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RESOURCES AND EFFECTIVE CONDITIONS FOR THE PRODUCTION OF CEREAL AND OIL PLANTS IN THE EUROPEAN UNION

Key words: resource determinants of agricultural production, efficiency of agricultural producers,
the cereals and oil plant market

ABSTRACT. The aim of the article was to compare the resource conditions and efficiency of cereal and oil plant production in individual EU member states and assess changes over the analyzed decade 2007-2016. This implementation was used to construct three indicators regarding resource conditions, which are the relation of land and labor (area of agricultural land/labor input AWU), capital and land (value of fixed assets/area of agricultural land), and capital and labor (value of fixed assets/labor input AWU). In turn, production efficiency was determined using the following indicators: the ratio of production and land (value of production/area of agricultural land), production and labor (value of production/labor input AWU) and production and capital (value of production/value of fixed assets). The above indicators were developed for the years 2007-2009, 2010-2013 and 2014-2016, and then the position in ranking and distance from the model for each country were determined using the Hellwig method. The research used data from the Accounting Data Network from Agricultural Holdings. The obtained results indicate a high level of convergence between the resources owned by agricultural holdings and production results achieved. There was also a significant difference between the development of individual resource and efficiency indicators in favor of producers from the so-called "old Union", towards countries that joined the EU after 2004. However, comparing the results achieved in individual periods, it can be concluded that this disproportion was diminishing.

INTRODUCTION

Agricultural farms must cope with many challenges which, due to their context (social, environmental and economic), often stand in contradiction. In the economic dimension, the basic aspect of functioning of each market entity is to maintain business continuity, further development and ensure a fair income to its owners, hence monitoring the financial standing of market entities is extremely important [Nowicka, Stankiewicz 2009]. Equally important for the implementation of the above objectives is the economic situation of the whole economy and supply-demand relations in particular sectors.

Attention should also be paid to the universality of the concept of efficiency in economics. Most often and generally, they are defined as a relation between potential (broadly understood capital, people with experience and goals, land and information) and the ways

and results (effects) of its use [Kulawik 2007]. In turn, the improvement of efficiency can most often result from access to new technologies, from the more effective use of an existing one, or through the use of economies of scale [Latruffe 2010]. It is worth emphasizing that when assessing the effectiveness and productivity of entities operating on the market, relative values are particularly important, emphasizing the level of expenditure necessary to achieve specific results [Runowski 2008].

The structure and type of resources involved are of key importance to the production results of agriculture, and thus the efficiency of production factors [Czakowska, Czakowski 2018]. In the majority of so-called new Member States, in the last two decades, there has been a systematic reduction in the area of agricultural land, determined primarily by a decline in arable land. The loss of arable land was one of the determinants of the decrease in the number of farms and those working in agriculture. This tendency was also due to the dynamic development of infrastructure and rural urbanization processes near agglomerations, most typically associated with the conversion of land for non-agricultural purposes [Zasada 2011]. In this context, it is worth noting that the changes taking place were conditioned not only by the effects of the common agricultural policy, but also by mobilizing funds under cohesion funds and the development of human capital.

The purpose of the article was to compare the resource conditions and efficiency of cereal and oil plant production in individual EU member states and assess changes over the analyzed decade 2007-2016. Its implementation was based on selected indicators of resource and efficiency determinants and the study of interdependencies between the production results achieved and the production factors involved by individual producers. The work focuses on the study of the efficiency of cereal and oil plant production, as it is one of the key areas of agricultural production in Poland and the EU, in terms of production value and area of crops [Scarlat et al. 2013].

RESEARCH MATERIAL AND METHODS

The article uses two groups of indicators regarding resource and efficiency conditions. The first of these included three indicators regarding resource conditions, which are the relationship of land and labor (area of agricultural land/labor input AWU), capital and land (value of fixed assets/area of agricultural land), and capital and labor (value of fixed assets/labor input AWU). In turn, production efficiency was determined using the following indicators: the ratio of production and land (value of production/area of agricultural land), production and labor (value of production/labor input AWU) and production and capital (value of production/value of fixed assets). The above ratios were developed for the years 2007-2009, 2010-2013 and 2014-2016, giving an arithmetic mean value for the indicated periods, and then the position in ranking and distance from the standard for each country were determined using the Hellwig method. The research used data from the Farm Accountancy Data Network (FADN) for all 28 European Union member states, excluding 4 countries in which a representative sample was not collected – Belgium, the Netherlands, Luxembourg and Malta. The type of analyzed farms, based on the FADN classification, is TF-151.

Based on the constructed indexes of resource and efficiency conditions for agricultural holdings specializing in the production of cereals and oil plants, an attempt was made to determine which of them were the most effective among the EU countries surveyed. For this purpose, Hellwig's pattern of development was used [Hellwig 1968], often used in the literature on the subject [Matuszczak 2013]. It allows to synthesize factors of various character and assigns them one synthetic aggregate measure [Adamowicz, Janulewicz 2012]. The procedure of proceeding in this method assumes the normalization of variables, which leads to depriving the titres of measurement results and unifying their orders of magnitude. This process can be carried out in accordance with various standardization formulas, among which, the most commonly used ones include classical standardization carried out in accordance with the following formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}, \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, n$$

where:

z_{ij} – standardized values of the j -th feature for the i -th object,

x_{ij} – the value of the j -th characteristic for the i -th object,

\bar{x}_{ij} – the arithmetic mean of the j -th feature,

S_j – standard deviation of the j -th feature.

On the basis of a matrix of normalized values of features, a model method was used assuming the existence of an abstract model object (z_{oj}), with coordinates determined separately for characteristics being stimulants and destimulants according to the following procedure: $z_{oj} = \max z_{ij}$, when z_{ij} is a stimulant, $z_{oj} = \min z_{ij}$, when z_{ij} is a destimulant. In the next step of this method, the distances of each of the examined objects were determined from the abstract pattern, according to the following formula:

$$d_{io} = \sqrt{\sum_{j=1}^m (z_{ij} - z_{oj})^2}$$

where: d_{io} – the Euclidian distance of object z_{ij} from the reference object z_{oj} .

The last stage of application of the Hellwig development method was the calculation of a synthetic measure of development. The meters created take values in the interval [0; 1]. Closer to the unity of the meter value for a given object means that it is more similar to the pattern, including a set of the most advantageous features [Bąk 2016]:

$$d_i = 1 - \frac{d_{io}}{d_o}; \quad d_o = \bar{d}_o + 2S_d; \quad \bar{d}_o = \frac{1}{n} \sum_{i=1}^n d_{io}; \quad S_d = \sqrt{\frac{1}{n} \sum_{i=1}^n (d_{io} - \bar{d}_o)^2}$$

where:

d_i – synthetic development index (measure of development),

d_o – the Euclidian distance of the object from the reference object,

\bar{d}_o – the arithmetic mean of taxonomic distances,

S_d – standard deviation of taxonomic distances.

The article also examined the correlation between the value of production (thous. PLN) and expenditure: land (ha), labor (AWU) and capital (PLN thousand) for producers of cereals and oil plants in 2007-2016 using Pearson's linear correlation coefficients.

RESERCH RESULTS

Table 1 presents the most important resource conditions of producers of cereals and oilseeds in 2007-2009, 2010-2013 and 2014-2016. On the basis of developed indicators presenting technical equipment for labor and land, as well as areas of agricultural land attributable to labor input, it was determined that resource relations are most favorable for EU-15 countries. In the years 2014-2016, the countries from this group took the first 11 places among all explored EU countries, and the first country outside the "old Union" was Latvia, ranked 12th – in accordance with the results of the synthetic development index using the Hellwig method. In all the analyzed periods, the most favorable resource conditions occurred alternately in three countries: Great Britain, Denmark and Ireland. The distinguishing feature of these three leading variable countries was the ratio of the amount of capital held by producers of cereal and oil plants to the involvement of the labor resource that was higher than in other countries. The difference was particularly evident in relation to the least-developed EU countries, such as Romania and Bulgaria - in 2014-2016 the value of this variable was around 30 times lower there than in the ranking leaders (in the first analyzed period it was even around 70-times smaller). Producers of cereal and oil plants, in Poland, in this aspect, performed better, mainly due to a higher level of capital employed. However, in Poland, it was possible to observe a low level of land and labor relations, which resulted mainly from a considerable fragmentation of productive structures and a relatively high percentage of people working in agriculture [Czyżewski, Czakowski 2017].

Between the analyzed periods, a slight decrease in disproportions between countries with the lowest values of the development index and leaders of the ranking was observed. This group included producers of cereal and oil plants from Poland. Between the researched periods, the value of the synthetic development rate for them increased from 0.2 to 0.24, with a simultaneous decrease in classification from 20th to 21st place.

The obtained results of the effectiveness study of cereal and oil plant producers (Table 2), in the years 2007-2009, 2010-2013 and 2014-2016, indicated that the producers of cereal and oil plants from the same countries were closest to the optimal model, as in the case of the study of resource conditions, and again it was the EU-15 countries, and the producers of Denmark, Great Britain and Ireland who were the leaders on the list. The shaping of the relation of production results to the number and structure of individual production factors involved indicated that the most effective producers used much more capital in the production process than in the case of producers achieving worse results. It allowed to reduce the use of land, above all, the labor intensity of production. On the other hand, in countries characterized by a lower capital-intensive level, much more land and labor resources were involved. It is worth adding that this was, to some extent, compensated by lower labor costs and cheaper agricultural land in less affluent and economically weaker EU countries.

Table 1. More important resource determinants of cereal and oil plant producers in 2007-2009, 2010-2013 and 2014-2016

Specification	Land/labor ^a			Capital/land ^b			Capital/labor ^c			Development indicator ^d			Place in the ranking ^e		
	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016
UK	108.5	110.9	102.8	9.2	11.9	15.8	994.5	1313.8	1623.5	0.61	0.76	0.83	3	2	1
DK	72	75.9	83.6	20.7	20.0	19.4	1491.5	1521.7	1621.1	0.73	0.83	0.83	2	1	2
IE	70.5	76.8	72.4	27.1	17.1	20.2	1913.7	1313.3	1462.3	0.85	0.75	0.78	1	3	3
SE	126.9	120.9	105.3	4.5	6.6	8.4	576.6	793.9	889.3	0.54	0.61	0.61	4	4	4
FI	100.5	107.1	102.1	4.5	5.0	5.8	451.7	533.4	596.2	0.45	0.50	0.52	5	5	5
EE	120.8	145.4	145.4	0.9	0.9	1.3	107.7	135.6	183.9	0.41	0.47	0.5	7	6	6
DE	88.7	92.6	92.5	4.5	4.9	6.2	399.1	457.0	571.2	0.41	0.45	0.49	6	8	7
IT	24.4	24.1	30.1	18.1	17.9	15.6	439.2	430.0	468.2	0.4	0.46	0.45	8	7	8
FR	93.1	89.1	90.4	1.4	1.6	1.8	130.8	144.6	158.7	0.35	0.34	0.36	10	9	9
ES	81.3	65.9	75.5	3.2	3.4	2.9	259.9	221.5	217.0	0.36	0.32	0.35	9	11	10
AT	58.7	52.9	49.6	4.8	5.6	5.6	284.1	294.3	277.4	0.32	0.34	0.33	12	10	11
LV	78.5	86.3	76.9	0.9	1.1	1.5	69.8	93.7	116.6	0.29	0.32	0.32	13	12	12
SI	5	16.2	14.6	2.6	8.1	11.5	38.6	131.4	168.1	0.23	0.25	0.3	18	15	13
CZ	63.1	60.2	64.6	1.6	1.9	1.6	103.6	114.1	101.7	0.27	0.27	0.28	14	13	14
HU	65.4	62.7	60	1.2	1.6	2	80.4	97.1	117.2	0.26	0.27	0.28	15	14	15
SK	58.1	55.6	61.8	0.7	0.8	1.1	39.4	46.4	69.0	0.23	0.23	0.26	17	19	16
CY	61.4	40.3	42	5.2	3.9	3.6	316.3	212.7	156.0	0.33	0.25	0.26	11	17	17
GR	26.6	30.8	31.5	4.1	4.8	5.3	107.8	146.5	167.3	0.2	0.24	0.26	22	18	18
LT	65.1	59.8	54.2	0.9	1.2	1.4	60.5	70.0	73.8	0.26	0.25	0.25	16	16	19
PT	48.2	35.7	45.6	1.5	2.3	2.4	71.8	83.7	106.8	0.22	0.21	0.25	19	22	20
PL	33.6	25.2	21.9	2.9	5.0	6.2	93.2	125.0	135.2	0.2	0.23	0.24	20	20	21
BG	47.6	54.3	53.4	0.4	0.6	0.9	19.7	32.1	49.9	0.2	0.22	0.24	21	21	22
RO	29.6	45.8	37.2	0.7	0.8	1.4	21.0	35.5	53.0	0.15	0.20	0.2	23	23	23
HR	-	20.2	24.9	-	6.2	3.3	-	388.3	81.4	-	0.19	0.2	-	24	24
EU	68.4	67.0	64.0	5.45	5.6	6.05	361.5	363.7	394.3	-	-	-	-	-	-

^a the area of agricultural land (ha)/labor input (AWU), ^b value of fixed assets (thous. PLN)/agricultural area (ha), ^c value of fixed assets (thous. PLN)/labor input (AWU), ^d value of the synthetic development index (Hellwig's method), ^e place in the ranking among the surveyed countries

Country names: BG – Bulgaria, CY – Cyprus, CZ – the Czech Republic, DK – Denmark, DE – Germany, GR – Greece, ES – Spain, EE – Estonia, FR – France, HR – Croatia, HU – Hungary, IE – Ireland, IT – Italy, LT – Lithuania, LV – Latvia, AT – Austria, PL – Poland, PT – Portugal, RO – Romania, FI – Finland, SE – Sweden, SK – Slovakia, SI – Slovenia, UK – Great Britain, EU – the average for countries studied

Source: own calculations based on [FADN 2019]

Table 2. More important efficiency indicators for cereal and oil plant producers in 2007-2009, 2010-2013 and 2014-2016

Specification	Production/ land ^a			Production/labor ^b			Production/ capital ^c			Development indicator ^d			Place in the ranking ^e		
	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016	2007-2009	2010-2013	2014-2016
DK	2.03	3.24	2.29	146.3	246.0	190.9	0.10	0.16	0.12	0.94	1.00	1.00	1	1	1
UK	1.13	1.37	1.39	121.8	151.9	142.1	0.12	0.12	0.09	0.66	0.64	0.77	3	2	2
IE	1.04	1.40	1.45	73.7	107.2	104.7	0.04	0.08	0.07	0.68	0.59	0.70	2	3	3
SE	0.84	1.18	1.32	105.7	141.5	138.4	0.19	0.18	0.15	0.51	0.53	0.64	5	4	4
DE	1.14	1.43	1.37	101.3	132.3	126.5	0.26	0.29	0.22	0.53	0.50	0.59	4	5	5
AT	1.00	1.36	1.34	58.7	70.9	66.7	0.21	0.24	0.24	0.41	0.39	0.45	8	7	6
FR	1.05	1.35	1.15	97.7	120.3	103.7	0.75	0.83	0.65	0.47	0.43	0.45	6	6	7
IT	1.34	1.31	1.26	32.3	31.5	37.9	0.07	0.08	0.08	0.44	0.36	0.42	7	8	8
FI	0.56	0.61	0.65	55.5	64.9	66.6	0.12	0.12	0.11	0.35	0.33	0.37	9	9	9
CZ	0.81	1.01	1.05	50.9	60.7	67.7	0.49	0.53	0.67	0.33	0.31	0.37	10	10	10
HU	0.73	0.85	0.98	48.1	53.1	59.0	0.60	0.55	0.50	0.31	0.28	0.35	11	12	11
SK	0.66	0.93	0.98	38.5	51.8	60.5	0.99	1.12	0.87	0.27	0.28	0.34	14	11	12
EE	0.41	0.50	0.57	49.5	73.5	83.6	0.47	0.54	0.46	0.26	0.27	0.32	16	15	13
SI	0.34	1.16	1.16	5.0	18.8	16.9	0.04	0.15	0.10	0.11	0.28	0.32	23	13	14
GR	0.93	0.99	1.00	24.5	30.5	31.3	0.23	0.21	0.19	0.30	0.28	0.31	12	14	15
LV	0.52	0.64	0.70	40.8	54.4	53.7	0.59	0.58	0.46	0.26	0.26	0.29	17	17	16
PR	0.51	0.72	0.79	24.8	25.5	35.4	0.34	0.31	0.34	0.23	0.23	0.28	20	21	17
PL	0.72	0.92	0.85	24.8	23.1	18.6	0.29	0.19	0.14	0.27	0.26	0.26	15	16	18
BG	0.41	0.71	0.70	19.1	38.3	37.6	1.00	1.21	0.75	0.19	0.24	0.26	22	19	19
LT	0.53	0.64	0.68	34.2	37.9	36.8	0.58	0.54	0.51	0.25	0.24	0.25	18	20	20
ES	0.48	0.53	0.50	40.0	35.2	38.1	0.15	0.17	0.17	0.28	0.24	0.25	13	18	21
HR	-	0.76	0.74	-	15.4	18.5	-	0.21	0.23	-	0.06	0.24	-	24	22
RO	0.64	0.65	0.70	17.1	29.5	25.8	0.82	0.83	0.49	0.23	0.23	0.24	19	22	23
CY	0.27	0.59	0.40	16.7	30.9	14.9	0.07	0.11	0.12	0.20	0.19	0.18	21	23	24
UE	0.81	1.05	1.00	55.1	70.7	6567	0.38	0.40	0.32	-	-	-	-	-	-

^a value of production (thous. PLN)/agricultural area (ha), ^b value of production (thous. PLN)/labor input (AWU); ^c value of production (thous. PLN)/value of fixed assets (PLN thousand), ^d value of the synthetic development index (Hellwig's method), ^e place in the ranking among the surveyed countries
Country names: see Table 1

Source: own calculations based on [FADN 2019]

Table 3. Values of Pearson's linear correlation coefficients for producers of cereal and oil plants in 2007-2016, between the value of production (thous. PLN) and manufacturing factors: land (ha), labor (AWU), capital (thous. PLN)

Specification		Land [ha]	Labor [AWU]	Capital [thous. PLN]
Production value [thous. PLN]	BG	-0.314582	-0.385175	0.654224^a
	CY	0.611952	0.405286	-0.111798
	CZ	0.490401	0.384064	0.365955
	DK	0.216563	0.255298	0.026321
	DE	-0.281812	-0.268859	-0.032529
	GR	-0.332496	0.125803	0.219312
	ES	0.127031	0.825509^a	0.217605
	EE	-0.264501	0.121328	0.497272
	FR	0.465524	-0.242207	0.259387
	HR	0.227036	-0.917908	0.373090
	HU	0.677546^a	0.534768	0.624659
	IE	0.787670^a	0.868098^a	-0.284137
	IT	0.636019^a	0.654596^a	0.755012^a
	LT	0.597068	0.088492	-0.164508
	LV	0.106958	0.034809	-0.148087
	AT	0.391630	-0.542073	0.344022
	PL	0.976526^a	0.868694^a	-0.502655
	PR	-0.168480	-0.331354	0.447226
	RO	0.075239	0.691495^a	0.311202
	FI	0.388581	0.389726	0.455803
	SE	0.855624^a	0.672674^a	0.882410^a
	SK	0.541589	0.585080	0.788048^a
	SI	0.585231	0.620426	-0.158840
	UK	0.150258	-0.358866	0.603675

^a the correlation coefficient is statistically significant ($p = 0.05$, for $n = 10$ the critical value = 0.6319, the calculations were performed using the STATISTICA ver. 12, in order to determine the stationarity of the series, the Dickey-Fuller ADF test was performed using the gretl 1.9 econometric package)

Country names: see Table 1

Source: own calculations based on [FADN 2019]

On the basis of the above considerations, an attempt was made to determine the impact of selected variables concerning the resource conditions of cereal and oil plant crop production in 2007-2016 on the shaping of their production value (Table 3). Among the many interesting relationships, it is worth paying special attention to the fact that only for two countries (Italy and Sweden), correlation relationships between the value of production and all the researched resources were observed at the same time. On the other hand, in the case of Poland and Ireland, such a correlation appeared twice – in the case of explaining the value of production through land and labor. It is also interesting that none of the significant compounds were negative, and the correlation coefficients lower than zero were found least frequently between the development of land resources and the production value, which may indicate the special importance of this factor (in relation to the other two) to the production results.

CONCLUSIONS

On the basis of the conducted research, it can be concluded that producers of cereal and oil plants from EU-15 countries are most effective. In these countries, a significant level of capital expenditure was found in relation to the labor and land resources involved. This confirmed that, in these countries, there was a higher level of intensification of agriculture than in the EU-12 countries, in which production was more extensive. In countries that joined the European Union after 2004, a lower level of capital involvement was compensated by a greater share of land and labor resources, which has already been confirmed by previous studies of other authors [Bojnec et al. 2014].

However, comparing the results achieved in individual periods, it can be concluded that this disproportion has decreased over the ten years studied, and labor intensity and land consumption of production in less-developed countries has gradually been reduced in favor of an increasing share of capital. It is worth adding that the said process is quite slow due to the complexity of structural adjustments in agriculture.

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ZASOBOWE ORAZ EFEKTYWNOŚCIOWE UWARUNKOWANIA PRODUKCJI ZBÓŻ I ROŚLIN OLEISTYCH W UNII EUROPEJSKIEJ

Słowa kluczowe: ekonomiczne uwarunkowania produkcji rolnej, rynek zbóż i roślin oleistych, integracja europejska

ABSTRAKT

Celem artykułu jest porównanie uwarunkowań zasobowych oraz efektywności produkcji zbóż i roślin oleistych w poszczególnych krajach członkowskich Unii Europejskiej. Realizacji tego celu posłużyło skonstruowanie trzech wskaźników dotyczących uwarunkowań zasobowych, stanowiących relację ziemi i pracy (powierzchnia użytków rolnych/nakłady pracy AWU), kapitału i ziemi (wartość środków trwałych/powierzchnia użytków rolnych) oraz kapitału i pracy (wartość środków trwałych/nakłady pracy AWU). Efektywność produkcji określono przy zastosowaniu następujących wskaźników: stosunek produkcji i ziemi (wartość produkcji/powierzchnia użytków rolnych), produkcji i pracy (wartość produkcji/nakłady pracy AWU) oraz produkcji i kapitału (wartość produkcji/wartość środków trwałych). Powyższe wskaźniki opracowano dla lat 2007-2009, 2010-2013 oraz 2014-2016, a następnie określono przy wykorzystaniu metody Hellwiga pozycję w rankingu oraz odległość od wzorca dla każdego państwa. W badaniach wykorzystano dane z Sieci Danych Rachunkowych z Gospodarstw Rolnych. Uzyskane wyniki wskazują na wysoki poziom zbieżności pomiędzy zasobami posiadanymi przez gospodarstwa rolne a osiąganymi wynikami produkcyjnymi. Zaobserwowano również występowanie istotnej różnicy pomiędzy kształtowaniem się poszczególnych wskaźników zasobowych i efektywnościowych na korzyść producentów z państw tzw. „starej Unii”, względem państw, które dołączyły do Wspólnoty po 2004 roku. Porównując osiągnięte wyniki w poszczególnych okresach, można stwierdzić, że dysproporcja ta ulegała zmniejszaniu.

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