic agricultural activities concerning farm, new sophisticated devices are much better at stepping up farm productivity. Duczkowska-Małysz [1998] emphasizes that modernized farms are capable of absorbing biological and technical progress, cost reduction and meeting challenges of competence. In the EU policy there is a lot of attention focused on tasks connected with bridging disproportions of agricultural development in regional aspect.

In the countries of Western Europe (see Figure 1) in 2013 almost 100% of farms were in the possession of agricultural tractor. Best equipped farms were identified in Scandinavian countries and the countries of UE-12, in particular Germany, Austria and Benelux countries, where more than 90% of farms were equipped with agricultural tractor. One should also notice that the position of Poland in the ranking arrangement of the EU countries in this aspect is relatively high (66% of farms were in the possession of agricultural tractors). Moreover, Poland position was better than those of Italy, Portugal and Spain. Another observation is that agriculture in Romania and Bulgaria suffers from severe lack of finances. The reason for this phenomenon seems to be a significant fragmentation of farms.

Figure 1. Ranking arrangement of the EU countries with respect to the percentage of farms equipped with agricultural tractors in 2013
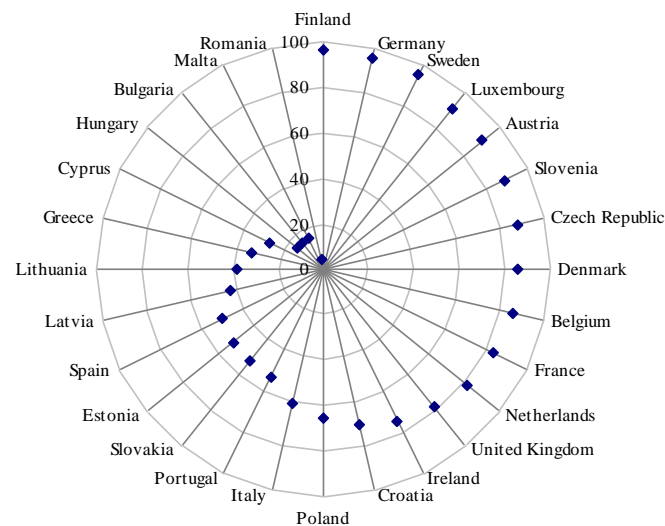
Source: own elaboration on the basis of Eurostat data

In 2013 (see Table 1) in case of one fourth of the EU countries with the lowest level of mechanization of agriculture the possession of agricultural tractors occurred in not more than 41.3% of farms. In turn, in case of half of the countries

considered in the research the level of mechanization was satisfactory, the index of farms in with agricultural tractors achieved at least 68%. Moreover, in farms of the area more than 20 hectares in the countries of the European Union at least 86% of farms on average is equipped with agricultural tractors, while in the areal group of farms up to 5 hectares the percentage is significantly lower and differentiated.

Table 1. Basic characteristics of the percentage of farms equipped with agricultural tractors according to areal groups of arable land

Specification	Areal groups [hectares]						Total
	< =5	5-10	10-20	20-50	50-100	>=100	
quartile 1	21.13	57.59	69.61	79.08	81.20*	83.15*	41.30
median	46.88	74.49	83.93	89.81	92.27*	90.91*	67.60
quartile 3	64.13	87.59	92.07	95.73	96.24*	95.60*	86.15
arithmetic mean	45.59	69.08	79.42	85.89	88.19*	87.58*	61.50
coefficient of variation	55.89	30.08	19.82	13.66	11.79*	11.51*	45.77

Source: own elaboration; *estimated for 27 countries (apart from Malta)

The aim of the paper was to present the level of technical equipment of farms in the EU countries with respect to agricultural tractors in spatial aspect. The analysis of structure of farms being in the possession of agricultural tractors was carried out, according to areal groups of arable land in the EU countries and groups of countries with similar structure were distinguished.

MATERIAL AND METHOD

The analysis was conducted on the basis of data from the Polish Central Statistical Office, concerning international statistics and EUROSTAT database. The data considered in the research refer to the number of farms equipped with agricultural tractors according to areal groups determined as follows: up to 5 hectares, 5-10 hectares, 10-20 hectares, 20-50 hectares, 50-100 hectares, more than 100 hectares in the European Union.

The structure under investigation according to the determined areal groups in 2013 in the EU countries can be expressed in the form of the following matrix $[a_{ij}]$:

$$\left[a_{ij}\right]_{\substack{i=1,2,\ldots n \\ j=1,2,\ldots m}} = \begin{bmatrix} a_{11} & a_{12} & \ldots\ldots & a_{1m} \\ a_{21} & a_{22} & \ldots\ldots & a_{2m} \\ \ldots & \ldots & \ldots\ldots & \ldots \\ \ldots & \ldots & \ldots\ldots & \ldots \\ a_{n1} & a_{n2} & \ldots\ldots & a_{nm} \end{bmatrix} \tag{1}$$

where a_{ij} describes the partition of number of farms equipped with agricultural tractors from the areal group j in the total number of farms under investigation in the country i, under the assumption that the following conditions are fulfilled:

$$0 \leq a_{ij} \leq 1 \text{ and } \sum_{j=1}^{m} a_{ij} = 1, i = 1, 2, \ldots, \text{n.}$$

The measure of concentration degree of his phenomenon on the basis of the information contained in the matrix $\lfloor a_{ij} \rfloor$ can be obtained by the application of the following formula [Kukuła 1989]:

$$K_i = \frac{\left(m + \sqrt{m} \right) \cdot W_i - \sqrt{m} - 1}{m - 1} \tag{2}$$

where $W_i = \left(\sum_{j=1}^{m} a_{ij}^2 \right)^{1/2}$ is the specialization coefficient [Szyrmer 1975].

The measure K_i takes values from the interval [0, 1]. Low values of this measure can be interpreted in terms of uniform distribution of the phenomenon under investigation.

The basis for the division of countries into groups of objects that are similar with respect to the structure under consideration is the symmetric matrix $[d_{ik}]_{(i,k=1,\ldots,n)}$, elements of which represent measures of differentiation of structures being investigated that are estimated for each pair of countries according to the following formula [Kukuła 1989]:

$$d_{ik} = \frac{\sum_{j=1}^{m} \left| \alpha_{ij} - \alpha_{kj} \right|}{2} \tag{3}$$

Matrix $[d_{ik}]_{(i,k=1,\ldots,n)}$ was transformed into binary matrix of similarities $[p_{ik}]_{(i,k=1,\ldots,n)}$, with elements p_{ik} defined as follows:

$$p_{ik} = \begin{cases} 0, & when \quad d_{ik} < d^* \\ 1, & when \quad d_{ik} \geq d^* \end{cases}, \tag{4}$$

where the threshold value was assumed to be at the following level:

$$d^* = \frac{2\sum_{i=1}^{n} \sum_{k>i} d_{ik}}{n(n-1)} \tag{5}$$

Matrix $[p_{ik}]_{(i,k=1,\ldots,n)}$ is the starting point for grouping of voivodeships according to the procedure of Victor elimination proposed by Chomątowski and Sokołowski [1978].

RESEARCH RESULTS

High differentiation level expressed in the value of the coefficient of variation (see Table 2) is observed in case of these elements of the structure that refer to the farms of smallest area (up to 5 hectares) or large area (more than 20 hectares). Only in case of seven EU countries not more than 11% of agricultural tractors were identified in farms of the area up to 5 hectares. Turn in half of these countries at least 46% of the total number of tractors were in the possession of these small farms.

Table 2. Basic characteristics of elements of the structure of farms equipped with agricultural tractors according to areal groups of arable land

Specification	Areal groups [hectares]					
	< =5	5-10	10-20	20-50	50-100	>=100
quartile 1	0.11	0.12	0.11	0.09	0.03*	0.03*
median	0.27	0.16	0.16	0.17	0.07*	0.08*
quartile 3	0.46	0.21	0.20	0.23	0.17*	0.15*
arithmetic mean	0.29	0.17	0.16	0.18	0.10*	0.10*
coefficient of changeability	69.46	32.82	30.98	55.09	75.90*	83.64*

Source: own elaboration; *estimated for 27 countries (apart from Malta)

In the research of distribution uniformity of agricultural tractors in farms with respect to their area the concentration coefficient described by the formula (2) was applied. It is very useful due to its simple structure and easy interpretation. It is based merely on frequencies of occurring some levels instead of their values. Ranking arrangement of the EU countries with respect to the K_i value is presented by Figure 2. The highest level of the concentration coefficient was observed in Cyprus and Malta, in these countries there are most farms of the area up to 10 hectares and in fact there are no farms the area of which is more than 20 hectares, therefore the majority of machines occurred in small farms. In case of eight countries (Croatia, Portugal, Poland, Greece, Slovenia, Italy, Ireland and Romania) the average level of concentration of the phenomenon was established. In general in these countries most tractors were used in farms of the area up to 10 hectares. This fact can be explained by significant fragmentation of agriculture in case of countries classified in this group. The concentration coefficient in the other eighteen countries presented in the research and slow, on the level of less than 0.2, which show that the technical equipment of farms is uniform in all areal groups under investigation.

Figure 2. Ranking arrangement of the EU countries with respect to the K_i value estimated
   according to the formula (2)
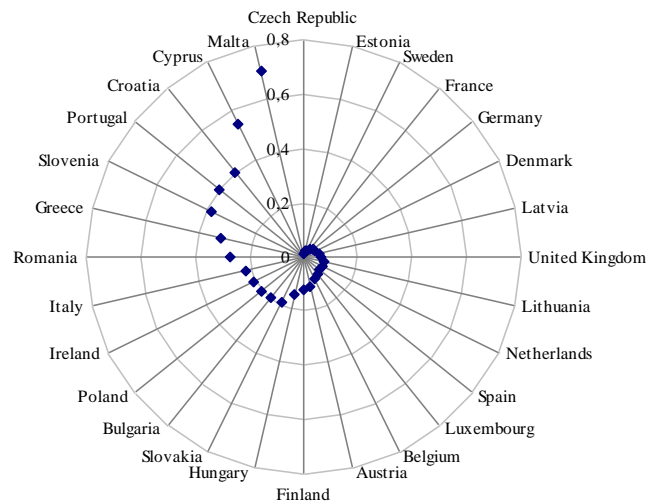
Source: own investigation

The interesting issue concerning such disciplines as regional policy for example, is the observation of objects with respect to the similarities that occur among them. The problem of identifying groups of similar objects out of the population under consideration can be solved with the help of vector elimination method. The result of the application of the research methods discussed earlier is the distinction of groups of objects of similar structure.

In 2013 assuming the thresh hold value for differentiation level to be *d*=0.345*, basing on vector elimination method 4 groups of similar countries were distinguished. Membership of particular objects in distinguished typological groups is shown in Figure 3.

Figure 3. Groups of countries similar with respect to the structure of percentage of farms
with agricultural tractors in 2013
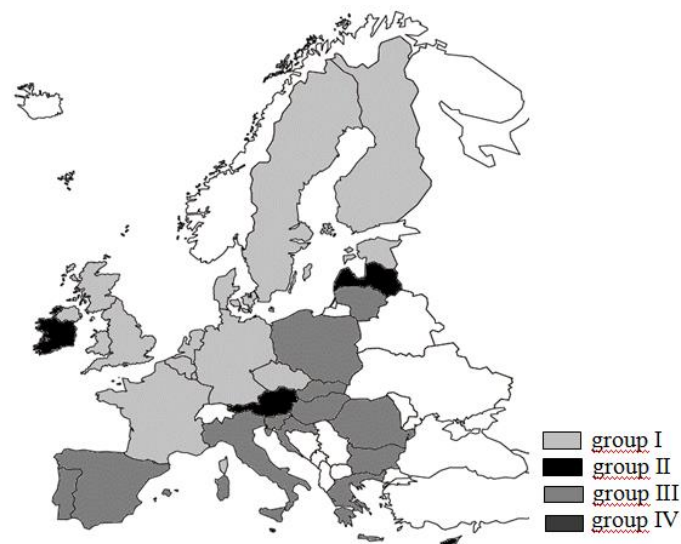
Source: own elaboration on the basis of the EUROSTAT database

Group I consists of Scandinavian countries and the EU-12 (Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Luxemburg, The Netherlands, Sweden, Great Britain), where the percentage of farms in the possession of agricultural tractors in particular areal groups was the highest in case of large farms, of the area more than 20 hectares.

In the countries of group II (Austria, Ireland, Latvia) the domination of farms of the area 10-20 hectares and 20-50 hectares occurs. This is associated with the highest percentage of farms with agricultural tractors.

The most numerous group III contains countries (Bulgaria, Croatia, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, Spain) with the agriculture of the highest level of fragmentation, where the percentage of farms equipped with agricultural tractors according to areal groups of arable land is the highest in the group of farms of the area up to 5 hectares.

Group IV consists of island countries (Malta, Cyprus), where small farms of the area up to 5 hectares dominate and large farms of the area more than 20 hectares do not occur. Therefore the highest percentage of farms with agricultural tractors is noticed in the lowest areal group up to 5 hectares.

The average profile of the percentage of farms with the agricultural tractors in particular areal groups for the EU countries is moderated by the most numerous groups – first and third group. The highest level of differentiation of average values in groups of EU countries can be observed in case of farms of the area of less than

5 hectares. The average value for group IV (Malta and Cyprus) differs significantly from the others indicating high level of average percentage of farms with the tractors (76%) for the areal group of farms of he area less than 5 hectares. In turn, in case of other areal groups one can observe some similarity of groups of the countries considered.

Figure 4. Centres of gravity of distinguished groups of countries similar with respect
        to the structure of farms in the possession of agricultural tractors in areal groups
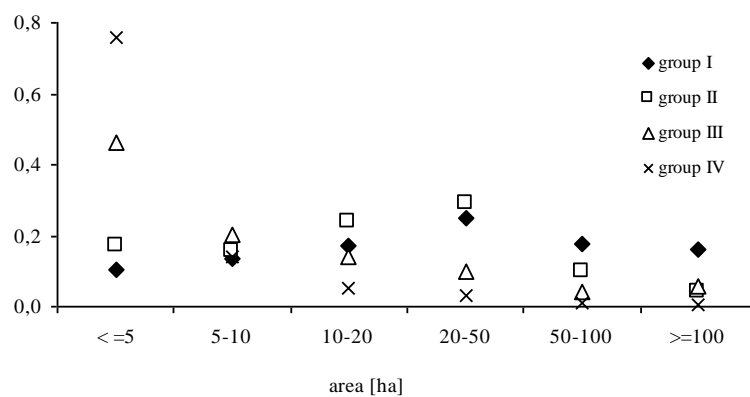
Source: own elaboration

CONCLUSIONS

The problem of selection of objects of similar structure out of the global population was solved with the help of the method of vector elimination. This procedure can be applied in case of the division of set into subsets containing units of similar structures. As a result of the application of this method four groups of countries of s method four types of countries were distinguished according to the similarity of the structure of farms being in the possession of agricultural tractors in particular areal groups of arable land. Tools of statistical analysis of structures turned out to be very helpful in the investigation that was carried out.

In case of farms of the area within 5-10 hectares, 10-20 hectares and 20-50 hectares one can observe a uniform distribution of the arithmetic mean and other position measures within each group.

The concentration coefficient related to the eighteen countries under investigation is rather low, less than 0.2, which proves uniform distribution of farm equipment with agricultural tractors in all of the areal groups under investigation.

The percentage of farms with agricultural tractors is connected with the character of areal structure of the particular country, therefore the highest percentage of farms being in the possession of such machinery in case

of Scandinavian countries and the countries of Western Europe occurs in the areal groups of 20-50 hectares, 50-100 hectares and more than 100 hectares. The countries of Western Europe with the agriculture of high level of fragmentation of farms (Italy, Portugal, Spain) and the EU members the accession of which took place after 2004 display the highest percentage of agricultural tractors for farms of the area up to 10 hectares. In countries such as Austria, Ireland or Latvia the percentage of farms with agricultural tractors is the highest in case of the areal groups of 10-20 hectares and 20-50 hectares. Island countries – Malta and Cyprus, form a separate group. In this case the highest percentage of farms in the possession of agricultural tractors occurs in small farms up to 5 hectares.

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