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**MARKET OUTPUT AS A CRITERION
FOR THE USE OF AGRICULTURAL POTENTIAL
IN DIFFERENT REGIONS OF POLAND**

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Abstract

The aim of the study was to present agricultural market output as a criterion for using agricultural potential in various regions of Poland.

The analysis was conducted taking into account selected indicators characterizing the natural, agrotechnical, organizational, and economic conditions of agriculture in individual voivodeships. The average for Poland was used as the basis for comparisons. The basic sources of information were the statistical data of Statistics Poland, the research results of the Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy, and the research results presented in the literature.

According to our hypothesis, the environmental, agrotechnical, organizational, and economic conditions determine the level and structure of agricultural market output in Poland as a criterion for using the agricultural potential in the regions. The research conducted so far shows that the impact of individual groups of conditions is clearly differentiated and visible in the production specialization and their share in agricultural market output in Poland. Regional diversification of agricultural market output in Poland should be basis for directing scientific research and advisory activities. It also reflects the regional differentiation of the effects of the EU Common Agricultural Policy.

Keywords: agricultural potential, agricultural market output, regional diversification.

JEL codes: Q10, Q13, Q24.

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Introduction

A characteristic feature of Polish agriculture is its regional diversification, both in terms of the environmental conditions and the production and economic effects.

One of the criteria for evaluating the regional diversification of the use of the potential of Polish agriculture may be marketability, which derives from the production function of this sector of the national economy and its links to the market (Sadowski, 2017). Only part of the agricultural production, obtained on the basis of the existing potential, is intended for the market. Market output is the part of the global production which is intended for sale by a farm or an agricultural enterprise.

The concept of the marketability of production, commonly used in practice and statistics (Statistics Poland, 2000-2001; Harasim, 2006), means the ratio of the value of agricultural market output to the value of global production of this sector, branch, farm, or product. Agricultural market output is adopted in regional research as a criterion for the use of agricultural potential in various regions of Poland (Gałecka, 2015).

The regional diversification of the use of the potential of Polish agriculture derives from the habitat conditions as well as the organizational and economic conditions. The impact of the organizational and economic conditions is growing. Research by the Institute of Soil Science and Plant Cultivation – Scientific Research Institute (ISSPC-SRI) shows that the western part of the country is characterized by a larger average farm area, lower fragmentation of land, greater possibilities for the use of new technologies, as well as higher yields of crops, a higher share of the so-called market species, i.e. wheat and rape, in the sowing structure, and a larger production scale (Kopiński and Matyka, 2016; Krasowicz and Kuś, 2015). At the same time, it can be observed that in western and northern Poland, agriculture is mainly focused on the crop production, in particular on the cultivation of cereals and rape. The regional diversification also applies to the livestock production, which dominates the structure of the agricultural market output in Poland (Krasowicz and Kuś, 2015).

In the agricultural and economic and agricultural literature, much attention is paid to the problems of regional diversification and the use of the potential of Polish agriculture. However, an analysis of the publications on the agricultural diversification indicates that so far relatively little attention has been paid to the problems of regional diversification of the agricultural market output in Poland in terms of the use of its potential. The interests of the authors of publications, representing various research centers and specializations, have been more often focused on the problems, functions, and competitiveness of agriculture (Nowak, 2017; 2019), production of selected agricultural products (Krasowicz and Madej, 2020), possibilities for the development of the bioeconomy (Chylek et al., 2017), greenhouse gas emissions (Gołębiewska, Chlebicka and Maciejczak, 2016), and evaluation of the environmental impact of agricultural production, taking into account the balance of nutrients (Wrzaszcz and Prandecki, 2019; Wrzaszcz and Kopiński, 2019). These problems are, of course, directly or indirectly linked to the use of agricultural potential, which so far has been considered mainly through the prism of possibilities for the development of various groups of farms (Zegar, 2018). Sometimes, it has only been emphasized that

the area structure, marketability, and specialization of farms determine the possibilities for sustainable development and for shaping innovation and the competitiveness of agriculture in the regions (Zegar, 2014). Pawlak and Pocztą (2010) showed that the weakness of Polish agriculture is the fact that mainly farms with a small-scale production show significant production which is often their permanent feature. Research by the ISSPC-SRI evaluated the use of the agricultural production area as one of the determinants of agricultural potential (Fotyma and Krasowicz, 2001; Krasowicz and Filipiak, 1999; Igras, Jadczyzyn and Stuczyński, 2010).

When comparing the agricultural production potential in the European Union countries, Sadowski and Wojtasik (2019) found that the level of development of European agriculture varies significantly. They showed that the highest manufacturing potential exists in the EU-15 countries, and out of the EU-12 countries in the Czech Republic and Slovakia. The lowest level, measured by means of a synthetic indicator, was observed in Bulgaria, Greece, and Romania in 2008, while in 2016 the lowest level was observed in Greece, Romania, Slovenia, and Poland. These countries are characterized by a fragmented agrarian structure and relatively high labor input in agriculture.

Cereal yields are regarded as a measure for the use of agricultural potential and, above all, of the agricultural production area, and this is justified by the dominant share of this group of crops in the sowing structure (Krasowicz and Kuś, 2015). Little information can be found in the literature about the impact of the agrarian structure on marketability. Siekierski (2020) claims that Polish agriculture is changing, but the existing family farm model has a positive impact on the development of our country's agricultural sector and its position in the EU and in the world. He emphasizes that "among the countries joining the European Union in 2004, it was Poland which was successful in the production of and trade in agri-food products, not the Czech Republic or Hungary which rely on large farms".

The share in the European and global agricultural markets is mostly determined by medium and large farms. Their importance in Poland is growing and the structural changes occurring in Polish agriculture are a contributing factor to the improvement of production efficiency. These farms have a significant impact on the level, dynamics, and structure of the agricultural market output. The area structure of farms is just one of the determinants of the agricultural market output in the regions.

The aim of the study was to present agricultural market output as a criterion for the use of agricultural potential in various regions of Poland.

Research Materials and methods

The analysis was conducted taking into account selected indicators characterizing the regional diversification of the environmental, agrotechnical, organizational, and economic conditions and the dynamics of their changes, by voivodeship. The average values for Poland were used as a benchmark.

The basic sources of information were the statistical data from Statistics Poland (2000-2019), the research results of the ISSPC-SRI (Kopiński and Matyka, 2016; Krasowicz and Kuś, 2015) and the results of research conducted by various authors (Czudec, Kata, and Miś, 2017; Smędzik, 2018).

The following methodological assumptions were adopted:

1. The resources of agricultural production factors (land, labor, capital) are regionally diversified and determine the production potential of Polish agriculture.
2. The degree of use of the potential of Polish agriculture and the diversification of its marketability are determined, to a significant extent, by organizational and economic conditions, including the principles of the common agricultural policy.
3. Poland's integration with the European Union contributed to the growing interest in the regional diversification of the use of the potential of Polish agriculture and its marketability.
4. The regional diversification of the use of the potential of Polish agriculture, evaluated through the prism of marketability, determines the priorities of advisory activities supporting practice.

The hypothesis was adopted that environmental, agrotechnical, organizational, and economic conditions determine the level and structure of the agricultural market production in Poland as a criterion for the use of the agricultural potential in the regions.

The environmental conditions of agricultural production have been presented using the agricultural production area valorization index according to the ISSPC-SRI (Krasowicz and Kuś, 2015), which takes into account the quality and agricultural suitability of soils, agro-climate, relief, and hydrographical conditions. The share of permanent grassland in utilized agricultural area has also been taken into account.

The following characteristics were considered as the agrotechnical conditions determining the use of the potential of the agricultural production area:

- consumption of mineral fertilizers in kg NPK·ha⁻¹ of UAA;
- consumption of lime fertilizers in kg CaO·ha⁻¹ of UAA;
- share of very acidic and acidic soils in %;
- cereal yields in t·ha⁻¹ as a measure of the standard of agricultural conditions and the use of the agricultural production area.

The regional diversification of the organizational and economic conditions, by voivodeship, has been presented using the following indicators:

- share of farms with an area of less than 5 ha of UAA(%);
- share of farms with an area of more than 50 ha of UAA (%);
- average farm area in ha of UAA;
- employment of persons·100 ha⁻¹ of UAA;
- stocking density in LU·100 ha⁻¹ of UAA;
- global crop production in cereal units per 1 ha of UAA;
- purchase of products in cereal units per 1 ha in kg·haha⁻¹ (on average, for 2016 and 2017);
- share of the voivodeships in the purchase of agricultural products expressed in cereal units in % (on average, for 2016 and 2017);
- purchase of cereals in kg·ha⁻¹;
- purchase value of the agricultural, crop, and livestock production in PLN·ha⁻¹ of UAA;
- share of livestock production in agricultural market output (%);
- investment expenditure in PLN ·ha⁻¹ of UAA.

The selected characteristics describe the specificities of agriculture in the voivodeships. At the same time, they are factors that shape the level and structure of the agricultural market output as a measure of the use of potential. The analyzed data have been presented in tabular and graphical forms. A statistical assessment of the analyzed indicators was also carried out and, using k-means cluster analysis, groups of voivodeships with similar marketability were identified and their simplified description was made. The scope of the research was determined by the data availability and degree of aggregation.

Discussion Results

Regional diversification of the agricultural market output in Poland

The regional diversification of the agricultural market output in Poland is determined by the environmental, agrotechnical, organizational, and economic conditions present in the individual voivodeships (Kopiński and Matyka, 2016, Krasowicz and Kuś, 2015; Krasowicz et al., 2009). These conditions determine the level and structure of the agricultural market output in the voivodeships. Table 1 shows that the purchase value of agricultural products in $\text{PLN}\cdot\text{ha}^{-1}$ of utilized agricultural area, as a measure of the agricultural market production, was clearly diversified among the voivodeships. On average, between 2017 and 2018, the highest purchase value in $\text{PLN}\cdot\text{ha}^{-1}$ of utilized agricultural area was observed in the three voivodeships: Wielkopolskie, Mazowieckie, and Kujawsko-Pomorskie. Low values of this indicator were found in the following voivodeships: Podkarpackie, Małopolskie, Lubelskie, Dolnośląskie, Świętokrzyskie, and Zachodniopomorskie.

The second group of voivodeships is characterized by a relatively small purchase value of animal products per 1 ha of utilized agricultural area, which is linked to the low stocking density. The relative diversification of the purchase value, as presented in Figures 1-3, attests to the presence of specialization of the agricultural production. It also reflects the impact of the production scale and intensity. The purchase values of agricultural products and the share in utilized agricultural area determine the share of the individual voivodeships in the agricultural market output of Poland (Table 2). The Wielkopolskie, Mazowieckie, Kujawsko-Pomorskie, and Łódzkie Voivodeships are characterized by a higher share in domestic agricultural market output than it would appear from their share in UAA. The high purchase value is mainly determined by processed production (into animal products).

The diversification of the share of crop and livestock production in agricultural market output derives from the agricultural sector's orientation and specialization. The voivodeships specializing in market crop output (Dolnośląskie, Lubelskie) are characterized by a higher share of this type of production in domestic agricultural production. The small share of the Podlaskie Voivodeship in market crop output is a consequence of the region's specialization in livestock production, especially in the production of milk.

Table 1
*Purchase value of agricultural products (PLN·ha⁻¹ of utilized agricultural area)
 by voivodeship (on average, from 2017-2018)*

No.	Voivodeship	Purchase value (PLN·ha ⁻¹ of UAA)		
		in total	plant products	animal products
1.	Dolnośląskie	2,625	1,808	817
2.	Kujawsko-pomorskie	5,025	1,953	3,072
3.	Lubelskie	2,945	1,418	1,527
4.	Lubuskie	3,225	1,081	2,144
5.	Łódzkie	4,428	935	3,493
6.	Małopolskie	2,186	730	1,456
7.	Mazowieckie	6,143	1,536	4,607
8.	Opolskie	4,487	2,464	2,023
9.	Podkarpackie	1,812	785	1,027
10.	Podlaskie	4,992	177	4,815
11.	Pomorskie	4,827	1,598	3,229
12.	Śląskie	3,880	951	2,929
13.	Świętokrzyskie	2,965	723	2,242
14.	Warmińsko-mazurskie	4,479	867	3,612
15.	Wielkopolskie	6,734	1,683	5,051
16.	Zachodniopomorskie	2,698	1,391	1,307
	POLAND	4,424	1,319	3,105

Source: Statistics Poland, 2000-2019 and own research.

Table 2
The share of voivodeships in agricultural market output in 2017 (2016 fixed prices) (%)

No.	Voivodeship	Share of voivodeships in UAA	Market output		
			in total	crop	livestock
1.	Dolnośląskie	6.3	4.3	7.7	1.9
2.	Kujawsko-pomorskie	7.3	7.7	9.0	6.9
3.	Lubelskie	9.6	8.5	13.2	5.4
4.	Lubuskie	2.8	1.9	2.4	1.7
5.	Łódzkie	6.7	7.6	7.2	7.4
6.	Małopolskie	3.7	3.2	3.9	2.7
7.	Mazowieckie	13.1	17.8	15.4	19.4
8.	Opolskie	3.5	2.7	3.7	2.1
9.	Podkarpackie	4.0	1.9	2.1	1.7
10.	Podlaskie	7.4	6.3	1.4	9.6
11.	Pomorskie	5.1	4.9	4.5	5.2
12.	Śląskie	2.6	2.9	2.5	3.1
13.	Świętokrzyskie	3.4	3.5	4.8	2.6
14.	Warmińsko-mazurskie	6.9	5.2	2.9	6.6
15.	Wielkopolskie	12.1	18.4	14.9	20.8
16.	Zachodniopomorskie	6.7	3.2	4.4	2.4
	POLSKA	100.0	100.0	100.0	100.0

Source: Statistics Poland, 2000-2019.

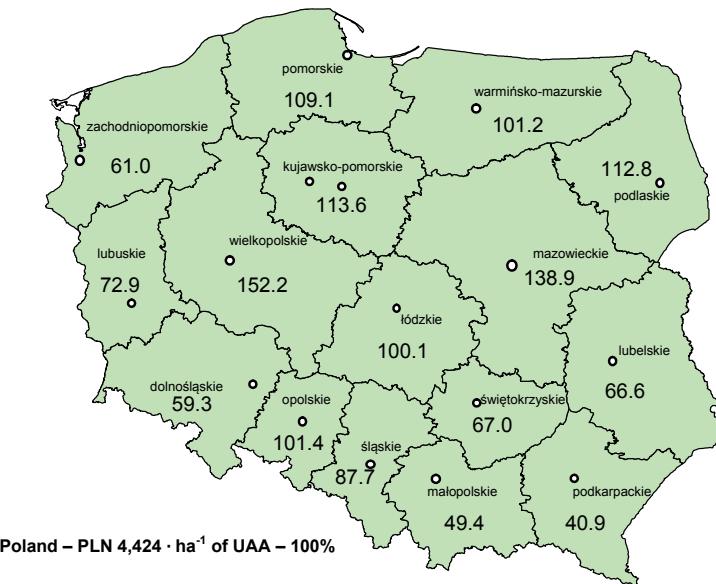


Fig. 1. Relative diversification in the purchase value of agricultural products in total, on average from 2017-2018 (%).

Source: Statistics Poland, 2000-2019 and own calculations.

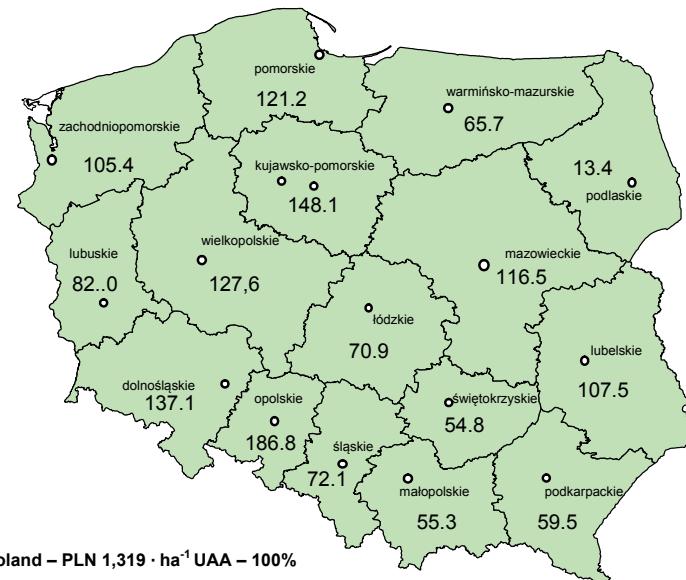


Fig. 2. Relative diversification in the purchase value of plant products, on average from 2017-2018 (%).

Source: as in Fig. 1.

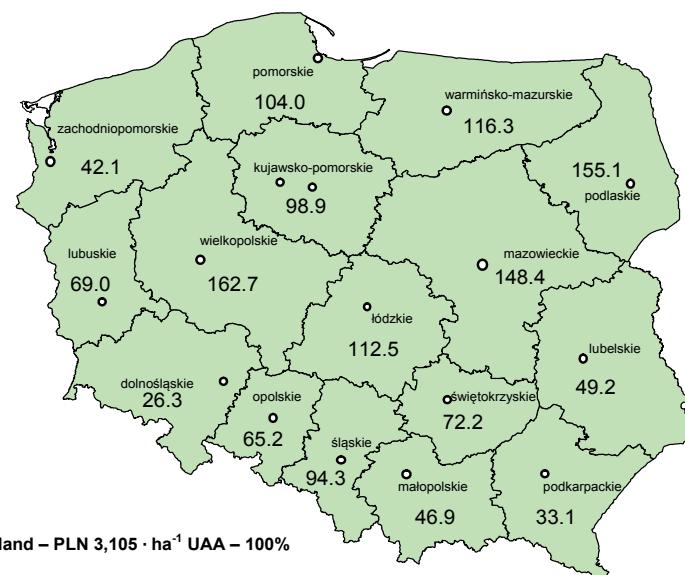


Fig. 3. Relative diversification in the purchase value of animal products, on average from 2017-2018 (%).

Source: as in Fig. 1.

Table 3
Environmental conditions of marketability of Polish agriculture (by voivodeship)

No.	Voivodeship	Agricultural production area valorization index according to the ISSPC-SRI (pts)	Agroclimate (pts) ^a	Share of permanent grassland in UAA (%)
1.	Dolnośląskie	74.9	10.4	15.2
2.	Kujawsko-pomorskie	71.0	9.2	13.1
3.	Lubelskie	74.1	10.6	16.5
4.	Lubuskie	62.3	11.6	21.7
5.	Łódzkie	61.9	11.5	16.4
6.	Małopolskie	69.3	9.3	39.5
7.	Mazowieckie	59.9	9.7	26.9
8.	Opolskie	81.4	13.2	8.8
9.	Podkarpackie	70.4	10.7	33.1
10.	Podlaskie	55.0	7.5	38.3
11.	Pomorskie	66.2	8.5	17.8
12.	Śląskie	64.2	11.2	21.2
13.	Świętokrzyskie	69.3	10.6	21.8
14.	Warmińsko-mazurskie	66.0	8.1	33.6
15.	Wielkopolskie	64.8	11.2	13.5
16.	Zachodniopomorskie	67.5	9.8	10.5
POLSKA		66.6	9.9	21.4

^a The assessment of agro-climate is a component of the agricultural production area valorization index, but it also reflects the specificities of the voivodeships

Source: ISSPC-SRI and Statistics Poland data and own study.

The conditions of marketability of Polish agriculture are diversified both regionally and within the voivodeships in the subregions. The environmental conditions of the agricultural market output by voivodeship have been presented in Table 3. The most favorable environmental conditions for the agricultural production, assessed according to the agricultural production area valorization index, are in the Opolskie and Dolnośląskie Voivodeships. The Opolskie Voivodeship, in addition to a high quality of soils, is also characterized by the most favorable agro-climate index in the country. On the other hand, the Podlaskie Voivodeship, which has the least favorable habitat conditions, is characterized by a large share of permanent grassland which, in addition to fodder crops grown on arable land, is a source of feed for livestock, particularly cattle.

The diversification of agrotechnical conditions and production efficiency, assessed by means of four selected indicators, has been presented in Table 4.

Table 4
Agrotechnical conditions of marketability of Polish agriculture (by voivodeship)

No.	Voivodeship	Consumption of mineral fertilizers, on average from 2016-2017 (kg NPK·ha ⁻¹ of UAA)	Consumption of lime fertilizers, on average from 2016-2017 (kg CaO·ha ⁻¹ of UAA)	Share of very acidic and acidic soils (%) (2017)	Cereal yields, on average 2016 and 2017 (t·ha ⁻¹)
1.	Dolnośląskie	168.1	87.2	28	5.2
2.	Kujawsko-pomorskie	183.3	126.9	25	4.5
3.	Lubelskie	143.3	50.0	40	4.3
4.	Lubuskie	105.6	32.3	37	4.4
5.	Łódzkie	135.1	44.9	55	3.5
6.	Małopolskie	88.1	23.1	51	4.0
7.	Mazowieckie	111.9	32.7	52	3.2
8.	Opolskie	195.9	96.4	17	5.9
9	Podkarpackie	78.7	30.8	58	3.8
10.	Podlaskie	103.5	35.6	58	3.0
11.	Pomorskie	138.8	46.4	41	4.1
12.	Śląskie	127.5	42.3	34	4.4
13.	Świętokrzyskie	111.9	28.3	36	3.1
14.	Warmińsko-mazurskie	107.6	48.9	38	3.8
15.	Wielkopolskie	160.8	42.7	34	4.5
16.	Zachodniopomorskie	126.6	76.7	35	4.3
	POLAND	133.5	53.0	37	4.1

Source: Statistics Poland, 2000-2019 and own calculations.

The highest production intensity, measured by the level of consumption of mineral fertilizers in kg NPK per 1 ha of utilized agricultural area, can be observed in the following voivodeships: Opolskie, Kujawsko-Pomorskie, Dolnośląskie, and Wielkopolskie. These voivodeships have a relatively lower share of very acidic and acidic soils and a higher standard of agricultural conditions, assessed based on the level of cereal yields obtained, shaped by the species structure of higher yielding cereals, especially the high share of wheat and corn cultivated for grain. The degree of use of the agricultural production potential in the regions, measured by the agricultural market output, is also determined by organizational and economic conditions. Their diversification, analyzed according to a number of selected indicators, has been presented in Table 5.

The inclusion of the organizational and economic conditions, particularly the area structure of farms and the average utilized agricultural area in ha per 1 farm, in the comparisons makes it possible to discover the reasons for the diversification of the marketability of Polish agriculture. The voivodeships characterized by a two- or three-times higher share of farms with an area of more than 50 ha than the national average are most often specialized in intensive market crop output. This group of farms uses modern, innovative technologies, makes more use of certified seed material, and uses rational fertilization and integrated pest management, as well as cultivation simplifications. Farms with an area of more than 50 ha, according to the IAFE-NRI classification (Józwiak, Sobierajewska, Zieliński, and Ziętara, 2019) are considered to be development-oriented and have a positive impact on the level of marketability of agriculture in the region. On these farms, an increase in the area for the cultivation of cereals has been observed in recent years; so has an increase in their impact on the market of this group of crops. The IAFE-NRI data (Józwiak et al., 2019) also shows that a group of about 32 thousand large farms is the major supplier of grain to the market and its share in turnover is about 85%. The share of this group of farms in the cultivation area is about 31%, and in production it is as much as 65%. There is no doubt that the high share of this group of farms in the domestic production of cereals as well as in market crop production is the result of using intensive technologies allowing them to obtain grain yields ranging from 6 to 10 t·ha⁻¹. The specialization of the individual voivodeships in the market production of cereals is evidenced by the purchase of cereal grain in kg·ha⁻¹ of utilized agricultural area. Table 5 shows that in terms of this criterion, the following voivodeships are in the lead: Opolskie, Dolnośląskie, Zachodniopomorskie, and Pomorskie, which are characterized by a much smaller stocking density, expressed in LU·100 ha⁻¹ of UAA, than the national average. The Wielkopolskie Voivodeship is characterized by the highest domestic purchase of agricultural products in cereal units and in PLN per 1 ha, mainly due to combining intensive crop production with livestock production. In addition to the stocking density, an important factor determining the regional diversification of the marketability of Polish agriculture is the sowing structure, which is characterized by major changes (Table 6).

Table 5
The organizational and economic conditions of marketability of Polish agriculture (by voivodeship) in 2017

No.	Voivodeship	Share of farms (%) with an area of up to 5 ha	Average farm area more than 50 ha	Employment (persons ·100 ha ⁻¹ of UAA)	Stocking density (LU ·100 ha ⁻¹ of UAA)	Global crop production (kg·100 ha ⁻¹ cereal unit·ha ⁻¹)	Purchase of cereals (kg·100 ha ⁻¹ UAA)	Purchase of products (cereal unit·ha ⁻¹)	Purchase of products in the purchase of agricultural products (%)	Share of livestock production in the purchase of agricultural products (%)	Share of voivodeships in the purchase of products (%)	Investment expenditure (PLN·ha ⁻¹ of UAA)
1.	Dolnośląskie	48.2	6.0	16.10	9.2	16.5	50.6	1787	31.9	25.4	5.5	302
2.	Kujawsko-pomorskie	32.7	4.5	16.15	9.9	53.5	48.6	1096	53.2	59.8	9.3	295
3.	Lubelskie	53.3	1.3	7.94	21.1	28.5	42.1	452	27.3	34.4	6.0	273
4.	Lubuskie	46.9	8.4	19.76	8.5	33.7	39.0	858	34.0	49.8	2.1	387
5.	Łódzkie	50.2	0.8	7.75	17.6	54.7	38.0	304	41.1	58.1	6.6	305
6.	Małopolskie	82.1	0.4	4.00	48.6	36.8	34.9	135	18.5	47.3	1.7	388
7.	Mazowieckie	45.4	1.3	9.02	15.6	60.7	33.9	313	53.6	66.3	16.5	390
8.	Opolskie	44.1	6.5	18.94	9.6	31.1	62.0	1831	55.8	39.8	4.5	414
9.	Podkarpackie	82.0	0.7	4.43	46.0	22.5	32.2	264	19.1	55.8	1.7	263
10.	Podlaskie	27.3	2.7	13.48	11.7	81.9	31.2	117	38.1	92.2	6.3	377
11.	Pomorskie	33.2	6.2	18.56	8.4	37.5	41.6	1332	52.6	62.5	6.2	290
12.	Śląskie	70.1	1.7	6.77	27.3	44.5	40.4	438	39.0	63.4	2.2	469
13.	Świętokrzyskie	64.3	0.5	5.75	30.7	38.0	34.7	170	29.1	39.9	2.0	302
14.	Warmińsko-mazurskie	28.2	9.2	23.70	7.1	53.1	34.1	668	40.3	75.8	5.9	404
15.	Wielkopolskie	39.2	3.5	13.96	11.8	78.2	46.7	743	65.9	70.5	18.6	468
16.	Zachodniopomorskie	35.7	12.4	28.68	5.5	18.7	42.8	1527	32.4	42.7	4.7	302
	POLAND	53.1	2.5	10.31	16.1	48.1	40.8	712	42.9	59.2	100.0	354

Source: Statistics Poland, 2000-2019 and own study.

Table 6

The share of selected groups of crops in the sowing structure in 2000 and 2017 (%)

Voivodeship	2000				2017			
	cereal		industrial in total	fodder	cereal		potatoes	industrial in total
	in total	including: wheat			in total	including: wheat		
Dolnośląskie	74.5	39.1	7.2	13.0	2.0	72.8	42.5	2.3
Kujawsko-pomorskie	73.2	22.5	5.5	10.7	6.7	66.5	24.7	2.6
Lubelskie	73.4	25.7	10.9	5.6	4.8	74.7	29.6	2.0
Lubuskie	78.8	21.0	5.5	7.2	3.7	72.8	23.7	1.2
Łódzkie	69.7	12.5	16.8	1.9	7.1	78.9	15.7	5.1
Małopolskie	55.9	24.4	17.1	1.0	19.4	71.8	30.8	7.8
Mazowieckie	71.0	10.5	14.2	2.5	7.2	73.6	14.1	3.2
Opolskie	75.2	34.9	5.5	14.5	3.0	77.4	44.1	1.0
Podkarpackie	59.9	27.0	17.7	2.8	13.2	73.3	31.8	8.6
Podlaskie	78.3	9.7	10.3	1.0	9.1	62.3	8.2	2.5
Pomorskie	74.7	25.1	6.6	7.9	7.9	69.9	32.0	2.8
Śląskie	70.8	21.7	12.6	4.3	7.9	78.8	28.6	3.3
Świętokrzyskie	65.1	20.4	15.1	3.3	10.1	74.3	26.0	5.3
Warmińsko-mazurskie	74.2	23.9	4.9	7.7	11.4	64.6	28.0	1.3
Wielkopolskie	77.0	15.7	6.7	7.8	4.9	72.4	16.4	3.1
Zachodniopomorskie	75.8	30.4	4.8	12.8	4.4	67.6	37.6	1.9
POLAND	72.3	21.2	10.1	6.4	7.2	70.7	22.2	3.0

Source: Statistics Poland, 2000-2019 and own study.

In 2017, compared to 2010, the share of potatoes and sugar beets in the sowing structure decreased significantly. On the other hand, the share of rape and turnip rape increased significantly, which resulted in an increase in the share of the group of industrial crops in total. The share of fodder crops also increased. However, the scale of the changes was clearly differentiated by voivodeship. In the Podlaskie Voivodeship, which specializes in market milk output and, at the same time, is characterized by the lowest agricultural production area valorization index in the country and a large (more than 38%) share of permanent grassland, fodder crops on arable land accounted for more than 30% in 2017. This was linked to the necessity of balanced feeding of cattle and the need to provide roughage, mainly in the form of corn silage. The voivodeships with a high level of agricultural fragmentation are characterized by a much higher share of potatoes in the sowing structure; in these voivodeships, potatoes are cultivated for the self-supply of households. A large share of rape in the sowing structure can be observed in the voivodeships of western and north-western Poland. The concentration of cultivation of crops, in addition to the area of land, determines the share of the voivodeships in the domestic harvest of the more important agricultural products. The figures in Table 7 indicate the specialization in crop production and also, indirectly, the share of individual products in the structure of the agricultural market production. The Mazowieckie, Lubelskie, Łódzkie, and Świętokrzyskie Voivodeships are the areas with a clear specialization in the cultivation of vegetables and fruit.

Table 7
The share (%) of the voivodeships in the harvest of selected agricultural products in 2016

Voivodeship	Cereals in total	Rape and turnip rape	Sugar beet	Potato	Root vegetables	Fruit from trees	Fruit from shrubs
Dolnośląskie	9.0	16.2	8.0	8.8	4.2	1.1	0.9
Kujawsko-pomorskie	8.8	9.5	20.0	6.9	12.7	2.1	2.0
Lubelskie	11.0	8.1	16.6	7.5	11.1	18.7	14.6
Lubuskie	2.7	4.2	0.7	1.7	1.9	0.9	0.9
Łódzkie	6.4	1.7	2.4	11.9	12.3	11.5	11.8
Małopolskie	2.9	1.1	0.6	6.3	12.4	3.3	3.4
Mazowieckie	9.0	3.2	6.4	11.7	15.0	42.4	46.3
Opolskie	6.7	10.9	7.6	3.8	1.1	0.2	0.2
Podkarpackie	2.9	2.2	2.1	6.9	1.9	1.4	1.2
Podlaskie	4.1	1.6	0.0	2.2	0.8	0.5	0.4
Pomorskie	5.1	8.3	5.1	6.6	2.6	0.7	0.6
Śląskie	2.9	2.9	0.9	2.7	1.6	0.3	0.2
Świętokrzyskie	2.4	0.9	2.0	4.1	7.1	11.8	12.8
Warmińsko-mazurskie	5.1	5.8	1.2	2.5	1.5	0.6	0.4
Wielkopolskie	15.1	12.8	20.3	11.0	12.0	3.4	3.5
Zachodniopomorskie	5.8	10.9	5.8	5.7	1.7	1.3	1.0
POLAND	100	100	100	100	100	100	100

Source: Statistics Poland, 2000-2019 and own study.

Table 8

Livestock production by voivodeship (annual average from 2013-2015)

Voivodeship	Cow's milk		Live cattle and calves ^a		Live pigs		Live poultry		Chicken eggs	
	million l	%	thousand tons	%	thousand tons	%	thousand tons	%	million pcs	%
Dolnośląskie	194	1.5	8.6	2.0	17.9	1.0	56.3	3.1	651	6.3
Kujawsko-pomorskie	900	7.1	32.4	7.4	209.1	12.0	101.3	5.5	373	3.6
Lubelskie	744	5.9	21.6	4.9	124.5	7.1	70.9	3.9	339	3.3
Lubuskie	100	0.8	3.5	0.8	25.6	1.5	79.0	4.3	335	3.3
Łódzkie	992	7.9	49.6	11.3	185.4	10.6	122.8	6.7	580	5.7
Małopolskie	345	2.7	17.7	4.0	45.2	2.6	27.6	1.5	555	5.4
Mazowieckie	2,730	21.7	80.8	18.4	171.6	9.8	430.5	23.4	1,957	19.1
Opolskie	263	2.1	6.4	1.5	53.7	3.1	38.7	2.1	132	1.3
Podkarpackie	235	1.9	4.6	1.1	39.5	2.3	26.9	1.5	285	2.8
Podlaskie	2,430	19.3	49.1	11.2	78.0	4.5	80.3	4.4	192	1.9
Pomorskie	356	2.8	15.2	3.5	146.3	8.4	90.7	4.9	282	2.8
Śląskie	241	1.9	12.1	2.8	41.1	2.4	74.9	4.1	439	4.3
Świętokrzyskie	256	2.0	17.3	3.9	45.0	2.6	44.5	2.4	178	1.7
Warmińsko-mazurskie	941	7.5	19.5	4.4	84.9	4.9	156.6	8.5	230	2.2
Wielkopolskie	1,710	13.6	94.2	21.5	439.1	25.1	325.2	17.7	3,466	33.8
Zachodniopomorskie	168	1.3	5.6	1.3	41.0	2.3	112.8	6.1	263	2.6
POLAND	12,605	100	438.2	100	1,748.1	100	1,839.0	100	10,257	100

^a per meat (including fats and offal)

Source: Chylek et al., 2017.

Table 9
Structure of the agricultural market output by product and by voivodeship in 2016 (2015 fixed prices) (%)

No.	Voivodeship	Total	Produkcja roślinna						Produkcja zwierzęca		
			total	cereals	industrial	potatoes	vegetables	fruit	total	live cattle	live pigs
1.	Dolnośląskie	100.0	74.6	37.6	14.0	6.6	10.1	3.7	25.4	2.6	2.4
2.	Kujawsko-pomorskie	100.0	40.2	13.9	8.2	3.4	11.3	2.3	59.8	8.1	20.7
3.	Lubelskie	100.0	65.6	12.3	7.2	2.5	13.0	25.7	34.4	3.6	9.8
4.	Lubuskie	100.0	50.2	18.0	5.3	2.4	9.1	7.0	49.8	2.2	8.1
5.	Łódzkie	100.0	41.9	5.0	1.1	7.9	13.4	12.3	58.1	10.0	17.5
6.	Małopolskie	100.0	52.7	6.9	1.7	4.7	26.9	9.6	47.3	6.9	8.8
7.	Mazowieckie	100.0	33.7	4.8	1.4	2.5	9.1	12.0	66.3	8.1	6.9
8.	Opolskie	100.0	60.2	31.1	19.9	2.4	4.5	0.9	39.8	3.2	10.8
9.	Podkarpackie	100.0	44.2	14.2	6.7	1.4	13.1	7.7	55.8	3.7	11.8
10.	Podlaskie	100.0	7.8	3.5	0.3	1.2	1.2	1.1	92.2	12.1	7.0
11.	Pomorskie	100.0	37.5	17.9	6.1	6.0	3.6	1.7	62.5	4.1	29.3
12.	Śląskie	100.0	36.6	9.7	3.6	3.1	11.2	1.6	63.4	6.8	9.0
13.	Świętokrzyskie	100.0	60.1	6.1	2.2	2.0	21.6	25.1	39.9	9.3	8.4
14.	Warmińsko-mazurskie	100.0	24.2	12.6	2.7	1.9	2.6	2.0	75.8	5.9	12.8
15.	Wielkopolskie	100.0	29.5	9.5	3.9	1.9	8.7	1.8	70.5	8.7	18.6
16.	Zachodniopomorskie	100.0	57.3	32.0	9.8	6.0	2.7	4.0	42.7	1.9	7.4
POLAND		100.0	40.8	12.0	4.8	3.3	9.7	7.9	59.2	7.1	12.7
											16.8
											6.0

Source: Statistics Poland, 2000-2019.

The diversification of the share of products of animal origin in domestic production has been presented in Table 8. The analysis of the data shows that the voivodeships specialize in livestock production. The relatively large share of individual products in domestic production can be noticed with respect to all major types of production.

However, it is worth stressing that the share of purchase in the production of various agricultural products varies regionally and affects the marketability of agricultural production in the voivodeships.

On average, in Poland in 2017/2018, the purchase of basic cereals accounted for 36% of their production, but it was clearly diversified by voivodeship. In the Małopolskie, Podkarpackie, and Świętokrzyskie Voivodeships it accounted for less than 10% of production, whereas in the Zachodniopomorskie, Pomorskie, and Dolnośląskie Voivodeships it accounted for 60-70%. A low share of purchase in the production of potatoes is characteristic of the voivodeships with a high level of fragmentation of farms, such as Małopolskie, Podkarpackie, and Świętokrzyskie. In the Dolnośląskie, Pomorskie, Podlaskie, and Zachodniopomorskie Voivodeships, the share of purchase is within the range of 37-59% of the potato production (Statistics Poland, 2000-2019).

The lower diversification of the share of purchase in production as a measure of the marketability of agriculture can be seen in the case of livestock for slaughter and milk. The purchase of livestock for slaughter in Poland amounted to 91.3%, on average, in 2018. It was relatively smaller in the voivodeships with a large fragmentation of farms due to the important role of home slaughter. A similar pattern can also be observed in relation to cow's milk, the purchase of which accounted for 84.4% of production, on average, in 2018. However, in the Małopolskie Voivodeship it accounted for only 44.5% of production, while in the Wielkopolskie Voivodeship it accounted for 96.5% and in Dolnośląskie – 94% (Statistics Poland, 2019).

This diversification shows that part of the production is dedicated to the internal needs of farms, or to self-supply of rural families. However, this does not have a decisive impact on the regional diversification of the structure of the agricultural market output. The existence of specialization is also evidenced by the diversification of the share of crop and livestock productions in agricultural market output. In relation to each above-mentioned type of production, the specialization of the voivodeships can be seen (Table 9).

The analysis presented shows that the regional diversification of the agricultural market output, as a measure of the use of the potential of Polish agriculture, is determined by various conditions, often interconnected and differing in terms of the directions and impact (Krasowicz and Kuś, 2015). The diversification of investment expenditure in PLN·ha⁻¹ of utilized agricultural area is determined, in addition to the existing farm equipment, also by the agrarian structure of agriculture. In the voivodeships with a higher share of farms with a larger area, investment expenditure is more reasonably used.

A statistical description of the more important conditions of the agricultural market production in Poland has been presented in Table 10.

Table 10
Description of the analyzed variables

Specification	Average	Median	Minimum	Maximum	Standard deviation
Purchase value (PLN·ha ⁻¹ of UAA in total)	3,815.1	3,928.0	1,672.0	6,559.0	1,346.9
including: plant products	1,237.5	1,234.0	206.0	2,390.0	600.9
animal products	2,577.6	2,445.5	754.0	4,877.0	1,272.4
Share of voivodeships in UAA (%) on average 2013-2015	6.3	6.5	2.6	13.1	3.2
total	6.3	4.6	1.9	17.9	4.8
crop	6.3	4.8	1.1	13.9	4.2
livestock	6.3	4.0	1.8	21.3	5.9
Agricultural production area valorization index according to the ISSPC-SRI (pts)	67.4	66.9	55.0	81.4	6.4
Share (%) of permanent grassland	21.7	19.5	8.8	39.5	9.8
Consumption of mineral fertilizers (kg NPK·ha ⁻¹ of UAA)	130.4	127.1	78.7	195.9	33.4
Share (%) of very acidic and acidic soils	39.9	37.5	17.0	58.0	12.0
Cereal yields (t·ha ⁻¹) on average 2016 and 2017	4.1	4.2	3.0	5.9	0.8
Share of farms with an area of up to 5 ha (%)	48.9	46.2	27.3	82.1	17.6
Share of farms with an area of more than 50 ha (%)	4.1	3.1	0.4	12.4	3.7
Average farm area (ha of UAA)	13.4	13.7	4.0	28.7	7.3
Stocking density (LU·100 ha ⁻¹ of UAA)	43.1	37.8	16.5	81.9	19.4
Purchase of cereals (kg·ha ⁻¹ of UAA)	752.2	560.0	117.0	1831.0	591.7
Purchase of products (cereal unit·ha ⁻¹)	40.4	38.8	18.3	67.4	14.4
Share of livestock production in agricultural market output (%)	55.2	57.0	25.4	92.2	17.0
Share of voivodeships in the purchase of agricultural production (%)	6.2	5.7	1.7	18.6	4.9
industrial in total	9.9	10.2	2.2	18.4	5.2
including: sugar beet	2.0	1.4	0.0	5.0	1.5
rape and turnip rape	10.2	8.3	2.3	22.3	6.8
Crop production in total (%)	44.8	43.1	7.8	74.6	17.0
cereals	14.7	12.5	3.5	37.6	10.4
industrial	5.9	4.6	0.3	19.9	5.2
vegetables	10.1	9.6	1.2	26.9	6.9
fruit	7.4	3.9	0.9	25.7	8.0
Livestock production in total (%)	55.2	57.0	25.4	92.2	17.0
milk	15.6	12.8	5.3	56.9	12.5

Source: own study.

The data comparison shows that high diversification is characteristic of the indicators describing the level and structure of the agricultural market production as well as those describing various groups of conditions.

Table 11
Agricultural market output as a criterion for the use of agricultural potential in groups of voivodeships against the background of conditions

Cluster No. (number of voivodeships)	Voivodeship	Share in market production (%)			Conditions of marketability of production					
		Share in agricultural UAA (%)	Share in agricultural crop	Purchase value in PLN·ha ⁻¹	APAV index	Share of farms with an area of >50 ha	Consumption of NPK (kg/ha)	Cereal yield t/ha	Industrial share (%)	Stocking density LU/100 ha
Dolnośląskie	6.3	4.3	7.7	1.9	2,625	74.9	6.0	168.1	5.2	18.4
Opolskie	3.5	2.7	3.7	2.1	4,487	81.4	6.5	195.9	5.9	16.1
Lubuskie	2.8	1.9	2.4	1.7	3,225	62.3	8.4	105.6	4.4	13.0
1(6) Zachodniopomorskie	6.7	3.2	4.4	2.4	2,698	67.5	12.4	126.6	4.3	15.5
Pomorskie	5.1	4.9	4.5	5.2	4,827	66.2	6.2	138.8	4.1	13.7
Lubelskie	9.6	8.5	13.2	5.4	2,945	74.1	1.3	143.3	4.3	12.2
Cluster 1 in total	34.0	25.5	35.9	18.7	3,468	x	x	x	x	x
Kujawsko-Pomorskie	7.3	7.7	9.0	6.9	5,025	71.0	4.5	183.3	4.5	14.5
Wielkopolskie	12.1	18.4	14.9	20.8	6,734	64.8	12.4	160.8	4.3	8.5
2(4) Łódzkie	6.7	7.6	7.2	7.4	4,428	61.9	0.8	135.1	3.5	3.5
Mazowieckie	13.1	17.8	15.4	19.4	6,143	59.9	1.3	111.9	3.2	5.2
Cluster 2 in total	39.2	51.5	46.5	54.5	5,583	x	x	x	x	x
Warmińsko-Mazurskie	6.9	5.2	2.9	6.6	4,479	66.0	9.2	107.6	3.8	10.9
3(2) Podlaskie	7.4	6.3	1.4	9.6	4,992	55.0	2.7	103.5	3.0	2.5
Cluster 3 in total	14.3	11.5	4.3	16.2	4,736	x	x	x	x	x
Śląskie	2.6	2.9	2.5	3.1	3,880	64.2	1.7	127.5	4.4	7.1
Małopolskie	3.7	3.2	3.9	2.7	2,186	69.3	0.4	88.1	4.0	3.8
4(4) Podkarpackie	4.0	1.9	2.1	1.7	1,812	70.4	0.7	78.1	3.8	9.4
Świętokrzyskie	3.4	3.5	4.8	2.6	2,965	69.3	0.5	111.9	3.1	3.9
Cluster 4 in total	13.7	11.5	13.3	10.1	2,711	x	x	x	x	x

Source: own study.

Using the methods of multivariate analysis, groups of voivodeships diversified in terms of agricultural market output have been identified as a criterion for the use of agricultural potential (Table 11). The division of the voivodeships into four groups has been shown in Fig. 1.

Description of the groups of voivodeships diversified in terms of the use of agricultural potential

The clusters (groups) of voivodeships vary in terms of the diversification of the use of agricultural potential evaluated by the criterion of the agricultural market output (Fig. 4), which is derived from the existing conditions and specialization of production in the regions. Table 11 presents the selected indicators describing the agricultural market output in the identified groups of voivodeships (clusters) against the background of the conditions. The simplified description of the groups of voivodeships (clusters) has been presented in Table 12.

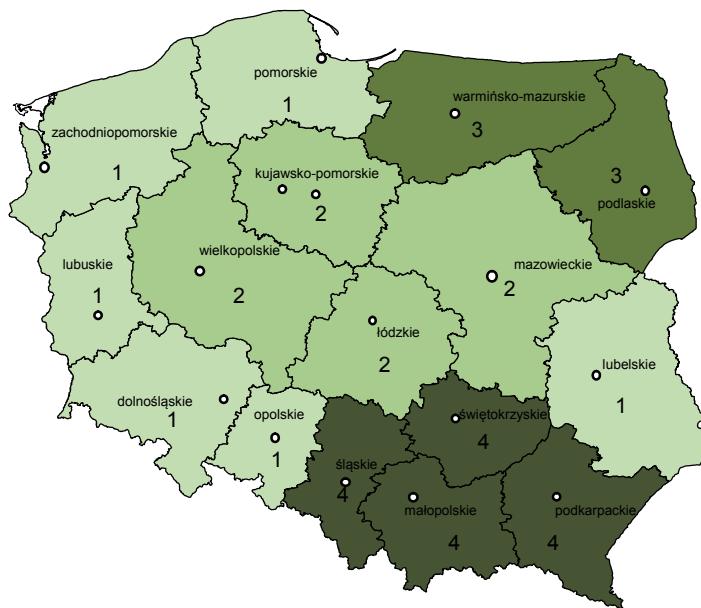


Fig. 4. Division of voivodeships into clusters with diversified marketability of agriculture.
Source: own study.

Table 12
Simplified description of the groups of voivodeships (clusters)

No. of the cluster	Voivodeships (groups of voivodeships)	Characteristics
1(6)	Dolnośląskie, Opolskie, Lubuskie, Zachodniopomorskie, Pomorskie, Lubelskie	<ul style="list-style-type: none"> • diversification of the agricultural production area valorization index (APAV), specialization in the market output of cereals and industrial crops, fruit and vegetables (Lubelskie) • relatively low stocking density, low consumption of natural fertilizers • relatively lower share of the livestock production in agricultural market output • simplified organization of agricultural production
2(4)	Kujawsko-Pomorskie, Wielkopolskie, Łódzkie, Mazowieckie	<ul style="list-style-type: none"> • intensive agriculture, specialization in various branches of agricultural production, internal diversification of agriculture in the voivodeships • relatively higher share of the voivodeships in agricultural market output than in utilized agricultural area (UAA) • occurrence of threats to the natural environment
3(2)	Warmińsko-Mazurskie, Podlaskie	<ul style="list-style-type: none"> • developed market livestock production (milk and live cattle) • high share of permanent grassland (PG) in the structure of the utilized agricultural area (UAA) • high share of fodder crops on arable land (AL) (especially corn) • diversified use of permanent grassland
4(4)	Śląskie, Małopolskie, Podkarpackie, Świętokrzyskie	<ul style="list-style-type: none"> • large fragmentation of farms, along with low stocking density • low purchase value in PLN/ha • low consumption of mineral fertilizers in kg NPK/ha of UAA, soil acidification • significant share of fruit and vegetables in the structure of the market output • large, poorly utilized labor resources

Source: own study.

Cluster 1 includes the voivodeships that are diversified in terms of the agricultural production area valorization index and specializing in the market production of cereals and industrial crops. In the case of the Lubelskie Voivodeship, characterized by a smaller average farm area and a less favorable area structure of farms, the inclusion in this cluster was determined by the share in the market production of industrial crops (sugar beet and rape) and fruit from trees and shrubs. The diversification also applies to the consumption of mineral fertilizers. A common characteristic of the voivodeships classified into this cluster is relatively lower stocking density and, consequently, a lower share of livestock production in the structure of the agricultural market output. This results in a relatively lower purchase value in PLN from 1 ha of utilized agricultural area.

Cluster 2 includes the Wielkopolskie and Kujawsko-Pomorskie Voivodeships, generally recognized as the regions of intensive agriculture, characterized by a higher standard of agricultural conditions. In addition to these, the cluster includes the Łódzkie and Mazowieckie Voivodeships, specializing both in the typical agricultural production and in poultry and horticultural production. A common characteristic of these voivodeships is that their share in the Polish agricultural market output is larger than it would appear from their share in utilized agricultural area. In addition to crop production, livestock production is highly important in these voivodeships and they skillfully combine these types of production. These voivodeships are food-producing zones for major urban agglomerations, which also affects marketability.

Cluster 3 includes the Warmińsko-Mazurskie and Podlaskie Voivodeships, which have a relatively large share in Polish market livestock production, mainly due to the well-organized intensive production of milk, being the raw material base for the dairy sector which is well developed in north-eastern Poland. Both voivodeships, despite their large share of permanent grassland, are also characterized by a large share of fodder crops (especially corn) in the sowing structure on arable land. This is linked to the necessity of balanced feeding of cattle using high-energy feed in the form of corn silage.

Cluster 4 includes the following voivodeships: Śląskie, Małopolskie, Podkarpackie, and Świętokrzyskie, located in southern and south-eastern Poland. Their common characteristics are the large fragmentation of farms, relatively lower production intensity measured by the level of consumption of mineral fertilizers in $\text{kg NPK}\cdot\text{ha}^{-1}$, stocking density lower than the national average, and a high level of agricultural employment. In the structure of the agricultural market output of this group of voivodeships, the production of fruit and vegetables has a substantial, yet diversified, share.

The specificity of the voivodeships included in the individual clusters is reflected in the diversification in the purchase value in $\text{PLN}\cdot\text{ha}^{-1}$ of utilized agricultural area and its structure. Much higher purchase values are characteristic of the voivodeships included in Cluster 2, combining intensive, often specialized, crop production with livestock production. In the Warmińsko-Mazurskie and Podlaskie Voivodeships, the relatively high purchase value of animal products is not accompanied by a correspondingly high market crop production. This is particularly visible in the example of the Podlaskie Voivodeship. In the value structure of the agricultural market output in this voivodeship, milk accounted for nearly 60%.

A comparison of the level and structure of the agricultural market output, taking into account the voivodeships and their clusters, indicates the relatively weaker impact of the environmental (habitat) conditions on the use of agricultural potential. A much stronger impact is made by organizational and economic conditions such as the area structure of farms, intensity of organization and farming, specialization of production, and its connection with the market and processing industry. The existing regional diversification of the Polish agricultural market output, as a measure of the use of the potential of this sector of the national economy, is one of the deter-

minants of the prospects for the development of agriculture and types of support, directed by science and advice on agricultural practice (Chyłek et al., 2017; Czudec, 2017). It also has an impact on the directions of agricultural research, including economic and agricultural research (Gołębiewska et al., 2016).

The research conducted confirmed the research hypothesis and the results provided a basis for identifying the groups of voivodeships with diversified marketability of agriculture. It allowed for evaluating them from the point of view of the use of agricultural potential.

Conclusions

The regional diversification of the environmental, agrotechnical, organizational, and economic conditions determines the level and structure of the agricultural market output in Poland, as a criterion for the use of agricultural potential. The impact of individual groups of conditions is clearly diversified, and their impact is visible in the production specialization and marketability of regions, as well as in their share in the Polish agricultural market output. The regional diversification of the level and structure of the Polish agricultural market output should be the basis for the directions of scientific research and improving advisory activities.

The agricultural market output reflects the regional diversification of agriculture and is an important determinant of the development of the bioeconomy in Poland.

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PRODUKCJA TOWAROWA JAKO KRYTERIUM WYKORZYSTANIA POTENCJAŁU ROLNICTWA W RÓŻNYCH REGIONACH POLSKI

Abstrakt

Celem opracowania było przedstawienie towarowej produkcji rolniczej jako kryterium wykorzystania potencjału polskiego rolnictwa w różnych regionach Polski.

Analizę przeprowadzono z uwzględnieniem wybranych wskaźników charakteryzujących warunki przyrodnicze, agrotechniczne i organizacyjno-ekonomiczne rolnictwa w poszczególnych województwach. Jako podstawę porównania przyjęto średnie dla Polski. Podstawowe źródła informacji stanowiły dane statystyczne GUS, wyniki badań Instytutu Uprawy Nawożenia i Gleboznawstwa – PIB w Puławach oraz rezultaty badań prezentowane w literaturze.

Przyjęto hipotezę, że uwarunkowania przyrodnicze i agrotechniczne oraz organizacyjno-ekonomiczne decydują o poziomie i strukturze towarowej produkcji rolniczej w Polsce, jako kryterium wykorzystania potencjału rolnictwa w regionach. Z dotychczasowych badań wynika, że siła oddziaływania poszczególnych grup uwarunkowań jest wyraźnie zróżnicowana, a ich wpływ ujwadza się w specjalizacji produkcji i ich udziale w towarowej produkcji rolniczej Polski. Regionalne zróżnicowanie produkcji towarowej polskiego rolnictwa powinno być przesłanką kierunków badań naukowych i ukierunkowania działalności doradczej. Odzwierciedla ono również regionalne zróżnicowanie efektów wspólnej polityki rolnej UE.

Słowa kluczowe: potencjał rolnictwa, towarowa produkcja rolnicza, zróżnicowanie regionalne.

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