Proceedings of the 2019 International Conference "ECONOMIC SCIENCE FOR RURAL DEVELOPMENT" No 51
Jelgava, LLU ESAF, 9-10 May 2019, pp. 137-143
DOI: 10.22616/ESRD.2019.068

INTENSITY OF TRITICALE PRODUCTION IN DIFFERENT REGIONS OF POLAND

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Abstract: The paper presents the main reasons for the intensity of triticale production in various regions of Poland. The analysis was based on statistical data from the Central Statistical Office (GUS) for the years 2015—2017, compiled by voivodships. The statistical analysis was performed on 19 variables. Cluster analysis was used to group voivodships. Five groups of voivodships were distinguished, which differed in triticale production. The intensity of triticale production in the regions of Poland is determined by the intensity of animal production (pigs, cattle and poultry population) and structural and organisational factors. The amount of triticale yields obtained is determined by the intensity of farming and the level of agricultural culture. The Wielkopolskie Voivodeship and the central and eastern parts of Poland have a significant share in the national production of triticale.

Key words: triticale, groups of voivodships, yields.
JEL code: R19.

Introduction

The area under cultivation and the share of triticale in the structure of cereal sowing in Poland is the largest among all countries in the world. By 2015, the area under cultivation increased to 1.52 million hectares (CSO, 2017). In 2017, it amounted to 1.35 million ha and 5.1 million tons of grain were harvested. It was 84 % destined for feed, mainly due to its high nutritional value (Djekic et al., 2011; Jaskiewicz and Szczepanek 2016, 2018). The increase in triticale cultivation area was accompanied by a decrease in rye cultivation area (Jaskiewicz and Sulek, 2017). Thanks to its high yield potential and good nutritional value, triticale has become competitive with other cereal species (Fardet, 2010; Mcgovern et al., 2011).

A research hypothesis was made that the intensity of triticale production is determined by the intensity of animal production, i.e. the level of livestock density and structural and organisational conditions of agriculture.

The aim of the study is to determine the factors that have led to the diversification of triticale production intensity in different regions of Poland.

To analyse the intensity of triticale production in Poland, GUS data from three years 2015-2017 were used. The production of triticale was analysed by subjectively selecting 19 variables, which were subjected to statistical analysis. The main indicators of triticale production (by voivodships) were: grain yields (dt.ha-1) and the percentage in the sowing structure (%).

On the basis of statistical characteristics of the analysed variables by voivodships, their extreme values and coefficients of variation were evaluated. Correlations between the production of triticale in the country and the level of analysed variables, were calculated. Groups of voivodships, which differed in triticale production volume, were separated by means of Ward's cluster analysis. The separated groups were described using the analysed indicators, and compared against the national average.

Research results and discussion

Main indices of triticale production: grain yields and its percentage in the sowing structure, are characterized by regional differentiation (Fig. 1). Voivodships located in the southern part of Poland, except for Slaskie, are characterised by a lower share of triticale in the structure of cereal crops. Higher triticale yields were recorded in the western part of the country. The grain yields in voivodships were shaped by natural conditions and extensification of production. This includes reduced use of mineral fertilisers, plant protection products, and certified seeds (Krasowicz and Kopinski, 2006).

Kopinski and Krasowicz (2010) state that the low level of cereal yields is determined by both soil and climatic conditions in Poland, low production intensity, and high negligence in cereal agrotechnology. According to Jaskiewicz and Sulek (2017), the area of triticale sown was related to trends in animal production. Pig fattening, farm poultry production and cattle production based on dry fodder composed of cereal grain with the addition of protein concentrates, favoured the expansion of triticale cultivation (Jaskiewicz, 2006).

The statistical characteristics of the analysed variables are presented in Table 1. The lowest variability was found for the percentage of cereals in the sowing structure and the index of agricultural production space valorisation, while the highest for the density of pigs, the number of individual farms, use of calcium fertilisers, purchase of cereals, and employment in agriculture.

The comparison of simple correlation coefficients shows that triticale yields were significantly positively correlated with cereal yields, Agricultural Production Space Valuation Ratio (WWRPP), use of mineral fertilizers (NPK), nitrogen fertilizers, use of lime, percentage of farms with an area above 50 ha, average farm area and purchase of cereals. On the other hand, significant negative correlations among triticale grain yields and acidic and very acidic soils, soils with very low and low phosphorus and potassium contents, and the number of individual farms, were found. The percentage of triticale in the sowing structure was significantly negatively correlated with the total percentage of wheat in the sowing structure, with the quality of natural conditions (WWRPP) as well as the percentage of soils with very low and low content in phosphorus. Agricultural producers interested in commercial cereal production are introducing wheat for cultivation in weaker positions meant for triticale cultivation (Jaskiewicz and Sulek, 2017). Positive correlations were found between the percentage of triticale in the sowing structure with the percentage of cereals in the sowing structure, cattle population, the numbers of pigs and chickens per 100 ha of AL, and employment in agriculture.

The regional diversity of yields obtained in production and the share of triticale in the sowing structure is determined by factors determined by means of discrimination analysis: agrotechnical, structural and organisational, intensity of animal production organisation (Filipiak and Wilkos, 1998). On the basis of these factors, 5 groups of voivodships, diversified in terms of triticale production, were distinguished (Fig. 2). The characteristics of variables in groups of voivodships are presented in Table 2.

Group 1 comprises three voivodships: Dolnoslaskie, Opolskie, and Kujawsko-Pomorskie. This group is characterized by the highest Agricultural Production Space Valuation Ratio. Favourable natural conditions, especially the high quality of soils, determine the high percentage of winter wheat and a small percentage of triticale in the sowing structure. The consumption of mineral fertilizers and lime per 1 ha of AL is above the national average in this group of voivodships. A characteristic feature of this voivodship is its favourable agrarian structure. Large-area farms are characterised by a better use of specialised equipment, a higher level of expertise of farmers engaged in specialised cereal cultivation, and easier implementation of technological progress (Kopinski and Krasowicz, 2010). Technological progress is particularly visible in voivodships with intensive grain production. This region specializes in commercial production of cereals (wheat) and a high purchase of cereals. It is distinguished by high grain yields, including triticale.

Group 2 includes seven voivodships (Lubuskie, Zachodniopomorskie Pomorskie, Warminsko-Mazurskie, Slaskie, Swietokrzyskie, Lubelskie). The percentage of cereals, wheat, and triticale in the sowing structure, yield level, and agrarian structure in this group are at the level of the national average.

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Table 1

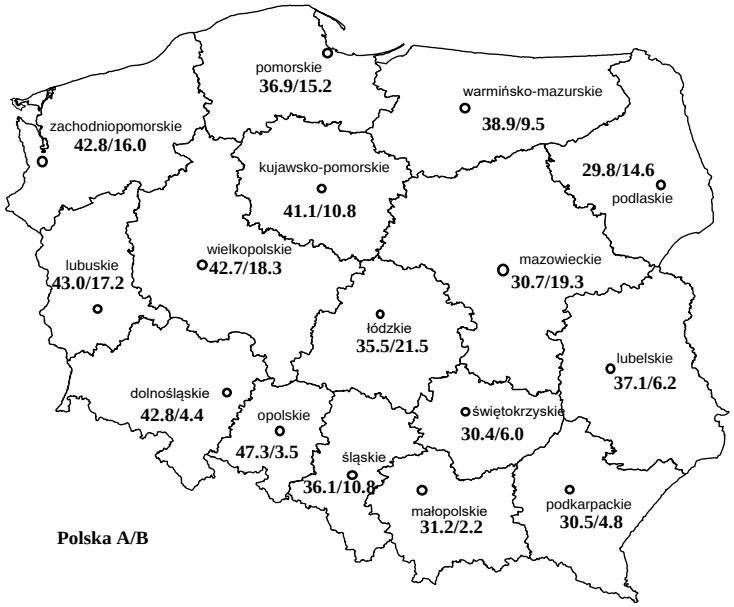
Statistical characteristics of variables for voivodships (averages from 2015-2017)

No	Variables	Average	Range of variability	Variation coefficient [%]	Correlation coefficients	
					of triticale yield	of share in cropping pattern
1.	Share of triticale in the cropping pattern [%]	11.3	2.2-21.5	55.6	0.03	-
2.	Triticale yield [dt·ha^{-1}]	37.3	29.8-47.3	15.1	-	0.03
3.	Share of cereals in the cropping pattern [%]	72.7	64.0-77,0	4.8	0.21	0.53*
4.	Cereale yield [dt·ha^{-1}]	40.1	29.2-56.3	17.5	0.86*	-0.36
5.	Share of wheat in the cropping pattern [%]	40.4	18.0-64.0	32.4	0.37	-0.80*
6.	Valorization index of agricultural area [point]	67.4	55.0-81.4	9,4	0.48*	-0.75*
7.	Share of acid very acid soil [%]	40.1	18.0-57.0	28,9	-0.81*	0.29
8.	Share of soil with very low and low K content [%]	40.8	25.0-61.0	28.7	-0.88*	0.21
9.	Share of soil with very low and low P content [%]	32.7	18.0-54.0	30.3	-0.62*	-0.68*
10.	Mineral fertilization consumption [kg NPK·ha^{-1} of AL]	128.4	74.0-198.0	27.6	0.75*	-0.05
11.	Nitrogen fertilization consumption [kg N·ha^{-1} of AL]	71.7	37.0-112.0	29.0	0.80*	0.02
12.	Agricultural limestone consumption [kg Ca·ha^{-1} ha^{-1} of AL]	50.9	16.3-109.1	58,9	0.84*	0.03
13.	Share of farms with area > 50ha [%]	2.0	0.4-4.0	55.2	0.51*	0.32
14.	Private farms [thousand piece]	86.1	20.0-215.0	67.8	-0.55*	0,04
15.	Cattle of stock [large units·100ha^{-1} of AL]	35.9	11.0-91.3	58.2	-0.40	0.43*
16.	Share of swine [heats·100ha^{-1} of AL]	66.4	22.0-233.0	80.4	0.33	0.44*
17.	Share of poultry [heats·100ha^{-1} of AL]	1003.0	391.0-2001.0	45.8	-0,12	0.51*
18.	Grain purchase [kg·ha^{-1} of AL]	910.0	152.0-1956.0	59,6	0.86*	-0.09
19.	Employment in farming [persons·100ha^{-1} of AL]	9.2	3.6-24.5	59,5	0.32	0.52*

** - significant relationship*

Source: author's calculations based on the GUS (2015-2017)

DOI: 10.22616/ESRD.2019.068



Source: author's calculations based on the GUS (2015-2017)

Fig. 1. **Triticale grain yield in dt·ha^{-1}(A) and its percentage in the sowing structure (B) in 2015-2017**

Table 2

Variables in groups of the voivodships analysed with the cluster method

No	Variables	Region group*					Average for the country
		1 n=3	2 n=7	3 n=3	4 n=2	5 n=1	
1.	Share of triticale in the cropping pattern [%]	6.23	11.6	18.5	3.5	18.3	11.3
2.	Triticale yield [dt·ha^{-1}]	43.7	37.9	32.0	30.8	42.7	37.3
3.	Share of cereals in the cropping pattern [%]	71.7	73.7	75	66.5	75.0	72.7
4.	Cereal yield [dt·ha^{-1}]	49.9	40.0	31.3	37.8	42.9	40.1
5.	Share of wheat in the cropping pattern [%]	54.7	41.3	21.3	52.0	26.0	40.4
6.	Valorization index of agricultural area [point]	75.8	67.1	60.0	69.8	64.8	67.4
7.	Share of acid very acid soil [%]	24.0	37.8	55.0	53.5	33.0	40.1
8.	Share of soil with very low and low K content [%]	29.0	36.6	57.3	51.5	35.0	40.8
9.	Share of soil with very low and low P content [%]	28.7	31.9	30.3	53.0	18.0	32.7
10.	Mineral fertilization consumption [kg NPK·ha^{-1} of AL]	184.0	120.7	112.3	80.0	161.0	128.4
11.	Nitrogen fertilization consumption [kg N·ha^{-1} of AL]	104.3	68.6	62.3	40.0	87.0	71.7
12.	Agricultural limestone consumption [kg Ca·ha^{-1} ha^{-1} of AL]	92.1	42.5	31.4	20.1	106.1	50.9
13.	Share of farms with area > 50ha [%]	2.5	2.0	1.9	0.7	4.0	2.0
14.	Private farms [thousand piece]	48.3	64.3	130.7	136.5	121.0	86.3
15.	Cattle of stock [large units·100ha^{-1} of AL]	27.3	27.9	65.0	22.9	56.4	35.9
16.	Share of swine [heats·100ha^{-1} of AL]	72.0	52.1	63.0	30.0	233.0	66.4
17.	Share of poultry [heats·100ha^{-1} of AL]	719	967	1211	843	1797	1003
18.	Grain purchase [kg·ha^{-1} of AL]	1712	888	467	375	1069	910
19.	Employment in farming [persons·100ha^{-1} of AL]	8.1	8.2	9.8	5.3	24.5	9.2

**- see Fig. 2*

Source: author's calculations based on the GUS (2015-2017)

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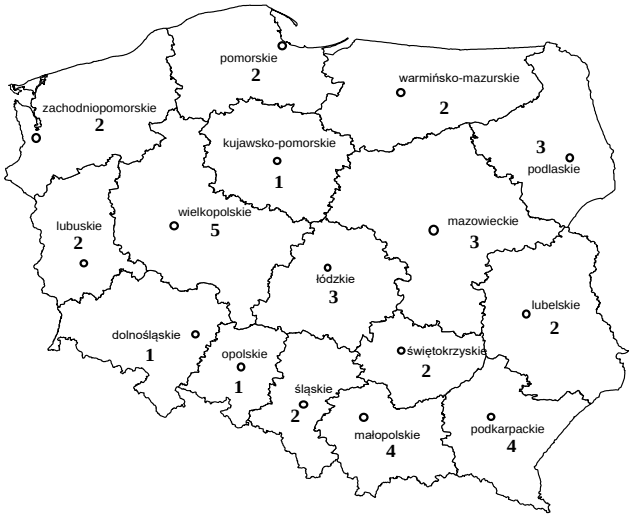

Source: author's calculations based on the GUS (2015-2017)

Fig. 2. **Groups of voivodships designated with cluster analysis according to their triticale production volume**

This region is very diverse in terms of soil quality (Zulawy and Kaszuby). The consumption of mineral and calcium fertilisers is slightly below the national average. The same is true for the number of poultry, pigs, and cattle per 100 ha of farmland. These voivodships are characterised by a commercial production similar to the national average. Kopinski and Krasowicz (2010) indicate a relationship between the value of indicators characterising the level of agrotechnology with the agrarian structure and the related scale of production.

Group 3 consists of three voivodeships: Lodzkie, Mazowieckie, and Podlaskie. The pig population is at the level of the national average while the poultry population is above theis average. A region with a significant percentage of permanent grassland is characterised by a relatively twice as high density of cattle in comparison with the national average. This group of voivodships has a low share of large-area farms. There is a high number of individual farms. One of the factors determining relatively low yields of triticale is the lowest Agricultural Production Space Valuation Ratio, low level of calcium fertilisation, and low quality of soils. In the group of these voivodships, the purchase of cereals is two times lower than the national average. The research by Tluczak (2015), Krasowicz and Matyka (2015) indicates that in the conditions of intensifying market competition, the concentration of cow breeding takes place, which is shifting to large-area groups specializing in animal production. As a result, there is a strong and growing regression of livestock number in the region of fragmented agriculture. Two regions have been designated within this group: south-eastern region with a very unfavourable and a central-eastern region with a relatively favourable area structure of farms.

Group 4 consists of two voivodships: Malopolskie and Podkarpackie. This group has relatively the lowest percentage of triticale in the structure of cereal sowing. The low level of triticale yields is determined, among others, by agro-technical negligence manifested in the low level of mineral fertilisation and very low consumption of nitrogen and calcium fertilisers. The soil quality is poor. This region is characterised by the percentage of wheat in the sowing structure above the national average. This wheat is produced for the needs of the farms where it is grown as these voivodships are generally characterised by low commerciality of production. The region is distinguished by the high number of individual farms. Krasowicz and Matyka (2015) and Parzonko (2013) emphasized the significant role of agrarian fragmentation and the size of farms as a factor of regional diversification. The number of poultry, pigs and cattle per 100 ha of agricultural land is below the national average.

Group 5 comprises the Wielkopolskie Voivodeship. It is characterized by a high density of poultry, pigs and cattle per 100 ha of agricultural land. Triticale accounts for 18.3 % of the sowing structure. Consumption of mineral and nitrogen fertilizers and fertilizer lime is above the national average. High yields of triticale and cereals are obtained in comparison to the national average. The characteristic feature of this region is the low proportion of very acidic and acidic soils, and a very low and low abundance of phosphorus and potassium. This indicator often indicates the level of agricultural culture. Due to this criterion, the region is assessed positively. This indicates a relatively good use of the potential created by natural conditions (Krasowicz and Kopinski, 2006). In recent years, there has been an increase in the intensity of productivity of production animals (milk yield of cows, laying hens, slaughter efficiency and production). This applies to all regions and is related to breeding progress, change of animal nutrition and concentration of production (Kopinski, 2011). Cereal grains, including triticale as a component of compound feed, is used to feed farm animals. Farmers prepare such mixtures themselves on their own farm, adding also supplementary mixtures from the purchase.

Conclusions, proposals, recommendations

1) Different intensity of triticale production was found in Polish regions. This is determined by the intensity of animal production (pigs, cattle, poultry population) and structural and organisational factors.
2) In Dolnoslaskie, Opolskie (group 1) and Wielkopolskie (group 5) voivodeships, the area structure is definitely better than in the south-eastern part of Poland, which is reflected in higher triticale yields.
3) The level of agricultural culture and intensity of farming is related to the yields of triticale.
4) Wielkopolskie voivodeship and the central and eastern part of Poland, have a significant share in the national production of triticale

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