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**REGIONAL CHANGES IN CATTLE AND COW POPULATION
IN POLAND FROM 2010 TO 2023**

Key words: cattle, cows, stocking rate, population, counties, concentration, divergence

ABSTRACT. The aim of the research was to assess regional changes in cattle (excluding cows) and cow population. Surveys were carried out at the provincial level in 2010-2023, and at the county level on the basis of 2010 and 2020 agricultural census data. The surveys show that the processes of spatial concentration of cattle population in Poland are occurring faster in the case of cows, and they are also more advanced 62 and 93 counties with the highest cattle population and counties with the highest cattle density without cows and cows, using 20% and 30% of agricultural land in Poland. However, there was no correlation of the level of cattle stocking without cows and cows in 2010 in individual counties with changes in stocking rates by 2020. It was found that in the case of both studied groups of animals, the stocking is located mainly in the belt from Podlaskie to Wielkopolskie provinces. The fastest depopulation process occurs in southeastern Poland.

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INTRODUCTION

The cattle (excluding cows) and cow populations in Poland are developing in opposite directions despite similar nutrition and dependence on own feed. In the case of cattle, an upward trend has been evident over the past 20 years, while in the case of cows there has been a systematic decline in the population. In the case of cattle, the increase in interest in this production was due to, among other things, Poland's entry into the European Union (UE) and the increase in foreign demand for Polish beef, which, along with the elimination of customs barriers, contributed to an increase in the price of beef livestock [Stańko, Mięka 2016]. In addition, in the following years, Polish meat companies managed to enter more widely into non-EU markets that offered high prices, such as the Turkish, Middle Eastern Arab countries and Israel market. The development of this production was also encouraged by programs to support the sector under the RDP, among others, which were the primary source of funds for investment [Ziętara 2019]. After 2008, as the crisis in the Polish pork livestock market progressed, beef cattle production became a frequent alternative to pork production on many medium-sized farms. Despite long periods in which the profitability of this production is low, there are indications that Poland's position in the European beef market may strengthen. An advantage is the use of mainly roughage in animal nutrition and limited use of concentrated feed [Skarżyńska 2017]. A limitation, however, may be the still marginal share of beef cows, which on the one hand results in the production of lower quality beef from dairy breeds, and on the other hand requires basing production on imported calves, which in turn increases the risk of importing and concentrating in Poland cattle diseases found throughout Europe. In the case of cows, until April 2015, the primary factor limiting the cow population was milk quotas, which, along with the rapid increase in cow milk yields in Poland, forced a reduction in the population [Rycombel et al. 2012, Pasińska 2015]. At present, the rapid increase in milk yields with fairly slow growth in domestic and export demand is also leading to a decline in the dairy cow population.

At the same time, two-dimensional concentration processes were taking place. On the one hand, there was a rapid reduction in the number of herds, and on the other, there were processes of spatial concentration of production. The reduction in the number of herds, although it has significantly accelerated in recent years, is still too slow, because the share of cattle and cows in the largest herds that have prospects for long-term development is still too low, especially since the minimum scale of operation that gives prospects for long-term development is increasing. Taking the increase in the number of farms with a certain number of animals as a criterion, according to the CSO data from 2013-2022, farms keeping at least 50 cattle and a minimum of 30 cows can be considered prospective, while according to the data from 2005-2013 it was a minimum of 20 cows [Pepliński et al. 2019].

The spatial distribution of cattle and cow populations and their changes in different regions of the country varies strongly. It has been noted that there are processes of

divergence in agricultural production, which intensified after 1990 and included most agricultural commodities. For example, a study conducted by Benedykt Peplinski [2019] for the pig population showed the reproduction of partition boundaries.

Another agricultural census conducted in 2020 provided new data on cattle and cow populations in counties in Poland. Therefore, the aim of the study was to assess regional changes in cattle (excluding cows) and cow populations. The analysis was carried out at the provincial level in 2010-2023 and in counties in Poland in 2020 in relation to 2010.

MATERIAL AND METHODS

The analyses were based on data obtained from the Bank of Local Data, from the 2010 and 2020 Agricultural Censuses. Data were used according to the location of the farm, i.e., the location of the farm's habitat declared by the user, i.e., residential buildings and farm buildings and equipment used for agricultural production [BDL 2023]. The surveys included changes in cow stock and total cattle minus cow stock, which allowed a more precise determination of the distribution of beef livestock production. The studies conducted at the provincial level analyzed changes in livestock populations by province and the share of the 3 provinces with the highest livestock populations from 2010 to 2023. County-level analyses for 2010 and 2020 omitted cities with county rights, since in these counties, due to the small acreage of AL, even a small herd located in a county city can result in high stocking rates and distort the results of the analyses. The changes in the share of the 62 and 93 counties (i.e., 20 and 30% of the units analyzed) with the highest stock and the counties with the highest cattle (excluding cows) density and cows density, and using 20% and 30% of the AL in Poland were examined here, among other things, to exclude inequality in potential due to different AL acreage in each county. An extension of the study was the evaluation of the effect of stocking rates in individual counties on changes in livestock populations by calculating changes in livestock populations of the analyzed animal groups in a further 10% of counties ranked according to the level of stocking rates of cows and cattle without cows in 2010.

RESULTS OF THE STUDY

The cattle population without cows (the term "cattle" will also be used in the rest of the article) in Poland has been steadily increasing over the period under review, with the fastest growth occurring in 2010-2015, and the slowest in the next 5-year period. If the growth rate of cattle from 2020-2023 is maintained until 2025, cattle growth will be nearly 16.0% from 2020-2025. Despite this, the number of provinces with declining cattle populations increases in subsequent sub-periods. In the last sub-period, there were already four provinces, while

in earlier sub-periods, there was either no such case or only one. However, the change in the size of the cattle population in each province did not occur evenly. An increase of more than 50% occurred in the Mazowieckie, Wielkopolskie provinces, which, together with Podlaskie, were characterized by a cattle population of more than 0.6 million and the highest cow population in 2023, and the Lubuskie Province, where over the entire period under review the population increased from 32,500 head to 59,400 head largely due to an increase in the cow population in large herds. The lowest increases of several percent in the cattle population occurred in the Łódzkie, Podkarpackie and Świętokrzyskie regions. In the case of the former, the low increase in livestock may be to some extent related to the relatively low, for Polish conditions, decline in the pig population and the continuing high interest in contract fattening of fattening pigs in this province, as well as the effects of AL drainage by the Belchatow lignite open pit in the districts of the southwestern part of this province [Pepliński 2023]. For the other two provinces, this is due to the general low interest in livestock production in this part of Poland.

The population of dairy and beef cows (which account for about 6% of the Polish cow population) declined by 18.1% during the analyzed period. Only in Lubuskie and Zachodniopomorskie provinces did the herd increase, but their total herd in 2023 accounted for only 3.7% of the national herd. All of this growth occurred in herds of more than 20 cows. At the opposite pole were the 3 provinces of southeastern Poland, i.e. Małopolskie, Podkarpackie and Świętokrzyskie, where the herd decreased by 43-53%, and by about 1/3 in Lubelskie and Łódzkie. The decline occurred there in every sub-period listed in Table 1, suggesting that even a good milk economy does not lead to increased interest in this region of Poland. Reasons for this include the marginal number (less than 10 each) of herds with at least 100 cows and dozens of herds with 50-99 cows. In total, these farms account for 5.1-9.5% of the cow population in these provinces. Therefore, it can be assumed that the process of depopulation of the cow herd in these provinces will continue to be the fastest, as changes in the size of farms in 2013-2022 indicate a decrease in the number of farms keeping up to 50 cows. These data are consistent with studies of the competitiveness of Polish dairy farms, which showed that herds with at least 62 cows were competitive in 2018-2020 [Ziętara, Mirkowska 2023].

The data in Figure 1 show that the share of the 3 provinces with the highest stocking rates in the national cattle and cow population is steadily increasing. In 2010-2023, the average annual increase in the value of the index was 0.373 and 0.289 percentage points (p.p.) per year, and it amounted to 53.7% and 53.1%, respectively, in 2023. Despite the slowdown in the process of spatial concentration, further growth in the importance of the Mazowieckie, Podlaskie and Wielkopolskie provinces in the national cattle and cow population should be expected in the coming years. On the other hand, the population in the provinces of southeastern Poland will be marginalized.

Table 1 Changes in the size of the cattle population without cows and cows in Poland and provinces from 2010 to June 2023

Specification	Cattle (without cows) base year = 100%				Cows base year = 100%			
	2015/ 2010	2020/ 2015	2023/ 2020	2023/ 2010	2015/ 2010	2020/ 2015	2023/ 2020	2023/ 2010
Poland	118.3	112.4	107.9	143.3	87.4	103.8	90.3	81.9
Dolnośląskie	125.7	96.7	110.9	134.9	97.3	104.3	97.0	98.5
Kujawsko-Pomorskie	113.8	114.7	98.4	128.5	83.1	96.0	96.1	76.6
Lubelskie	130.4	109.2	94.0	133.8	79.6	97.1	87.1	67.4
Lubuskie	137.2	115.4	115.4	182.7	113.8	126.0	97.7	140.1
Łódzkie	104.6	108.5	98.8	112.2	79.0	97.2	83.7	64.2
Małopolskie	115.8	108.8	100.4	126.5	74.5	99.4	76.8	56.9
Mazowieckie	128.4	106.2	116.8	159.3	92.2	102.9	87.7	83.1
Opolskie	112.9	111.9	111.7	141.1	86.8	107.9	97.3	91.1
Podkarpackie	115.0	83.7	123.3	118.6	69.3	71.1	95.9	47.2
Podlaskie	114.1	112.5	112.6	144.5	93.9	101.8	90.7	86.7
Pomorskie	116.9	118.1	108.6	149.9	96.1	101.8	102.2	99.9
Śląskie	103.9	108.1	110.0	123.6	84.8	111.2	94.8	89.3
Świętokrzyskie	121.3	101.0	92.2	113.1	73.9	86.7	83.7	53.6
Warmińsko-Mazurskie	106.3	122.3	106.0	137.8	89.7	118.3	89.1	94.5
Wielkopolskie	125.0	120.1	111.1	166.8	86.1	117.2	95.0	95.9
Zachodniopomorskie	107.2	119.7	103.3	132.5	102.2	122.1	94.0	117.2

Source: own calculations based on BDL data

The strong degree of regional concentration of cattle and cows is also confirmed by data on the stocking density of these animals in counties, which are presented in Figures 2 and 4. In the case of cattle, two regions with the highest concentration of stock can be distinguished, namely. The southwestern part of the Wielkopolskie Province, the western part of the Podlaskie Province along with the northeastern part of the Mazowieckie Province, where in 2020 there were eight and five counties, respectively, with stocking rates exceeding 60 cattle (excluding cows) per 100 ha of AL, with the average for the surveyed counties at 26.1 head. In addition, another 17 counties with a stocking density of

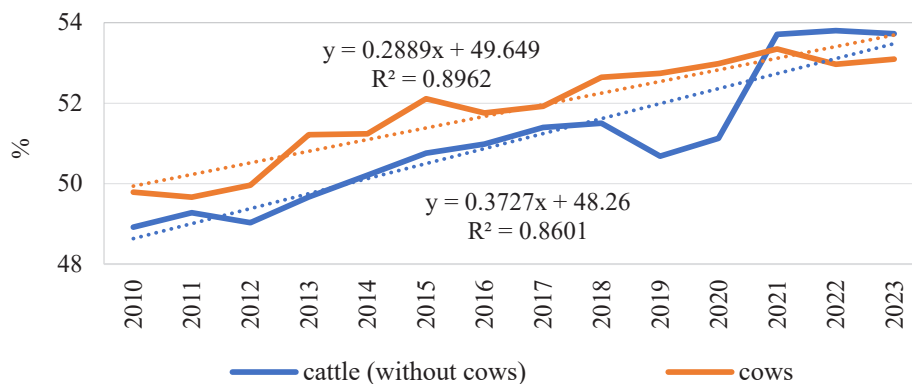


Figure 1. Share of the three provinces with the highest cattle population without cows and cows in 2010-June 2023

Source: own calculations based on BDL data

50-60 heads outside the above-mentioned regions were located mainly in the northern part of the borderland of the Kujawsko-Pomorskie and Mazowieckie provinces. Generalizing, it can be assumed that beef livestock production is located in a wide belt from Podlaskie to Wielkopolskie. Counties with the lowest stocking rates (84 in total) are located mainly in the southeastern and western parts of Poland, as most counties in these areas in 2020 were characterized by stocking rates of no more than 10 cattle (excluding cows) per 100 ha of AL. A small area of low concentration is the counties located southwest of Warsaw.

Although there was a 32.9% increase in the cattle population without cows between 2010 and 2020, as many as 107 of the 314 counties saw a decrease in the population (Figure 3). These were located mainly in provinces from southern and, to a lesser extent, northern Poland. The only provinces where there were no counties in which the herd declined were the Kujawsko-Pomorskie and Wielkopolskie provinces, except that in the former, in most counties the increase in the herd did not exceed 20%, while in the latter, in 19 out of 31 counties the increase in the herd exceeded 40%, and the lowest was in Kępiński, where the cattl herd increased by 18.1%. One of the main reasons for the development of fattening of fattening pigs in these provinces is the replacement of pig production with beef livestock production in modernized pigsties or other general-purpose buildings. In the case of Podlaskie and the northern part of Mazowieckie, the development of this production has more to do with the high importance of milk production.

In the case of cows, there is basically only one region particularly specialized in milk production, and it is located in the northern and western parts of Podlaskie Province, along with four counties in the northeastern part of Mazowieckie Province (Figure 4).

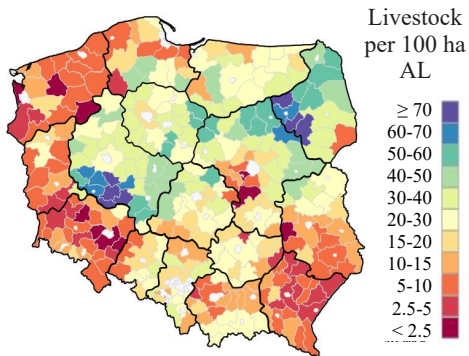


Figure 2. Cattle stocking rate (excluding cows) in counties in Poland in 2020

Source: own calculations based on BDL data

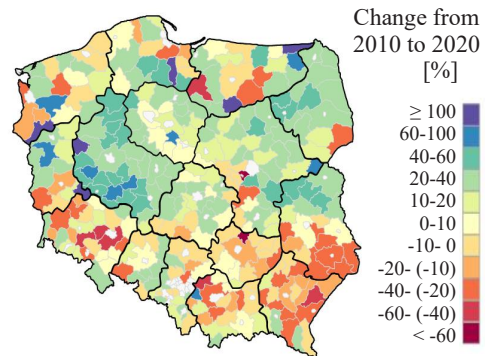


Figure 3. Changes in cattle population (without cows) in counties in Poland from 2010 to 2020

Source: own calculations based on BDL data

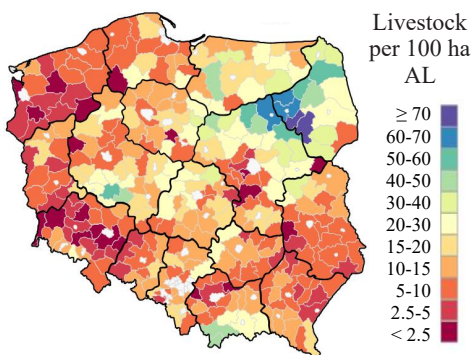


Figure 4. Cows stocking rate in counties in Poland in 2020

Source: own calculations based on BDL data

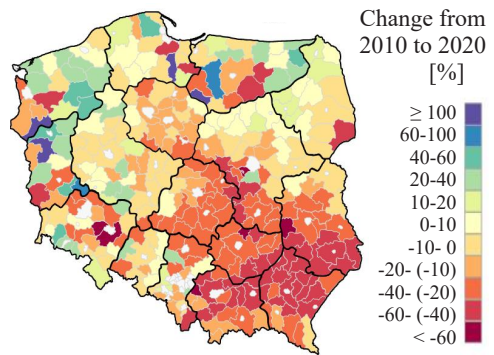


Figure 5. Changes in cows population in counties in Poland from 2010 to 2020

Source: own calculations based on BDL data

Around this area and in the southwestern part of the Wielkopolskie Province, areas with fairly intensive milk production with a stocking rate of 20-40 cows per 100 ha AL can be delineated, as well as with 4 counties where the stocking rate exceeded 40 cows. In addition to these areas, in 2020 there were only 2 more counties with stocking rates exceeding 40 cows per 100 ha AL in the Małopolska province, except that in this case, due to the small acreage of AL, the number of animals in nominal terms is not significant in comparison with other counties in Poland, and this is related to the dominance of mountain and foothill agriculture, in which the processes of deagrarianization and deproductivization of AL are

far advanced [Sroka 2019]. This is due, among other things, to the high fragmentation of agriculture in southern Poland and the absence or low profitability of agricultural production on such farms. Counties with cow stocking rates lower than the national average (16.7 cows per 100 ha AL) are mainly located in southern and western Poland, with 53 counties having stocking rates below 5.0 cows, 20 of which were below 2.5 cows, and were most often located in Dolnośląskie, Zachodniopomorskie and to the east and south of Warsaw. Counties with such low stocking rates were absent only in Podlaskie, Łódzkie and Warmińsko-Mazurskie, and one each in Kujawsko-Pomorskie and Wielkopolskie. There is thus an analogy with the distribution of cattle, as milk production is also mainly carried out in a belt from Podlaskie to Wielkopolskie provinces.

Changes in the cow population (Figure 5) indicate that the process of depopulation of the cattle population between 2010 and 2020 occurred primarily in the southwestern part of Poland, where the population decreased 20-60% in most of them. A particularly strong depopulation process (especially when comparing to farther-flung counties) occurred around Wrocław and, to a lesser extent, Szczecin. The increase in the cow population occurred mainly in northern and western Poland, except that in the case of the western provinces it occurred mainly in counties with low stocking rates. For example, in Sulęcín and Myśliborski counties, where cow stocking increased by more than 100% between 2010 and 2020, cow stocking density in 2020 was only 15.5 and 4.7 cows per 100 ha AL, respectively. In other counties from the region, despite dozens of percent increases in stocking density, stocking density in most of them did not exceed 10 cows. On a positive note, however, the increase in stocking rates occurred mainly in herds of more than 50 cows, i.e. in development herds. An increase in stocking rates of no more than 20% also occurred in the area that is the center of dairy production in Poland. On the one hand, this is a positive development, as it reinforces the importance of this region in national milk production, but on the other hand, as cattle stocking rates are also increasing, the environmental risks associated with the use of manure and slurry are increasing.

The importance of counties with the highest cattle population and stocking rates in the national cattle and cow population is also increasing (Figure 6). Between 2010 and 2020, for cattle, the share of the 20 and 30 percent of counties with the highest population and stocking rates increased by 2.2-3.8 p.p., while for cows it was 3.7-5.0 p.p. There was a higher level of concentration for cows (by 3.1-6.6 p.p.), which may be due to the presence of one prominent dairy region and a much larger number of counties with lower than average cow stocking rates than for cattle. Particular attention should be paid to the 27 counties that were both in the counties with the highest cattle and cow densities using 20% of AL. As many as 10 of them are located in the Mazowieckie Province, mainly in its northeastern part, 7 in the Podlaskie Province, mainly from its western part, and 4 in the southwestern part of the Wielkopolskie Province. In the Mazowieckie and Podlaskie

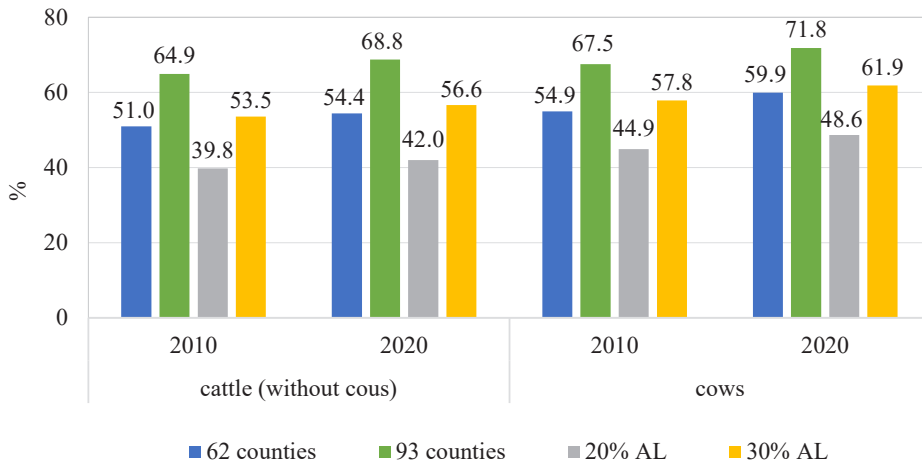


Figure 6. Share of the 62 and 93 counties with the highest cattle (without cows) and cows density and the counties with the highest cattle (without cows) and cows density using 20% of AL and 30% of AL in Poland in 2010 and 2020

Source: own calculations based on BDL data

provinces, the development of production, especially dairy production, is favored by a large share of rationally used meadows and pastures [Bórawski, Zalewski 2018], which provide fodder with a low cost per feed unit [Olszewska 2015]. In the Wielkopolska Province, corn silage is more important, providing high yields of green matter. Farmers in regions with high stocking rates benefit from a faster flow of know-how, an extensive service sector, suppliers, a large number of buyers, including the leaders of the dairy industry in Poland, thus improving their competitive position *vis-à-vis* other regions of the country. However, there are often problems with access to feed, especially in crop failure years, as in some regions the AL reserves that can be used for feed are small. The heavy reliance of cattle on roughage, especially silage and haylage, which are economically sensitive to transport and have a short feeding time after being taken from the heap, means that opportunities for transport from longer distances are severely limited. A crop failure then leads to a disproportionate increase in the price of these feeds. Similar problems apply to straw used mainly as bedding and to a lesser extent as fodder. Too high a concentration can also generate environmental problems. Ornithological studies carried out in the southwestern part of the Wielkopolskie Province, which has the highest concentration of livestock production in Poland, indicate that with good agricultural practices, the state of the environment can be high, as indicated by the stable biodiversity of the area [Kupczyk 2017]. However, the increasing use of organic fertilizers along with an increase in the use

of mineral fertilizers to obtain more fodder can lead to nitrate and phosphate pollution of groundwater. If water pollution occurs, then, as in the case of Germany (which has the most nitrate-polluted groundwater in the EU), a top-down livestock restriction may be imposed [Pepliński 2022].

The level of stocking rates in each county did not have a significant impact on the changes in stocking rates between 2010 and 2020 for both non-cow and cow cattle, as evidenced by the very low coefficients of determination (Figures 7 and 8). For counties with the highest stocking rates, a similar level of population change can be observed.

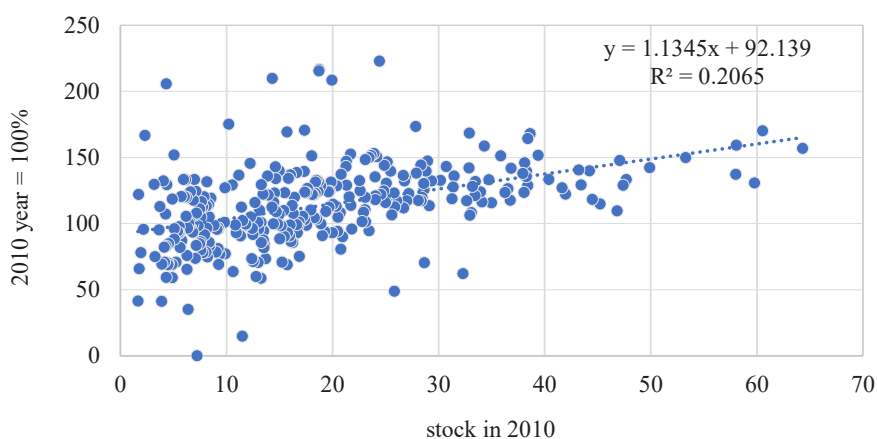


Figure 7. Cattle population (without cows) in 2010 and its change from 2010 to 2020

Source: own calculations based on BDL data

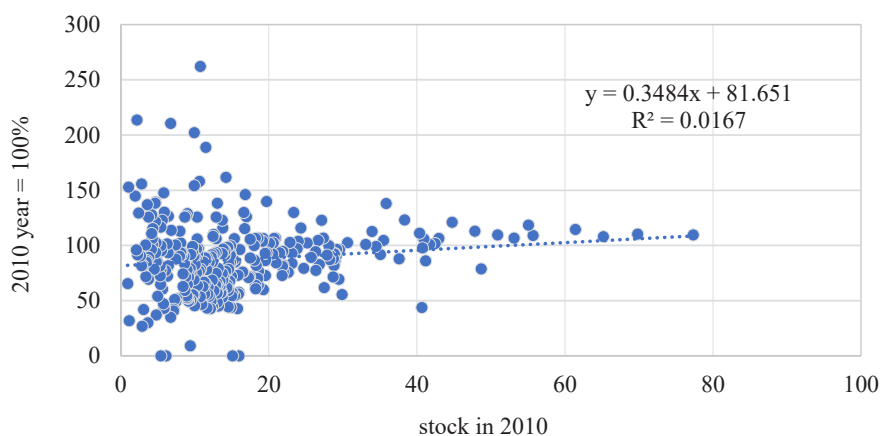


Figure 8. Cows population in 2010 and its change from 2010 to 2020

Source: own calculations based on BDL data

Table 2. Changes in cattle (excluding cows) and cow population in 2020 relative to 2010 in counties in Poland ranked from the highest level of cattle (excluding cows) and cow population in 2010

No. of district	Cattle (without cows) [pcs]			Cows [pcs]		
	2010	2020	2010 = 100%	2010	2020	2010 = 100%
Poland	3,087,946	3,825,666	123.9	2,645,932	2,455,730	92.8
1-31	867,729	1,193,706	137.6	896,859	930,882	103.8
32-62	586,974	741,140	126.3	483,258	449,669	93.0
63-93	441,489	560,432	126.9	307,005	274,225	89.3
94-125	285,445	338,082	118.4	229,229	180,744	78.8
126-156	285,107	350,269	122.9	190,162	153,293	80.6
157-188	229,670	254,400	110.8	181,618	146,096	80.4
189-219	135,693	130,236	96.0	133,780	125,608	93.9
220-251	126,884	129,473	102.0	116,840	94,398	80.8
252-282	82,375	83,546	101.4	66,692	60,549	90.8
283-314	46,580	44,382	95.3	40,489	40,266	99.4

Source: own calculations based on BDL data

In the case of counties with lower or similar stocking rates to the national average, there were counties in which the stocking rate increased by more than 100%, but at the same time there were counties in which it decreased by more than 50%, or even liquidated completely, or, more likely, the number of farms was so small that it did not allow for statistical secrecy.

A somewhat clearer picture is provided by an analysis of livestock population changes in sets of 10% counties ranked by stocking rate in 2010 (Table 2). In the case of cattle without cows, it can be seen that the stocking rate of these animals increased the most in the counties with the highest stocking rates, and for the three groups of counties with the highest stocking rates, it increased by more than 26%, while for the four groups of counties with the lowest stocking rates, the increase in stocking rates was minimal, or there was a decrease in stocking rates. In the case of cows, only the first 31 counties recorded an increase in herds, but the largest decrease in cow numbers was in counties with average herds in 2010. What may be surprising is the stabilization of herds in the 31 counties with the lowest herds. In conclusion, this analysis confirms the progressive process of spatial concentration of cattle and cow herds in Poland.

CONCLUSIONS

The analysis made it possible to formulate the following conclusions:

1. The processes of spatial concentration at the provincial and district level occurred during the studied period, with the former being faster for cattle without cows, while at the district level for cows.
2. The cattle population is concentrated in a wide belt from Podlaskie to Wielkopolskie province, while in the case of cows there is one region with very high stocking rates located on the border of Podlaskie and Mazowieckie provinces and with medium-high stocking rates around this region and in southwestern Wielkopolskie Province.
3. Mainly the provinces of southeastern Poland, where the growth of cattle population without cows is much lower than the national average, and the depopulation of cow population is more than twice as high as the average in Poland, are losing importance.
4. As many as 27 counties were among the counties characterized by the highest populations of both cattle without cows and cows and using 20% of AL.
5. There was no statistically significant correlation between the size of cattle without cows and cows and changes in the size of the population in 2010-2020.
6. The progressive process of spatial concentration should be viewed positively, as it will foster the emergence of cluster structures that will contribute to improving the competitiveness of Polish dairying, thanks to, among other things, faster spread of know-how, better access to services, etc. However, this will require greater commitment to fulfilling the principles of good agricultural practice and concern for the environment. This is particularly true in the area of southwestern Wielkopolskie province, which has a particularly high density of cattle, cows, pigs and poultry.

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REGIONALNE ZMIANY POGŁOWIA BYDŁA I KRÓW W POLSCE
W LATACH 2010-2023

Słowa kluczowe: bydło, krowy, obsada, pogłowie, powiaty, koncentracja, dywergencja

ABSTRAKT. Celem badań była ocena regionalnych zmian pogłowia bydła (bez krów) i krów. Przeprowadzono badania na poziomie wojewódzkim dla okresu 2010-2023 i na poziomie powiatowym na podstawie danych spisów rolnych za lata 2010 i 2020. Z badań wynika, że procesy przestrzennej koncentracji pogłowia w Polsce zachodzą szybciej w przypadku krów. Były one także bardziej zaawansowane w 62 i 93 powiatach o najwyższym pogłowie i powiatach o najwyższej obsadzie bydła bez krów i krów, użytkujących 20 i 30% użytków rolnych w Polsce. Nie wykazano natomiast zależności poziomu obsady bydła bez krów i krów w 2010 roku w poszczególnych powiatach ze zmianami pogłowia do 2020 roku. Stwierdzono, że w przypadku obu badanych grup zwierząt pogłowie jest zlokalizowane głównie w pasie od Podlasia do Wielkopolski. Najszybciej proces depopulacji następuje w południowo-wschodniej Polsce.

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