

*Original Research*

# Share of Agricultural Land in Spatial Variation in Plant Cover of Kujawy and Pomorze Province

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## Abstract

The objective of this elaboration was to define the share of different land types, of which mainly agricultural land in the degree of vegetation coverage of rural areas in Kujawy and Pomorze Province in Poland. A principal component analysis of landscape composition was made. The degree of coverage of the area of communes by vegetation of agricultural land was also determined according to some indices of the coverage by: the crops grown on arable land ( $I_{sa}$ ), the vegetation of agricultural land ( $I_{aa}$ ), and the vegetation of agricultural land and woodland ( $I_{ta}$ ). The index-determined share of the vegetation of agricultural land in the coverage of the area ( $I_{sh}$ ) was calculated as the percentage ratio of indices  $I_{aa}$  and  $I_{ta}$ . Coverage of the province with vegetation strongly depends on cropland and woodland. The highest value of the index of coverage of the area by crops grown on agricultural land occurs in three communes: Łasin, Papowo Biskupie, and Osiećiny and it ranges 0.843-0.631. In one fourth of the communes of Kujawy and Pomorze agricultural land, more than 90% can determine permanent plant cover area, while in almost half of the communes they account for 75% of the area of such plant cover.

**Keywords:** agroecosystem, agricultural land, woodland, plant cover

## Introduction

The most essential part of the area of Poland is agricultural land. Agriculture is not only an important economic sector, but also an integral element of the environment and its biodiversity [1]. Pressure on the environment from agricultural activities is evident. Plant and animal productions have an effect on soil, water, and air quality. Erosion and acidification of soil, pesticide use, greenhouse gas, and ammonia emissions, plus pollution of water bodies from nutrients are major problems associated with farming [2]. Poland is widely perceived to have a rich biodiversity in agricultural areas compared to many other countries.

But the biodiversity is diversified territorially. In the agricultural areas an important habitat element is the vegetation

of agricultural acreage and arable land. Their high biodiversity, however, changing due to social and economic changes, is a result of specific structure of land use and forms and methods of management. Agricultural acreage accounts for more than 50% of the area of Poland, of which almost 75% is arable land. The area is dominated by family farms [3, 4]. Another important landscape component is forests. Woodlands and green veining can have significant role for biodiversity [5]. Woodland coverage accounts for about 30% of the country and 23% of Kujawy and Pomorze [6].

Agroecosystems in Poland are in general considered areas of high diversity and natural quality. The biodiversity of plants and the accompanying organisms on arable land depend on crop rotation. The threat is posed especially by monoculture [7]. Grasslands, especially natural or semi-natural areas, have a special significance for natural diversity. Half of them are classified as meadows and semi-natural

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pasture land, also covering wetlands [8]. The domination in the agrarian structure of small farms, the low number of large-acreage farms, the multi-directional nature of production, and the application of low-input technologies have enhanced preservation of the biodiversity and the mosaic nature of the rural landscape.

The results of ecological and agri-ecological research show a close relationship between the method of agricultural use and the diversity and comprehensive nature of the landscape. Plant cover is a complex and dynamic element of the landscape. Organisms representing different taxa occurring in agroecosystems and rural landscape affect the conditions and effects of agricultural production. Besides economic significance, they also play an important ecological role [9-11]. At the moment, actions for protecting the environment and biodiversity are supported by agri-environmental programs [12].

The aim of the present paper is to define the share of different land types, mainly agricultural land in the coverage by vegetation of rural areas in Kujawy and Pomorze Province.

## Materials and Methods

Our paper is based on information on the share of different land types: cropland (Ss), meadow (Sm), pasture land (Sp), orchard (So), and woodland (Sf) in a rural area of the 127 towns of the Kujawy and Pomorze Province. In the first stage there was principal component analysis, using the share of each land cover type as a trait, indices of the land coverage as supplementary variables, and communes as cases [13]. Then, the coverage of commune area by vegetation of respective agricultural land was determined according to the following algorithms:

$$I_{sa} = \sum(p_i \cdot t_i) \cdot S_{ss} \quad (1)$$

$$I_{aa} = I_{sa} + S_{gh} \quad (2)$$

$$I_{ta} = I_{aa} + S_f \quad (3)$$

...where:

$I_{sa}$  – index of the coverage of the commune by the crops grown on arable land

$I_{aa}$  – index of the coverage of the commune by the vegetation of agricultural land

$I_{ta}$  – index of the coverage of the commune by the vegetation of agricultural land and woodland

$p$  – share of the cultivation area  $i$ -plant species ( $i=21$ ) in the cropland acreage

$t$  – share of the period of the occurrence of the crop in the field throughout the year

$S_{ss}$  – share of the cropland acreage in the total commune area

$S_{gh}$  – share of the area of meadows (Sm), pasture land (Sp), and orchards (So) in the total commune area

$S_f$  – share of the woodland area in the total commune area

$t_i$  – defines the share of the period of crop presence in the field, grown on arable land throughout the year. To evaluate it, it was assumed that some crops (perennials on

arable land) cover the field for 12 months, namely for one year (1.0). Winter crops, depending on the species, 0.8-0.9 of the year, and spring crops: 0.25-0.50 of the year.

The indices stand for what part of the commune area is covered by specific land in use, arable land, agricultural land, and combined agricultural land and woodland with their vegetation, respectively.

We also evaluated a share of the vegetation of agricultural land in the coverage of the area of respective communes by plant cover ( $I_{sh}$ ). To do so we determined the percentage ratio of the earlier calculated indices of the coverage of the commune area by the vegetation of agricultural land ( $I_{aa}$ ) and total coverage by the vegetation of agricultural land and woodland ( $I_{ta}$ ).

$$I_{sh} = I_{aa}/I_{ta} \cdot 100 [\%] \quad (4)$$

The variation in the value of that index in the Kujawy and Pomorze Province is presented in the form of a map.

## Results and Discussion

Kujawy and Pomorze Province, despite habitat conditions being only partway favorable, is a region of developed and intensive agriculture. The conditions of its implementation, the size and character are, however, varied across the territory [14, 15]. The share and diversity of the crop plantations [16] in respective counties of the province, and seed plantations [17] differ. The area of the region shows a low value for the index of wood coverage, which in some areas is lower than 10% [18]. Soils vary from fertile to poor sandy soils. Locally, soil erosion occurs [19, 20].

Under such habitat-and-economic conditions the role of vegetation and its type in the coverage of the province area is essential.

Drawing on *Principal Component Analysis*, it was found that the two principal components account for over 70% of the variation in coverage of the area of the communes of the province with the vegetation of different types of agricultural land and woodland.

The first principal component is, mostly, made up by the variables defining the share of cropland (Ss) and woodland (Sf) in the area of the commune. Their share in the first component is similar, but they are strongly negatively correlated (Fig. 1). The indices estimated with formulas (1)-(3) have a similar structure. There are too different locations of the communes. Outlying communes are Łasin, Papowo Biskup, Wielka Nieszawka, Nowa Wieś Wielka, and Solec Kuj. That means that a high share of sown crops in the commune area is connected with their low woodland coverage, and high woodland coverage – with a low share of sown crops on arable land. At the same time there is a strong positive relationship between the share of cropland and the share of orchards, as in coverage of the communes with vegetation. The share of the orchard areas in the variation in coverage of the area of the province with vegetation is, however, lowest of all the types of land under use.

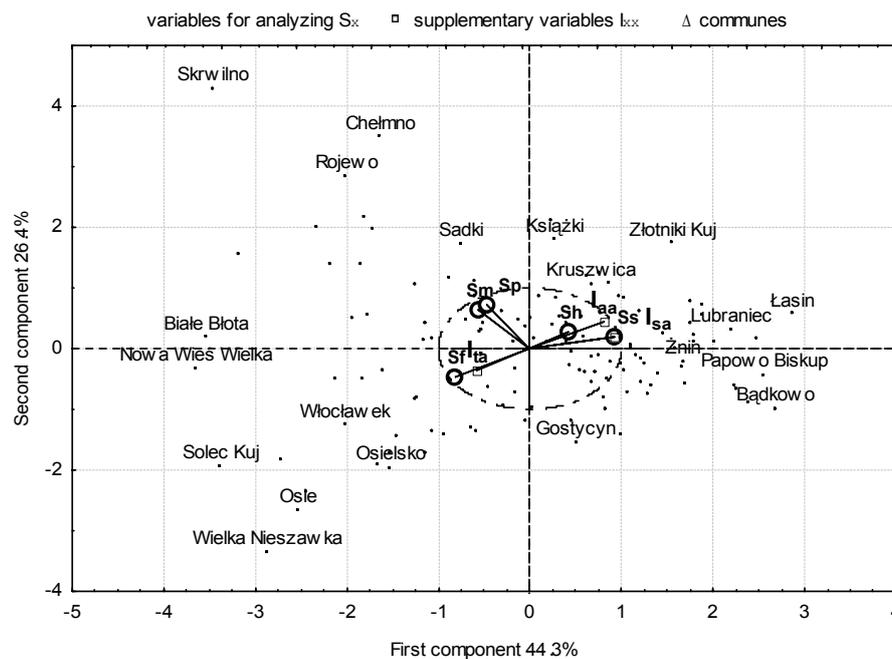


Fig. 1. Distribution of land types in plant coverage of area and communes location for first two principal components.

The second principal component includes, especially, the shares of pasture land (Sp) and meadows (Sm), which are strongly correlated. The share of grasslands in the coverage of the communes with vegetation is, at the same time, strongly correlated with neither cropland nor woodland coverage.

The highest value of the index of coverage of the area of communes by crops grown on arable land occurs in the following communes: Łasin, Papowo Biskupie, and Osiecin, and it ranges from 0.771 to 0.598. Only in 10 communes is it higher than 0.500, while in 9 communes it is lower than 0.100. The lowest index in the Wielka Nieszawka commune is 0.018 (Table 1). Plants grown on arable land are the main element of agricultural land; hence the similarity of the index of coverage of the area of respective communes by the plants of agricultural land in total ( $I_{aa}$ ) to the index of the coverage by the crops grown on arable land ( $I_{sa}$ ). In the communes of Łasin, Papowo Biskupie, and Osiecin it is, respectively, 0.843-0.631, and in Wielka Nieszawka 0.047 (Table 2). The difference in the values of the two indices points to the share of the plants of agricultural land permanent in the rural landscape, including grasslands and orchards, in commune area coverage. Their greatest share in the degree of coverage by plants of agricultural land occurs in the communes of Skrwilno and Chełmno. In those communes the difference between the value of indices  $I_{aa}$  and  $I_{sa}$  is over 0.200, while in the other 29 communes it is higher than 0.100. Agricultural land plays important environmental functions. They increase the variation in the landscape structure. The plants that cover the soil permanently protect it from erosion and nutrient leaching, and it is an essential (besides woodland and tree planting) element of agricultural biodiversity [21].

An integral element of the rural landscape are the areas under no-direct agricultural use on which permanent vegetation occurs. However, they emerge in functional relationships with agroecosystems, since they affect agricultural production conditions and determine its effects, undergoing changes themselves. In that sense tree plantings and woodland are essential [22, 23]. In the Kujawy and Pomorze Province in 12 communes over 50% of the total area is covered by woodland. In two of them, namely Wielka Nieszawka and Solec Kujawski, wood coverage exceeds 80%. However, in as many as 51 communes woodland accounts for less than 10% of the area. Ten communes where more than 75% of the area is covered by vegetation of agricultural land and woodland in total, are as follows in decreasing order: Solec Kujawski, Wielka Nieszawka, Łasin, Warlubie, Osie, Śliwice, Cekcyn, Nowa Wieś Wielka, Tuchola, and Bobrowniki (Table 3). Only in the Łasin commune is it determined by the vegetation of agricultural land (index  $I_{sh}=93.8\%$ ). In as many as 94 of 127 of the communes of the province the vegetation of agricultural land and woodland covers less than 0.666 of their area, and in 64 the index is lower than 0.600. In seven communes of the province, Inowrocław, Choceń, Pakość, Lubień Kujawski, Zbójno, Kikół, and Brzuze, the vegetation occurs on less than 50% of the area ( $I_{ta}<0.500$ ). These are the deforested communes, where index  $I_{sh}>86\%$ . Throughout the Kujawy and Pomorze Province in 31 communes the share of the vegetation of agricultural land in the coverage of the area by plant cover is over 90%, in 59 communes ( $I_{sh}>75\%$ ), and in as many as 102 it is over 50% (Table 4). The communes of the greatest share of agricultural land in the coverage of the area with vegetation are located in the southern and northeastern parts of the province (Fig. 2).

Table 1. Index ( $I_{sa}$ ) of coverage of the commune by crops grown on arable land.

Commune	$I_{sa}$	Commune	$I_{sa}$	Commune	$I_{sa}$
Aleksandrów Kuj	0.285	Jabłonowo Pom	0.415	Pruszcz	0.469
Barcin	0.346	Janikowo	0.559	Raciążek	0.382
Bartniczka	0.331	Janowiec Wlkp	0.434	Radomin	0.440
Baruchowo	0.188	Jezióra Wielkie	0.306	Radziejów	0.537
Bądkowo	0.579	Jeżewo	0.144	Radzyń Chełm	0.464
Białe Błota	0.027	Kamień Kraj	0.322	Rogowo/Żnin	0.336
Bobrowniki	0.153	Kcynia	0.311	Rogowo/Rypin	0.228
Bobrowo	0.356	Kęsowo	0.349	Rogóźno	0.278
Boniewo	0.423	Kijewo Król	0.457	Rojewo	0.275
Brodnica	0.308	Kikół	0.361	Rypin	0.321
Brześć Kuj	0.400	Koneck	0.430	Sadki	0.316
Brzozie	0.270	Koronowo	0.330	Sępólno Kraj	0.219
Brzuze	0.326	Kowal	0.242	Sicienko	0.336
Bukowiec	0.423	Kowalewo Pom	0.439	Skepe	0.104
Bytoń	0.425	Kruszwica	0.452	Skrwilno	0.213
Cekcyn	0.075	Książki	0.418	Solec Kuj	0.043
Chełmno	0.312	Lipno	0.274	Sośno	0.325
Chełmża	0.467	Lisewo	0.519	Stolno	0.398
Choceń	0.390	Lniano	0.280	Strzelno	0.371
Chodecz	0.425	Lubanie	0.350	Szubin	0.212
Chrostkowo	0.366	Lubicz	0.266	Śliwice	0.072
Ciechocin	0.246	Lubień Kuj	0.346	Świecie	0.217
Czernikowo	0.202	Lubiewo	0.224	Świecie/Osą	0.385
Dąbrowa	0.378	Lubraniec	0.533	Świdziebnia	0.276
Dąbrowa Biskup	0.289	Łabiszyn	0.216	Świekatowo	0.374
Dąbrowa Chełm	0.124	Łasin	0.771	Tłuchowo	0.318
Dębowa Łąka	0.384	Łubianka	0.422	Topólka	0.389
Dobrcz	0.396	Łysomice	0.410	Tuchola	0.193
Dobre	0.471	Mogilno	0.447	Unisław	0.365
Dobrzyń/Wisła	0.430	Mrocza	0.393	Waganiec	0.430
Dragacz	0.176	Nakło	0.274	Warlubie	0.222
Drzycim	0.233	Nowa Wieś Wielka	0.036	Wąbrzeźno	0.418
Fabianki	0.238	Nowe	0.188	Wapielsk	0.299
Gąsawa	0.282	Obrowo	0.208	Wielgie	0.262
Gniewkowo	0.301	Osie	0.065	Wielka Nieszawka	0.018
Golub-Dobrzyń	0.307	Osiek	0.332	Więcbork	0.235
Gostycyn	0.335	Osielsko	0.075	Włocławek	0.095
Górzno	0.140	Osięciny	0.598	Zakrzewo	0.427
Grudziądz	0.216	Pakość	0.328	Zbiczno	0.166
Gruta	0.536	Papowo Biskup	0.639	Zbójno	0.365
Inowrocław	0.404	Piotrków Kuj	0.419	Zławieś Wielka	0.291
Izbica Kuj	0.391	Płużnica	0.490	Złotniki Kuj	0.395
				Żnin	0.534

Table 2. Index ( $I_{aa}$ ) of coverage of the commune by vegetation of agricultural land.

Commune	$I_{aa}$	Commune	$I_{aa}$	Commune	$I_{aa}$
Aleksandrów Kuj	0.386	Jabłonowo Pom	0.500	Pruszcz	0.542
Barcin	0.410	Janikowo	0.589	Raciążek	0.461
Bartniczka	0.460	Janowiec Wlkp	0.485	Radomin	0.480
Baruchowo	0.296	Jezióra Wielkie	0.359	Radziejów	0.558
Bądkowo	0.595	Jeżewo	0.198	Radzyń Chełm	0.550
Białe Błota	0.171	Kamień Kraj	0.390	Rogowo/Żnin	0.392
Bobrowniki	0.244	Kcynia	0.450	Rogowo/Rypin	0.364
Bobrowo	0.416	Kęsowo	0.470	Rogóźno	0.334
Boniewo	0.518	Kijewo Król	0.531	Rojewo	0.456
Brodnica	0.381	Kikół	0.418	Rypin	0.423
Brześć Kuj	0.451	Koneck	0.491	Sadki	0.478
Brzozie	0.346	Koronowo	0.380	Sępólno Kraj	0.313
Brzuze	0.375	Kowal	0.355	Sicienko	0.427
Bukowiec	0.489	Kowalewo Pom	0.497	Skępe	0.261
Bytoń	0.491	Kruszwica	0.552	Skrwilno	0.430
Cekcyn	0.131	Książki	0.546	Solec Kuj	0.115
Chełmno	0.528	Lipno	0.371	Sośno	0.411
Chełmża	0.509	Lisewo	0.568	Stolno	0.444
Choceń	0.462	Lniano	0.394	Strzelno	0.411
Chodecz	0.461	Lubanie	0.400	Szubin	0.351
Chrostkowo	0.448	Lubicz	0.360	Śliwice	0.149
Ciechocin	0.291	Lubień Kuj	0.404	Świecie	0.332
Czernikowo	0.257	Lubiewo	0.300	Świecie/Osą	0.455
Dąbrowa	0.405	Lubraniec	0.603	Świdziebnia	0.388
Dąbrowa Biskup	0.370	Łabiszyn	0.391	Świekatowo	0.479
Dąbrowa Chełm	0.223	Łasin	0.843	Tłuchowo	0.394
Dębowa Łąka	0.465	Łubianka	0.484	Topólka	0.453
Dobrcz	0.474	Łysomice	0.471	Tuchola	0.261
Dobre	0.539	Mogilno	0.504	Unisław	0.492
Dobrzyń/Wisłą	0.508	Mrocza	0.462	Waganiec	0.490
Dragacz	0.299	Nakło	0.468	Warlubie	0.290
Drzycim	0.281	Nowa Wieś Wielka	0.179	Wąbrzeźno	0.516
Fabianki	0.357	Nowe	0.326	Wąpielsk	0.369
Gąsawa	0.334	Obrowo	0.272	Wielgie	0.353
Gniewkowo	0.357	Osie	0.111	Wielka Nieszawka	0.047
Golub-Dobrzyń	0.372	Osiek	0.427	Więcbork	0.334
Gostycyn	0.366	Osielsko	0.120	Włocławek	0.176
Górzno	0.202	Osięciny	0.631	Zakrzewo	0.526
Grudziądz	0.377	Pakość	0.437	Zbiczno	0.211
Gruta	0.596	Papowo Biskup	0.667	Zbójno	0.437
Inowrocław	0.477	Piotrków Kuj	0.486	Zławieś Wielka	0.424
Izbica Kuj	0.488	Płużnica	0.537	Złotniki Kuj	0.532
				Żnin	0.590

Table 3. Index ( $I_{ta}$ ) of coverage of the commune by vegetation of agricultural land and woodland.

Commune	$I_{ta}$	Commune	$I_{ta}$	Commune	$I_{ta}$
Aleksandrów Kuj	0.554	Jabłonowo Pom	0.608	Pruszcz	0.560
Barcin	0.502	Janikowo	0.604	Raciążek	0.512
Bartniczka	0.633	Janowiec Wlkp	0.542	Radomin	0.575
Baruchowo	0.690	Jezióra Wielkie	0.572	Radziejów	0.560
Bądkowo	0.605	Jeżewo	0.748	Radzyń Chełm	0.563
Białe Błota	0.718	Kamień Kraj	0.609	Rogowo/Żnin	0.652
Bobrowniki	0.753	Kcynia	0.678	Rogowo/Rypin	0.697
Bobrowo	0.501	Kęsowo	0.586	Rogóźno	0.674
Boniewo	0.569	Kijewo Król	0.553	Rojewo	0.655
Brodnica	0.565	Kikół	0.439	Rypin	0.500
Brześć Kuj	0.642	Koneck	0.560	Sadki	0.620
Brzozie	0.502	Koronowo	0.693	Sępólno Kraj	0.592
Brzuze	0.436	Kowal	0.584	Sicienko	0.621
Bukowiec	0.617	Kowalewo Pom	0.562	Skepe	0.657
Bytoń	0.520	Kruszwica	0.592	Skrwilno	0.683
Cekcyn	0.828	Książki	0.553	Solec Kuj	0.940
Chełmno	0.654	Lipno	0.602	Sośno	0.575
Chełmża	0.525	Lisewo	0.571	Stolno	0.572
Choceń	0.482	Lniano	0.662	Strzelno	0.669
Chodecz	0.561	Lubanie	0.609	Szubin	0.709
Chrostkowo	0.565	Lubicz	0.554	Śliwice	0.830
Ciechocin	0.661	Lubień Kuj	0.460	Świecie	0.570
Czernikowo	0.709	Lubiewo	0.720	Świecie/Osą	0.542
Dąbrowa	0.615	Lubraniec	0.642	Świdziebnia	0.566
Dąbrowa Biskup	0.569	Łabiszyn	0.722	Świekatowo	0.561
Dąbrowa Chełm	0.680	Łasin	0.899	Tłuchowo	0.572
Dębowa Łąka	0.554	Łubianka	0.536	Topólka	0.544
Dobrcz	0.542	Łysomice	0.700	Tuchola	0.755
Dobre	0.568	Mogilno	0.556	Unisław	0.585
Dobrzyń/Wisłą	0.533	Mrocza	0.617	Waganiec	0.503
Dragacz	0.583	Nakło	0.662	Warlubie	0.864
Drzycim	0.617	Nowa Wieś Wielka	0.812	Wąbrzeźno	0.655
Fabianki	0.568	Nowe	0.589	Wapielsk	0.574
Gąsawa	0.593	Obrowo	0.663	Wielgie	0.539
Gniewkowo	0.639	Osie	0.838	Wielka Nieszawka	0.903
Golub-Dobrzyń	0.705	Osiek	0.513	Więcbork	0.611
Gostycyn	0.660	Osielsko	0.706	Włocławek	0.672
Górzno	0.733	Osięciny	0.681	Zakrzewo	0.556
Grudziądz	0.612	Pakość	0.472	Zbiczno	0.647
Gruta	0.679	Papowo Biskup	0.672	Zbójno	0.459
Inowrocław	0.495	Piotrków Kuj	0.547	Zławieś Wielka	0.672
Izbica Kuj	0.524	Płużnica	0.557	Złotniki Kuj	0.595
				Żnin	0.645

Table 4. The share ( $I_{sh}$ ) of coverage of vegetation of agricultural land in total area coverage.

Commune	$I_{sh}$	Commune	$I_{sh}$	Commune	$I_{sh}$
Aleksandrów Kuj	69.6	Jabłonowo Pom	82.2	Pruszcz	96.7
Barcin	81.7	Janikowo	97.5	Raciążek	90.1
Bartniczka	72.7	Janowiec Wlkp	89.6	Radomin	83.5
Baruchowo	42.8	Jeżozero	62.8	Radziejów	99.6
Bądkowo	98.2	Jeżewo	26.5	Radzyń Chełm	97.7
Białe Błota	23.7	Kamień Kraj	64.0	Rogowo/Żnin	60.1
Bobrowniki	32.4	Kcynia	66.4	Rogowo/Rypin	52.2
Bobrowo	83.4	Kęsowo	80.3	Rogóźno	49.6
Boniewo	91.0	Kijewo Król	96.0	Rojewo	69.7
Brodnica	67.3	Kikół	95.3	Rypin	84.7
Brześć Kuj	70.2	Koneck	87.7	Sadki	77.1
Brzozie	69.0	Koronowo	54.8	Sępólno Kraj	52.9
Brzuze	86.0	Kowal	60.8	Sicienko	68.8
Bukowiec	79.2	Kowalewo Pom	88.3	Skępe	39.7
Bytoń	94.4	Kruszwica	93.2	Skrwilno	63.0
Cekcyn	15.8	Książki	98.7	Solec Kuj	12.2
Chełmno	80.7	Lipno	61.6	Sośno	71.5
Chełmża	97.1	Lisewo	99.5	Stołno	77.6
Choceń	95.8	Lniano	59.5	Strzelno	61.5
Chodecz	82.3	Lubanie	65.7	Szubin	49.5
Chrostkowo	79.4	Lubicz	65.1	Śliwice	18.0
Ciechocin	44.0	Lubień Kuj	87.8	Świecie	58.2
Czernikowo	36.3	Lubiewo	41.6	Świecie/Osą	84.0
Dąbrowa	65.9	Lubraniec	94.0	Świdziebnia	68.5
Dąbrowa Biskup	65.1	Łabiszyn	54.1	Świekatowo	85.3
Dąbrowa Chełm	32.8	Łasin	93.8	Tłuchowo	68.8
Dębowa Łąka	83.9	Łubianka	90.3	Topólka	83.3
Dobrcz	87.4	Łysomice	67.2	Tuchola	34.5
Dobre	94.9	Mogilno	90.7	Unisław	84.0
Dobrzyń/Wisła	95.3	Mrocza	74.8	Waganiec	97.4
Dragacz	51.3	Nakło	70.7	Warlubie	33.5
Drzycim	45.5	Nowa Wieś Wielka	22.1	Wąbrzeźno	78.8
Fabianki	62.8	Nowe	55.3	Wąpielsk	64.2
Gąsawa	56.3	Obrowo	41.0	Wielgie	65.5
Gniewkowo	55.9	Osie	13.3	Wielka Nieszawka	5.2
Golub-Dobrzyń	52.8	Osiek	83.3	Więcbork	54.6
Gostycyn	55.5	Osielsko	17.0	Włocławek	26.2
Górzno	27.6	Osięciny	92.7	Zakrzewo	94.5
Grudziądz	61.6	Pakość	92.5	Zbiczno	32.6
Gruta	87.6	Papowo Biskup	99.2	Zbójno	95.1
Inowrocław	96.4	Piotrków Kuj	88.9	Zławieś Wielka	63.1
Izbica Kuj	93.2	Płużnica	96.3	Złotniki Kuj	89.5
				Żnin	91.4

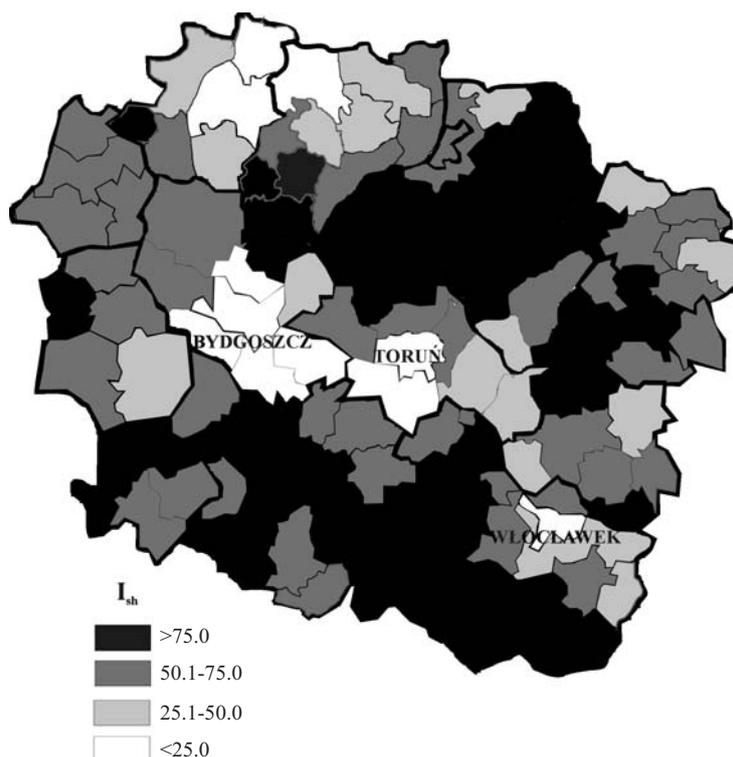


Fig. 2. Map of the share of agricultural land vegetation in coverage of the total area ( $I_{sh}$ ) of the Kujawy and Pomorze Province.

In the communes of Białe Błota, Nowa Wieś Wielka, Śliwice, Osielsko, Cekcyn, Osie, Solec Kuj, and Wielka Nieszawka, the value of index  $I_{sh}$  is lower than 25%. The areas of the lowest share of agricultural land in the coverage of communes with vegetation are found in the central and northern parts of Kujawy and Pomorze Province. Those are the communes located in the vicinity of the city clusters Bydgoszcz, Toruń, and Włocławek, and within large woodland complexes, including the Bydgoszcz and the Tuchola forests.

### Conclusions

Coverage of Kujawy and Pomorze Province with vegetation depends mostly on the share of cropland, permanent grasslands, and woodland in the area of the communes and much less considerably on the share of orchards. Agricultural land is an important, yet heavily varied in its structure and across the territory, element of the plant cover in a region. In one fourth of the communes, agricultural land can account for more than 90%, and in almost half of the communes – more than 75% determine the area of permanent vegetation. Those are mostly communes located in the southern and in the northeastern parts of the province, in the typical agriculture areas of the region. The vegetation of that area, of very low woodland coverage, is mainly made up by crops, meadows, pasture land and orchards, and its variability depends on the structure of that land under use. In this region the agricultural policy should stimulate agrobiodiversity and plant coverage of soil. One ought to cultivate perennial plants, winter forms of crops, many various cultivars, mixtures, and catch crops.

In the Kujawy and Pomorze region, only communes in close vicinity of the cities lose their agricultural character: Białe Błota, Nowa Wieś Wielka, Osielsko, and Solec Kujawski. On the heavily wooded communes of Cekcyn, Osie, Śliwice, and Wielka Nieszawka, the vegetation of agricultural land does not account for more than 25% of the permanent plant cover.

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