An attempt at a new division of Poland into regions for the purposes of the Polish FADN

Monika Bocian, Izabela Cholewa

Abstract

The changing conditions in agriculture enforce the need for constant monitoring of phenomena. One of the issues that require revision is the division into four agricultural regions applicable in the Polish FADN research. This division may have become outdated due to the long time that has passed since its creation. The aim of the article is to analyse environmental, agricultural, economic and social phenomena in Polish voivodships and to determine homogeneous groupings of voivodships on their basis.

For the analysis, variables from 2016 were purposively selected from the databases of Statistics Poland, ISSPC-SRI, Institute of Labour and Social Affairs and Polish FADN. A statistical evaluation of the selected indicators was carried out and using the k-means cluster analysis groups of voivodships with similar values of these indicators were distinguished.

As a result of statistical procedures, with the assumed territorial compactness, six clusters were determined. The obtained results lead to the conclusion that it is necessary to conduct further analyses in order to update the assessment of trends in agriculture.

The article is a prelude to further research work in terms of verification of the regional distribution of FADN, which will be based on data from the Census of Agriculture 2020.

Keywords: cluster analysis, FADN, farm, regional breakdown, region.

Monika Bocian, M.Sc., Department of Agricultural Holdings Accountancy, Institute of Agricultural and Food Economics – National Research Institute (IERiGŻ-PIB); **Izabela Cholewa**, M.Sc., Department of Agricultural Holdings Accountancy, Institute of Agricultural and Food Economics – National Research Institute (IERiGŻ-PIB).

Introduction

Recently, the topic of dividing Poland into regions in the context of the Polish FADN research[1] is increasingly under discussion. According to methodologists, until recently the existing regional division was useful in describing phenomena occurring in Polish agriculture. However, with the passage of time, in the light of emerging changes in agriculture, the need for verification of the regional division in force in the Polish FADN System and its possible adaptation to the current realities was recognised, in order to ensure the reliability and credibility of the research work and analyses.

Moreover, since FADN regions were distinguished, which took place before Poland's accession to the European Union, climatic, environmental and social factors have gained in importance. There is a need, therefore, to take somewhat more account of those parameters which have been missing from the current regional breakdown. Over the years, there have been significant changes in climate, instability of water conditions or changes in the number of people working in agriculture. All of this is an important part of the production risk faced by farmers.

What is more, in case of the Polish FADN, regions are an additional criterion (apart from agricultural type and economic size) used in the selection procedure for stratifying a set of farms in the sample of the Polish FADN, which is supposed to ensure the representativeness of the sample and a possibility of generalising the results to the whole surveyed population (field of observation)[2]. It should be explained here that the tool for selection of agricultural holdings for the FADN research sample is the so-called Community Typology of Agricultural Holdings, i.e. a unified system of agricultural holdings classification of the European Union according to their economic size and agricultural type, taking into consideration location of these holdings in one of the four FADN regions in case of Poland[3].

The aim of this paper is to analyse environmental, agricultural, economic and social phenomena in provinces and cluster analysis, which is the first approach to revise and, if necessary, modify the current division of Poland into FADN regions. This study is an introduction to further work based on data from the 2020 Census of

1. The Polish FADN (*Farm Accountancy Data Network*) is a System for Collecting and Using Accountancy Data from Agricultural Farms. More information: https://fadn.pl/.
2. Z. Floriańczyk et al., *Plan wyboru próby gospodarstw rolnych Polskiego FADN od roku obrachunkowego 2016*, Warsaw, IAFE-NRI, 2015.
3. L. Goraj, M. Bocian, I. Cholewa, *Wspólnotowa Typologia Gospodarstw Rolnych po zmianie w 2010 roku*, "Zagadnienia Ekonomiki Rolnej" 2013, nr 1, p. 91.

Agriculture, which presents the current structure of farms and changes in agriculture since the last Census of Agriculture.

Region and regional breakdown

The region is an important territorial unit as a research tool. The concept of a region as a tool for spatial research or analysis boils down to the separation of homogeneous areas in terms of the presence of a certain feature or set of features relevant to the research problem being solved. As P.E. James states[4], a region is an area of any size, homogeneous in respect of certain criteria, which is distinguished from neighbouring areas by a set of spatially related characteristics. The region is a tool for highlighting the factors that are the catalyst for a problem that would be less understood without it[5].

The division of a country into regions is an essential element for numerous analyses. There are many regional divisions in Poland. The model is the division used in public statistics resulting from Poland's membership in the EU structures, i.e. statistical division into NUTS units (Nomenclature of Territorial Units for Statistics) – the so-called Classification of Territorial Units for Statistical Purposes[6]. This classification is a geographical standard for the statistical division of European Union Member States (their economic territories) into three regional levels with defined population classes. In Poland, NUTS is currently divided into seven NUTS 1 macroregions (grouping voivodships), 17 NUTS 2 regions (voivodships or parts thereof) and 73 NUTS 3 sub-regions (grouping counties) – Table 1. It is worth noting that the division of Poland NUTS 2 coincides with the borders of the voivodships (except for two additionally separated from the area of Mazowieckie voivodship).

The NUTS breakdown was established in order to collect, compile and disseminate comparable data for certain regional statistics within the European Union. The NUTS classification is also used for shaping regional policies of European Union countries and is indispensable for carrying out analyses of the level of socio-economic development of regions[7].

4. P.E. James, *American geography at Mid-Century* [in:] *New viewpoints in geography,* red. P.E. James, Washington, 1959, p. 10–18.
5. Z. Chojnicki, T. Czyż, *Region – regionalizacja – regionalizm* [in:] *Ruch prawniczy, ekonomiczny i socjologiczny*, Year LIV, 2, p. 1–18.
6. Statistics Poland, https://stat.gov.pl/statystyka-regionalna/jednostki-terytorialne/klasyfikacja-nuts/, access 2.11.2021.
7. Statistics Poland, https://stat.gov.pl/statystyka-regionalna/jednostki-terytorialne/klasyfikacja-nuts/rewizja-nuts-2021/, access 2.11.2021.

Table 1. Regional breakdown by NUTS 1 and NUTS 2 valid in Polish official statistics

NUTS 1		NUTS 2	
Code	**Macro-region**	**Code**	**Region**
PL2	south	PL21	Małopolskie
		PL22	Śląskie
PL4	north-west	PL41	Wielkopolskie
		PL42	Zachodniopomorskie
		PL43	Lubuskie
PL5	south-west	PL51	Dolnośląskie
		PL52	Opolskie
PL6	north	PL61	Kujawsko-Pomorskie
		PL62	Warmińsko-Mazurskie
		PL63	Pomorskie
PL7	central	PL71	Łódzkie
		PL72	Świętokrzyskie
PL8	east	PL81	Lubelskie
		PL82	Podkarpackie
		PL84	Podlaskie
PL9	Mazowieckie voivodship	PL91	Warsaw Metropolitan Area
		PL92	Mazowieckie regional

Source: Own study based on: Regions of Poland 2021, ed. J. Hausman-Czerwińska, Warsaw, Statistics Poland, 2021.

The regional division used by Statistics Poland is a typical administrative division based on the assumption that the units of each NUTS level from all European Union countries are to be similar in terms of population. Thus, one parameter representing a group of demographic parameters is considered here, which is sufficient for statistical purposes. However, regional differentiation is a resultant of many factors, such as natural, agricultural, economic or social. Taking into account a combination of all of them guarantees a more reliable regional breakdown for research work and analysis. At present, in Polish FADN there is a division into four homogeneous regions (Figure 1) grouping four voivodships each (Table 2). This division was established years ago using the nine natural-agricultural-economic parameters listed below[8]:

8. A. Skarżyńska, L. Goraj, I. Ziętek, *Metodologia SGM "2002" dla typologii gospodarstw rolnych w Polsce*, "Multi-Annual Programme 2005–2009" 2005, No. 4, p. 7–19.

1) the value of Gross Domestic Product per capita in 2001,
2) the share of agriculture in the Gross Domestic Product in 2001,
3) the proportion of permanent pasture in agricultural land in 2001,
4) the average cereal yield in the years 1999–2001,
5) NPK consumption per ha of agricultural land in 2001,
6) the average annual milk production per cow over the period 1999–2001,
7) the average utilised agricultural area of an individual farm in 1996,
8) Average number of milking cows in individual agricultural holdings in the years 1999–2001 (end-of-year stock),
9) Average total number of pigs in individual agricultural holdings in the years 1999–2001 (end-of-year stock).

Figure 1. Current division of Poland into FADN regions

Source: A. Skarżyńska, L. Goraj, I. Ziętek, Metodologia SGM "2002" dla typologii gospodarstw rolnych w Polsce, "Multi-Annual Programme 2005–2009" 2005, No. 4, p. 16.

Table 2. Division of Poland into FADN regions

Region	Letter code	Numerical code	Voivodships comprising the region
Pomorze and Mazury	PL_A	785	Lubuskie, Zachodniopomorskie, Pomorskie, Warmińsko-Mazurskie
Wielkopolska and Śląsk	PL_B	790	Wielkopolskie, Kujawsko-Pomorskie, Dolnośląskie, Opolskie
Mazowsze and Podlasie	PL_C	795	Podlaskie, Mazowieckie, Łódzkie, Lubelskie
Małopolska and Pogórze	PL_D	800	Świętokrzyskie, Śląskie, Małopolskie, Podkarpackie

Source: Own study.

On the basis of the analysis of the deviations of the above mentioned parameters, with the initial assumption of the maximum number of regions, it was found that the lines of division for the designation of four FADN regions will run along the lines marking the borders of provinces. It is also worth noting that this breakdown is the same for the FADN and for the Standard Output coefficients[9], i.e. classification coefficients calculated to determine the agricultural type and economic size of holdings (already mentioned in the article) within the framework of the Community Typology of Agricultural Holdings. These coefficients are set at regional level, i.e. for separate agricultural regions, while some countries (e.g. Cyprus, Lithuania) consider the area of the whole country as one agricultural region. Therefore, the regional breakdown is of great importance not only for the definition of the survey sample and for the analyses conducted within the framework of the FADN, but also for the coefficients of standard production, the values of which must correspond to the weighted average values achieved in agricultural holdings located in a given region.

The division of Poland into four FADN agricultural regions with their official names was presented in the annex to the Treaty of Accession of the Republic of Poland to the European Union, signed on April 16, 2003 in Athens, as well as in

9. The Standard Output (SO) is a 5-year average value of production of a specific plant or animal activity obtained from 1 ha or 1 animal in 1 year, under average conditions for a given region. Each Member State is obliged to develop a set of regional Standard Output Coefficients for each plant and animal production activity identified in the framework of the farm structure survey conducted by Statistics Poland. The Standard Output Coefficients serve to define the agricultural type and economic size of agricultural holdings within the framework of the Community Typology of Agricultural Holdings.

the European Commission Regulation No. 730/2004 of April 19, 2004[10] amending Regulation No. 1859/82[11].

Looking at the parameters on the basis of which Poland was divided into regions for FADN purposes years ago, it is easy to observe that they relate to a distant period, which may make the analysed phenomena outdated. Moreover, among the parameters taken into account there was a predominance of those from the agricultural group, therefore the need to extend them with those concerning the environment, economics or demography becomes all the more justified, especially taking into account the fact that the European Commission has started work on transforming FADN into FSDN.

Research method and data sources

After the analysis of descriptive statistics and correlation matrixes, as well as the substantive analysis of the significance of individual variables in the clustering of provinces, 16 of the initial set of 46 variables were accepted for cluster analysis, on the assumption that the regional division would be determined on the basis of a combination of environmental, agricultural, economic and social variables (Table 3). These variables were again subjected to correlation analysis[12] to examine the relationship between the two. Then, using k-means cluster analysis[13], using the Euclidean distance, groups of voivodships (clusters) with the most similar values of these indicators were identified[14]. In addition, for the descriptive analysis of

10. Commission Regulation No 730/2004 of 19 April 2004 adapting Regulation No 1859/82 concerning the selection of returning holdings for the purpose of determining incomes of agricultural holdings by reason of the accession of the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Poland, Slovenia and Slovakia to the European Union.
11. A. Skarżyńska, L. Goraj, I. Ziętek, *Metodologia SGM "2002"*…, op. cit., p. 16.
12. Correlation analysis – individual elements included in the examined group of units are usually described by more than one feature (variable). In most cases the analysed variables are in some way related to each other. In such situations there is a need to examine them together. The purpose of correlation analysis is to determine whether there are any relationships between the variables under study, (J. Wątroba, *Wprowadzenie do analizy korelacji i regresji*, https://media.statsoft.pl/_old_dnn/downloads/wprowadzenie_do_analizy_korelacji_i_regresji.pdf, access 3.11.2021).
13. Cluster analysis is a tool for exploratory data analysis, the aim of which is to arrange objects into groups in such a way that the degree of association of objects with objects belonging to the same group is as high as possible, and with objects from other groups as low as possible (StatSoft, https://www.statsoft.pl/textbook/stathome_stat.html?https%3A%2F%2Fwww.statsoft.pl%2Ftextbook%2Fstcluan.html, access 3.11.2021).
14. Calculations were performed using Statistica version 13.1 software.

voivodships, the structure of farms by economic size classes and the structure of farms by agricultural types according to Statistics Poland data from 2016 was used[15].

Table 3. Variables selected for cluster analysis by data source

Statistics Poland
Average area of the agricultural holding in ha
Number of employed in agriculture per 100 ha of agricultural land
Share of the section "Agriculture, forestry, hunting and fishing" in the creation of the Gross Value Added of Poland
Average monthly gross salary in the national economy
Stocking rate as number of large heads (SD) per 100 ha of agricultural land
Grain harvest in dt/ha
Milk production from 1 cow in l/pc
Mineral fertiliser consumption in NPK per 1 ha of agricultural land
Calcium fertiliser consumption in Ca per 1 ha of agricultural land
Percentage of households with an agricultural holding user obtaining more than 50% of total income from agricultural activity
The Institute of Soil Science and Plant Cultivation – NRI
Valorisation Index of Agricultural Production Space (VIAPS)
Polish FADN
Value of total production per person fully employed in PLN/AWU*
Share of sold production in total production (commodity production)
Income from a family agricultural holding per person in a fully employed family in PLN/FWU**
Institute of Labour and Social Affairs
Social minimum for a one-person household
Minimum subsistence level in a one-person household

* AWU (Annual Work Unit) – total human labour input within the operational activity of a holding expressed in labour units, i.e. full-time employed persons, which is 2120 hours/year (Z. Floriańczyk, D. Osuch, R. Płonka, *2016 Standard Results of Polish FADN agricultural holdings. Part I. Standard Results*, Warsaw, IAFE-NRI, 2017).

** FWU (Family Work Unit) – own labour input, i.e. labour input within the operational activity of the agricultural holding of unpaid persons, mainly family members, expressed in family labour units (full-time family workers). The unit is equivalent to 2120 labour hours per year (Z. Floriańczyk, D. Osuch, R. Płonka, *2016 Standard Results of Polish FADN agricultural holdings. Part I. Standard Results*, Warsaw, IAFE-NRI, 2017).

Source: Own study.

15. *Characteristics of agricultural holdings in 2016,* ed. A. Łączyński et al., Warszawa, Statistics Poland, 2017.

The basic source of data for assessing the diversity of agriculture in individual provinces was the 2016 base of Statistics Poland[16], from which a purposive selection of a range of demographic, economic and agricultural variables by province was made.

In order to determine natural conditions, the index of valorisation of agricultural production space (VIAPS) was used in individual voivodships. This indicator reflects the potential of agricultural productive space resulting from natural conditions. It was developed in ISSPC-SRI as a part of research on methodology of evaluation of agricultural land quality in Poland. The main objective of the study was to create indicators to quantify and spatially assess the natural factors that determine potential crop yields at the local level. VIAPS is an integrated indicator based on the assessment of indicators of individual habitat elements such as: soil quality and agricultural suitability, soil water conditions, relief and agroclimate[17].

Two variables describing the subsistence minimum and the social minimum have been taken from the resources of the Institute of Labour and Social Affairs. In the part characterising the voivodships, the analysis of this phenomenon was abandoned; nevertheless, it is applicable in the cluster analysis.

According to the authors, economic variables accurately depicting the financial side of farms were taken from the Polish FADN database. These data are from agricultural accounting farms in the 2016 System for Collecting and Using Accountancy Data from Agricultural Farms. The empirical base of the research consisted of 12,302 farms, where the vast majority were farms of natural persons (individual farms), and less than 2% were farms with legal personality (in large numbers cooperatives). In the field of observation of FADN there are commercial farms, thus usually economically stronger than an average farm in the country. The collected data illustrate the situation of approximately 53% of all farms in Poland; nevertheless, they are the only source providing information on the economic situation of farms, where data are collected on a continuous basis. The minimum economic size beyond which an agricultural holding is included in the field of observation of the FADN shall be determined on the basis of an analysis of the sum of the Standard Output. The area of interest of FADN are farms producing 90% of the Standard Production of the country[18]. Currently in Poland there is a threshold of economic size equal to the equivalent of EUR 4 thousand of Standard Production.

16. Statistics Poland data from the Census of Agriculture 2020 will be available at a later date, therefore data from the last available farm structure survey, i.e. from 2016, are referred to here.
17. T. Stuczyński et al., *Przyrodnicze uwarunkowania produkcji rolniczej w Polsce* [in:] *Współczesne uwarunkowania organizacji produkcji w gospodarstwach rolniczych*, Studia i Raporty IUNG–PIB, 2007, p. 77–115.
18. Z. Floriańczyk, D. Osuch, R. Płonka, *Wyniki Standardowe 2016 uzyskane przez gospodarstwa rolne uczestniczące w Polskim FADN. Część I. Wyniki Standardowe*, Warszawa, IERiGŻ–PIB, 2017.

Test results

The largest number of farms was located in Mazowieckie, Lubelskie and Małopolskie Voivodships (respectively: 15.1%, 12.8% and 9.9% of all farms in Poland) – Table 4. Podkarpackie Voivodship was not much further in this respect (9.4%). While on the territory of the Mazowieckie and Lubelskie Voivodships there was a relatively high percentage of agricultural land (13.2% and 9.8% of total agricultural land in Poland), in the case of the Małopolskie and Podkarpackie Voivodships their share in agricultural land amounted to approx. 4%. As a consequence, the average area of an agricultural holding was very small, at the level of 4 and 4.4 ha respectively, which placed these entities on the last position in the country (for comparison, in the Zachodniopomorskie Voivodship, where the largest units dominate in this respect, the average area of a holding was 28.7 ha).

Table 4. Basic characteristics of voivodships in terms of the structure of agriculture

Voivodships	Share of GR number (%)	Share of UAA area (%)	Average GR area (ha)
Dolnośląskie	4.0	6.2	16.1
Kujawsko-Pomorskie	4.5	7.1	16.1
Lubelskie	12.8	9.8	7.9
Lubuskie	1.4	2.8	19.8
Łódzkie	8.8	6.6	7.8
Małopolskie	9.9	3.8	4.0
Mazowieckie	15.1	13.2	9.0
Opolskie	1.9	3.5	18.9
Podkarpackie	9.4	4.0	4.4
Podlaskie	5.8	7.5	13.5
Pomorskie	2.8	5.0	18.6
Śląskie	3.9	2.5	6.8
Świętokrzyskie	6.0	3.4	5.8
Warmińsko-Mazurskie	3.1	7.0	23.7
Wielkopolskie	8.6	11.6	14.0
Zachodniopomorskie	2.1	5.8	28.7

Source: Own study based on Statistics Poland data.

The structure of agricultural holdings by economic size class illustrates the production potential of entities in the territory of individual voivodships. The economic size of a holding is determined as the product of the area of crop production and of the average annual number of animals and the relevant coefficients of Standard Outputs[19].

The economically weakest farms were in Podkarpackie, Małopolskie and Śląskie Voivodships (Table 5). The percentage of farms below EUR 8,000 SO was 88.2%, 83.7% and 77%, respectively. The highest percentage of farms with an economic size over EUR 100,000 SO was in the Wielkopolskie, Lubuskie, Warmińsko-Mazurskie and Zachodniopomorskie Voivodships and in each of them it reached a share of more than 5% of the total number of farms in the voivodship. With regard to the FADN study, attention was paid to the percentage of farms with an economic size above EUR 25,000 SO. Exceeding this threshold allows, according to the FADN, to generate an income from a family agricultural holding per full-time family worker at the level of the average annual net wage in the national economy[20]. The highest percentage of such entities in the structure occurs in the Kujawsko-Pomorskie (29.9%), Warmińsko-Mazurskie (29.6%) and Wielkopolskie (26.4%) Voivodships.

Table 5. Structure of agricultural holdings by economic size classes in voivodships (%)

	Economic size classes (in thousand EUR SO)						
Voivodships	**0–2**	**2–8**	**8–25**	**25–50**	**50–100**	**100–500**	**500 and more**
Dolnośląskie	28.8	35.1	21.9	6.5	3.9	3.2	0.4
Kujawsko-Pomorskie	14.5	26.3	29.4	15.7	9.3	4.5	0.4
Lubelskie	23.5	43.2	24.3	5.8	2.1	0.9	0.1
Lubuskie	29.5	33.4	20.0	6.9	4.8	4.6	0.8
Łódzkie	25.1	39.1	23.0	7.6	3.5	1.5	0.2
Małopolskie	41.0	42.7	12.9	2.0	0.9	0.4	0.0
Mazowieckie	24.6	35.4	22.8	10.3	4.5	2.2	0.3
Opolskie	22.9	31.5	23.4	10.3	7.1	4.2	0.6
Podkarpackie	45.8	42.4	9.1	1.4	0.8	0.4	0.0
Podlaskie	18.9	35.1	22.6	12.3	8.3	2.6	0.2
Pomorskie	19.6	31.8	27.3	11.1	6.0	3.8	0.5

Continued on the next page.

19. M. Bocian, I. Cholewa, R. Tarasiuk, *Współczynniki Standardowej Produkcji "2013" dla celów Wspólnotowej Typologii Gospodarstw Rolnych*, Warsaw, IAFE-NRI, 2017.
20. Z. Floriańczyk, D. Osuch, R. Płonka, *2016 Standard Results of Polish FADN agricultural holdings. Part II. Standard Results Analysis*, Warsaw, IAFE-NRI, 2017.

Table 5. Structure of agricultural holdings by economic size classes in voivodships (%) (cont.)

	Economic size classes (in thousand EUR SO)						
Voivodships	**0–2**	**2–8**	**8–25**	**25–50**	**50–100**	**100–500**	**500 and more**
Śląskie	44.2	32.8	14.6	4.3	2.3	1.5	0.2
Świętokrzyskie	26.4	44.8	22.2	4.8	1.3	0.6	0.0
Warmińsko-Mazurskie	19.2	26.8	24.3	14.3	9.4	5.2	0.7
Wielkopolskie	20.2	29.3	24.2	12.5	8.7	4.7	0.5
Zachodniopomorskie	25.8	29.4	22.8	9.7	6.0	5.5	0.8

Source: Own calculations based on Statistics Poland data.

The structure of farms by agricultural types determines the direction of agricultural specialisation in individual voivodships (Table 6). In all voivodships, the majority of farms are units specialising in field crops (from 49.7% in the Mazowieckie Voivodship to 76.8% in the Dolnośląskie Voivodship). The highest percentage of farms specialising in permanent crops is in the Świętokrzyskie, Lubelskie and Mazowieckie Voivodships. Mazowieckie Voivodship is also characterised by a high percentage (17.0%) of farms specialising in breeding animals fed with roughage, which gives it third place in the country, after Podlaskie (30.8%) and Warmińsko-Mazurskie (25.0%). In voivodships with the largest percentage of farms of low economic size class there is the highest percentage of mixed entities, i.e. without a specific specialisation.

Table 6. Structure of agricultural holdings by GTF[21] agricultural types in voivodships (%)

Voivodships	**Field crops (GTF 1)**	**Horticultural crops (GTF 2)**	**Permanent crops (GTF 3)**	**Rearing of grazing livestock (GTF 4)**	**Rearing of animals fed with concentrated feed (GTF 5)**	**Mixed (GTF 6+7+8)**
Dolnośląskie	76.8	1.3	1.3	4.1	1.4	12.9
Kujawsko-Pomorskie	58.3	1.8	1.2	11.0	2.9	23.9
Lubelskie	59.3	1.0	8.5	4.5	1.3	24.1
Lubuskie	69.7	2.1	1.8	7.1	2.7	14.7
Łódzkie	55.8	2.1	5.3	9.5	3.3	22.4
Małopolskie	52.6	2.2	1.6	13.8	1.5	27.0

21. GTF stands for General Agricultural Type, the highest level in the systematics of agricultural types according to EU standards.

Voivodships	Field crops (GTF 1)	Horticultural crops (GTF 2)	Permanent crops (GTF 3)	Rearing of grazing livestock (GTF 4)	Rearing of animals fed with concentrated feed (GTF 5)	Mixed (GTF 6+7+8)
Mazowieckie	49.7	3.1	8.1	17.0	1.5	18.9
Opolskie	70.5	1.0	0.3	3.5	2.2	21.5
Podkarpackie	58.9	0.8	2.1	3.7	3.2	27.7
Podlaskie	52.1	0.2	0.5	30.8	1.2	13.9
Pomorskie	57.6	1.7	0.5	10.1	2.3	26.3
Śląskie	58.2	2.5	0.7	8.5	4.1	23.1
Świętokrzyskie	50.0	1.5	9.7	5.5	2.3	29.4
Warmińsko-Mazurskie	54.3	0.7	0.8	25.0	2.8	14.7
Wielkopolskie	55.2	3.5	1.5	10.0	4.0	25.6
Zachodniopomorskie	70.8	1.5	2.3	4.6	2.2	13.2

Source: Own study based on Statistics Poland data.

The highest number of persons employed in agriculture per 100 ha of farmland (Table 7) was observed in holdings of the Małopolskie (48 persons), Podkarpackie (43 persons) and Świętokrzyskie (30 persons) Voivodships, i.e. where units belonging to the smallest area group operate. At the opposite pole were farms in Zachodniopomorskie and Warmińsko-Mazurskie Voivodships, where there were only 5–6 persons employed in the agricultural sector per 100 ha of farmland.

The importance of agriculture in the national economy is indicated by the share of agriculture, forestry, hunting and fishing in the generation of the national Gross Value Added. In individual voivodships it varied – from 0.8% in the Śląskie Voivodship to over 7% in the Podlaskie Voivodship

The purchasing power of the inhabitants of particular voivodships is reflected in the average monthly remuneration in the national economy, hence this indicator was also analysed (Table 7). The variation of this parameter ranged from PLN 3,457 to PLN 4,948, with the highest level achieved in the Mazowieckie, Dolnośląskie and Śląskie Voivodships, while the lowest in the Warmińsko-Mazurskie, Świętokrzyskie and Podkarpackie Voivodships.

Table 7. Number of persons employed in agriculture, importance of agriculture and average remuneration in the national economy in the voivodships

Voivodships	Employed in agriculture (person per 100 ha)	Share of agriculture in GVA (%)	Average monthly gross salary in the national economy (PLN)
Dolnośląskie	9.3	1.5	4,141
Kujawsko-Pomorskie	10.2	4.0	3,506
Lubelskie	21.4	5.7	3,625
Lubuskie	8.3	3.7	3,542
Łódzkie	18.5	3.5	3,712
Małopolskie	48.4	1.5	3,840
Mazowieckie	15.6	2.5	4,948
Opolskie	9.5	3.2	3,708
Podkarpackie	43.5	1.9	3,502
Podlaskie	11.4	7.1	3,583
Pomorskie	8.6	2.3	3,995
Śląskie	26.9	0.8	4,059
Świętokrzyskie	30.1	4.3	3,473
Warmińsko-Mazurskie	6.4	6.1	3,457
Wielkopolskie	12.4	3.8	3,711
Zachodniopomorskie	5.2	3.3	3,682

Source: Own study based on Statistics Poland data.

In terms of the number of animals in large heads (SD) per 100 ha of farmland (Table 8), the Wielkopolskie Voivodship dominates (82.1 SD/100 ha). The second and third places were occupied by Podlaskie and Kujawsko-Pomorskie Voivodships (74.9 and 56.6 SD/100 ha respectively). At the opposite pole were the Voivodships of Dolnośląskie, Zachodniopomorskie and Podkarpackie (stocking density ranged from 13.5 to 18.3 SD/100 ha).

The best production effects in the form of the highest cereal yields were achieved by farms of the Opolskie Voivodship (almost 60 dt/ha), next by units of the Dolnośląskie Voivodship (almost 52 dt/ha) and ex aequo by the Wielkopolskie and Śląskie Voivodship (44 dt/ha). On the other hand, holdings from Podlaskie, Świętokrzyskie and Mazowieckie Voivodships had the lowest (within 30 dt/ha).

Grain harvest was related to the level of fertilisation, among other factors. The highest NPK fertilisation per 1 ha (over 203 kg/ha) was recorded in the Opolskie Voivodship and it was almost 3 times higher than in the Podkarpackie Voivodship,

which showed the lowest NPK fertilisation at the level of just over 70 kg/ha. It is worth noting that holdings from the Opolskie Voivodship were also among those applying a relatively high level of calcium fertilisation, several times higher than in the Małopolskie, Podlaskie, Świętokrzyskie and Podkarpackie Voivodships (Table 8).

Farms in the Opolskie Voivodship also had the highest productivity of dairy cows (almost 7,000 l/milk cow), with a simultaneous small share in national production of this raw material at the level of 3.1%. One of the higher milk yields was also obtained by farms situated in the Wielkopolskie (6,938 l/head) and Kujawsko-Pomorskie (6,488 l/head) Voivodeships – Table 8. Voivodships with the lowest milk yields (Małopolskie, Podkarpackie and Świętokrzyskie) marketed the smallest part of produced milk.

Table 8. Basic characteristics of agricultural production in voivodships

Voivodships	Stocking density (SD/100 ha UR)	Grain harvest (dt/ha)	Milk production from 1 cow (l/head)	NPK fertiliser consumption per pure component (kg/ha UR)	Calcium fertiliser consumption per pure component (kg/ha UR)
Dolnośląskie	13.47	51.8	6,358	165	86.1
Kujawsko-Pomorskie	56.59	43.1	6,488	179.3	78.4
Lubelskie	27.64	41.3	5,927	132	43
Lubuskie	21.70	42.2	6,009	108.5	48.7
Łódzkie	55.73	33.9	5,614	136.5	42.8
Małopolskie	34.46	40.0	4,370	77.5	16.4
Mazowieckie	53.75	31.1	5,796	111.9	39.7
Opolskie	30.77	59.9	6,999	203.2	136.6
Podkarpackie	18.34	37.5	4,578	70.2	21.5
Podlaskie	74.87	29.4	6,150	95.1	16.6
Pomorskie	39.77	39.4	6,212	142.4	61.7
Śląskie	39.23	44.0	6,227	123	50.5
Świętokrzyskie	34.90	30.3	4,689	96.6	21.3
Warmińsko-Mazurskie	42.69	37.3	6,298	104.8	45.5
Wielkopolskie	82.12	44.0	6,938	163.1	208.7
Zachodniopomorskie	14.64	43.0	6,050	131.9	64.9

Source: Own study based on Statistics Poland data.

The percentage of households with a farm user obtaining income mainly from agricultural activity (i.e. in the amount exceeding 50% of total income) varied between voivodships (Table 9). In the Kujawsko-Pomorskie and Warmińsko-Mazurskie Voivodships more than a half of such entities maintained themselves mainly from agricultural activity (respectively: 59.4% and 51%). In the Podkarpackie, Śląskie and Małopolskie Voivodships this percentage did not exceed 20%. As shown earlier, farms from these provinces had the smallest average area of agricultural land.

Table 9. Percentage of households where more than 50% of total income constituted income from agricultural activity by voivodship

Voivodships	Percentage of households obtaining more than 50% of their total income from agricultural activities (%)
Dolnośląskie	30.6
Kujawsko-Pomorskie	59.4
Lubelskie	34.4
Lubuskie	31.6
Łódzkie	33.5
Małopolskie	18.7
Mazowieckie	40.0
Opolskie	39.3
Podkarpackie	13.6
Podlaskie	45.6
Pomorskie	43.2
Śląskie	18.6
Świętokrzyskie	31.2
Warmińsko-Mazurskie	51.0
Wielkopolskie	45.2
Zachodniopomorskie	35.2

Source: Own study based on Statistics Poland data.

Valorisation index values of agricultural production space in individual voivodships are presented in Table 10. The best natural conditions according to the aggregated index were characteristic for Opolskie Voivodship, where it takes the value of 81.4 points.

Table 10. Partial indices of habitat conditions valorisation and agricultural production space valorisation index in voivodships (points)

Voivodships	Soil quality and agricultural suitability	Agroclimate	Landforms	Water conditions	Total VIAPS
Dolnośląskie	56.9	10.4	3.8	3.8	74.9
Kujawsko-Pomorskie	54.4	9.2	4	3.4	71
Lubelskie	55.8	10.6	4	3.8	74.1
Lubuskie	43.6	11.6	4.3	2.7	62.3
Łódzkie	43.2	11.5	4.4	2.8	61.9
Małopolskie	53.6	9.3	2.4	4	69.3
Mazowieckie	43.1	9.7	4.1	3	59.9
Opolskie	60.5	13.2	4.1	3.6	81.4
Podkarpackie	52.7	10.7	3	4	70.4
Podlaskie	41	7.5	3.7	2.8	55
Pomorskie	50.6	8.5	3.7	3.4	66.2
Śląskie	46.8	11.2	3.6	2.6	64.2
Świętokrzyskie	52.2	10.6	3.1	3.5	69.3
Warmińsko-Mazurskie	51.1	8.1	3.4	3.4	66
Wielkopolskie	46.4	11.2	4.4	2.8	64.8
Zachodniopomorskie	50	9.8	4	3.6	67.5

Source: T. Stuczyński et al., Przyrodnicze uwarunkowania produkcji rolniczej w Polsce [in:] Współczesne uwarunkowania organizacji produkcji w gospodarstwach rolniczych, Studia i Raporty IUNG–PIB, 2007, p. 77–115.

In the Dolnośląskie and Lubelskie Voivodships this value is also high, at 74.9 points and 74.1 points respectively. The worst situation is observed in Podlaskie and Mazowieckie Voivodships, where the index values do not exceed 60 points. The natural values of the Łódzkie and Lubuskie Voivodships were rated slightly higher (over 60 points).

On the basis of FADN data, the value of production per full-time employee, the commodity of production and the income from a family agricultural holding per full-time employee were determined. The results are shown in Table 11.

Table 11. Financial data characterising Polish FADN farms in voivodships

Voivodships	Total value of production per person fully employed (PLN/AWU)	Commodity of production (%)	Income from a family agricultural holding per person in a fully employed family (PLN/FWU)
Dolnośląskie	84,920	97.7	28,934
Kujawsko-Pomorskie	107,968	90.6	34,467
Lubelskie	54,023	92.0	22,939
Lubuskie	87,904	102.3	35,682
łódzkie	50,358	91.3	15,329
Małopolskie	39,432	87.2	13,412
Mazowieckie	56,406	91.5	21,792
Opolskie	118,092	95.6	31,836
Podkarpackie	53,709	92.5	24,672
Podlaskie	89,934	97.5	30,280
Pomorskie	91,887	91.5	29,493
Śląskie	72,883	88.8	20,574
Świętokrzyskie	42,347	88.4	16,093
Warmińsko-Mazurskie	124,606	100.3	29,693
Wielkopolskie	104,517	90.3	27,850
Zachodniopomorskie	115,845	101.4	29,488

Source: Own study based on FADN data.

The value of total production per full-time employed person showed significant variation in individual provinces. The best results were achieved by households from the Warmińsko-Mazurskie (124,606 PLN/AWU), Opolskie (118,092 PLN/AWU) and Zachodniopomorskie (115,845 PLN/AWU) Voivodships. Farms in the Małopolskie Voivodship, with the lowest total output per full-time employee (at the level of 39,432 PLN/AWU), achieved results in this respect 3 times worse than those of the Warmińsko-Mazurskie voivodship. A low value of this indicator was also found in the farms of Świętokrzyskie and Łódzkie Voivodships.

The share of sold production in total production fluctuated between 87% in Małopolskie Voivodship farms and over 102% in Lubuskie Voivodship farms[22].

22. Because of the methodology for calculating production in accordance with the FADN rules, it may in some cases have negative values. The value of production is established as the sum of sales, internal consumption, off-farm transfers, stock differences and adjusted for the change in the value of animals due to price changes and reduced by the value of animal purchases.

The income from a family holding per a fully employed non-salaried person reached the highest value in the units of Lubuskie, Kujawsko-Pomorskie and Opolskie Voivodships (from 31,836 PLN/FWU to 35,682 PLN/FWU). The lowest value (13–16 thousand PLN/FWU) was characteristic for farms in the Małopolskie, Łódzkie and Świętokrzyskie Voivodships, which is consistent with the low value of production per full-time employed person achieved there.

Substantive evaluation of the variables listed in Table 3 indicated their high suitability for clustering and analysis for delineating new regions. The descriptive statistics of these variables calculated during the study are presented in Table 12, while the correlation results are presented in Table 13.

Table 12. Descriptive statistics of variables subjected to k-means cluster analysis

Variable		Average	Minimum	Maximum	Standard deviation	Coefficient of variation
1	Average area of the agricultural holding in ha	13.44	4.00	28.70	7.33	54.52
2	Number of employed in agriculture per 100 ha of farmland	17.86	5.20	48.40	13.11	73.44
3	Share of the section "Agriculture, forestry, hunting and fishing" in the creation of the Gross Value Added of Poland	3.44	0.80	7.10	1.75	50.90
4	Average monthly gross salary in the national economy	3,780.26	3,456.95	4,948.10	375.71	9.94
5	Stocking rate as number of large head (SD) per 100 ha of agricultural land	40.04	13.47	82.10	20.26	50.59
6	Grain harvest in dt/ha	40.51	29.40	59.90	7.86	19.40
7	Milk production from 1 cow in l/pc	5,918.96	4,369.71	6,999.20	772.18	13.05
8	Mineral fertilizer consumption in NPK per 1 ha of agricultural land	127.56	70.20	203.20	36.84	28.88
9	Calcium fertilizer consumption in Ca per 1 ha of agricultural land	61.40	16.40	208.70	49.79	81.09

Continued on the next page.

Table 12. Descriptive statistics of variables subjected to k-means cluster analysis (cont.)

10	Percentage of households with an agricultural holding user obtaining more than 50% of total income from agricultural activity	35.68	13.55	59.40	12.14	34.03
11	Valorisation index of agricultural production space (VIAPS)	67.39	55.00	81.40	6.39	9.49
12	Value of total production per person fully employed in PLN/AWU	80,926.90	39,432.15	124,606.30	28,679.05	35.44
13	Share of sold production in total production (commodity production)	93.69	87.20	102.30	4.80	5.13
14	Income from family agricultural holding per person fully employed in family in PLN/FWU	25,783.34	13,411.77	35,681.80	6,811.13	26.42
15	Social minimum for a one-person employee household	1,094.95	1,033.18	1,181.10	37.98	3.47
16	Social minimum for a one-person employee household	552.75	512.09	601.00	27.52	4.98

Source: Own study.

Table 13. Correlation coefficients[23] between variables adopted for cluster analysis (total for Poland)

	Variable	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15.	16.
1	Index of valorisation of agricultural production space (VIAPS)	1.0000															
2	Number of people working in agriculture per 100 ha of farmland	0.1009	1.0000														
3	Average area of an agricultural holding in ha	0.0612	-0.8311	1.0000													
4	Stocking rate as number of large heads (SD) per 100 ha of farmland	-0.5552	-0.1687	-0.1434	1.0000												
5	Grain harvest in dt/ha	0.7484	-0.2541	0.3678	-0.3796	1.0000											
6	Milk production from 1 cow in l/pc	0.0808	-0.8399	0.6304	0.3063	0.5378	1.0000										
7	Share of the section "Agriculture, forestry, hunting and fishing" in the creation of the Gross Value Added of Poland	-0.2638	-0.3912	0.2638	0.4103	-0.3654	0.2187	1.0000									
8	Percentage of households with a farm user obtaining more than 50% of total income from agricultural activity	-0.1217	-0.7520	0.5601	0.5470	-0.0235	0.6478	0.6120	1.0000								
9	The subsistence minimum of a one-person labour household	-0.1487	-0.2380	0.3910	-0.3831	0.2281	0.1250	-0.4463	-0.3000	1.0000							
10	The subsistence minimum of a one-person employee household	-0.1488	-0.5293	0.5614	-0.0649	0.3814	0.4852	-0.3633	0.0960	0.7593	1.0000						
11	Average gross monthly remuneration in the national economy	-0.1914	-0.0442	-0.1675	0.0586	-0.0371	0.0773	-0.4875	-0.0932	0.4347	0.2601	1.0000					
12	Value of total production per full-time employed person in PLN/AWU	0.1207	-0.7832	0.8883	0.1086	0.4865	0.8015	0.2798	0.6487	0.1599	0.4489	-0.2262	1.0000				
13	Share of sold production in total production (commodity production)	-0.0747	-0.6442	0.7916	-0.3247	0.2031	0.3747	0.3539	0.2367	0.3827	0.3476	-0.2109	0.6151	1.0000			
14	Income from a family agricultural holding per person in a fully employed family in PLN/FWU	0.0892	-0.7350	0.7662	-0.0266	0.4204	0.6918	0.2841	0.5629	0.0262	0.3858	-0.2163	0.8276	0.6852	1.0000		
15	Consumption of NPK mineral fertilisers per 1 ha of agricultural land	0.4910	-0.6130	0.4232	0.1123	0.7218	0.7998	-0.0607	0.5076	0.0172	0.4129	0.0681	0.5650	0.0625	0.4541	1.0000	
16	Consumption of calcium fertilisers in Ca per 1 ha of agricultural land	0.3046	-0.4333	0.3438	0.3066	0.6226	0.7149	-0.0697	0.3644	-0.0013	0.4092	0.0067	0.5580	0.0162	0.3911	0.7534	1.0000

* Values in column headings correspond to the designation of variables in rows.

Source: Own study.

23. Statistically significant correlation coefficients (at p<0.0500) are indicated in bold.

The above-mentioned variables were grouped in order to determine homogeneous groupings of voivodships (clusters), which are presented in Figure 2. Clustering was performed using k-means cluster analysis, assuming compactness of regions[24].

Figure 2. Clusters of voivodships with diverse natural, social, agricultural and economic conditions

Source: Own study.

Tables 14 and 15 present the basic characteristics of the resulting clusters of provinces.

24. The compactness of regions, understood as combining voivodships into groups consisting of adjacent units, was not taken into account at the stage of cluster analysis. This assumption was taken into account when analysing the individual clusters calculated using different sets of variables. Comparing the results obtained, the clusters formed by the neighbouring voivodships were proposed and presented in the paper.

Table 14. Basic variables characterising clusters of voivodships

Clustering	Employed in agriculture (person/100 ha)	Average farm area (ha)	Stocking rate (SD/100 ha)	Grain harvest (dt/ha)	Milk production from 1 cow (l/head)	Share of agriculture in GVA (%)	Percentage of households making their living mainly from agriculture (%)
1	7.9	20.04	18.4	50.0	6,478	2.4	33.5
2	10.9	15.39	65.6	42.8	6,703	3.4	48.9
3	9.0	17.03	59.3	33.3	6,191	6.5	47.4
4	16.6	8.55	54.4	32.2	5,746	2.7	37.6
5	24.2	7.16	31.1	39.7	5,687	2.3	30.9
6	45.9	4.21	26.2	38.7	4,446	1.6	16.2

Source: Own study based on Statistics Poland data.

Table 15. Basic economic categories in clusters of voivodships

Clustering	Value of total production per person fully employed (PLN/AWU)	Commodity of production (%)	Income from a family agricultural holding per person in a fully employed family (PLN/FWU)
1	101,794.8	98.9	30,998
2	103,558.9	90.6	30,033
3	100,390.9	98.6	30,124
4	53,902.8	91.4	19,091
5	53,391.2	90.5	20,417
6	43,212.4	88.9	16,369

Source: Own study based on FADN data.

Cluster 1 includes the following Voivodships: Zachodniopomorskie, Lubuskie, Dolnośląskie, Opolskie, covering 9.4% of farms in the country and 18.3% of agricultural land. There is a clear domination of farms specialising in field crops. These farms are characterised by large areas of arable land, low animal density and high grain harvest. They also have the smallest number of people working in agriculture per 100 ha of farmland, and at the same time 33.5% of the units maintain themselves mainly from agricultural activity. Entities located in this area, according to data of the Polish FADN, are characterised by the highest commodity production,

high value of production per 1 AWU, they also achieve the highest income from the family farm per person fully employed in the family. In terms of environmental conditions, as determined by the index of valorisation of agricultural production space, the cluster is highly diversified.

Cluster 2 includes three Voivodships: Pomorskie, Kujawsko-Pomorskie and Wielkopolskie. High livestock density farms are located here. These units are larger in area, but nevertheless smaller in size than in clusters 1 and 3. This cluster included 15.9% of farms and 23.7% of agricultural land. 48.9% of entities located in this group make their living mainly from agriculture. Farms have relatively high grain yields and the highest milk yields. According to the data of Polish FADN these units reach on average the highest production per AWU, high income from a family agricultural holding per person fully employed in the family and the commodity production at the level of 90.6%.

Cluster 3 includes Warmińsko-Mazurskie and Podlaskie Voivodships, which are characterised by the highest share of agriculture in the creation of Gross Value Added. Farms located here are characterised by a high density of animals per 100 ha of farmland and high milk yield in cows with a simultaneous low yield of cereals. Of all households with a farm user, 47.5% derive their income predominantly from agriculture. These farms are also characterised by significant production per AWU, income from family farm per FWU and very high commodity production. The difference in the level of the agricultural production space valorisation index in the case of these two voivodships is 10 points.

Cluster 4 includes the Mazowieckie and Łódzkie Voivodships. They include farms with a much smaller area of arable land than in the cases discussed above. Similarly as in cluster 3, these entities are characterised by relatively high animal density and low cereal yields. A high proportion of households with a farm user make their main living from farming. The economic performance of the farms covered by the FADN observation field is in this group definitely lower than in the previously discussed clusters. Both voivodships belonging to the cluster are characterised by a low index of valorisation of agricultural production space.

Lubelskie, Świętokrzyskie and Śląskie Voivodships qualified to cluster 5. Farms in these voivodships are smaller in area, with a relatively low number of animals per 100 ha of farmland, achieving cereal yields at an average level. They are characterised by a higher than in previous clusters number of people working per 100 ha of arable land, but it should be remembered that in the Lubelskie and Świętokrzyskie Voivodships there is a relatively large percentage of farms specialised in permanent crops, which require increased labor input.

Cluster 6, comprising the Małopolskie and Podkarpackie Voivodships, includes the smallest farms in terms of area, which are also characterised by relatively low animal density, significant labour outlays per 100 ha, average cereal yields and the lowest cow milk yields. The least intensive NPK fertilisation/ha was carried out there. According to the FADN research, farms located in this cluster showed the lowest commodity production, the lowest total production per 1 AWU and the lowest income from a family agricultural holding per 1 full-time family worker.

Summary

Within the framework of the Polish FADN research there are currently four regions grouping four voivodships each. For many years, this division was valid in analyses and served its function well. However, it was created in the early 2000s, which may indicate that it does not reflect current environmental, social, economic conditions, due to the fact that they have changed significantly over the years.

Current division of Poland into FADN regions takes into account nine natural-agricultural-economic parameters, with domination of agricultural ones. This indicates that a review and, if necessary, a new delimitation of FADN regions is needed. However, the modification would entail a number of serious consequences. Changing regions would lead to changes in the FADN analyses, but above all it will require interference with legal acts and working documents that contain information on the regions of all Member States. Moreover, it will influence the structure and quality of the Polish FADN sample.

A revision of the regional breakdown of FADN may also be needed as work is currently underway in the European Commission to transform FADN into FSDN (Farm Sustainability Data Network). The transformation of FADN into FSDN follows the European Green Deal and the subsequent new EU strategy commonly referred to as the From Farm to Fork Strategy[25]. In a general sense, it is a strategy for a fair, healthy and environmentally friendly food system. The adoption of the strategy implies changes in the Common Agricultural Policy, which in turn will have a direct impact on the scope of data collected in FADN (targeted extension to environmental and social variables). The inclusion of variables related to the sustainability

25. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A From Farm to Fork Strategy for a fair, healthy and environmentally friendly food system, Brussels 2020.*

of agriculture in FADN data may be another indication towards a new division of Poland into FADN regions[26].

The topic of agriculture regionalisation has been discussed by researchers[27], however this study is the first to include economic data from the Polish FADN System. It is also an initial stage of works on verification of the regional division used in the Polish FADN research. The analysis made use of a number of environmental, demographic, economic and agricultural indicators by voivodship from several data sources, i.e. the Central Statistical Office (GUS), the Institute of Agricultural and Food Economics (IUNG-PIB), the Institute of Labour and Social Affairs (Instytut Pracy i Spraw Socjalnych) and the Polish FADN. The statistical evaluation of the indicators allowed several general trends to be outlined.

Mazowieckie Voivodship is distinguished by a relatively high share of the number of agricultural holdings, a high percentage of arable land, as well as the highest purchasing power of inhabitants measured by a monthly average remuneration in the national economy, at the same time with the lowest agricultural potential of the production space resulting from natural conditions, which is reflected in one of the lowest levels of grain harvest.

Favourable natural conditions prevail in the Opolskie and Lubelskie Voivodships. In the Opolskie Voivodship the best production effects are observed in the form of the highest milk yields and grain harvest, with a high level of mineral and calcium fertilisation. These effects translate into one of the highest income levels achieved by farmers in this province.

Economically strong farms are the domain of the Wielkopolskie, Warmińsko-Mazurskie and Zachodniopomorskie Voivodships. The latter two are characterised by the highest value of total output per full-time employed person, which is related to low employment in agriculture.

On the other hand, Małopolskie and Podkarpackie Voivodships are very similar, which is evidenced by, inter alia, the lowest share of the number of agricultural holdings in the total number of units in Poland, a low percentage of agricultural land, the lowest average farm area in the country and the highest number of people working in agriculture per 100 ha. Agriculture in both voivodships is less intensive, with relatively low production effects and low NPK fertilisation levels. Farms are generally economically weaker, and average monthly wages are among the lowest in the country. The bordering Świętokrzyskie Voivodship is quite similar in many respects.

26. *Workshop on the Conversion of Farm Accountancy Data Network (FADN) into the Farm Sustainability Data Network (FSDN). Mandate and key areas of work*, European Commission, 8–9 February 2021.
27. See S. Krasowicz, M. Matyka, *Produkcja towarowa jako kryterium wykorzystania potencjału rolnictwa w różnych regionach Polski*, "Zagadnienia Ekonomiki Rolnej" 2021, nr 2(367), p. 48–72.

In all provinces, farms specialising in field crops dominate. The Świętokrzyskie, Lubelskie and Mazowieckie Voivodships are permanent crop regions. Mazowieckie Voivodship is also characterised by a high percentage of farms specialising in rearing animals fed with roughage (right after Podlaskie and Warmińsko-Mazurskie Voivodships).

As a result of the cluster analysis and assuming territorial compactness, six groups of voivodships (clusters) were determined, the structure and characteristics of which prove that over the years agriculture has undergone continuous changes, but there are still significant differences between eastern and western Poland in the level of agriculture and farm income. In comparison with the current regional division in FADN, the most controversial are warmińsko-mazurskie and podlaskie voivodships, which in the light of the research presented in this article belong to one group.

This justifies the continuation of work in this area, however, the correctness of the division presented in the paper will be verified after the publication of the results of the Agricultural Census 2020 by Statistics Poland.

Bibliography

Bocian M., Cholewa I., Tarasiuk R., *Współczynniki Standardowej Produkcji "2013" dla celów Wspólnotowej Typologii Gospodarstw Rolnych,* Warsaw, IAFE-NRI, 2017.

***Characteristics** of agricultural holdings in 2016,* ed. A. Łączyński et al., Warszawa, Statistics Poland, 2017.

Chojnicki Z., Czyż T., *Region – regionalizacja – regionalizm* [in:] "*Ruch prawniczy, ekonomiczny i socjologiczny*" 1992, z. 2.

European Commission, *Workshop on the Conversion of Farm Accountancy Data Network (FADN) into the Farm Sustainability Data Network (FSDN). Mandate and key areas of work,* 8–9 February 2021.

Floriańczyk Z. et al., *Plan wyboru próby gospodarstw rolnych Polskiego FADN od roku obrachunkowego 2016*, Warsaw, IAFE-NRI, 2015.

Floriańczyk Z., Osuch D., Płonka R., *2016 Standard Results of Polish FADN agricultural holdings. Part I. Standard Results,* Warsaw, IAFE-NRI, 2017.

Floriańczyk Z., Osuch D., Płonka R., *2016 Standard Results of Polish FADN agricultural holdings. Part II. Standard Results Analysis*, Warszawa, IAFE-NRI, 2017.

Goraj L., Bocian M., Cholewa I., *Wspólnotowa Typologia Gospodarstw Rolnych po zmianie w 2010 roku*, "Zagadnienia Ekonomiki Rolnej" 2013, nr 1.

Statistics Poland, *Local Data Bank*, https://bdl.stat.gov.pl, access 21.10.2021.

Statistics Poland, *Regions of Poland 2021,* ed. J. Hausman-Czerwińska, Warsaw 2021.

Statistics Poland, https://stat.gov.pl/statystyka-regionalna/jednostki-terytorialne/klasyfikacja-nuts/, access 2.11.2021.

Statistics Poland, https://stat.gov.pl/statystyka-regionalna/jednostki-terytorialne/klasyfikacja-nuts/rewizja-nuts-2021/, access 2.11.2021.

James P. E., *American geography at Mid-Century* [in:] *New viewpoints in geography*, ed. P. E. James, Washington, 1959.

***Communication** from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A From Farm to Fork Strategy for a fair, healthy and environmentally friendly food system, Brussels 2020.*

Krasowicz S., Matyka M., *Produkcja towarowa jako kryterium wykorzystania potencjału rolnictwa w różnych regionach Polski*, "Zagadnienia Ekonomiki Rolnej" 2021, nr 2(367).

Skarżyńska A., Goraj L., Ziętek I., *Metodologia SGM „2002" dla typologii gospodarstw rolnych w Polsce*, "Multi-Annual Programme 2005–2009" 2005, nr 4.

StatSoft., *Electronic Statistics Textbook*: https://www.statsoft.pl/textbook/stathome_stat.html?https%3A%2F%2Fwww.statsoft.pl%2Ftextbook%2Fstcluan.html, access 3.11.2021.

Stuczyński T. et al., *Przyrodnicze uwarunkowania produkcji rolniczej w Polsce* [in:] *Współczesne uwarunkowania produkcji w gospodarstwach rolniczych,* Studies and reports ISSPC-SRI, 2007.

Wątroba J., *Wprowadzenie do analizy korelacji i regresji*, Materials of StatSoft Poland: https://media.statsoft.pl/_old_dnn/downloads/wprowadzenie_do_analizy_korelacji_i_regresji.pdf, access 3.11.2021.

received: 08.11.2021
accepted: 30.11.2021