

The regional differentiation of legumes cropping area in Poland between 2001 and 2007

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Abstract: Selected problems of the regional differentiation of legumes production for seeds and green mass in Poland were presented in the paper. Data from the Central Statistical Office from 2001 to 2007 was used in accordance with the current administrative division into voivodships as well as being used for the source material. Based on a k-Means cluster analysis, different voivodships were distinguished according to the intensity of legumes seeds production and the ability to use the productive potential of the natural environment. Each group was characterised by selected analysed parameters over the whole country.

In between 2001 and 2007, the surface area of the seed and fodder legumes was about 100,000 ha and was almost four times less than the area of cultivation of leguminous plants for seeds in 1989. The area of fodder crops cultivation has been strongly limited (more than five times), and edible crops by only 35%. The average share of legume crops on arable land was 0.86% and the highest were recorded in the Lubelskie (2.0%), Świętokrzyskie (1.7%), Pomorskie (1.4%) voivodships, while the smallest in Dolnośląskie (0.3%), Opolskie (0.2%) and Śląskie (0.3%) voivodships. The yield of fodder seeds was 17 dt per ha and was approximately 12% lower than in food crops. The best yields of the fodder species were recorded in the Małopolskie and Pomorskie voivodships, and of the edible crops – in the Opolskie and Warmińsko-Mazurskie voivodships, leguminous-cereal mixtures for seeds – in Opolskie voivodship. The lowest yields of fodder crops were recorded in Lubuskie, Mazowieckie, Świętokrzyskie, Podlaskie voivodships, edible crops – Lubuskie, Zachodniopomorskie, Podlaskie, mixtures with cereals – in Mazowieckie voivodships. Most of the seeds were produced in the Lubelskie voivodship (mostly edible), while very little of the edible seeds are produced in Lubuskie and Podlaskie voivodships. The only features that have an adverse effect on the volume of the production of seed legumes were the share of grasslands, cereal yield, share of maize and potato in arable land. The production of legume-cereal mixture seeds correlated negatively with many more factors: the mixture seeds yield, valorization index of agricultural

production area, the share of grassland, maize, oilseed rape, potatoes in arable land, while the cattle, pig, and poultry stocks had a positive effect.

key words: area of legumes, legume seeds, share of legumes (% AL), green matter

INTRODUCTION

Climatic conditions in Poland allow the cultivation of leguminous plants over the whole area of the country. Those plants can be cultivated both in organic and in sustainable production systems. Interest in this results from its capability of utilisation and its role played in the crop rotation and animal feed (Książak, 2000a, 2000b). According to Krzymuski and Oleksiak (1989), regarding issues of leguminous plants, all aspects natural as well as economical-organisational should be considered in connection with plant and animal production. Krzymuski et al. (1977) performed a regionalisation for the whole group of leguminous plants, as well as individual species in the 1970s. These authors reported that the arrangement of leguminous plants was uneven and participation of leguminous plants in the cropping pattern increased from the south-east to north-west part of Poland with a distinct focus on the Pojezierze Pomorskie voivodships. Soil conditions have a strong influence on the localisation of these crops, as a factor that differentiates the species from others in this group. The cultivation of yellow lupine is concentrated on light soils, whereas the high quality soil demand of the faba bean determines its possibility of cultivation (Bochniarz, Bochniarz, 1971). According to Krzymuski and Oleksiak (1989), the most beneficial region for faba bean cultivation is the north-eastern part of Poland, where there is a larger competition from other plants. In addition to climate, soil, and other natural factors, the regionalisation of legume crops is largely shaped by the agrarian structure. In the available literature, there is no study on the current diversity of crop legumes and their mixtures with cereals across current administrative divisions.

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Received 2 September 2009

Therefore, in this work we formed the hypothesis that the regional diversity of legume crops besides natural conditions is determined by organisational and economical factors.

The aim of the study was an estimation of the regional disparity of seeds and green forage of leguminous plants and its mixtures with cereals production between 2001 and 2007.

MATERIALS AND METHOD

The study concerned the regional differentiation of seed production of leguminous plants (fodder and edible) and their mixtures with cereals, as well as green forage production in Poland. Data from the Central Statistical Office between 2001 and 2007 (Produkcja..., 2000-2007; Użytkowanie..., 2000-2007) was used into accordance with the current administrative division into voivodships as well as being used for the source material.

Due to their variability, a number of indicators characterising the agriculture had to be calculated as a mean average. The analysis took into account some of the characteristics that are describing natural-economic conditions in the analysed period. The main criteria for regional differences of seed and green forage production (according to voivodships) were the area for seeds and green mass cultivation, share of arable land, total production area, as well as obtained yields.

The statistical characteristics of the variables analysed in the regional approach were assessed as a mean, extreme and correlation coefficient. In the analysis it was taken into consideration the chosen features that characterised the natural-economic conditions in the study period: share of cereals, oilseed rape, potato, maize, grasslands, stock of cattle, pigs and poultry, NPK fertilisation per 100 ha agricultural area, as well as the valorisation index of agricultural production area.

Each group was characterised by selected parameters that were analysed over the whole country. The correlation method was used to find the relationship of leguminous seed production and its mixtures with cereals as well as green forage according to selected variables. Taking into account the impact of cluster analysis using k-Means (Filiipiak, Wilkos, 1998), groups of different voivodships due to the scale of their production of legumes and mixtures with cereals and fodder production in addition to their capacity to utilize the natural environment were identified. This method consists of combining objects into groups focusing on an advance observation, taken as reference points for the constructed clusters. The number of clusters was defined based on the diagram of critical distance among groups.

RESULTS AND DISCUSSION

The average area of legumes and their mixtures with cereals cultivated for seeds and green mass in Poland in between 2001 and 2007 was a little more than 100,000 ha,

and it was almost four times less than the area of leguminous plants cultivated for seeds in 1989 (Książak, 2004). The area of leguminous plants both fodder and edible cultivated for seeds, was almost the same (about 39,000 ha), while green fodder was cultivated on an area a little more than 24,000 ha (Table 1).

The most fodder legumes for seeds was cultivated in the Mazowieckie, Pomorskie and Warmińsko-Mazurskie voivodships, while the least was in Opolskie and Śląskie voivodships. The intensive cultivation for those plants according to Krzymuski et al. (1977) was concentrated in the north and the central-eastern part of Poland. In the central-eastern part of Poland, lupines dominated the cultivation whereas those plants in south-eastern part of Poland are the least disseminated. The faba bean cultivation was located in the north (Elbląskie and Olsztyńskie voivodships[#]) and in the south-western part of Poland (Opolskie and Wrocławskie voivodships[#]). According to Bobrecka-Jamro (1989), the most valuable conditions for faba bean cultivation occur in the southern voivodships[#] (Rzeszowskie, Wrocławskie, Krakowskie, Jeleniogórskie, Wałbrzyskie, Legnickie, Opolskie) and in the north of Poland (Gdańskie voivodship[#]). Faba bean was used as green matter for feeding or as green manure in the Mazowieckie voivodship. These plants were cultivated on a small area of Opolskie and Świętokrzyskie voivodships. Edible leguminous plants for seeds were cropped mainly in the Kujawsko-Pomorskie and Świętokrzyskie voivodships, while there was almost no cultivation of these plants in Lubuskie, Podlaskie and Śląskie voivodships. Krzymuski et al. (1989) reported the cultivation of pea increasing in a few microregions of the north of Poland, especially in Bydgoskie and Elbląskie voivodships[#]. Moreover, in this period, mixtures of pea with cereals or other plant species were cultivated on an area of 55,000 ha, where 75% of this area concerned mixtures with cereals cultivated for seeds and about 20% mixtures for green forage. Most of those mixtures were cultivated in the Mazowieckie, Podlaskie and Wielkopolskie voivodships. According to Krzymuski et al. (1977), cultivation of mixtures dominates the north of country. Mixtures of pea with cereals and other species of plants for green forage were cultivated only in one voivodship (Opolskie) on an area of 2,000 ha, while in Śląskie voivodship on very small area (less than 100 ha) and little more in the Opolskie voivodship. The share of leguminous crops in the discussed period on arable land was 0.86% (Fig. 1) and it was four times smaller than in 1989 (Książak, 2004). At the same time, there were significant differences between particular voivodships in the percentage of those species in the cropping system. The highest share was recorded in the Lubelskie (2.0%), Świętokrzyskie (1.67%), Warmińsko-Mazurskie (1.1%), Pomorskie (1.4%) voivodships, while the lowest in Dolnośląskie (0.32%), Opolskie (0.16%) and Śląskie (0.3%) voivodships.

[#] acc. to former administrative division of Poland (1975–1998)

Table 1. Cropping area and production of leguminous plants.

Voivodships	Edible legumes for seeds		Feed legumes for seeds		Cropping area of feed legumes for green mass [thous. ha]
	cropping area [thous. ha]	production [thous. t]	cropping area [thous. ha]	production [thous. t]	
Dolnośląskie	1.2	2.8	1.0	1.7	0.5
Kujawsko-Pomorskie	3.4	7.7	2.7	4.5	0.9
Lubelskie	17.5	28.4	2.9	4.5	2.8
Lubuskie	0.2	0.2	1.7	2.5	0.4
Łódzkie	0.6	1.0	2.1	2.5	2.0
Małopolskie	1.5	3.1	0.7	1.7	0.5
Mazowieckie	1.4	2.4	4.9	6.4	5.6
Opolskie	0.4	0.9	0.2	0.4	0.2
Podkarpackie	1.1	2.0	0.8	1.7	0.7
Podlaskie	0.2	0.2	3.2	4.6	1.5
Pomorskie	1.8	4.5	5.2	10.1	1.6
Śląskie	0.2	0.4	0.4	0.7	0.4
Świętokrzyskie	4.5	7.5	1.1	1.8	1.5
Warmińsko-Mazurskie	1.1	2.5	5.5	11.4	1.8
Wielkopolskie	2.4	5.5	4.1	6.0	2.0
Zachodniopomorskie	1.2	2.5	2.5	3.7	1.7
Poland	38.7	71.7	39.0	64.3	24.3

Source: Produkcja..., 2000-2007; Użytkowanie..., 2000-2007.

In the reported period, the average seed yield of fodder leguminous plants was 17 dt per ha (Table 2). The highest average yields were noted in Małopolskie and Pomorskie voivodships, while the lowest in central Poland (Mazowieckie and Świętokrzyskie voivodships) as well as Lubuskie and Podlaskie voivodships. In this period the highest yield was obtained from faba bean (23 dt per ha), yields of fodder varieties of pea were 18.5 dt per ha whereas yields of vetch and lupine were very similar (about 13.2 dt per ha).

Krzymuski et al. (1989) said that yields of faba bean seeds were significantly higher in the north and east than in the west of Poland. According to Gonet (1984), there is no basis for a division into regions of fodder legumes grown for seeds and green mass on account of the climate. The central-eastern and southern regions are the most beneficial for yields of faba bean (Gonet, 1984). The highest yield of edible plants was noted in Opolskie and Warmińsko-Mazurskie voivodships. Considerably higher yields in the

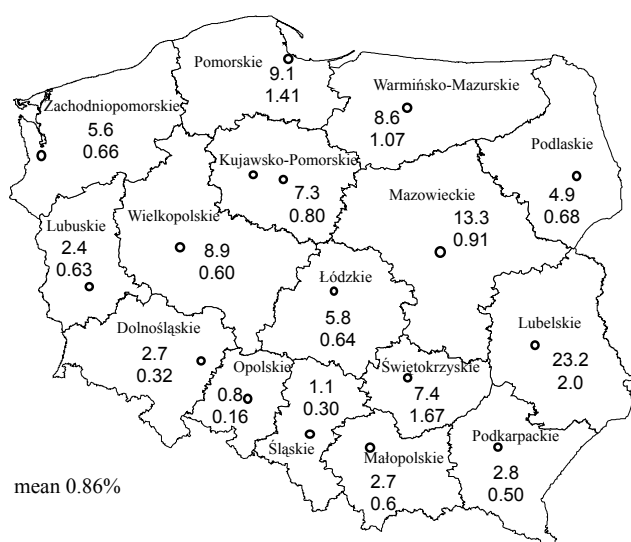


Fig. 1. Area of leguminous plants [thous. ha] (upper number) and share of legumes [% AL] (bottom number).

Source: Użytkowanie..., 2000-2007.

Table 2. Yields of legumes [dt ha⁻¹].

Voivodships	Edible legumes	Feed legumes	
		seeds	green mass
Dolnośląskie	16.1	16.3	188.5
Kujawsko-Pomorskie	20.1	18.1	161.8
Lubelskie	20.4	18.6	195.0
Lubuskie	11.8	13.1	126.6
Łódzkie	14.5	15.2	166.9
Małopolskie	20.8	19.2	206.8
Mazowieckie	16.1	14.7	145.5
Opolskie	22.0	17.3	152.7
Podkarpackie	16.8	18.1	196.9
Podlaskie	10.6	14.3	153.3
Pomorskie	18.8	20.2	179.1
Śląskie	12.6	16.2	204.7
Świętokrzyskie	17.1	14.9	179.1
Warmińsko-Mazurskie	22.1	17.5	184.1
Wielkopolskie	19.2	16.4	173.4
Zachodniopomorskie	10.5	15.5	177.0
Poland	19.2	17.0	172.1

Source: Produkcja..., 2000-2007.

Opolskie voivodships were caused by advantageous agricultural conditions in this region as well as high mineral fertilisation. Soil quality index and agroclimate are the best in this region and significantly higher than average for the country (Stuczyński et al., 2000). According to Demidowicz (1991), the most advantageous climatic conditions for faba bean yield were in the central part of Pomorze, Pobrzeże Bałtyckie, west part of Mazury and west part of Wyżyny Środkowopolskie. Green matter yields of leguminous plants are relatively low and only in two voivodships (Małopolskie, Śląskie) in the south of Poland were higher than 200 dt per ha, whereas in Lubuskie voivodship they did not reach 130 dt per ha.

In the reported period, the yield of edible leguminous plants was approximately 12% higher than fodder leguminous plants; moreover, the reaction to water stress was minimal. One of the reasons for the low seed yields of this species is a strong sensitivity to weather conditions during its vegetation period, especially to a water shortage in the last 20 days of June and the first 10 days of July (flowering and pod setting). Other reasons are the improper choice of plant species to soil conditions and crop rotation, delayed seeding, shallow sowing, inappropriate plant protection especially of faba bean (aphids) and lupines (anthracnose). Average seed yields of legume-cereal mixtures were about 66% higher than seed yield of fodder species of leguminous plants and approximately 46% than edible legumes (Table 3). High yields of mixtures and edible plants were noted in the Opolskie voivodship, whereas in four voivodships (Kujawsko-Pomorskie, Lubelskie, Małopolskie, Wielkopolskie) yields were higher than 30 dt per ha. The yields of legume-cereal mixtures were higher by approximately 8 dt per ha than yields of mixtures with other species of plants. In the Podkarpackie voivodship they were over 25 dt per ha, but in many voivodships were about 15 dt per ha. The green mass yields of mixtures of legumes with cereals and other plant species were similar to the yields of those plants grown in pure sowing. In two voivodships localised in the north of Poland (Podlaskie, Pomorskie) yields were over 210 dt per ha and in two others (Lubuskie, Mazowieckie) were under 150 dt per ha.

In between 2001 and 2007, the average seed production of leguminous plants was 136,000 t, but edibles were produced approximately 11% more than fodder seeds. It is a result of a strong reduction of the area for fodder leguminous plants since 1990 (from 255,000 to 39,000 ha). Especially large reduction in cultivated area occurred in 1993 and 1994 years (Książak, 2004). At the same time, the reduction in the area of edible leguminous plants was significantly lower (approx. 35%) in relation to the year 1990. The highest total production of leguminous seeds (edible and fodder) was in the Lubelskie voivodship, whereas in the Pomorskie and Warmińsko-Mazurskie voivodships production of those seeds was over 50% less. Not many seeds were produced in the Lubuskie, Śląskie and Podlaskie voivodships. In the dis-

cussed period, the total seed production was positively correlated with the most important factors which decided about its level (yield, production area), while it was negatively correlated (not significantly) with the share of grasslands, cereals yield, and percentage of maize and potato (Table 4).

The most seeds of leguminous-cereal mixtures were produced in the Wielkopolskie voivodship, which is a result of the large arable area as well as of a high yielding level (Table 3). Somewhat less seeds were obtained in Podlaskie voivodship, mainly as an effect of a lower yield than in the Wielkopolskie voivodship. Large production of mixtures in those regions was caused by an intensity of animal production; pig breeding in the Wielkopolskie voivodship along with dairy cattle production in the Podlaskie voivodship. The area of fodder production for one livestock unit in those regions was the smallest and amounted to 0.49 ha in Wielkopolskie and 0.66 ha in Podlaskie voivodships (Książak, 2008). Not many seed mixtures were produced in Lubuskie and Podkarpackie voivodships. The number of non-considered factors that affect the seed production of legume-cereal mixtures is much greater than those which impact seed production of legumes alone. There was noticed, among others, a strong correlation with cattle, pig, and poultry stock (Table 4). Mixtures were cultivated mainly in farms with a low intensity of pig production. Cultivation of those plants allows fodder production with a higher protein content with an advantageous amino acids composition than in the fodder grain of cereals.

Considering the indicators chosen by the cluster analysis method k-Means, three groups of different voivodships were identified in terms of their agro-environmental conditions, intensity of crop and animal production, which have a significant impact on the share of legumes in arable land and achieved yield level.

The first group includes nine voivodships (Dolnośląskie, Lubuskie, Łódzkie, Małopolskie, Opolskie, Podkarpackie, Śląskie, Świętokrzyskie, Zachodniopomorskie) located in south and western part of Poland (Table 5). This cluster includes a significant surface area of Poland, while leguminous seed production as well as their mixtures with cereals was the smallest in comparison to two other clusters and two times less than average of the country. It is caused by the least share of these species in the cropping pattern and the lowest yield level. In this cluster, more edible leguminous seeds than fodder were produced and cereal yields were higher than the average for the country. Moreover, it was characterized by a significantly higher share of maize, potato and oilseed rape in the cropping pattern than the third cluster. Furthermore, in this cluster cattle stock and pig stock were two times less than in the third cluster and almost three times less than in the second cluster.

The second group is composed of six voivodships (Kujawsko-Pomorskie, Mazowieckie, Podlaskie, Pomorskie, Warmińsko-Mazurskie, Wielkopolskie) localised in the central and in the north of Poland. In this cluster, in spite

Table 3. Cropping area, yield and production of legume mixture.

Voivodship	Mixtures of legumes with cereals for seeds			Mixtures of legumes with other species for seeds			Mixtures of legumes with other species for green mass	
	cropping area [thous. ha]	yield [dt ha ⁻¹]	production [thous. t]	cropping area [thous. ha]	yield [dt ha ⁻¹]	production [thous. t]	cropping area [thous. ha]	yield [dt ha ⁻¹]
Dolnośląskie	1.4	29.0	4.0	0.06	19.6	0.1	0.4	197.5
Kujawsko-Pomorskie	3.7	31.1	11.4	0.2	21.8	0.4	0.5	152.5
Lubelskie	4.0	30.1	11.9	0.4	19.7	0.8	1.3	188.0
Lubuskie	1.1	25.0	2.5	0.07	13.3	0.08	0.5	147.5
Łódzkie	3.4	24.5	8.5	0.2	17.7	0.4	1.0	155.5
Małopolskie	1.5	30.2	4.6	0.1	22.2	0.2	0.3	177.5
Mazowieckie	5.0	23.4	11.8	0.3	17.9	0.6	2.2	144.0
Opolskie	1.3	38.6	5.0	0.06	24.5	0.2	0.2	179.5
Podkarpackie	1.2	29.2	3.4	0.1	27.4	0.3	0.4	196.5
Podlaskie	4.6	26.4	12.3	0.3	20.8	0.6	0.4	213.5
Pomorskie	2.7	29.2	8.0	0.3	22.7	0.6	1.1	221.0
Śląskie	1.2	29.7	3.7	0.06	18.4	0.09	0.08	192.5
Świętokrzyskie	1.4	25.7	3.8	0.06	22.4	0.1	0.4	156.0
Warmińsko-Mazurskie	3.4	27.4	9.3	0.4	21.6	0.7	1.1	172.0
Wielkopolskie	4.6	30.9	14.0	0.3	16.8	0.5	0.9	161.0
Zachodniopomorskie	1.6	25.5	4.0	0.1	15.7	0.2	0.3	163.5
Poland	42.1	28.2	118.2	2.9	20.6	5.7	10.9	173.0

Source: Produkcja 2000-2007; Użytkowanie 2000-2007.

Table 4. Characteristics of analyzed variables for 16 voivodships (averages from the years 2001–2007).

Variables	Mean	Range of variability	Correlation coefficient			
			production of seeds (total)	production of edible seeds	production of fodder seeds	production of mixture seeds
Production of legume seeds [thous. t]	8.50	1.17–32.82	-	0.9144	0.5054	0.5564
Share of legumes [% AL]	0.81	0.16–2.02	0.8398	0.7572	0.4474	0.3226
Area of legumes [thous. ha]	6.70	0.8–23.88	0.9330	0.8520	0.4740	0.6390
Production of edible legume seeds [thous. t]	4.48	0.24–28.37	0.9144	-	0.1129	0.3719
Area of edible legumes [thous. ha]	2.41	0.17–17.58	0.8920	0.9946	0.0692	0.3350
Yield of edible legume seeds [dt ha ⁻¹]	16.8	10.5–22.1	0.4507	0.3835	0.2889	0.2559
Production of fodder legume seeds [thous. t]	4.02	0.44–11.43	0.5054	0.1129	-	0.5731
Area of fodder legumes for seeds [thous. ha]	2.44	0.20–5.52	0.5154	0.1448	0.9565	0.7092
Yield of fodder legume seeds [dt ha ⁻¹]	16.6	13.1–20.1	0.4333	0.3707	0.2732	0.0945
Area of fodder legumes for green mass [thous. ha]	1.52	0.17–5.63	0.4329	0.2771	0.4720	0.6064
Yield of fodder legumes for green mass [dt ha ⁻¹]	174.5	126.6–206.8	0.2126	0.2846	0.0850	-0.2014
Area of legume-cereal mixtures for seeds [thous. ha]	2.63	1.09–4.99	0.4920	0.2906	0.5882	0.9744
Yield of legume-cereal mixture seeds [dt ha ⁻¹]	28.5	23.3–38.6	0.0295	0.1387	-0.2233	-0.0263
Production of legume-cereal mixture seeds [thous. t]	7.38	2.53–14.0	0.5564	0.3719	0.5731	-
Valorization index of agricultural production area [points]	67.4	55.0–81.6	0.1654	0.3450	-0.3296	-0.3266
Share of arable land [% AA]	74.5	60.5–88.9	0.1586	0.2140	-0.0669	0.2207
Share of meadows and pastures [% AA]	20.8	10.2–34.4	-0.2110	-0.2764	0.0712	-0.0991
NPK [kg ha ⁻¹ AA]	99.9	63.6–142.7	0.0169	-0.0033	0.0485	0.0932
Share of cereals [% AL]	73.5	65.1–78.4	0.1581	0.2360	-0.1150	0.1735
Yields of cereals [t ha ⁻¹]	30.4	23.5–43.9	-0.2281	-0.1420	-0.2573	-0.2968
Share of maize [% AL]	4.3	1.1–11.5	-0.3593	-0.2368	-0.3773	-0.0518
Share of potato [% AL]	4.9	1.9–11.2	-0.2646	-0.1331	-0.3657	-0.3850
Share of rape [% AL]	8.5	0.7–18.5	0.0110	0.0014	0.0240	-0.1507
Cattle stock [thous. heads]	358.2	69.4–928.7	0.2764	0.1209	0.4208	0.8570
Pig stock [mln heads]	1.12	0.26–4.6	0.2994	0.1844	0.3420	0.7655
Poultry stock [mln heads]	7.1	3.6–20.3	0.1153	0.0427	0.1920	0.5461

Significant values were marked by bold letters.

Table 5. The values of variables in the selected groups of voivodships (clusters).

Variables	Clusters		
	I (n = 9)	II (n = 6)	III (n = 1)
Production of legume seeds [thous. t]	4.13	11.00	32.80
Share of legumes [% AL]	0.61	0.92	2.02
Area of legumes [thous. ha]	3.47	8.67	23.88
Production of edible legume seeds [thous. t]	2.27	3.82	28.37
Area of edible legumes [thous. ha]	1.21	1.70	17.58
Yield of edible legume seeds [dt ha ⁻¹]	15.8	17.8	20.4
Production of fodder legume seeds [thous. t]	1.86	7.18	4.46
Area of fodder legumes for seeds [thous. ha]	1.17	4.26	2.95
Yield of fodder legume seeds [dt ha ⁻¹]	16.2	16.9	18.6
Area of fodder legumes for green mass [thous. ha]	0.88	2.26	2.82
Yield of fodder legumes plants green [dt ha ⁻¹]	177.7	166.2	195.0
Area of legume-cereal mixtures for seeds [thous. ha]	1.57	3.99	3.96
Yield of legume-cereal mixtures for seeds [dt ha ⁻¹]	28.6	28.1	30.1
Production of legume-cereal mixture seeds [thous. t]	4.38	11.14	11.88
Valorization index of agricultural production area [points]	69.0	63.8	74.1
Share of arable land [% AA]	73.7	75.1	78.0
Share of meadows and pastures [% AA]	20.8	21.5	16.9
NPK [kg ha ⁻¹ AA]	98.3	102.9	96.1
Share of cereals [% AL]	73.4	72.9	78.4
Yields of cereals [t ha ⁻¹]	31.7	28.9	27.5
Share of maize [% AL]	4.7	4.0	2.41
Share of potato [% AL]	6.0	3.6	3.4
Share of rape [% AL]	8.8	8.4	7.2
Cattle stock [thous. heads]	212.9	561.9	443.4
Pig stock [mln heads]	0.6	1.9	1.3
Poultry stock [mln heads]	5.8	9.2	6.6

of a lesser area than the size of the first cluster, three times more leguminous seeds and their mixtures with cereals than in the first cluster were produced. This is a result of a larger share of arable area and higher share of these species in the cropping pattern, because the yield levels are similar to the first cluster. The productions of fodder seeds are two times higher than of edible seeds. An analysis of the indicators characterising the production of seeds and their effective yield level, concludes that the values of many of them are close to the average in the country (share of arable land and permanent pasture in the agricultural area, the level of NPK fertilization, the share of cereals and maize in the crop structure). In addition, the index of agricultural production space was only about three points lower. At the same time in this region, the cultivation of the oilseed rape was much smaller than the national average, and cattle, pig, and poultry stocks were significantly higher as compared with the national average. Ufnowska et al. (2001) reported that the Wielkopolskie and Kujawsko-Pomorskie voivodships were characterised with high intensity of pig production because the pig purchase and density per 1 ha of agricultural acreage were over two times higher than the average of the country.

The third group includes the Lubelskie voivodship only. The production of leguminous seeds was three times higher

than in the second cluster and eight times higher than in the first one. The production of legume-cereal mixtures was the same as in the second cluster and three times higher than in the first one. The surface of leguminous plants was two times higher than in the first and second groups. The yield of edible seeds was approximately 25% higher than in the first cluster and at about 10% higher than in the second cluster. This region was characterised by considerably higher index of agricultural production area as well as the soil quality index, which had direct influence on yield level of leguminous crops and their mixtures with cereals and green mass yields of leguminous plants. In this region the share of grassland, cereal grain yields, as well as mineral fertilisation doses were considerable smaller than the average of the country. Moreover the percentage of maize and potato in cropping pattern was two times smaller than in the first cluster but the percentage of cereals was approximately 5% higher than average of country.

CONCLUSION

Between 2001 and 2007, the surface of the legumes crops for seed and green mass was about 100,000 ha and was almost four times less than the area of cultivation leguminous plants for seeds in 1989. The area of fodder plants

cultivation was strongly reduced (by more than five times), while that of edible crops only by 35%. The average share of legume crops on the arable land was 0.86% and the highest was recorded in the Lubelskie (2.0%), Świętokrzyskie (1.6%), Pomorskie (1.4%) voivodships, while the smallest in Dolnośląskie (0.33%), Opolskie (0.16%) and Śląskie (0.30%) voivodships. The yield of fodder seeds was 17 dt per ha and was approximately 13% lower than that of edible crops. The highest yield of fodder plants was noted in the Małopolskie and Pomorskie voivodships and edible – in Opolskie, Warmińsko-Mazurskie, mixtures – in Opolskie. The lowest yields of fodder were recorded in Lubuskie, Mazowieckie, Świętokrzyskie, Podlaskie voivodships, edible – in Lubuskie and Podlaskie, mixtures in Mazowieckie. The most seeds were produced in Lubelskie voivodship (mostly edible); while in Lubuskie and Podlaskie voivodships edible seeds are hardly produced at all. Features that are unfavourable for the production of legume seeds were the share of grasslands, maize, and potato on arable land. With regard to the production of legume-cereal mixtures for seeds, factors that had a much more negative impact were the yield of seeds, the valorization index of agricultural production area, the share of grasslands, maize, oilseed rape, potatoes in arable land, while the cattle, pig, and poultry stocks had a significant positive effect.

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