p-ISSN 0044-1600
e-ISSN 2392-3458

Problems of Agricultural Economics

www.zer.waw.pl

1(346) 2016, 56-78

JERZY KOPIŃSKI
MARIUSZ MATYKA
Institute of Soil Science and Plant Cultivation
– State Research Institute
Puławy

DOI: 10.5604/00441600.1196363

ASSESSMENT OF REGIONAL DIVERSITY CORRELATIONS OF ENVIRONMENTAL AND ORGANISATIONAL-PRODUCTION FACTORS IN POLISH AGRICULTURE*

The paper assesses regional differences in the interactions between the natural and organisational factors in Polish agriculture. The analysis carried out in the dynamic approach covers the 2002-2013 period, and the indicators for individual voivodeships are compared to the average for Poland as a reference system. The research, in addition to descriptive statistics, uses also grouping of voivodeships with the use of cluster analysis with method of k-means. Conducted research indicates that the direction and strength of the interaction of selected environmental and organisational factors is differentiated between Polish regions. The observed nationwide trends and interdependencies of analysed natural and organisational factors do not reflect properly the scale and effects of changes in different regions of the country. Because of the multifactor determinants of agricultural production, consequences of their impact on the regions are highly different. This is manifested by realization, in various parts of Poland, of different models of agricultural production, which are characterised by different levels of organisation and intensity. The analysis indicates the need for regionalisation of national agricultural policy, including the Rural Development Programme. This approach should contribute to more effective spending of funds addressed to agriculture and rural areas by optimising the process of their development.

Key words: agriculture, natural conditions, organisational conditions, regional differences.

* The paper was prepared under task 2.1 of the multiannual programme of the Institute of Soil Science and Plant Cultivation – State Research Institute (2016-2020).

Introduction

Agriculture undergoes constant economic and structural changes which follow from changes varied in terms of dynamics and directions. The changes pertaining to agrarian structure, level and structure of agricultural production and also the advancement level of its concentration and specialisation, are a derivative of the lapsing time function (Matyka, Krasowicz and Kuś, 2013). They are also a derivative of civilisation and cultural changes manifested in the overall level and quality of life of rural residents, not only on the local but also national scale (Niedzielski, 2015). The changes occur in diverse dimensions and are an inherent part of the development process. According to Runowski (2014), they include: economic, technological, international, environmental, political and legal, and social and cultural changes. He points out that the impact of individual dimensions of the environment on the overall agri-food sector is growing and takes place in closely related and interpenetrating relations. This mainly follows from Poland's accession to the European Union (EU), which – apart from changes in the relations between use costs of respective factors of production and growth in technical progress advancement – results also in the ongoing increase in the significance of subsidies in farm income (Runowski, 2014). This phenomenon, to some extent, undermines the thesis of. Banaś (2008) stating that production is not carried out for the sake of itself, but to place the manufactured products on the market and earn income from their sales. Because the real growth in the productivity of inputs not necessarily has a positive impact on a change in farm income, as the most important are "price scissors", followed by subsidies (Czyżewski and Majchrzak 2015). Also Poczta (2010) points to the dropping efficiency of capital, fixed assets and labour in a thorough analysis of changes in the Polish agriculture. After Poland's accession to the EU, a growth in the agriculture sector income would not have been possible without a major growth in the level of subsidies, despite a rise in productivity of land and labour resources, which is low in the Polish agriculture (Poczta et al., 2009). Whereas the impact of external factors on agriculture, food economy and rural areas, was broadly discussed in the paper edited by Wigier (2011).

Crop and livestock production is characterised by major regional disparity (Matyka, 2013), which is continually growing (Józwiak and Mirkowska, 2011; Kopiński, 2013). This is mainly determined by changes in organisational and economic factors, whose strength of impact is now greater than the strength of natural conditions shaping the agricultural potential of the production space, the valuation of which is in particular marked by soil conditions (Krasowicz, 2009; Krasowicz et al., 2012). The potential of the agricultural production space and economic conditions of agriculture development, shaped by agricultural policy, influence the socio-economic situation of agricultural producers, rural areas development and also food security of the country (Szymańska, 2014).

In the conditions of growing competition in agriculture, the main actions leading to higher efficiency of inputs in agricultural production is implementation of progress, including biological and technological. But the scope and scale of these actions are limited by the deteriorating relation between prices of agricultural products and prices of means of production (seeds, mineral fertilisers, plant protection products, feeds, machines, etc.); (Runowski, 2014; Józwiak and Mirkowska, 2011). It needs to be emphasised that the assessment of changes and processes taking place in agricultural production is, in general, contrary to the economic and environmental goals, and it is strongly differed and often inconclusive (Zegar, 2013). This indirectly results from a varied rate of concentration, polarisation and specialisation processes happening in respective regions of Poland (Kopiński, 2012). Moreover, according to Brelik and Grzelak (2011), creation of development by increasing capital productivity, thus intensification, causes not only negative externalities but also fails to guarantee adequate growth in farm income.

The paper aims at defining the directions and strengths of impact between the selected natural and organisational and production factors in regional terms. Thus, the spatial diversity of varied models of agricultural production development will be indicated and determined.

Research materials and methodology

Public statistics were used as input data for the paper (*Rocznik Statystyczny Rolnictwa*, 2002-2013; *Użytkowanie gruntów…*, 2002-2013). The Agricultural Production Space Valuation Ratio (Polish: *Wskaźnik Waloryzacji Rolniczej Przestrzeni Produkcyjnej*, WWRPP), developed by the Institute of Soil Science and Plant Cultivation (*Instytut Uprawy Nawożenia i Gleboznawstwa*, IUNG) (Witek, 1981), was used to assess the production space, as it considers the quality and usability of soil, soil humidity, land form and agro-climate. Dynamic analysis, covering the 2002-2013 period, was carried out on the basis of the following indices:

- natural:
  - Agricultural Production Space Valuation Ratio (points),
- organisational and production:
  - average farm area (ha of UAA),
  - employment (AWU per 100 ha of UAA),
  - share of cereals in the cropping structure (%),
  - stocking density of pigs (LU per 100 ha of UAA),
  - commercial production (PLN per ha of UAA),
  - share of permanent grasslands and forage areas per arable land in UAA (points),
  - stocking density of cattle and sheep (LU per 100 ha of UAA),
  - fixed assets (PLN per ha of UAA),

- stocking density (LU per 100 ha of UAA),
- intensity of crop production organisation (points),
- intensity of livestock production organisation (points),
- consumption of mineral fertilisers NPK (kg per ha of UAA),
- production in cereal units (cereal units per ha of UAA).

The indices considered in the research were selected and classified based on available literature (Harasim, 2006; Klepacki, 1997).

Indices for respective voivodeships were compared to the means for Poland as a reference system. Crop yields, by means of conversion factors, were changed into cereal units, livestock into livestock units (LU), in line with the principles applicable in the agricultural economics (Harasim, 2006).

To establish the changes in regional differences in the Polish agriculture in the research, apart from descriptive statistics, groups voivodeships using the cluster analysis by the *k*-means method for 2002, 2007 and 2013. Initial cluster centres were determined by maximising the distances between clusters with the use of the standardised measure of distance (Euclidean distance).

To determine the strength and direction of impact between the assessed parameters, the correlation coefficient was used at the level of significance: $\alpha = 0.05$, both for voivodeships (NUTS-2) and for separated clusters (Kot, Jakubowski and Sokołowski, 2007). Analysis was carried out based on 2002--2013 data for clusters isolated in 2013 and the results interpretation and description consider statistically and substantively significant interrelations.

For indices, such as average farm area and intensity of crop and livestock production organisation (points), their regional differentiation was determined against the change dynamics in 2002-2013.

Research results

The available data point to a significant regional differentiation of the Polish agriculture in terms of the analysed natural and organisational and production factors (Fig. 1-3). Dynamic deepening of differences, both in spatial and time terms, is visible in north-western voivodeships of Poland (clusters I, II and IV). No important changes as regards regional differentiation was noted in south--eastern and central Poland (cluster III). In all analysed years, depending on the separated and changing clusters, major differences between the assessed indices were noted (Tables 1-3).

Voivodeships forming cluster I are characterised, in general, by a clear inclination towards intensive crop production (Tables 1-3). This is evidenced by a relatively low level of: employment, stocking density, intensity of crop production organisation, commercial production and value of fixed assets. Intensive crop production is conducted there, which has high efficiency expressed in cereal units. Agricultural production is run by the principle of Andreae (1974)

"produce intensively – organise extensively". Execution of such a production model is possible mainly due to highly favourable natural conditions expressed by WWRPP value and, all at once, high use of mineral fertilisers.

Cluster II of voivodeships is definitely different (Tables 1-3), as it is characterised, in general, by the best assessed parameters. This region is definitely targeted at livestock production, which is manifested by the highest stocking density and intensity of livestock production organisation. Moreover, it stands out as having the highest level of crop production organisation with its high productivity, as well. Consequently, this translates to the highest commercial production value among all comparable clusters.

The agricultural production model used in cluster III can be termed as mixed and extensive. No clear direction is evidenced by the average: stocking density, intensity of crop and livestock production organisation and commercial production organisation (Tables 1-3). Extensiveness of agriculture in voivodeships forming the cluster is predetermined by its high agrarian fragmentation, high employment rate, low use of mineral fertilisers and low crop production efficiency. In the light of the above data, high value of owned fixed assets may additionally point to insufficient use of the technical potential in the region.

The size of the analysed indices in cluster IV points to (Tables 1-3), just like for cluster III, a mixed and extensive production direction inclined to ruminants rearing. Its characteristic feature is the highest average farm area with simultaneously the lowest: employment rate, share of cereals in the cropping structure and intensity of livestock production organisation. The region achieves the lowest value of commercial production and fixed assets per area unit. Livestock production is focused mainly on cattle rearing, while stocking density of pigs in the region is the lowest among all comparable clusters. The organisational and production indices of the cluster are indirectly conditioned by the least favourable natural conditions.

The assessment of interactions between natural and organisational and production conditions points to a number of important linkages and interrelations (Tables 4-8).

Based on the analysis, held for all voivodeships, it was concluded that along with a growth in farm area the following also dropped significantly: the employment rate, share of cereals in the cropping structure, value of fixed assets and intensity of crop production organisation (Table 4). In Poland, a growth in farm size leads to simplifications in crop production organisation. What increases, is the consumption of mineral fertilisers and production in cereal units. A growth in farm size (production scale) results in simplifications in crop production organisation with simultaneous increase in its intensity. The overall national trend is decidedly affected by changes in north-western Poland.

The employment rate shows a major direct correlation with the share of permanent grasslands and forage areas per arable land in UAA and the value of

fixed assets. All the factors are typical for conditions of rearing cattle and sheep. Thus, continuing or even developing the labour-intensive production directions is necessary to manage the surplus workforce in rural areas. Whereas inversely proportional interrelations between the employment rate and consumption of mineral fertilisers and production in cereal units, point to a phenomenon of substitution of human labour with inputs incurred for means of production (technical labour replacement). Rearing ruminants leads, simultaneously, to decreasing the share of cereals in the cropping structure and increasing the share of permanent grasslands and forage areas per arable land in UAA. The share of cereals grows significantly along with a decline in the quality of agricultural production space (WWRPP). Its poor quality has a negative impact on the development of livestock production.

But then, the stocking density of pigs is positively related with a growth in the commercial production value, intensity of crop production organisation, consumption of mineral fertilisers and production in cereal units. Thus, it can be stated that pig rearing is an intensive direction of production of major marketability.

Along with better natural conditions for agricultural production (WWRPP), what grows is the intensity of crop production organisation, consumption of mineral fertilisers and production in cereal units. Hence, demanding crops (fertiliser-intensive) are basically farmed in favourable soil and climate conditions. This is largely confirmed by positive interrelation between intensity of crop production organisation, consumption of mineral fertilisers and productivity of farmed crops.

The value of commercial production is positively influenced by a growth in livestock production (stocking density), value of fixed assets, degree of crop and livestock production organisation, consumption of mineral fertilisers and production in cereal units. A growth in the value of fixed assets, apart from the aforementioned interrelations, is directly correlated with the intensity of livestock production organisation and production in cereal units.

The share of fodder crops, cultivated in the permanent grasslands and arable lands, in the structure of UAA, directly affects the rise in stocking density of cattle and sheep and, consequently, the intensity of livestock production organisation. Whereas this share is negatively linked to the intensity of crop production organisation, consumption of mineral fertilisers and production in cereal units.

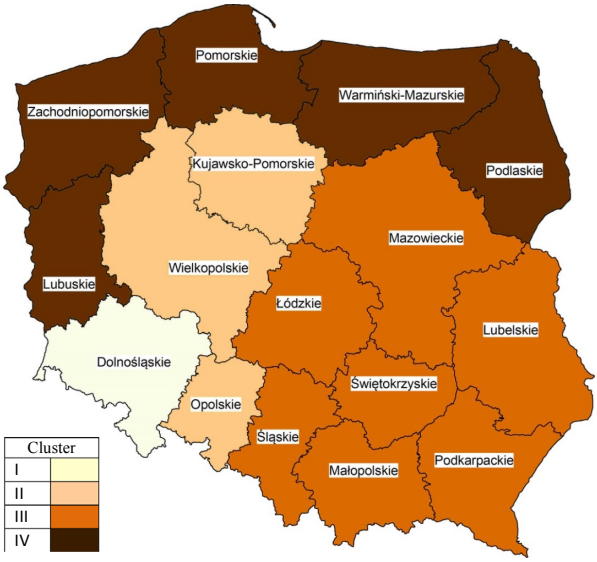

Fig. 1. Clusters by natural conditions and organisational and production conditions in 2002.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002; Użytkowanie gruntów..., 2002; Witek, 1981).

Table 1

Characteristics of clusters for 2002

Specification	Cluster			
	I	II	III	IV
Average farm area (ha of UAA)	9.6	10.8	5.1	13.4
Employment (AWU per 100 ha of UAA)	6.9	10.2	18.1	6.6
Share of cereals in the cropping structure (%)	79	77	74	79
Stocking density of pigs (LU per 100 ha of UAA)	6.0	21.8	9.1	8.8
Agricultural Production Space Valuation Ratio (points)	75	72	67	63
Commercial production (PLN per ha of UAA)	2,196	2,953	2,210	1,794
Share of permanent grasslands and forage areas per arable land in UAA (points)	18.4	16.5	26.1	28.1
Stocking density of cattle and sheep (LU per 100 ha of UAA)	10.2	24.8	26.4	22.1
Fixed assets (PLN per ha of UAA)	6,180	6,922	7,166	5,441
Stocking density (LU per 100 ha of UAA)	22.0	53.8	45.3	39.9
Intensity of crop production organisation (points)	112	126	115	96
Intensity of livestock production organisation (points)	59	162	113	101
Consumption of mineral fertilisers NPK (kg per ha of UAA)	85	124	77	102
Production in cereal units (cereal units per ha of UAA)	44.0	43.8	31.8	30.9

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002; Użytkowanie gruntów..., 2002; Witek, 1981).

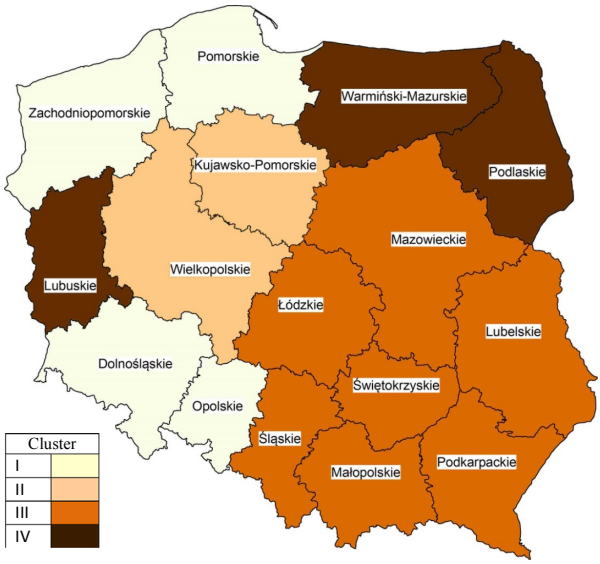

Fig. 2. Clusters by natural conditions and organisational and production conditions in 2007.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2007; Użytkowanie gruntów…, 2007; Witek, 1981).

Table 2

Characteristics of clusters for 2007

Specification	Cluster			
	I	II	III	IV
Average farm area (ha of UAA)	13.0	12.0	5.4	13.6
Employment (AWU per 100 ha of UAA)	6.8	11.1	19.1	7.8
Share of cereals in the cropping structure (%)	72	72	74	74
Stocking density of pigs (LU per 100 ha of UAA)	10.8	28.3	10.0	7.8
Agricultural Production Space Valuation Ratio (points)	73	68	67	61
Commercial production (PLN per ha of UAA)	2,403	3,770	2,732	2,338
Share of permanent grasslands and forage areas per arable land in UAA (points)	18.1	19.2	29.1	36.9
Stocking density of cattle and sheep (LU per 100 ha of UAA)	14	30.9	28	34.9
Fixed assets (PLN per ha of UAA)	6,708	7,793	7,995	6,167
Stocking density (LU per 100 ha of UAA)	29.6	66.2	46.3	53.9
Intensity of crop production organisation (points)	121	133	120	100
Intensity of livestock production organisation (points)	80	198	111	121
Consumption of mineral fertilisers NPK (kg per ha of UAA)	136	166	109	120
Production in cereal units (cereal units per ha of UAA)	45.0	44.5	34.2	33.1

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2007; Użytkowanie gruntów..., 2007; Witek, 1981).

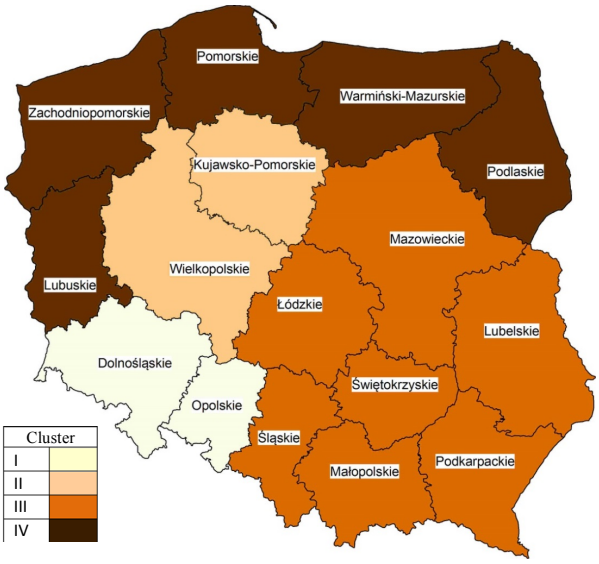

Fig. 3. Clusters by natural conditions and organisational and production conditions in 2013.
Source: own study on the basis of: (Rocznik Statystyczny Rrolnictwa, 2013; Użytkowanie gruntów…, 2013; Witek, 1981).

Table 3

Characteristics of clusters for 2013

Specification	Cluster			
	I	II	III	IV
Average farm area (ha of UAA)	14.0	13.8	6.3	18.1
Employment (AWU per 100 ha of UAA)	9.2	10.9	29.1	7.9
Share of cereals in the cropping structure (%)	73	72	76	68
Stocking density of pigs (LU per 100 ha of UAA)	5.9	19.6	6.3	5.8
Agricultural Production Space Valuation Ratio (points)	78	68	67	63
Commercial production (PLN per ha of UAA)	4,620	6,937	4,914	4,367
Share of permanent grasslands and forage areas per arable land in UAA (points)	14.7	21.1	30.5	36.1
Stocking density of cattle and sheep (LU per 100 ha of UAA)	12	34.5	26.7	29.7
Fixed assets (PLN per ha of UAA)	8,798	9,900	10,683	7,354
Stocking density (LU per 100 ha of UAA)	21.8	60.1	40.1	43
Intensity of crop production organisation (points)	125	127	120	107
Intensity of livestock production organisation (points)	58	176	102	106
Consumption of mineral fertilisers NPK (kg per ha of UAA)	194	164	113	139
Production in cereal units (cereal units per ha of UAA)	52.6	48.7	34.4	37.6

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2013; Użytkowanie gruntów..., 2013; Witek, 1981).

Table 4

Correlation matrix[a] characterising interrelations between the assessed natural and organisational and production indices for voivodeships in total (the analysis covers data for 2002-2013)

	Specification	1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Average farm area (ha of UAA)	1.000													
2	Employment (AWU per 100 ha of UAA)	**-0.757**	1.000												
3	Share of cereals in the cropping structure (%)	**-0.252**	-0.035	1.000											
4	Stocking density of pigs (LU per 100 ha of UAA)	0.087	**-0.168**	0.081	1.000										
5	Agricultural Production Space Valuation Ratio (points)	-0.069	0.060	**-0.183**	0.018	1.000									
6	Commercial production (PLN per ha of UAA)	0.086	0.116	0.012	0.317	-0.118	1.000								
7	Share of permanent grasslands and forage areas per arable land in UAA (points)	-0.109	**0.346**	**-0.291**	**-0.394**	**-0.576**	-0.078	1.000							
8	Stocking density of cattle and sheep (LU per 100 ha of UAA)	-0.073	**0.149**	-0.024	**0.199**	**-0.613**	**0.330**	**0.606**	1.000						
9	Fixed assets (PLN per ha of UAA)	**-0.442**	**0.622**	0.063	0.123	0.015	**0.661**	0.088	**0.211**	1.000					
10	Stocking density (LU per 100 ha of UAA)	-0.053	0.065	0.019	**0.562**	**-0.562**	**0.384**	**0.393**	**0.900**	**0.229**	1.000				
11	Intensity of crop production organisation (points)	**-0.171**	0.120	-0.010	**0.418**	**0.446**	**0.260**	**-0.574**	-0.125	0.129	-0.004	1.000			
12	Intensity of livestock production organisation (points)	-0.001	-0.008	0.055	**0.726**	**-0.442**	**0.434**	**0.186**	**0.809**	**0.230**	**0.962**	**0.141**	1.000		
13	Consumption of mineral fertilisers NPK (kg per ha of UAA)	**0.484**	**-0.475**	-0.043	**0.400**	**0.316**	**0.465**	**-0.601**	**-0.186**	0.067	-0.048	**0.352**	0.101	1.000	
14	Production in cereal units (cereal units per ha of UAA)	**0.274**	**-0.254**	-0.059	**0.244**	**0.605**	**0.385**	**-0.601**	**-0.342**	**0.220**	**-0.257**	**0.320**	-0.106	**0.713**	1.000

[a] Statistically significant correlations are in bold, $\alpha = 0.05$.

[b] Numbers correspond to parameter designation in the vertical column.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002-2013; Użytkowanie gruntów..., 2002-2013; Witek, 1981).

The interrelations (Tables 5-8) between the assessed natural and organisational and production indices for individual clusters (I-IV) support a conclusion that the indicated linkages and trends, typical for the whole country, appear also in other parts of the country.

The statistical analysis shows that interrelations between natural and organisational and production indices in cluster I (Table 5) are different than for voivodeships as a whole. This cluster is made up of the Dolnośląskie and Opolskie Voivodeships. Conversely to the entire population, the growth in the average farm area in these voivodeships leads to a growth in employment in agriculture, increase in the commercial production value and fixed assets. In general, contrary to the average in the country, in this group of voivodeships all three factors of production (land, labour and capital) are involved to a similar degree in agricultural production at the sametime. Moreover, high commercial production is inversely linked to a high share of cereals in the cropping structure.

Additionally, in the region pigs and other groups of livestock are reared, in general, at farms having better soil and climate conditions (WWRPP). This also had a positive impact on the growth in the value of fixed assets. The growth in the share of crops cultivated for fodder in the structure of UAA in the cluster, had a significant negative impact on the value of commercial production.

In the group of these voivodeships, differently than in the country, a large share of the permanent grasslands in UAA did not incline to undertake cattle rearing. This production direction in the cluster was linked to crop production extensification. Economic and organisational conditions are here very important.

In cluster II, the interrelations between the average area of farms, stocking density of pigs and WWRPP were different than for voivodeships, in general. In the region comprising the Wielkopolskie and Kujawsko-Pomorskie Voivodeships, the growth in farm size was linked also to better quality of agricultural production space and lower stocking density of pigs. Contrary to the rest of the country, here it also resulted in an increase in the intensity of production organisation and thus reduction in the share of cereals in the cropping structure (Table 6). The growth in the employment rate was closely linked to the growth in the stocking density of pigs. Crop production, i.e. mainly cultivation of cereals being the basic source of own fodder for the granivores, was directly subordinated to livestock production. Farms dealing with pig rearing in the region did not engage in highly intensive crop production. No important interrelation between the level of stocking density of pigs and the level of commercial production and fixed assets was noted. The two latter indices were largely influenced in the region by stocking density of cattle and simplifications in the crop production organisation. The share of permanent grasslands and forage areas per arable land in UAA showed a positive correlation with the value of fixed assets and intensity of livestock production organisation. Thus, it can be stated that the investments taken, causing a growth in the value of fixed assets, were significantly linked to cattle rearing. In voivodeships forming the cluster, livestock production (cattle rearing) was accompanied by a growth in intensity of crop production.

Table 5

Correlation matrix[a] characterising interrelations between the assessed natural and organisational and production indices for cluster I, separated based on 2013 data (the analysis covers data for 2002-2013)

	Specification	1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Average farm area (ha of UAA)	1.000													
2	Employment (AWU per 100 ha of UAA)	**0.520**	1.000												
3	Share of cereals in the cropping structure (%)	**-0.707**	**-0.439**	1.000											
4	Stocking density of pigs (LU per 100 ha of UAA)	-0.174	**0.511**	0.131	1.000										
5	Agricultural Production Space Valuation Ratio (points)	0.060	**0.659**	-0.023	**0.948**	1.000									
6	Commercial production (PLN per ha of UAA)	0.857	**0.655**	-0.616	0.105	0.377	1.000								
7	Share of permanent grasslands and forage areas per arable land in UAA (points)	-0.382	**-0.678**	0.304	**-0.778**	**-0.889**	**-0.626**	1.000							
8	Stocking density of cattle and sheep (LU per 100 ha of UAA)	0.025	**0.614**	0.020	**0.966**	**0.983**	0.311	**-0.882**	1.000						
9	Fixed assets (PLN per ha of UAA)	**0.846**	**0.675**	-0.692	0.229	**0.457**	**0.923**	**-0.732**	**0.427**	1.000					
10	Stocking density (LU per 100 ha of UAA)	-0.115	**0.546**	0.104	**0.992**	**0.961**	0.169	**-0.816**	**0.986**	0.294	1.000				
11	Intensity of crop production organisation (points)	0.055	0.389	-0.262	0.098	0.204	0.171	-0.130	0.117	0.198	0.105	1.000			
12	Intensity of livestock production organisation (points)	-0.144	**0.535**	0.152	**0.993**	**0.961**	0.150	**-0.792**	**0.980**	0.259	**0.996**	0.077	1.000		
13	Consumption of mineral fertilisers NPK (kg per ha of UAA)	**0.651**	**0.656**	-0.680	0.292	**0.504**	**0.820**	**-0.765**	**0.443**	**0.847**	0.338	0.192	0.307	1.000	
14	Production in cereal units (cereal units per ha of UAA)	**0.572**	**0.659**	**-0.497**	**0.443**	**0.601**	**0.726**	**-0.782**	**0.572**	**0.706**	**0.486**	0.049	**0.465**	**0.752**	1.000

[a] Statistically significant correlations are in bold, $\alpha = 0.05$.

[b] Numbers correspond to parameter designation in the vertical column.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002-2013; Użytkowanie gruntów..., 2002-2013; Witek, 1981).

Table 6

Correlation matrix[a] characterising interrelations between the assessed natural and organisational and production indices for cluster II, separated based on 2013 data (the analysis covers data for 2002-2013)

	Specification	1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Average farm area (ha of UAA)	1.000													
2	Employment (AWU per 100 ha of UAA)	**-0.757**	1.000												
3	Share of cereals in the cropping structure (%)	**-0.811**	**0.767**	1.000											
4	Stocking density of pigs (LU per 100 ha of UAA)	**-0.900**	**0.810**	**0.711**	1.000										
5	Agricultural Production Space Valuation Ratio (points)	**0.732**	**-0.770**	**-0.748**	**-0.766**	1.000									
6	Commercial production (PLN per ha of UAA)	0.176	0.280	0.073	0.017	**-0.463**	1.000								
7	Share of permanent grasslands and forage areas per arable land in UAA (points)	0.013	0.331	0.117	0.182	-0.583	0.790	1.000							
8	Stocking density of cattle and sheep (LU per 100 ha of UAA)	0.278	0.076	-0.166	-0.102	-0.341	**0.864**	**0.780**	1.000						
9	Fixed assets (PLN per ha of UAA)	0.049	0.333	0.142	0.133	-0.600	**0.947**	**0.869**	0.924	1.000					
10	Stocking density (LU per 100 ha of UAA)	**-0.758**	**0.791**	**0.662**	**0.886**	**-0.928**	**0.408**	**0.507**	0.341	**0.552**	1.000				
11	Intensity of crop production organisation (points)	**0.475**	**-0.628**	**-0.615**	**-0.533**	**0.863**	**-0.567**	**-0.592**	-0.479	**-0.707**	**-0.785**	1.000			
12	Intensity of livestock production organisation (points)	**-0.798**	**0.830**	**0.690**	**0.916**	**-0.914**	0.356	**0.462**	0.264	**0.489**	**0.991**	**-0.766**	1.000		
13	Consumption of mineral fertilisers NPK (kg per ha of UAA)	**0.543**	-0.401	**-0.693**	-0.399	0.325	0.266	0.164	**0.475**	0.252	-0.218	0.137	-0.245	1.000	
14	Production in cereal units (cereal units per ha of UAA)	**0.610**	-0.376	**-0.415**	**-0.574**	0.225	**0.490**	0.295	**0.541**	**0.405**	-0.297	0.125	-0.351	0.355	1.000

[a] Statistically significant correlations are in bold, $\alpha = 0.05$.

[b] Numbers correspond to parameter designation in the vertical column.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002-2013; Użytkowanie gruntów..., 2002-2013; Witek, 1981).

Based on the matrix of correlations between the analysed indices in cluster III, it can be stated that most of the interrelations between farm size and other of the analysed indices was different than for the voivodeships in general (Table 7). The separated cluster is the largest among all of the analysed ones and it is formed by the following voivodeships: Lubelskie, Łódzkie, Małopolskie, Mazowieckie, Śląskie, Świętokrzyskie and Podkarpackie. Raising the average farm area in the region was linked to a growth in the share of cereals in the cropping structure, stocking density of pigs, value of fixed assets, intensity of crop and livestock production organisation, and consumption of mineral fertilisers (Table 7). The high employment rate in agriculture in these voivodeships points to a negative correlation with the organisational and production indices characterised by considerable labour-intensity. Thus, major labour resources in south-eastern Poland result from other, non-production and non-agriculture related conditions. Interrelations between the share of cereals and other assessed indices are similar to those indicated in cluster II. Pig rearing in the region is closely linked to the poor quality of the agricultural production space, whose deterioration leads to extensification of crop production. Commercial production in the cluster is obtained by a growth in farm size and increase in cropping of cereals and cattle rearing. This is accompanied by a growth in the value of fixed assets. The level of mineral fertilisation, as opposed to the country average, grows along with the stocking density of cattle and sheep, thus along with increasing the resources of natural fertilisers. This does not put the fertilisation economy in the region in the best light. Values of fixed assets are increased through simplifications in the crop production organisation, which contrary to the country average, favour higher crop productivity.

In cluster IV, which is composed of 5 voivodeships of north-western Poland, the growth in the farm area, just like in cluster II, was linked to better quality of agricultural production space and higher value of commercial production. The farm area was vitally linked to the growth in intensity, productivity and crop production organisation. By investments in machines and devices used in crop production, the value of fixed assets (Table 8) grew in the region. The livestock production in cluster IV predetermined cattle rearing and changes in the pig population failed to have a major impact on the other organisational and production indices. Cattle, in this region, are reared in poorer quality soil and climate conditions. Their improvement favoured, just like for the voivodeships in general, growth in intensity and efficiency of crop production. Whereas contrary to the country as a whole, cattle rearing intensification has a major positive effect on simplification of the crop production organisation and its intensity, measured with the mineral fertilisation level. Inverse interrelation between the indices of crop production intensity and organisation and intensity of livestock production point to a high production specialisation of the region.

Table 7

Correlation matrix[a] characterising interrelations between the assessed natural and organisational and production indices for cluster III, separated based on 2013 data (the analysis covers data for 2002-2013)

	Specification	1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Average farm area (ha of UAA)	1.000													
2	Employment (AWU per 100 ha of UAA)	**-0.504**	1.000												
3	Share of cereals in the cropping structure (%)	**0.693**	**-0.421**	1.000											
4	Stocking density of pigs (LU per 100 ha of UAA)	**0.429**	**-0.522**	**0.403**	1.000										
5	Agricultural Production Space Valuation Ratio (points)	**-0.455**	**0.450**	**-0.354**	**-0.516**	1.000									
6	Commercial production (PLN per ha of UAA)	**0.550**	-0.014	**0.370**	0.162	**-0.476**	1.000								
7	Share of permanent grasslands and forage areas per arable land in UAA (points)	**-0.566**	**0.542**	**-0.669**	**-0.530**	0.004	-0.104	1.000							
8	Stocking density of cattle and sheep (LU per 100 ha of UAA)	**0.552**	**-0.372**	0.100	**0.473**	**-0.751**	0.522	0.066	1.000						
9	Fixed assets (PLN per ha of UAA)	-0.133	**0.414**	0.155	-0.093	-0.196	0.605	0.212	-0.054	1.000					
10	Stocking density (LU per 100 ha of UAA)	**0.458**	**-0.478**	0.133	**0.681**	**-0.798**	0.429	-0.054	0.938	-0.023	1.000				
11	Intensity of crop production organisation (points)	**0.387**	-0.157	0.114	**0.295**	0.199	0.057	-0.448	0.179	-0.423	0.139	1.000			
12	Intensity of livestock production organisation (points)	**0.568**	**-0.538**	**0.291**	**0.774**	**-0.805**	0.473	-0.241	0.885	-0.029	**0.963**	**0.229**	1.000		
13	Consumption of mineral fertilisers NPK (kg per ha of UAA)	**0.587**	**-0.357**	**0.588**	**0.538**	**-0.291**	0.626	-0.587	0.251	0.271	**0.308**	**0.298**	**0.444**	1.000	
14	Production in cereal units (cereal units per ha of UAA)	0.062	0.092	**0.409**	-0.076	0.080	**0.402**	-0.212	**-0.250**	**0.593**	**-0.216**	**-0.231**	-0.196	**0.401**	1.000

[a] Statistically significant correlations are in bold, $\alpha = 0.05$.

[b] Numbers correspond to parameter designation in the vertical column.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002-2013; Użytkowanie gruntów…, 2002-2013; Witek, 1981).

Table 8

Correlation matrix[a] characterising interrelations between the assessed natural and organisational and production indices for cluster IV, separated based on 2013 data (the analysis covers data for 2002-2013)

Specification		1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Average farm area (ha of UAA)	1.000													
2	Employment (AWU per 100 ha of UAA)	**-0.446**[a]	1.000												
3	Share of cereals in the cropping structure (%)	**-0.728**	0.093	1.000											
4	Stocking density of pigs (LU per 100 ha of UAA)	-0.241	0.156	0.029	1.000										
5	Agricultural Production Space Valuation Ratio (points)	**0.613**	**-0.841**	**-0.350**	0.247	1.000									
6	Commercial production (PLN per ha of UAA)	0.380	0.327	-0.567	-0.154	-0.093	1.000								
7	Share of permanent grasslands and forage areas per arable land in UAA (points)	-0.112	**0.731**	-0.145	-0.192	**-0.725**	**0.324**	1.000							
8	Stocking density of cattle and sheep (LU per 100 ha of UAA)	**-0.262**	**0.862**	-0.028	-0.019	**-0.784**	**0.306**	**0.932**	1.000						
9	Fixed assets (PLN per ha of UAA)	**0.352**	**0.530**	**-0.560**	0.059	-0.205	**0.747**	**0.536**	**0.601**	1.000					
10	Stocking density (LU per 100 ha of UAA)	-0.322	**0.836**	0.004	0.111	**-0.740**	**0.254**	**0.922**	**0.970**	**0.538**	1.000				
11	Intensity of crop production organisation (points)	**0.261**	-0.243	-0.200	0.177	**0.413**	0.167	**-0.552**	**-0.449**	0.110	**-0.497**	1.000			
12	Intensity of livestock production organisation (points)	**-0.339**	**0.878**	-0.003	0.241	**-0.705**	0.244	**0.860**	**0.962**	**0.571**	**0.973**	**-0.408**	1.000		
13	Consumption of mineral fertilisers NPK (kg per ha of UAA)	**0.348**	**-0.405**	**-0.312**	0.079	**0.542**	**0.353**	**-0.557**	**-0.539**	0.111	**-0.534**	**0.595**	**-0.525**	1.000	
14	Production in cereal units (cereal units per ha of UAA)	**0.496**	**-0.357**	**-0.409**	0.022	**0.538**	**0.411**	**-0.476**	**-0.432**	0.202	**-0.487**	**0.518**	**-0.444**	**0.648**	1.000

[a] Statistically significant correlations are in bold, $\alpha = 0.05$.

[b] Numbers correspond to parameter designation in the vertical column.

Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2002-2013; Użytkowanie gruntów..., 2002-2013; Witek, 1981).

The above-mentioned analyses confirm a thesis on a major regional differentiation of the Polish agriculture, which concerns also an interaction between natural factors and organisational and production factors. Mutual relations and interrelations between respective natural and organisational factors are different depending on the region of Poland. The obtained results indicate that depending on the cluster, there are several interrelations varying in strength and direction. Interrelations and trends observed at the national level often fail to be reflected at the regional level. This allows to make a thesis that it is necessary to regionalise Common Agricultural Policy (CAP), since the directions and effects of changes in respective indices in the regions are often quite varied. This may enable efficient troubleshooting and more optimal development of agricultural production in Poland.

Most of the indices used in the analysis, which describe agricultural production, are characterised not only by varied level but also different dynamics over time.

The largest average farm area in 2013 was typical of the Warmińsko-Mazurskie and Zachodniopomorskie Voivodeships (Fig. 4). The highest dynamics of changes for the index in 2002-2013 was noted for the Lubuskie, Opolskie and Śląskie Voivodeships. Taking into consideration the two parameters, the best situation is in the Opolskie and Lubuskie Voivodeships, which are characterised by fairly high average farm area at high growth dynamics. The worst, from the perspective of agrarian structure, is the situation in the Łódzkie, Lubelskie, Świętokrzyskie, Małopolskie and Podkarpackie Voivodeships, which are characterised by a significant agrarian fragmentation and, at the same time, low dynamics of changes in farm area. Despite the accession to the EU and subsides allocated to agriculture, the traditional (family) farming model prevails in these voivodeships, which prevents them from benefiting from the so-called economies of scale. But then, extensive character of production can favour preservation of biodiversity and values of the natural environment.

It should be emphasised that the average and median values are different for the analysed factors. Median for farm size is higher than the average, but lower than for change dynamics.

The highest intensity of crop production organisation in 2013 was typical of the Lubelskie, Świętokrzyskie and Kujawsko-Pomorskie Voivodeships (Fig. 5). As far as for the two former voivodeships berries and fruit had a vital impact on the situation, in the Kujawsko-Pomorskie Voivodeship it was preconditioned by other input-intensive crops (sugar beet, rape). However, among the three Voivodeships only in Lubelskie Voivodeship the 2002-2013 growth rate in the index was higher than the average for the country. In the period, Zachodniopomorskie and Lubuskie Voivodeship definitely had the highest change dynamics. In 2002-2013, crop production organisation was simplified only in the Wielkopolskie and Podlaskie Voivodeship. The latter voivodeship was marked by the lowest level of intensity of crop production organisation in 2013 (by 95 points).

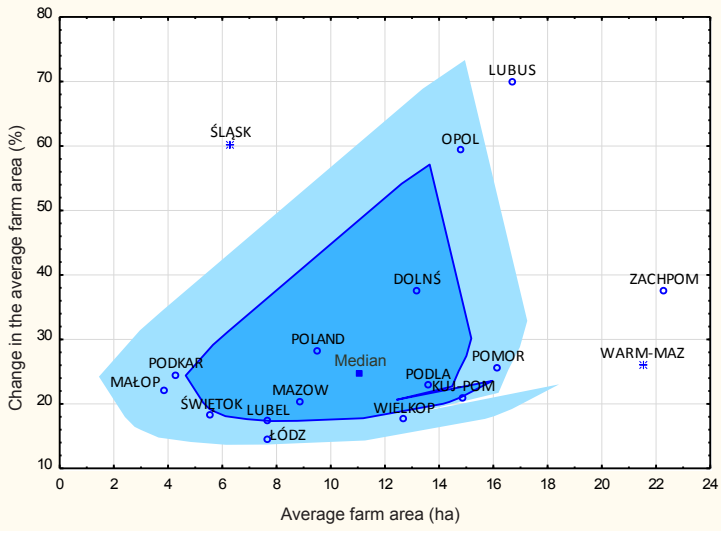

Fig. 4. Average farm area in voivodeships in 2013 against change dynamics in 2002-2013.
Source: own study on the basis of: (Rocznik Statystyczny Rolnictwa, 2013).

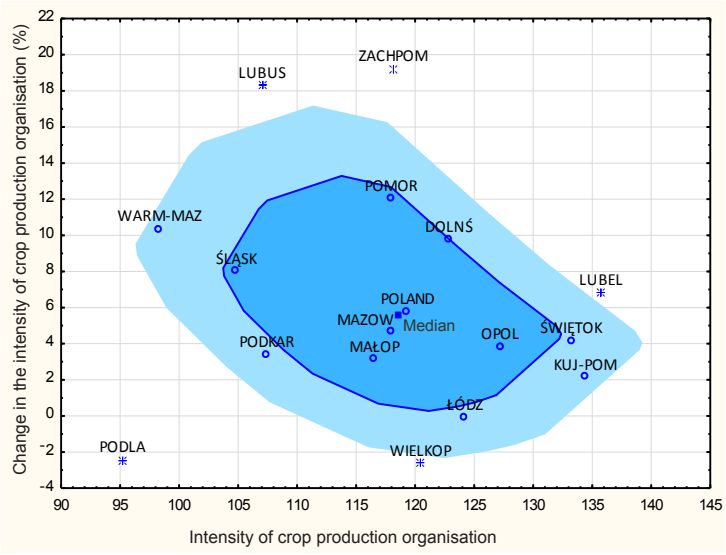

Fig. 5. Intensity of crop production organisation in voivodeships in 2013 against change dynamics in 2002-2013.
Source: own study on the basis of: (Użytkowanie gruntów…, 2013).

The highest intensity of livestock production organisation and positive change dynamics in 2002-2013 was typical of the Podlaskie Voivodeship (Fig. 6). Also in the Mazowieckie Voivodeship the value and dynamics of changes in the index was higher than the country average. The high value of the intensity of livestock production organisation was noted also in the Wielkopolskie Voivodeship, but the index did not change significantly over the analysed years. Also in the Warmińsko-Mazurskie Voivodeship the index did not drop. In the remaining voivodeships in 2002-2013, there was a fairly high drop in intensity of livestock production organisation which should be assessed decidedly negatively, both in production and environmental terms (decrease in the organic substance in the soil). The Dolnośląskie Voivodeship noted the highest drop in and the lowest value of the intensity of livestock production organisation. The value of the parameters is shaped definitely unfavourably also in the Podkarpackie, Lubuskie, Zachodniopomorskie, Opolskie, Małopolskie and Lubelskie Voivodeships. Changes in livestock production in the analysed years confirm, just like earlier the analysis by Kopiński (2014), further deepening of polarisation between Polish voivodeships.

The values of the average and median look similar also for intensity of livestock production organisation. The median for the discussed parameters is definitely lower than the average value.

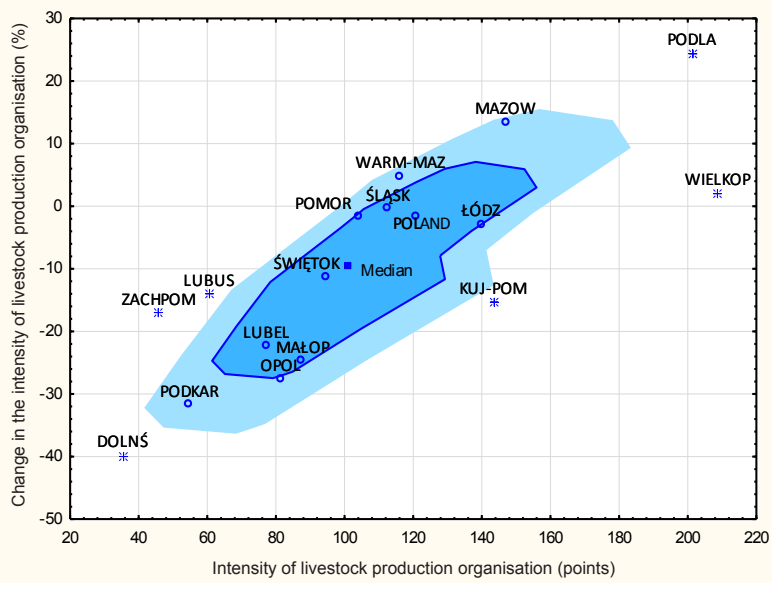

Fig. 6. Intensity of livestock production organisation in voivodeships in 2013 against change dynamics in 2002-2013.

Source: own study on the basis of: (Użytkowanie gruntów..., 2013).

Conclusions

Changes concerning organisational and production factors in the Polish agriculture take place under varied dimensions and are an inseparable element of the development process. However, the direction and scale of the changes are predetermined by natural conditions, although their strength of impact decreased over the last years. The conducted analysis showed that the direction and strength of mutual interrelations between the selected organisational and production factors against natural conditions differs in individual regions of Poland. The observed nationwide trends in and process of interrelations between the analysed organisational and production factors fail to properly reflect the scale and effects of their changes in different regions of the country. Given the multifaceted and complex conditions of agricultural production, the effects of impact of externalities in individual regions highly differ. This is manifested by spatial differences in varied models of agricultural production realisation, which are characterised by different level of organisation and intensity. Thus, this justifies the conclusion that it is necessary to regionalise the national agricultural production, including the Rural Development Programme. Such an approach should contribute to a more optimal and more efficient spending of funds allocated to rural areas.

Literature:

Andreae, B. (1974). *Ekstensywnie organizować – intensywnie gospodarować*. Warszawa: PWRiL, p. 121.

Banaś, K. (2008). Konkurencyjność produktów rolniczych na przykładzie gospodarstwa specjalizującego się w produkcji roślinnej. Rocz. Nauk. SERiA, no. 10(3), pp. 20-24.

Brelik, A., Grzelak, A. (2011). The evaluation of the trends of Polish farms incomes in the FADN regions after the integration with the EU. *J. Agrib. Rural Devel., seria Ekonomia, no. 2(20)*: 5-11.

Czyżewski, B., Majchrzak, A. (2015). Związek dochodów, cen i produktywności w rolnictwie w Polsce – ujęcie makroekonomiczne. *Rocz. Nauk. SERiA*, *no. 17*(2), pp. 26-31.

Harasim, A. (2006). *Przewodnik ekonomiczno-rolniczy w zarysie*. Puławy: IUNG-PIB, p. 171.

Józwiak, W., Mirkowska, Z. (2011). Trendy w rolnictwie polskim (lata 1990-2009) i próba projekcji na 2013 rok. In: *Procesy zachodzące w rolnictwie polskim w latach 1990-2010, projekcje na rok 2013 i pożądana wizja rolnictwa w 2020 roku – zagadnienia wybrane*. (pp. 9-31). Program Wieloletni 2011-2014, Warszawa: IERiGŻ-PIB.

Klepacki, B. (1997). *Wybrane pojęcia z zakresu organizacji gospodarstw, produkcji i pracy w rolnictwie*. Warszawa: SGGW.

Kopiński, J. (2014). Określenie stopnia polaryzacji głównych kierunków produkcji zwierzęcej w Polsce. *Roczn. Nauk. SERiA, no. 16*(2), pp. 142-147.

Kopiński, J. (2012). Realizacja celów środowiskowych i ekonomicznych w gospodarstwach o różnych kierunkach specjalizacji. *Problemy Inżynierii Rolniczej, no. 2*(76), pp. 37-45.

Kopiński, J. (2013). Stopień polaryzacji intensywności i efektywności produkcji rolniczej w Polsce w ostatnich 10 latach. *Rocz. Nauk. SERiA, no. 15*(1), pp. 97-103.

Kot, S., Jakubowski, J., Sokołowski, A. (2007). *Statystyka*. Warszawa: Wyd. Difin, p. 520.

Krasowicz, S. (2009). Regionalne zróżnicowanie zmian w rolnictwie polskim. *Studia i Raporty IUNG-PIB*, no. 15, pp. 9-36.

Krasowicz, S., Górski, T., Budzyńska, K., Kopiński, J. (2012). Agricultural characteristics of the territory of Poland. In: J. Igras and M. Pastuszak (ed.), *Temporal and spatial differences in emission of nitrogen and phosphorus from Polish territory to the Baltic Sea*. Wyd. IUNG-PIB Puławy – MIR Gdynia, pp. 45-108.

Matyka, M., Krasowicz, S., Kopiński, J., Kuś, J. (2013). Regionalne zróżnicowanie zmian produkcji rolniczej w Polsce. *Studia i Raporty IUNG-PIB, no. 32*(6), pp. 143-165.

Niedzielski, E. (2015). Funkcje obszarów wiejskich i ich rozwój. *Zagadnienia Ekonomiki Rolnej, no. 2*(343), pp. 84-93.

Poczta, W. (2010). Przemiany w rolnictwie. *Polska wieś 2010. Raport o stanie wsi*. Warszawa: Scholar, pp. 9-43.

Poczta, W., Czubak, W., Pawlak, K. (2009). Zmiany w wolumenie produkcji i dochodach rolniczych w warunkach akcesji Polski do UE. *Zagadnienia Ekonomiki Rolnej, no. 4*(321), pp. 40-52.

Rocznik Statystyczny Rolnictwa 2002-2013. Warszawa: GUS, 2002-2013.

Runowski, H. (2014). Ekonomika rolnictwa – przemiany w gospodarstwach rolnych. In: *Rolnictwo, gospodarka żywnościowa, obszary wiejskie – 10 lat w Unii Europejskiej*. Warszawa: Wyd. SGGW, pp. 31-48.

Szymańska, J. (2014). Ubytek ziemi rolniczej w województwie dolnośląskim w długim okresie (wybrane problemy za lata 1998-2012). In: A. Olszańska (ed.), *Agrobiznes w teorii i w praktyce*. Wrocław: Wyd. UE, pp. 100-110.

Użytkowanie gruntów, powierzchnia zasiewów i pogłowie zwierząt gospodarskich w 2002--2013 r. Warszawa: GUS, 2002-2013.

Wigier, M. (ed.). (2011). *Analiza efektów realizacji polityki rolnej wobec rolnictwa i obszarów wiejskich*. Program Wieloletni 2011-2014. Warszawa: IERiGŻ-PIB, p. 144.

Witek, T. et al. (1981). *Waloryzacja rolniczej przestrzeni produkcyjnej Polski według gmin*. Seria A-40, Puławy: Wyd. IUNG.

Zegar, J. (2013). *Konkurencyjność celów ekologicznych i ekonomicznych w rolnictwie*. Program Wieloletni 2011-2014. Warszawa: IERiGŻ-PIB, pp. 28-46.

JERZY KOPIŃSKI
MARIUSZ MATYKA
Instytut Uprawy Nawożenia i Gleboznawstwa – PIB
Puławy

OCENA REGIONALNEGO ZRÓŻNICOWANIA WSPÓŁZALEŻNOŚCI CZYNNIKÓW PRZYRODNICZYCH I ORGANIZACYJNO-PRODUKCYJNYCH W POLSKIM ROLNICTWIE

Abstrakt

W pracy oceniono regionalne zróżnicowanie interakcji pomiędzy czynnikami przyrodniczymi a organizacyjnymi w polskim rolnictwie. Przeprowadzona w ujęciu dynamicznym analiza obejmowała lata 2002-2013, a wskaźniki dla poszczególnych województw porównywano do średnich dla Polski, jako układu odniesienia. W badaniach, oprócz statystyk opisowych, zastosowano również grupowanie województw z wykorzystaniem analizy skupień metodą k-średnich. Przeprowadzone badania wskazują, że kierunek i siła wzajemnego oddziaływania wybranych czynników przyrodniczych i organizacyjnych jest zróżnicowana pomiędzy poszczególnymi regionami Polski. Obserwowane ogólnokrajowe tendencje i wzajemne zależności analizowanych czynników przyrodniczych i organizacyjnych nie odzwierciedlają właściwie skali i skutków ich zmian w różnych regionach kraju. Ze względu na wieloczynnikowe uwarunkowania prowadzenia produkcji rolniczej skutki ich oddziaływania w poszczególnych regionach są mocno zróżnicowane. Przejawem tego jest realizacja, w poszczególnych częściach Polski, odmiennych modeli produkcji rolniczej, charakteryzujących się różnym poziomem organizacji i intensywności. Dokonana analiza wskazuje na konieczności regionalizacji krajowej polityki rolnej, w tym Programu Rozwoju Obszarów Wiejskich. Podejście takie powinno przyczynić się do bardziej efektywnego wydatkowania środków kierowanych do rolnictwa i na obszary wiejskie, poprzez optymalizowanie procesu ich rozwoju.

Słowa kluczowe: rolnictwo, uwarunkowania przyrodnicze, uwarunkowania organizacyjne, regionalne zróżnicowanie.

Accepted for print: 31.03.2016.