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USE OF AGRICULTURAL SERVICES IN EUROPEAN UNION REGIONS – A TYPOLOGICAL ANALYSIS

Key words: agricultural services, agriculture, European Union, typology of the regions

ABSTRACT. The purpose of this paper is to identify types that represent differing classes of European Union regions and agricultural service consumption indicators as of 2017. A comparison of the characteristics of agricultural farms in the identified types was used to search for a relationship between selected farm characteristics and the level of use of agricultural services. Data from the Farm Accountancy Data Network (FADN) were used in the research. The analysis covered 131 FADN regions located in 25 countries. The Ward method clustering procedure resulted in identifying five types of EU regions differing from one another in service consumption levels and selected agricultural indicators. The costs of agricultural services per hectare of agricultural land was the lowest on farms classified as types with the lowest average area of agricultural land (I and II), higher on farms encompassed by the types with a high average area of agricultural land (III and V), while in the type composed of regions with the highest average area of agricultural land (IV), it was lower than in types III and V. It can be supposed that farms with a small area of agricultural land almost exclusively used own equipment, neighborhood assistance and joint machinery ownership, while limiting the use of commercial agricultural services. Agricultural farms classified as the fourth type of regions primarily used own high-effective machines in plant production, while on large farms, but not large-scale farms, it was economically more favorable to purchase the services. The costs of agricultural services per 1 AWU were subject to similar regularities as the costs of agricultural services per hectare of agricultural land.

INTRODUCTION

The shift towards services is increasingly often regarded as a yardstick of economic advancement, both at a macro- and microeconomic level. Paweł Bożyk [2008] notes that the development of the service sector is a consequence of economic development and, at the same time, one of the conditions for this development. The differences in the level and pace of development, as well as the internal structure of this sector in individual countries may determine the power of their economies, vulnerability to crises and wealth of inhabitants. Services have also become an indispensable element of the economy's structure that meets the postulates of the concept of sustainable development. The use of services can substitute an operator's own capital and labor input while being a source of knowledge, innovation and know-how transfer. In agriculture, using services can stimulate an increase in production efficiency and, under certain conditions, can contribute to production sustainability [Kołodziejczak 2019].

The most important factors determining the level of use of agricultural services include the specialization of production and technological progress. As a result, these two factors increase the demand for services [Fereniec 1999, Jabłonka et al. 2010, Kołodziejczak 2011, 2016].

Three main service groups are used in agriculture: veterinary services (related to animal production); agricultural services (related to plant production); and financial services relating to the whole spectrum of farm operations. The level and patterns of service consumption are related to production structure and agricultural particularities found in different regions and countries, and may be regarded as an indirect yardstick of agricultural advancement. Due to size limitations, this paper focuses on one of these three groups: services related to plant production. In the case of agricultural services, which often require the use of expensive and complex machines, it is possible to choose between their purchase, maintenance and use on a farm, the purchase of a commercial service, the use of neighborhood assistance or owning machinery jointly with other farmers. This choice results from the economic optimization of production processes, own labor and hired labor resources, structure of agricultural production, farming practices and availability of co-financing for the purchase of machinery, especially under European Union structural programmes and the CAP [cf. Jabłonka et al. 2012, Kołodziejczak 2019]. According to Małgorzata Kołodziejczak [2019], in the case of agricultural services (connected with crop production), we may find two basic factors describing the absorption of services. Firstly, it is the level of development of agriculture and its intensity as well as the structure of crop production. The other factor is connected with the machine pool of farms and the volume of labor resources involved in production; however, the direction and intensity of the effect of these factors vary due to the specific character of agriculture in individual countries. Ownership of machines on farms does not have to mean that the value of their capital is high. Machines may be obsolete and depreciated many years earlier but may still be operational, which, despite low efficiency, may eliminate the need to purchase services on condition adequately large labor resources may be used in field works. On the other hand, machines may also be modern and purchased by farmers thanks to the funds obtained from EU programmes, if they decide to choose the expansion of their own machine park instead of using services. The level of absorption of agricultural services results, first of all, from needs defined by the volume of labor resources and the structure of crop production, owned equipment and preferences of farms concerning the choice between payment for services and investment in own machines.

European Union regions differ from one another in the value of characteristics considered. The agriculture of individual countries and regions operates in different natural conditions, differs in the level of development, structure and intensity of production, saturation with capital and farming practices, which are largely a result of their historical past [Kołodziejczak 2019]. The purpose of this paper is to identify the types that represent classes of European Union regions differing in agricultural production and agricultural services consumption indicators as of 2017. A comparison of characteristics of agricultural farms in the identified types was used to search for the relationship between selected farm characteristics and level of use of agricultural services. The volume of this paper is limited as per editorial requirements and, therefore, focus was placed on selected issues.

MATERIAL AND RESEARCH METHODS

In accordance with EU legislation [Council Regulation EC No. 138/2004] "**agricultural services constitute the hire of machines and equipment with corresponding labor**". Two categories of agricultural services can be identified: "1) agricultural services in the form of contract work at the production stage (i.e. agricultural contract work); 2) "other" agricultural services (the operation of irrigation systems; the design, planting and maintenance of gardens, parks, and green areas for sports facilities and the like; tree pruning and hedge trimming, etc.)". The term "contract work" could be confusing and was, therefore, clarified as follows: "contract work (...) may be performed by specialist contractors for whom these are principal activities (contractors in the true sense)". Data from the Farm Accountancy Data Network (FADN) were used in the research. The analysis covered all farms included in the Farm Accountancy Data Network located in 131[1] FADN regions in 25 countries. "Service cost" is understood in accordance with variable SE350 used in FADN standard results, i.e. "contract work – c.u., costs linked to work carried out by contractors and the hire of machinery" [EC 2000]. These services are almost exclusively connected with plant production. The use of these services in animal production is theoretically possible, however, from a FADN point of view, such a case is of marginal importance[2].

The hierarchical agglomerative method[3] was used to group the regions by intra-cluster variation and, thus, identify the types that represent classes of European Union regions differing in agricultural production levels and agricultural service consumption indicators. Among the many hierarchical methods, the Ward's method[4] was selected for the purposes of this study because of its widely recognized high efficiency. This allowed to extract groups of regions similar to each other in terms of variables estimated in this study. Euclidean distance[5] was used for clustering purposes:

$$\text{distance } (x, y) = \left\{ \sum_i (x_i - y_i)^2 \right\}^{\frac{1}{2}} \tag{1}$$

The approach based on the analysis of variance was adopted.

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[1] Five regions were not considered due to their non-agricultural nature: three French islands (Reunion, Martinique, Guadeloupe), Cyprus and Malta.

[2] In FADN standard results veterinary services are classified as SE330: "other livestock specific costs -c.u. Veterinary fees and reproduction costs, milk tests, occasional purchases of animal product (milk, etc.) costs incurred in market preparation, storage, marketing etc. of livestock products. Financial services and costs are recorded as SE380: interest paid – c.u. Interest and financial charges paid on loans obtained for the purchase of land, buildings, machinery and equipment, livestock, circulating capital, and interest and financial charges on debts. Interest subsidies are to be deducted" [EC 2000].

[3] Clustering, as a method of ordering objects, is essential in examining economic processes [Błażejczyk-Majka, Kala 2005].

[4] The more objects are similar to each other, the earlier they are grouped together (this is done by minimizing the sum of squared deviations of any two clusters that may be created at each stage) [Sokołowski 2002].

[5] Euclidean distance is one of the most common yardsticks used in respect to objects with measurable features [Pawlak, Poczta 2011, after: Mardia et al. 1979, Marek 1989].

Clustering was based on selected agricultural characteristics of EU regions. A series of attempts was made to create typology based on different sets of characteristics. The set of characteristics presented in this paper proved to be the only one meeting the material (from the perspective of economic significance) and statistical selection criteria. Upon eliminating strongly correlated variables[6], typology was developed based on the following indicators of agricultural production and agricultural service consumption in different European Union regions:

x_1 – agricultural land (ha),

x_2 – own labor input (FWU),

x_3 – share of plant production in the agricultural production structure (%),

x_4 – service cost per hectare of agricultural land (EUR),

x_5 – service cost per AWU (EUR),

x_6 – ratio of service cost to intermediate consumption (%).

The features that characterize identified typological clusters are based on the values of measure of differences between means of active features [Wysocki, 2010]. Developed using Ward's method, typology was based on 2017 data. The values of all (K = 6) characteristics of EU regions covered by this study (N = 131) were arranged into a K x N (131 x 6) data matrix. This became the basis for elaborating typology of European Union regions according to service output consumed by farms[7].

RESULTS AND DISCUSSION

As a result of the agglomeration routine, based on the agglomeration graph[8], the division of the population of European Union regions into five classes, differing from one another in the characteristics covered by this study, was found to be the optimum option (Figure 1). The mean values of active characteristics of classes are shown in Table 1. The measure of the difference of means, used to identify the characteristics of classes, is shown in Table 2. Table 3 presents the characteristics of typological classes of European Union regions clustered by selected features related to their production potential, agricultural production type and consumption of agricultural services.

The first type was composed of 44 regions (Table 3), mostly located in the southern part of Europe. This included all Romanian regions (8), Italian regions (15), Spanish regions (9), Greek regions (4), Bulgarian regions (3), Hungarian regions (3), one Portuguese region and Slovenia. Farms based in these regions reported the smallest own labor input. Also, they had the smallest area of agricultural land, a very low cost of services per hectare of agricultural land and per AWU, a small share of service costs in intermediate consump-

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6   Correlation was checked in the initial set of characteristics. Following this, the characteristics strongly correlated with others were eliminated.

7   Calculations were performed using Statistica software.

8   The agglomeration graph can indicate the cut-off point of the dendrogram. Usually, this is the place where a plateau is noticeable, i.e. the place where multiple clusters are formed at the same linkage distance [Błażejczyk-Majka, Kala 2005, Stanisz 2007].
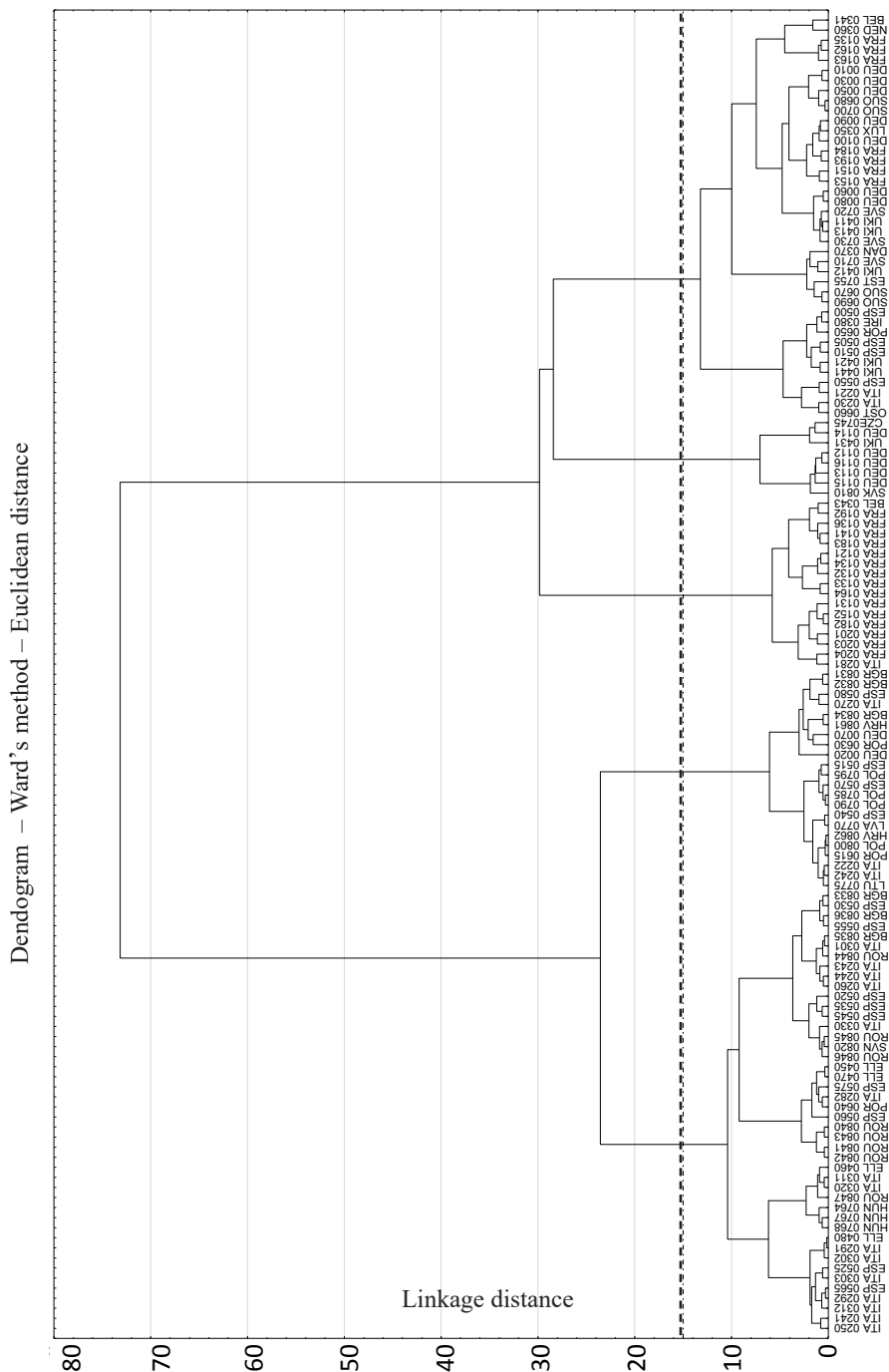
Figure 1. Dendrogram for EU regions clustered by service consumption in farms in 2017
Source: [FADN 2019], own calculations

tion and a very high share of plant production in the structure of agricultural production. Also, farms located in these regions demonstrated low labor productivity, low hired labor input and an extremely low value of machinery, equipment and vehicles [FADN 2019].

The second type was composed of 22 regions (Table 3), including all Polish regions (4), Croatian regions (2), four Spanish regions, three Bulgarian regions, three Italian regions, two German regions, two Portuguese regions, Lithuania and Latvia. Farms located in regions that form the second type were characterized by a small area of agricultural

Table 1. Intra-class mean levels of characteristics of service consumption in farms in EU regions in 2017

Characteristics	Classes					Total*
	1	2	3	4	5	
Active characteristics						
Agricultural land area [ha]	20.2	24.7	81.8	455.8	77.5	52.9
Own labor input [FWU]	1.0	1.2	1.3	1.0	1.3	1.2
Service cost per hectare of agricultural land [EUR]	47.3	40.8	201.9	68.0	119.5	75.0
Service cost per AWU [EUR]	712.7	726.6	7,672.7	4,488.4	5,942.5	2,118.6
Ratio of service cost to intermediate consumption [%]	5.6	4.7	14.4	6.0	7.9	6.4
Share of plant production in the agricultural production structure [%]	69.4	65.6	76.5	52.0	34.9	61.1

* median

Source: [FADN 2019], own calculations

Table 2. Measure of difference of means of service consumption characteristics for farms in different EU regions and classes (Ward's method) in 2017

Characteristics	Classes				
	1	2	3	4	5
Active characteristics					
Agricultural land area [ha]	-0.9	-0.8	0.8	11.6	0.7
Own labor input [FWU]	-1.3	0.0	0.7	-1.1	0.4
Service cost per hectare of agricultural land [EUR]	-0.6	-0.7	2.6	-0.2	0.9
Service cost per AWU [EUR]	-0.5	-0.5	2.0	0.9	1.4
Ratio of service cost to intermediate consumption [%]	-0.4	-0.7	3.4	-0.2	0.6
Share of plant production in the agricultural production structure [%]	0.5	0.3	1.0	-0.6	-1.6

Gray cells show the features that characterize identified typological clusters

Source: [FADN 2019], own calculations

land, the lowest cost of services per hectare of agricultural land and per AWU, and the smallest share of service costs in intermediate consumption. Also, they had a large share of plant production in the structure of agricultural production and own high labor input. Characteristically, farms located in these regions had the lowest total cost of services, the lowest service intensity of agricultural production, a small additional area of leased agricultural land, low hired labor input and the lowest productivity of land and labor [FADN 2019].

The third type (Table 3) includes 15 French regions, one Italian region and one Belgian region. Farms of this type reported the highest own labor input, the highest cost of services per hectare of agricultural land and per AWU, the largest share of service costs in intermediate consumption, and the highest share of plant production in the structure of agricultural production. Their other characteristics are: the highest service intensity of agricultural production, a large additional area of leased agricultural land, high hired labor input, a high value of machinery, equipment and vehicles owned, and high gross value added [FADN 2019].

Table 3. Characteristics of types of EU regions clustered by service consumption in farms in 2017*

Type	Characteristics of the type	Number of regions
1	Low share of service costs in intermediate consumption; low cost of services per hectare of agricultural land and per AWU; the smallest area of agricultural land; the smallest own labor input; and a high share of plant production in the structure of agricultural production	44
2	Extremely small area of agricultural land; the lowest cost of services per hectare of agricultural land and per AWU; the lowest share of service costs in intermediate consumption; and a high share of plant production in the structure of agricultural production	22
3	Large area of agricultural land; high own labor input; high cost of services per hectare of agricultural land and per AWU; the highest share of service costs in intermediate consumption; and the highest share of plant production in the structure of agricultural production	17
4	The largest area of agricultural land; high costs of services per AWU; and extremely low own labor input	8
5	Large area of agricultural land; high own labor input; high cost of services per hectare of agricultural land and per AWU; high share of service costs in intermediate consumption; and the smallest share of plant production in the structure of agricultural production	40

* regions which form the types: as per Tables 1 and 2
Source: [FADN 2019], own calculations

Type four included eight regions (Table 3): five German regions (all of them located in the eastern part), one British region, Slovakia and the Czech Republic. Farms of this type reported the largest area of agricultural land, extremely low own labor input, and a high cost of services per AWU. Characteristically, they also recorded the highest total cost of services, the highest hired labor input, the largest additional area of leased agricultural land, the highest value of machinery, equipment and vehicles, the highest gross value added and an extremely high productivity of labor. Conversely, this type was found to have low productivity of land [FADN 2019].

Type five was composed of 40 regions (Table 3), including all Finnish regions (4), German regions (7), French regions (7), British regions (5), Spanish regions (4), Swedish regions (3), Italian regions (2), one Belgian region, one Portuguese region, Austria, Denmark, Estonia, the Netherlands, Ireland and Luxembourg. The distinctive features of farms clustered in this type were the highest costs of services per AWU, an extremely high cost of services per hectare of agricultural land, a large area of agricultural land, and the smallest share of plant production in the agricultural production structure. Characteristically, farms located in these regions also reported a high cost of services per farm, an extremely high productivity of labor, and a high value of machinery, equipment and vehicles owned [FADN 2019].

The types characterized by high costs of services purchased are mainly located in Western and Northern Europe. Conversely, low costs of services are reported by types found in Central, Eastern and Southern Europe. Therefore, in addition to characteristics covered by the clustering routine, non-quantifiable impacts of the decades-long tradition of farming practices and economic development level (including agricultural development) also need to be taken into account. European Union regions where the costs of services are high are mainly located in Western and Northern Europe; conversely, low service costs can be found in Central, Eastern and Southern European regions. Therefore, in addition to microeconomic variables, the non-quantifiable impact of the multiannual tradition of farming practices and the overall level of regional agriculture development also need to be taken into account [cf. Kołodziejczak 2018, 2019].

CONCLUSIONS

The clustering procedure resulted in identifying five types of EU regions differing from one another in service consumption levels and selected agricultural indicators. As a result of the agglomeration routine, based on the agglomeration graph, the division of the population of European Union regions into five classes, differing from one another in the characteristics covered by this study, was found to be the optimum option. When summing up the conducted research, it can be noticed that:

1. The costs of agricultural services per hectare of agricultural land were the lowest on farms classified as types with the lowest average area of agricultural land (I and II), higher on farms encompassed by types with a high average area of agricultural land (III and V), while in the type composed of regions with the highest average area of agricultural land (IV), it was lower than in types III and V. It can be supposed that

farms with a small area of agricultural land almost exclusively used own equipment, neighborhood assistance and joint machinery ownership, while limiting the use of commercial agricultural services to selected field works (e.g. harvest). Agricultural farms classified as the fourth type of regions primarily used own high-effective machines in plant production. This presumption can be confirmed by a low share of agricultural service costs in intermediate consumption. Plant production predominated in the third type of regions characterized by the highest cost of services per hectare of agricultural land and per AWU, as well as by the highest share of agricultural service costs in intermediate consumption. A similar situation was observed in types I and II. The average area of agricultural land in the third type was high, however it did not include large-scale farms. On the one hand, such an area can be too large to use in the production process relatively cheaply but own low-effective machines as in types I and II. On the second hand, this area is too small to profitably buy high-effective but expensive machines as in type IV. In this situation, it was economically more favorable to purchase services.

2. The share of plant production in the structure of agricultural production was the highest in the third type of regions with the highest costs of agricultural services purchased, as well as in types I and II with the lowest costs of agricultural services purchased. In the fourth type of regions plant production reached more than 50% of agricultural production, while in the fifth type animal production predominated. A lower share of plant production could have had an impact on decreasing the share of agricultural service costs in intermediate consumption due to the costs connected with animal production. At the same time, a farm's orientation towards animal production could increase the level of use of agricultural services, if plant production was of either a complementary or an auxiliary nature in relation to animal production.

3. Costs of agricultural services per AWU were subject to similar regularities as the costs of agricultural services per hectare of agricultural land, with differences, resulted mainly from a different scale of labor input. Low own labor input (FWU) in type IV were supplemented by hired labor input, which is specific on large-scale farms. This caused a decrease in the average value of the cost of services per 1 AWU in this group, despite own low labor input.

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WYKORZYSTANIE USŁUG ROLNICZYCH
W REGIONACH UNII EUROPEJSKIEJ – ANALIZA TYPOLOGICZNA

Słowa kluczowe: usługi rolnicze, rolnictwo, Unia Europejska, typologia regionów

ABSTRAKT

Celem artykułu jest wyodrębnienie typów reprezentujących klasy regionów Unii Europejskiej, zróżnicowanych ze względu na wartości wskaźników charakteryzujących produkcję rolniczą i korzystanie z usług rolniczych w 2017 roku. Porównanie charakterystyk rolnictwa w wyodrębnionych typach posłużyło do poszukiwania zależności między wybranymi cechami gospodarstw a poziomem korzystania z tego rodzaju usług. Wykorzystano dane z systemu zbierania i wykorzystywania danych rachunkowych z gospodarstw rolnych w Unii Europejskiej – Farm Accountancy Data Network (FADN) z 2017 roku. Uwzględniono 131 regionów FADN znajdujących się w 25 państwach. W wyniku grupowania, przeprowadzonego metodą Warda, wyodrębniono pięć typów regionów UE, różniących się między sobą poziomem korzystania z usług i wartością wybranych wskaźników charakteryzujących rolnictwo. Koszt korzystania z usług rolniczych na 1 ha UR był najniższy w gospodarstwach zaliczonych do typów o najniższej średniej powierzchni UR (I i II), wyższy w gospodarstwach zaliczonych do typów o wysokiej powierzchni UR (III i V), ale w typie regionów o największej średniej powierzchni UR (IV) był niższy niż w typie III i V. Można przypuszczać, że gospodarstwa o niewielkiej powierzchni UR wykorzystywały przede wszystkim własny sprzęt, pomoc sąsiedzką oraz zespołowe użytkowanie maszyn, a ograniczały korzystanie z komercyjnych usług rolniczych. Gospodarstwa rolne w IV typie regionów, przypuszczalnie opierały produkcję roślinną w dużej mierze na własnych, wysokowydajnych maszynach. Dla dużych, ale nie wielkoobszarowych gospodarstw w typie III, korzystniejsze ekonomicznie mogło być wykorzystanie zakupionych usług. Koszt zakupu usług na 1 AWU podlegał podobnym prawidłowościom jak koszt zakupu usług na 1 ha UR.

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