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LABOR EFFICIENCY AND CHANGES IN SELECTED RELATIONS OF PRODUCTION FACTORS IN AGRICULTURE IN POLAND

Key words: labor efficiency, labor, land, fixed assets

ABSTRACT. The purpose of the work was the evaluation of changes in the effectiveness of the use of labor in agriculture against a background of changes in the relation of production factors. The analysis is presented on a regional basis. The empirical material consisted of CSO statistical data from 2000-2016. The following diagnostic variables were used for analysis: (1) the value of gross agricultural output per one employed in agriculture, (2) technical work equipment – the gross value of fixed assets in agriculture per one employed in agriculture, (3) the number of people working in agriculture per 100 hectares of agricultural land (AL), (4) technical equipment of agricultural land – the gross value of fixed assets in agriculture per 1 hectare of AL. Based on a set of diagnostic features describing individual voivodships in Poland, their classification was performed using the cluster analysis of the Ward method. A decrease in the technical equipment of labor was recorded, and an increase in the technical equipment of agricultural land and the number of people working in agriculture per 100 hectares of AL. At the same time, these changes varied in individual groups of voivodships. Analysis of regional differentiation demonstrates that, in voivodships with much more favorable relations of production, labour efficiency was higher. In addition, in these voivodships, the average annual rate of changes in labor efficiency was also at a higher level. This may result in a growing disparity in the level of farming efficiency.

INTRODUCTION

Agriculture in Poland is characterized by its regional diversity in its production potential, scale of production and degree of specialization, but also efficiency of management. These differences are conditioned by economic, environmental, historical and social factors [Muszyńska 2010, Miś 2011, Krasowicz 2013]. Several years of Polish agriculture in the European Union (EU) and the implementation of the Common Agricultural Policy (CAP) have contributed to structural changes in agriculture [Czudec et al. 2017]. These changes take place in the area of production factors, their mutual relations, the production scale, modernity of applied production technologies, as well as efficiency of management.

Literature on the subject draws attention to the plurality of factors affecting structural changes in agriculture, both exogenous and endogenous [Kusz 2018]. What is particularly important for the restructuring and modernization of agriculture are observed trends in

changes in the prices of factors of production, especially the rapid increase in labor costs compared to other factors of production [Runowski, Ziętara 2011]. In order to maintain the ability to generate income at a level acceptable to farmers, it is becoming necessary to implement labor-saving production technologies that primarily result in the improvement of the labor-capital and labor-to-land relation, and increase in agricultural productivity.

The purpose of the work was the evaluation of changes in the effectiveness of the use of labor in agriculture against a background of changes in the relation of production factors. The analysis is presented on a regional basis. It enables to assess the level of regional diversity, and gives essentials to the formulation of conclusions about the scale and scope of regionalization of agricultural policy.

MATERIAL AND METHODS

Empirical material consisted of CSO statistical data from 2000-2016. The following diagnostic variables were used for analysis: (1) the value of gross agricultural output per one employed in agriculture, (2) technical work equipment – the gross value of fixed assets in agriculture per one employed in agriculture, (3) the number of people working in agriculture per 100 hectares of agricultural land (AL), (4) technical equipment of agricultural land – the gross value of fixed assets in agriculture per 1 hectare of AL. The choice of diagnostic variables came from the fact that the efficiency of using labor in agriculture is one of the most important indicators determining the competitiveness of agriculture [Filipiak 2017, Kusz, Misiak 2017]. Low work performance results in low farmer income, limited capital accumulation capacity and, in the long run, the inhibition of development processes. In turn, selected relations between production factors allowed for a comparison of the production potential of agriculture in the regional system. Moreover, the relations between production factors indicate the production techniques used, changes in those relations caused by changes in the production technique. In agriculture, the land factor is of particular importance as a non-renewable and limited resource. Capital and labor factors also play an important role. Capital is essential to start and continue the production process, and labor is a basic production factor, conditioning the use of remaining factors. In general terms, efficiency results from the proper management of these resources [Zabolotny et al. 2018]. To maintain comparability of the amounts expressed in monetary measures, constant prices from 2016 were used, for this purpose Consumer Price Indices (CPI) were employed.

Based on a set of diagnostic features describing individual voivodships in Poland, their classification was performed using the cluster analysis of the Ward method. Cluster analysis was carried out for two time slots: for 2000-2004 and 2012-2016. Using this method, it is possible to identify clusters of objects similar in terms of selected statistics so that there is as little variation as possible within each cluster and as much variation as possible between individual clusters [Hydzik, Sobolewski 2009]. Variance analysis was employed to estimate the distance between individual units [Stanisz 2007]. Analysis was preceded by the standardization of statistics according to the following formulas:

– for the stimulant – $\dot{x_i} = \frac{x_i - x_{min}}{x_{max} - x_{min}}$ (1)

– for the destimulant – $\dot{x_i} = \frac{x_{max} - x_i}{x_{max} - x_{min}}$ (2)

The average annual rate of change was determined using chain indexes:

$$\bar{i_g} = \sqrt[n-1]{i_{n/n-1} * i_{n-1/n-2} * \ldots * i_{2/1} * i_{1/0}} \quad (3)$$

The average annual rate of change was calculated according to the following formula:

$$r = \bar{i_g} - 1 \quad (4)$$

The main goal was achieved through the implementation of the following research tasks: (1) the determination of changes in labor productivity in agriculture, (2) the determination of changes in relations of production factors in agriculture. These analyses were carried out for individual voivodships in Poland for the years 2000-2016.

RESEARCH RESULTS

Analyzing the level of work performance in Poland in individual voivodships, significant regional differences were found (Figure 1). The lowest level of this indicator was recorded mainly in the Podkarpackie, Świętokrzyskie and Lublin voivodships. At the same time, these differences deepened in the analyzed period. Analyzing average values of labor efficiency for the years 2012-2016, in comparison to the average from 2000-2004, in agriculture in Poland, an increase of 33.27% was calculated. This indicator was higher for all voivodships, except for the Małopolskie and Podkarpackie voivodships, where in 2012-2016 labor efficiency was lower (in the Małopolskie Voivodship by 6.75%, and in the Podkarpackie Voivodship by as much as 21.58%).

The efficiency of farming in agriculture largely depends on the production technique used, determined by the relations of factors of production. Changes in these relations depend on the prices of production factors, the availability of new technological solutions, but also on the ability of producers to implement these solutions. Implementation of these changes into production practice requires transformations in the resources of production factors, especially within tangible assets [Karwat-Woźniak 2011, Mundlak 1988]. First of all, there is an increase in the importance of capital in the production process in relation to other production factors [Zieliński 2014]. In the case of technical labor equipment in the analyzed period, in agriculture in Poland this indicator decreased by 4.79%. Wherein, in four voivodships there was an increase in the technical equipment of labor, these were the Wielkopolskie Voivodship (by 11.04%), the Opolskie Voivodship (by 10.08%), the Lubuskie Voivodship (by 7.82%) and the Podlaskie Voivodship (only 0.36%). However, regional differences in the level of technical labor equipment were still significant (Figure 2). In the case of technical equipment of agricultural land, regional differences were not as

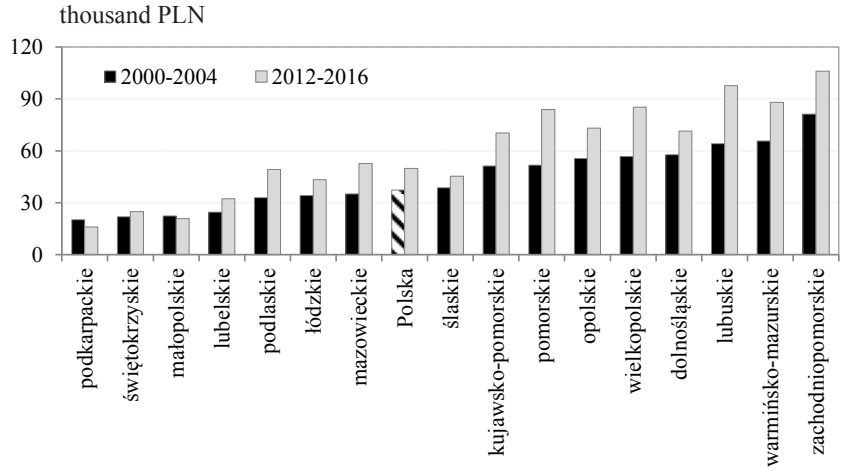

Figure 1. Labor efficiency in agriculture in Poland (average values for 2000-2004 and 2012-2016, constant prices from 2016)

Source: own calculations based on CSO data

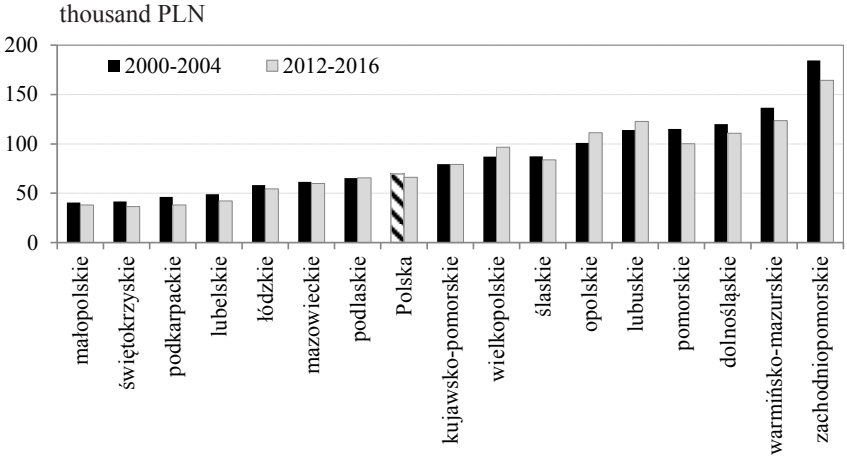

Figure 2. Technical equipment for agricultural labor in Poland (average values for 2000-2004 and 2012-2016, constant prices from 2016)

Source: own calculations based on CSO data

significant as in the case of technical labor equipment (Fiure 3). Technical equipment of agricultural land in agriculture in Poland in 2012-2016 was 3.69% higher than its average value for 2000-2004. The relation of the number of persons working in agriculture per 100 ha of AL was maintained at a high level in Poland, and significant regional variations of this indicator was noted (Figure 4). Only in two voivodships was the average value of this indicator for 2012-2016 lower than in 2000-2004. They were the Wielkopolskie Voivodship (a decrease of 1.41%) and the Kujawsko-Pomorskie Voivodship (a decrease of 0.21%).

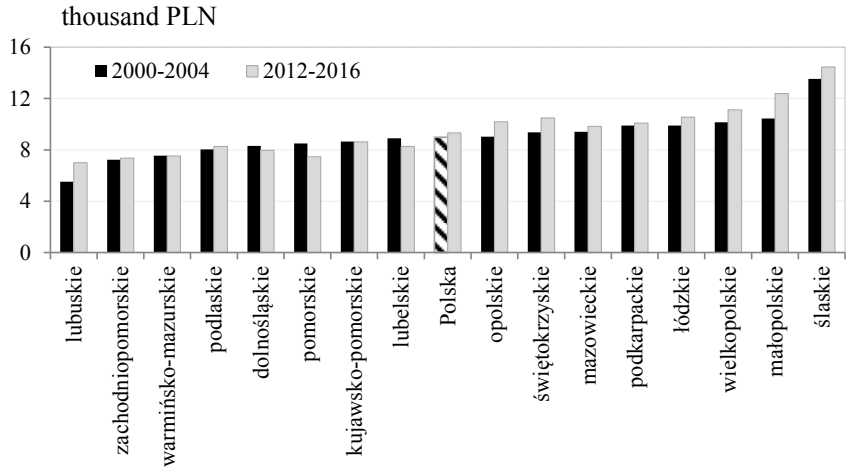

Figure 3. Technical equipment in agricultural land in Poland (average values for 2000-2004 and 2012-2016, constant prices from 2016)

Source: own calculations based on CSO data

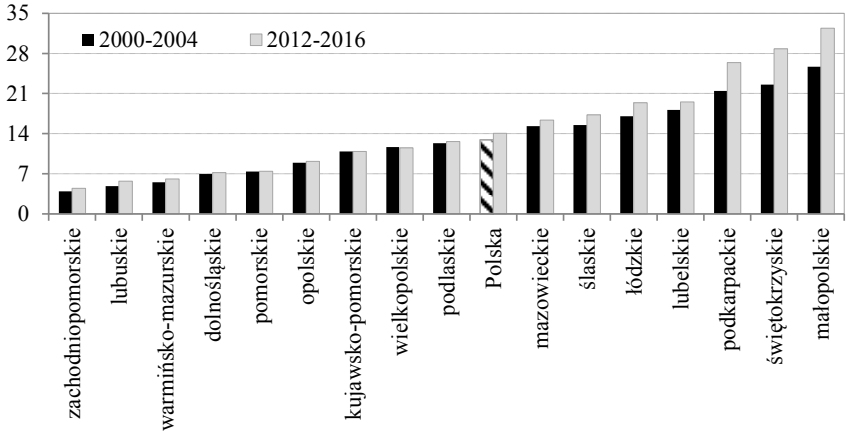

Figure 4. Employed in agriculture per 100 ha of AL in Poland (average values for 2000-2004 and 2012-2016)

Source: own calculations based on CSO data

Based on the cluster analysis using the Ward method (based on diagnostic variables: technical equipment of labor – the gross value of fixed assets in agriculture per one employed in agriculture; the number of persons working in agriculture per 100 ha of arable land (AL); the technical equipment of land – the gross value of fixed assets in agriculture per 1 ha of AL) typological classes of voivodships with similar relations of production factors were distinguished for both 2000-2004 (Figure 5) and 2012-2016 (Figure 6). Cluster I in 2000-2004 includes the Dolnośląskie, Pomorskie, Opolskie, Warmińsko-

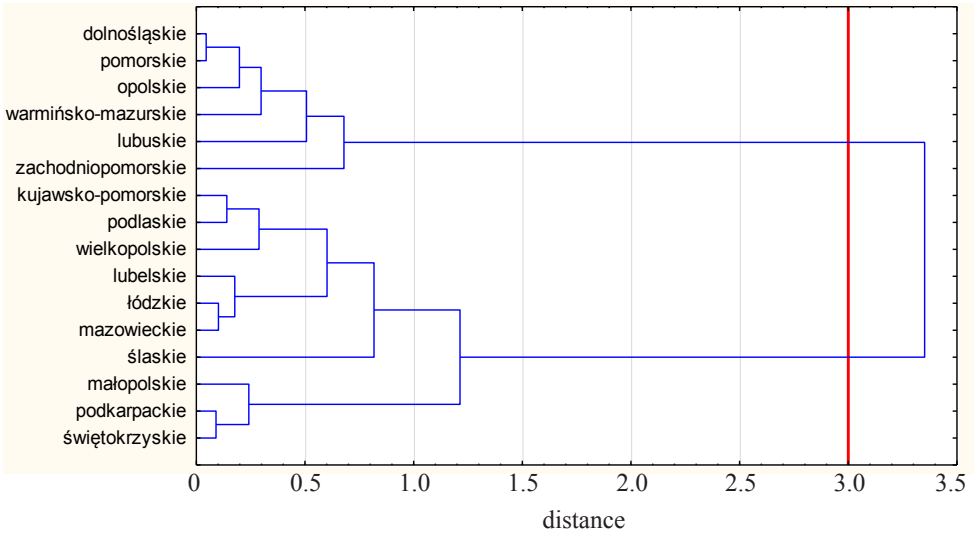

Figure 5. Classification of voivodships by the Ward method according to the relationship of production factors in agriculture for 2000-2004

Source: own calculations based on CSO data

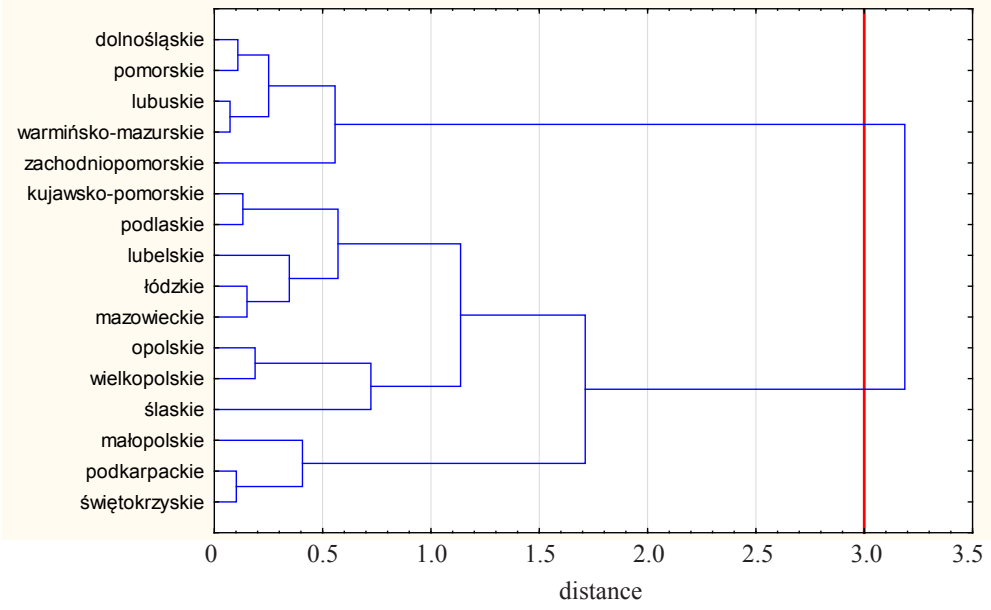

Figure 6. Classification of voivodships by the Ward method according to the relationship of production factors in agriculture for the years 2012-2016

Source: own calculations based on CSO data

Mazurskie, Lubuskie and Zachodniopomorskie voivodships (Figure 5). In turn, in the years 2012-2016, in the first group of farms there were only the Dolnośląskie, Pomorskie, Lubuskie, Warmińsko-Mazurskie and Zachodniopomorskie voivodships (Figure 6). The Opolskie Voivodship moved from the first group of voivodships to the second group. This indicates that, in the analyzed period, there were no significant changes in the scope of regional differences in relations of production factors in agriculture specific for individual voivodships. The voivodships of the first cluster are characterized by much larger technical equipment of labor, smaller technical equipment of agricultural land and a smaller number of employees per 100 ha of AL (Table 1 and 2). Also, agriculture from the first cluster of voivodships is characterized by much greater efficiency in the use of the labor factor (Table 1 and 2). Analyzing the changes occurring in the relations of production factors in individual clusters of voivodships, it was stated that, in the period under review, a decrease in the technical equipment of labor was recorded, while in the I cluster of voivodships, separated according to the relations of diagnostic variables for 2000-2004, the average annual decrease in technical labor equipment was smaller than in the voivodships of II clusters (Table 1). The situation was the opposite in the case of clusters of voivodships

Table 1. Statistics of diagnostic variables and their average annual changes for 2000-2016 in selected clusters of voivodships according to data for 2000-2004

Variables	Cluster I				Cluster II			
	$\overline{x}$	min.	max.	V_s	$\overline{x}$	min.	max.	Vs
Technical work equipment [thousand PLN]	128.51	101.09	184.41	23.1	61.67	40.71	87.50	29.07
The average annual rate of change of technical work equipment [%]	-0.21	-0.73	0.81	-336.9	-0.36	-1.38	0.77	-172.0
Technical equipment of agricultural land [thousand PLN]	7.69	5.52	9.03	16.2	9.83	8.04	13.53	15.2
The average annual rate of change of technical equipment of agricultural land [%]	0.45	-0.39	2.18	210.8	0.68	-0.24	1.36	72.6
The number of people working in agriculture per 100 hectares of AL	6.26	3.93	8.93	29.3	17.05	10.90	25.69	29.0
The average annual rate of change of the number of people working in agriculture per 100 hectares of AL [%]	0.65	0.01	1.60	82.1	1.05	0.21	1.90	65.9
Labor efficiency [thousand PLN]	62.72	51.71	81.24	16.7	33.81	20.34	56.67	36.8
The average annual rate of change of labor efficiency [%]	1.78	1.18	2.73	35.8	1.30	-2.31	3.06	137.7

Source: own calculations based on CSO data

Table 2. Statistics of diagnostic variables and their average annual changes for 2000-2016 in selected clusters of voivodships according to data for 2012-2016

Variables	Cluster I				Cluster II			
	$\overline{x}$	min.	max.	V_s	$\overline{x}$	min.	max.	Vs
Technical work equipment [thousand PLN]	124.34	100.07	164.46	19.6	64.20	36.43	111.28	40.0
The average annual rate of change of technical work equipment [%]	-0.41	-0.73	0.57	-133.6	-0.26	-1.38	0.81	-269.2
Technical equipment of agricultural land [thousand PLN]	7.47	7.00	7.98	4.7	10.39	8.26	14.46	17.7
The average annual rate of change of technical equipment of agricultural land [%]	0.37	-0.39	2.18	277.6	0.70	-0.24	1.36	67.9
The number of people working in agriculture per 100 hectares of AL	6.18	4.47	7.45	19.5	18.57	9.16	32.41	41.6
The average annual rate of change of the number of people working in agriculture per 100 hectares of AL [%]	0.78	0.34	1.60	61.9	0.96	0.01	1.90	76.2
Labor efficiency [thousand PLN]	89.38	71.35	106.01	14.8	46.67	15.95	85.20	48.4
The average annual rate of change of labor efficiency [%]	1.87	1.18	2.73	35.0	1.31	-2.31	3.06	130.9

Source: own calculations based on CSO data

separated according to diagnostic variables for the years 2012-2016, a higher average annual rate of change was recorded in the voivodships of the I cluster (Table 2). In the case of technical agriculture land equipment, the average annual increase of this indicator was recorded, with the higher growth rate being recorded in voivodships from the II cluster. The average annual rate of change for the number of people working in agriculture per 100 hectares of AL was positive. Higher growth rates were recorded in voivodships of the II cluster. This situation is not beneficial for improving the efficiency of work in agriculture, but results from a decrease in agricultural land with a stable level of employment in agriculture in Poland. The level of persons employed in agriculture per 100 hectares of AL in voivodships of the II concentration is particularly unfavorable. The overlapping low level of technical equipment for labor in the agriculture of voivodships from the II cluster adversely affects the efficiency of using labor resources in these voivodships. It is also worth noting that in the voivodships qualified for the first cluster, the average annual rate of change in work efficiency for the analyzed period was higher than in the voivodships of the II cluster (Table 1 and 2). This may result in further maintaining or growing disparities in the development of agriculture in the regional system.

CONCLUSIONS

In the analyzed period, an increase in work efficiency was recorded in Poland (measured at constant prices). The exceptions were the Małopolskie and Podkarpackie voivodships, where work efficiency for 2012-2016 was lower than in 2000-2004. This is due to significant structural weaknesses in agriculture in these two voivodships. The changes in the relation of factors of production were noted. A decrease in the technical equipment of labor was recorded, and an increase in the technical equipment of agricultural land and the number of people working in agriculture per 100 hectares of AL noted. At the same time, these changes varied in individual groups of voivodships. Also, changes in the effectiveness of the use of the labor factor in agriculture were regionally diversified. Voivodships with definitely more favorable factors of production were characterized by higher work efficiency. It should also be noted that the average annual rate of changes in work efficiency was higher in the voivodships of the I cluster, characterized by better relations of production factors and a higher level of work efficiency. This may result in a growing disparity in the level of management efficiency and endogenous factors of agricultural development.

On this basis, a more general conclusion can be made indicating the need for an agricultural policy taking interregional disparities and specific features of agriculture in Polish regions into consideration, and, above all, enabling the elimination of regional differences.

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EFEKTYWNOŚĆ PRACY A ZMIANY WYBRANYCH RELACJI CZYNNIKÓW PRODUKCJI W ROLNICTWIE W POLSCE

Słowa kluczowe: efektywność pracy, praca, ziemia, środki trwałe

ABSTRAKT

Celem pracy jest ocena zmian efektywności wykorzystania czynnika pracy w rolnictwie na tle zmian relacji czynników produkcji. Analizę przedstawiono w ujęciu regionalnym. Materiał empiryczny stanowiły dane statystyczne GUS za lata 2000-2016. Do analizy wykorzystano następujące zmienne diagnostyczne: (1) wartość produkcji globalnej w rolnictwie w przeliczeniu na jednego zatrudnionego w rolnictwie, (2) techniczne uzbrojenie pracy, (3) liczbę osób pracujących w rolnictwie na 100 ha użytków rolnych (UR), (4) techniczne uzbrojenie ziemi. Na podstawie zestawu cech diagnostycznych opisujących poszczególne województwa w Polsce przeprowadzono ich klasyfikację z wykorzystaniem analizy skupień metodą Warda. W analizowanym okresie zanotowano spadek technicznego uzbrojenia pracy oraz wzrost technicznego uzbrojenia ziemi i liczby osób pracujących w rolnictwie na 100 ha UR. Zmiany te były zróżnicowane w poszczególnych grupach województw. Analiza zróżnicowania regionalnego wykazała, że w województwach o zdecydowanie korzystniejszych relacjach czynników produkcji efektywność pracy była wyższa. Ponadto w województwach tych średnioroczna stopa zmian efektywności pracy też kształtowała się na wyższym poziomie. Skutkować to może narastaniem dysproporcji w poziomie efektywności gospodarowania w rolnictwie.

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