

THE INFLUENCE OF LAND CONSOLIDATION WORKS ON THE EFFICIENCY OF THE PRODUCTION PROCESS

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Abstract. The study will present studies involving the assessment of changes in shape of plots caused by carrying out land consolidation in Koźlice in Dolnośląskie Voivodeship. The research material includes all the land in the studied village. The source of data for the assessment will be the digital registry map in the state before and after the land consolidation. During the processing of the output data and determination of the necessary technical parameters for the tested surface elements, informatics and statistical tools will be implemented. The basic element of research, allowing the comparison of the land consolidation process efficiency will be registry plots and their continuous parts, under one form of use (arable land). The detailed research will concern the assessment of the shape of arable plots and their distribution in the village area. For each of them the shape index in the form of the cost of cultivation depending on their layout will be specified. The obtained result of the research will allow the determination, the extent to which the land consolidation carried out in the village Koźlice improved the conditions of agricultural production space.

Key words: layout of land, spatial structure of land, land consolidation

INTRODUCTION

Socio-economic transformations in rural areas are closely related to the function of the specified area [Magel 2015] and to the organization of the production process there. The current state of the spatial structure of farm land in Poland indicates the high diversity both in terms of the size of farms and the number and area of belonging to them registry plots [Sobolewska-Mikulska 2004, Woch 2001, 2010]. Among many factors, which had a direct influence on the current state of agricultural land, it seems that the most important may include the following: the first – associated with both the settlement and the the policy of the occupying countries on Polish territory; the second - related to inheritance and so-called fair sharing – causing land fragmentation [Żak 2006, Miraj 2010].

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As it turns out from numerous studies [Hopfer 1991, Harasimowicz 2002, Mielewczyk 2016] spatial configuration of land belonging to the farms is essential for their profitability. Unfavorable shape and distribution of land at the farm can lower production income even of 30% [Hopfer 1991].

The need for changes in the scope of the territory of farm shaping is now confirmed in the specified objectives of agricultural policy included in the Rural Areas Development Programme (PROW) for 2014–2020 [Pijanowski 2014]. It follows from the information contained in it that the taken measures are aimed to improve the conditions for development of rural areas and to increase the profitability of existing farms. The process of consolidation is one of the main tools enabling the improvement of unfavorable state of agricultural land [Sobolewska-Mikulska 2004]. It is the reconstruction of the faulty land arrangements carried out in a comprehensive manner [Noga 2001] enables the creation of more convenient conditions for the agricultural land management, increasing the efficiency of production.

Determination of the size of the economic changes caused by the correction of the shape of the borders of plots and farms requires measurable approach to geometrical indexes and the knowledge of the influence of individual components of the farm layout on the production process and its effects. Existing restrictions in the form of improper distribution and configuration of plots have negative influence on the production process, making it not fully effective.

Currently, there are many methods and tools enabling performance of assessment of farm land state. From classic – does not fully capturing the real state of the examined area, to the fully automated informatics methods using satellite imageries [Piech 2009, Jankowicz 2015, Bacior 2016, Różycka-Czas et al. 2016, Kwinta and Gniadek 2017] – taking into account all plots and farms existing in the village. Unfortunately, most of the results obtained in the range of the used methods mainly concern the borders of the registry plots which may include different land uses, also those which are separate cultivated fields. Correct assessment of the shape of the borders of the territory of the farm should therefore refer precisely to these surface elements (cultivated fields), which borders do not always coincide with the borders of the registry plots.

THE OBJECTIVE, SCOPE AND METHOD OF ELABORATION

The objective of the elaboration is the evaluation of the effectiveness of the agricultural land consolidation process in terms of changing the size and shape of plots in the village Koźlice – Polkowice District, Dolnosląskie Voivodeship. The primary source of data is a digital registry map and a tool enabling the necessary calculations – „Program for evaluation of the agricultural land layout”, which enables the determination of all necessary parameters of spatial shaping of plots such as: area, length, width, elongation, number and length of the turning belts and the distance from the center of the village. The overall assessment of the shaping of the surveyed plots will be carried out using the so-called layout cost, that is, the sum of the cost of cultivation and production losses, dependent on their spatial configuration. These costs will be estimated assuming a yield of more than $5 \text{ t} \cdot \text{ha}^{-1}$ and with full mechanization of field work. The studies will be

conducted in two stages. In the first, the primary objects of study will be registry plots. In the second, analysis will focus on the continuous parts of plots under one form of use (arable parcels equivalent to cultivated fields), which in the elaboration will be briefly described as plots. The parameters obtained in the course of the calculation will be subject to a statistical study, which consequently it possible to tell the extent to which land consolidation resulted in the improvement of conditions for agricultural production area.

CHARACTERISTICS OF THE LAND USE STRUCTURE

Koźlice village is a part of the Gaworzyce commune located in the northern part of dolnośląskie voivodship. This is a typically agricultural location, which has buildings in the central part of the village (Fig. 1). As shown in Table 1, the cultivated land occupies a total area of 474.25 hectares, which corresponds to approximately 78% of the village.

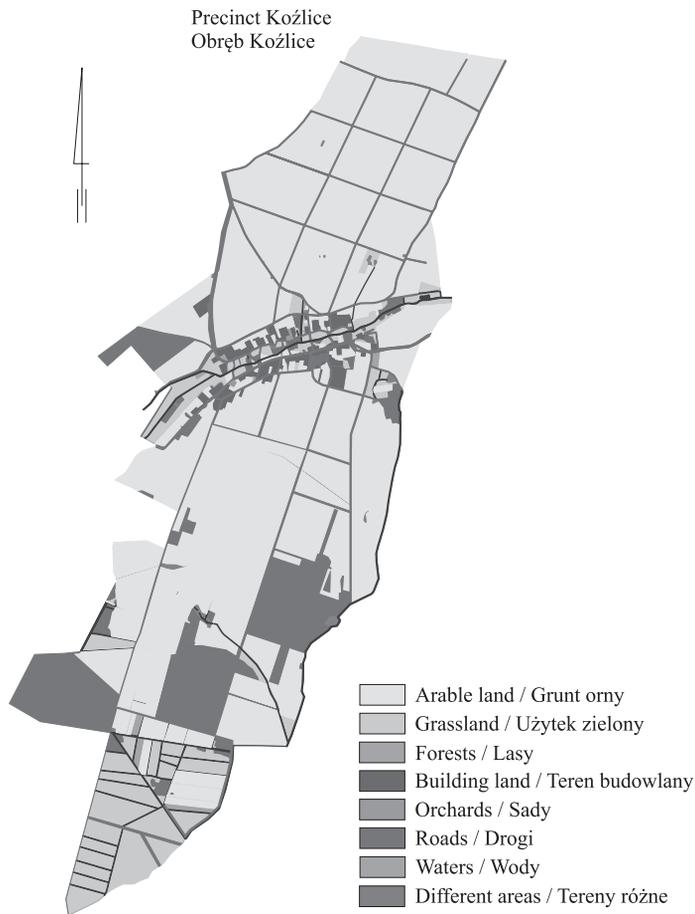


Fig. 1. Map of the land use in village Koźlice

Rys. 1. Mapa użytkowania wsi Koźlice

Percentage of individual land use is highly diversified. Approximately 411 hectares of village occupies the arable land mainly in the northern and central parts. Permanent grasslands occupy only about 62 hectares and they are located mainly in the south of the object and occasionally in the vicinity of buildings. A significant part of the total area (about 13%) is covered by forests and wooded areas. They occur mostly in a few dense areas in the vicinity of grasslands and some buildings. In the analyzed area of the village there is a network of rivers and drainage ditches. Flowing waters cut built-up areas and the network of drainage ditches occurs in the area of grassland. Less than 0.3% of the area of the village are wastelands, and the smallest percentage of the area are orchards and various land for which the percentages are respectively 0.02 and 0.01%. The remaining part of the village occupy roads (about 24 hectares), network of which creates regular road complexes. The existing system of agricultural transport network on one hand provides easy access to registry plots; on the other hand it may constitute a barrier for the design of new and better borders system.

Table 1. The structure of land use in the village Koźlice
Tabela 1. Struktura użytkowania gruntów we wsi Koźlice

Land use Użytek	Area Powierzchnia ha	Percentage Udział %
Arable land – Grunt orny	411.58	68.14
Grassland – Użytek zielony	62.67	10.38
Building land – Teren budowlany	13.41	2.22
Orchard – Sad	0.13	0.02
Forest – Las	61.85	10.24
Wooded area – Teren zadrzewiony	19.23	3.18
Roads – Drogi	24.36	4.03
Wasteland – Nieużutek	1.76	0.29
Water – Woda	8.93	1.48
Different areas – Tereny różne	0.09	0.01
Total – Razem	604.01	100.00

CHANGES IN THE AREA STRUCTURE OF THE REGISTRY PLOTS

To complete the assessment of registry plots before and after the land consolidation in the studied village the registry maps of land and buildings in the state before and after the land consolidation were used (Fig. 2). Each map has undergone a topological check by the computer program „MK” [Siejka M. et al. 2014], which made it possible to obtain the necessary output data. The information obtained was subject to detailed examination covering all the registry plots existing in the village Koźlice – plots included in the process of consolidation and those that were excluded from the area of elaboration. For the better illustration of the obtained results, fixed class intervals grouping plots of

specific areas were introduced. The obtained result showing the state before and after the land consolidation for registry plots is presented in the Table 2.

The carried out land consolidation has reduced the number of the registry plots in the new state of 207. This led to the setting of larger areas for a smaller number of registry plots in the new ground layout. The decrease in the number of plots is observed from 1 to 7 class intervals. In these intervals (from 0 to 1,99 hectares) the largest decrease in the number of plots is observed in 1, 5, 6 and 7 area intervals (a reduction of about 30 to 50%). Intervals 2, 3 and 4 have a slightly smaller decline of number in the range of 20 to 30%. Analyzing further intervals of area with a specific number of registry plots a change due to the increase number of plots in subsequent intervals of areas can be noticed and creation of new plots in areas that were missing in the old state. The largest numerical increase (9 parcels) was found in interval 8 containing plots of 2 to 2.99 hectares. A significant increase in the number of plots in the intervals of the larger areas also applies to intervals 9, 10, 14 and 16 for which an increase in the number consecutively is 6, 4, 2 and 2.

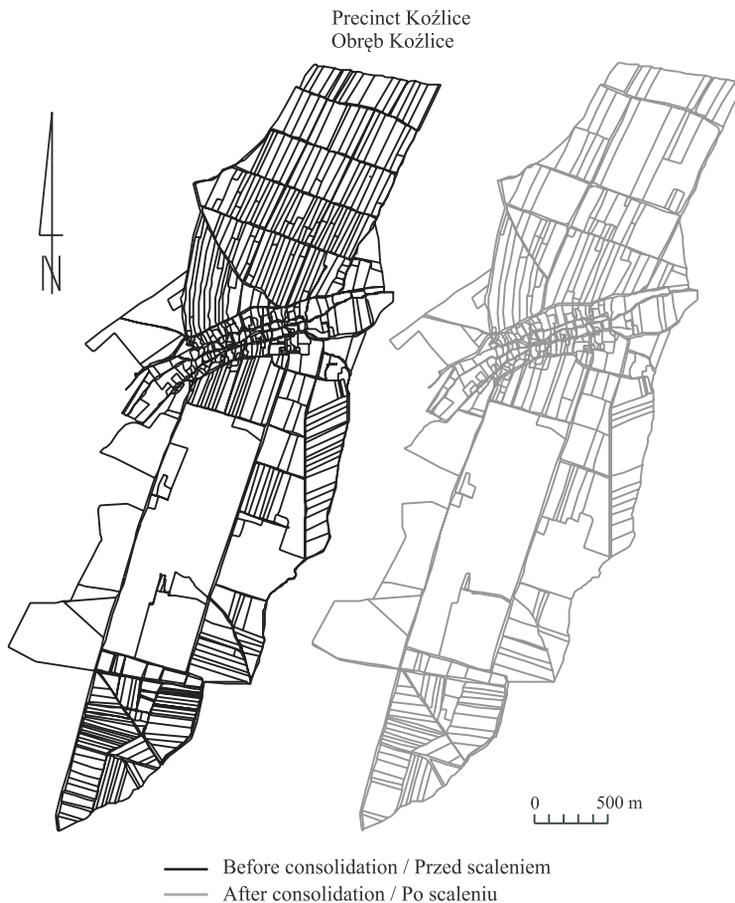


Fig. 2. The system of plots borders before and after the consolidation in the village Koźlice
Rys. 2. Układ granic działek przed i po scaleniu we wsi Koźlice

Table 2. The number and size of plots in the state before and after the land consolidation in the village Koźlice
 Tabela 2. Liczebność i powierzchnia działek ewidencyjnych w stanie przed i po scaleniu gruntów we wsi Koźlice

No. Lp.	Intervals of plots areas Przedziały powierzchni działek ha	Registry plots – Działki ewidencyjne							
		before land consolidation – przed scaleniem			after land consolidation – po scaleniu				
		quantity liczebność	total area powierzchnia łącznie ha	percentage udział %	average średnia ha	quantity liczebność	total area powierzchnia łącznie ha	percentage udział %	average średnia ha
1	> 0,09	122	6.71	1.11	0.05	72	4.09	0.68	0.06
2	0,10÷0,19	82	11.57	1.92	0.14	52	7.40	1.22	0.14
3	0,20÷0,29	68	17.32	2.87	0.25	53	13.04	2.16	0.25
4	0,30÷0,49	69	27.32	4.52	0.39	46	18.15	3.00	0.39
5	0,50÷0,74	78	47.88	7.93	0.61	42	26.52	4.39	0.63
6	0,75÷0,99	60	53.10	8.79	0.88	26	22.69	3.76	0.87
7	1÷1,99	138	187.55	31.05	1.36	93	131.02	21.69	1.41
8	2÷2,99	24	57.22	9.47	2.38	33	80.53	13.33	2.44
9	3÷3,99	3	9.81	1.62	3.27	9	29.42	4.87	3.27
10	4÷4,99	2	8.50	1.41	4.25	6	25.45	4.21	4.24
11	5÷5,99	–	–	–	–	–	–	–	–
12	6÷6,99	–	–	–	–	2	12.83	2.12	6.41
13	7÷7,99	2	14.67	2.43	7.33	3	22.36	3.70	7.45
14	8÷8,99	1	8.70	1.44	8.69	3	25.47	4.22	8.49
15	9÷9,99	–	–	–	–	–	–	–	–
16	10÷14,99	2	25.92	4.29	12.96	4	50.97	8.44	12.74
17	15÷19,99	3	56.04	9.28	18.68	3	56.43	9.34	18.81
18	20 <	1	71.68	11.87	71.68	1	77.65	12.86	77.65
Total – Razem		655	604.01	100.00	–	448	604.01	100.00	–

Comparing the total area of plots for established groups in individual area intervals (tab. 2) it can be stated, that like previously from 1 to 7 interval of registry plots seizes, a gradual decrease is observed in the total area of plots of about 0.4 to 9.4% of the area. This confirms the observed reduction in smaller plots because of separating large compact areas. As can be seen the total area of plots in the analyzed intervals in size from 8 to 16 changes and there is an increase of the total area of registry plots after the land consolidation, which oscillates between 1.3 and 4.1% of the plots area. Liquidation of smaller plots to increase new registry plots, is an action consistent with the overall objectives of the process of land consolidation, which allows the separation of the new surface elements, larger and more favorable formed.

According to the research, the land consolidation carried out contributed to a significant reduction in the number of plots in the new state. Their number has been reduced from 666 to 458, which is a significant result, proving the proper carrying out changes in the land layout in the studied village. One can only wonder, whether the result of reducing the number of plots could be further improved and to what extent the changes of shapes of plots borders have affected the efficiency of agricultural production. To find the answer to the first question should be applied one of the two informatics solutions Janus [2011] or Gniadek [2014], enabling the automatic elaboration of other variants of the new land layout and taking into account minimization of distances to land from habitats. The answer to the second question will be obtained in further part of the study, after discussing the results of detailed studies of spatial parameters of configuration of the continuous part of the plots covered by one form of use.

EVALUATION OF SPATIAL SHAPING PARAMETERS OF ARABLE PLOTS

Detailed studies of the technical parameters of surface elements in which is carried out a distinct cultivation, were performed for the continuous parts of the plots covered by one form of use (the so-called. arable plots), which will be arbitrarily called later in the study as „plots”. To obtain the necessary data another program was used – „MKTopo-GUTR” [Zygmunt 2002]. The support system for the assessment of the land layout (SWORG) enabled processing of obtained information and determination of the size of the necessary parameters of spatial shaping of plots, including cultivation cost index, dependent on the land layout. Elaboration of the results was performed using Statistica software.

The use of mentioned methodology allowed generation of full information about all continuous parts of the plots under one form of use for the state before and after land consolidation. All parcels that have areas smaller than 0.3 hectare were eliminated from the study. Other parcels were covered with detailed studies on the evaluation of the features of their layout, including synthetic index of the correctness of their shape in the form of the cost of cultivation dependent on the layout.

Elaborated research results in terms of changes in the parameters of spatial shape of plots were presented in the form of distributions of the quantity, which clearly reflect the changes which have occurred in relation to the state before and after the land consolidation. On this basis it can be concluded, the extent to which the process of land consolidation has contributed to changes in the areas of plots and shape of their borders.

The number of plots in relation to their area before and after the consolidation of land is shown in Figure 3. The largest groups are the plots between 1 and 2 hectares. Their quantity after the land consolidation is reduced about 50% from 117 to 59 plots. The size of the percentage of area in a state before and after land consolidation has been reduced only by 7%. Preservation of the similar percentage of the area of land in old and new state was probably dictated by the fact, that areas of plots between 1 and 2 hectares are considered sufficient for the use of the full mechanization of field works. Significant reduction in the quantity of plots has also appeared in the range of area from 0.5 to 1 hectare. Reduction in the number of these plots is associated with a reduction in the total area they occupy in the range of about 50%. This demonstrates that the land consolidation works eliminate the plots of land with adverse areas. A different situation occurs in the first range of from 0.3 to 0.5 hectares. Despite the reduction in the number of plots in the new state there was a slight increase in the percentage of their participation in the group. This is probably dictated by the need of the owners to have the land close to their buildings. Such condition can often effectively prevent the liquidation of the plots of small areas, limiting the actions of designers to changing their location in the vicinity of buildings. The increase in both the percentage and numerical share of plots can be observed in larger intervals exceeding 2 hectares, which should be considered positive. From the discussed figure results, the new plots created in these areas slightly increase their numbers, but the area occupied by them is significantly increased.

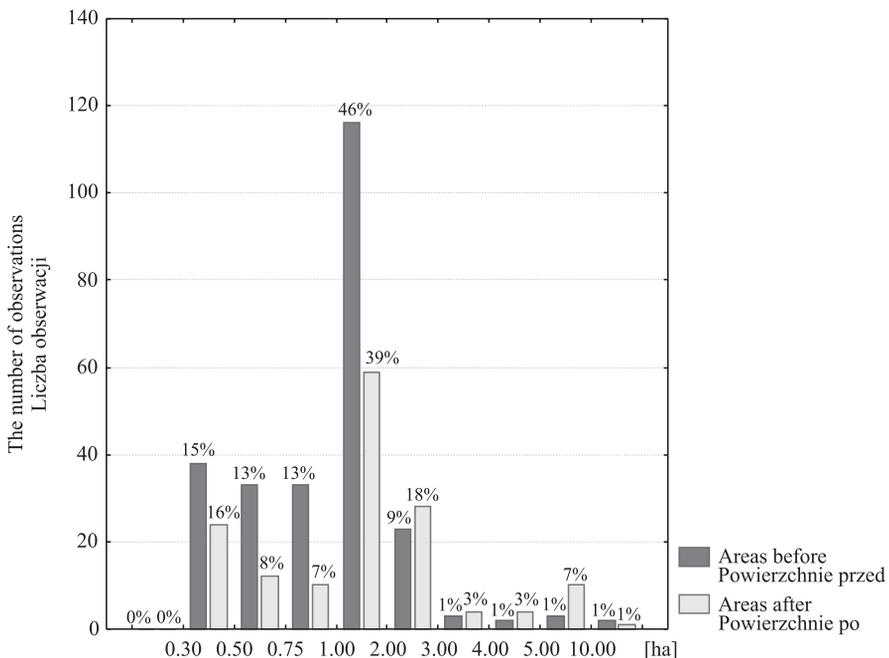


Fig. 3. The numbers of plots according to their area before and after the land consolidation
Rys. 3. Liczebność działek względem ich powierzchni przed i po scaleniu gruntów

The lengths of studied plots in relation to their quantity presents Figure 4. From the shown distribution results that most of the plots have the correct length greater than the minimal one considered to be correct – equal from 100 to 150 m. The analysis of the lengths of plots in the state before and after the consolidation of land shows that the quantity of plots with lengths from 50 to 100 m decreased, what should be regarded as positive. In the general statement plots with lengths not exceeding 100 m have the same percentage in both states – before and after consolidation. Presumably these are the plots of small areas, which as previously mentioned were separated at the request of the consolidation participants. Lots which have optimal length between 100 and 400 m in new state are characterized by smaller quantity and in most cases by the decrease of the percentage of quantity in relation to the state before consolidation. Other parcels with lengths over 400 m are subject to slight, one percent changes in the quantity.

Small changes in the length of plots may be due to the unchanged borders of the design complexes, apart from a few cases (connection of four design complexes in one in the northern part), within the limits of which the plots were separated with the same direction of cultivation, which existed in the state before the consolidation. The adopted variant did not adversely affect the correctness of the shape of new plots, but limited only the separation of longer plots.

Another important parameter influencing the efficiency of production is the width of the plot. According to Harasimowicz [2002] it can be assumed that the minimum value for this parameter for the plots intended for mechanical cultivation should not be less than 30 to 50 m. Presented quantity distribution in relation to this feature (Fig. 5) proves that in

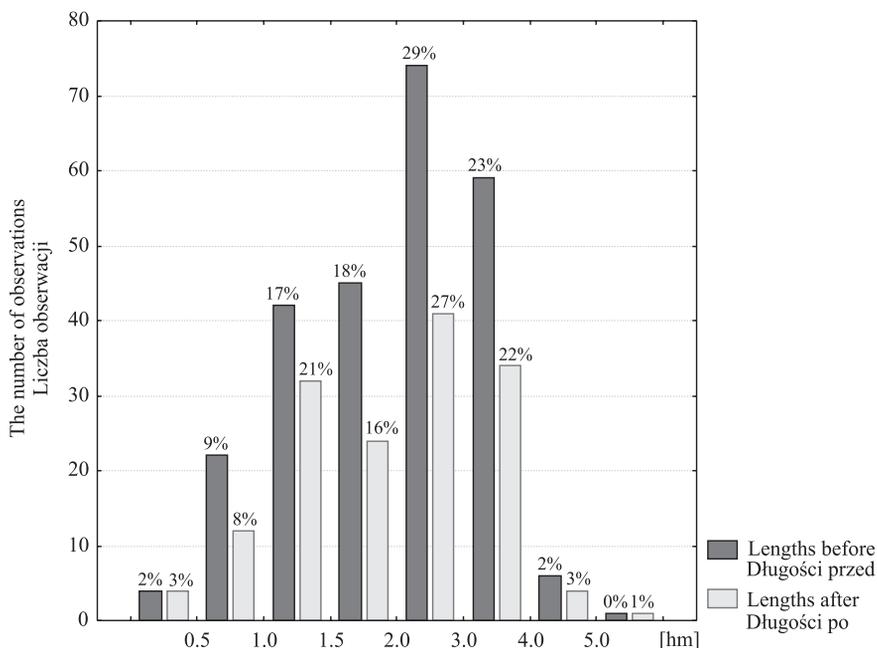


Fig. 4. The lengths of plots according to their quantity before and after consolidation of land
Rys. 4. Liczebność działek względem ich długości przed i po scaleniu gruntów

the interval of up to 30 m there was a significant reduction in the number of plots. In the old state the most of plots existed in the range of minimum, correct widths of 30 to 50 m. After the consolidation their number decreased by more than 60%, and the percentage of these plots in the whole population is 26%. For other parcels of larger widths less variation of quantity are observed in the individual intervals between the old and the new state. However, the occurrence of wider plots (greater than 50 m) in the state after the consolidation is significant and increasing from 4% in the range of 250 to 500 m to 10% for parcels with the widths of 100 to 250 m. The increase in both the percentage and quantity of wider plots can be explained by the fact that separation of plots with larger areas in the complexes of limited size can be achieved only by increasing the width of separated surface elements.

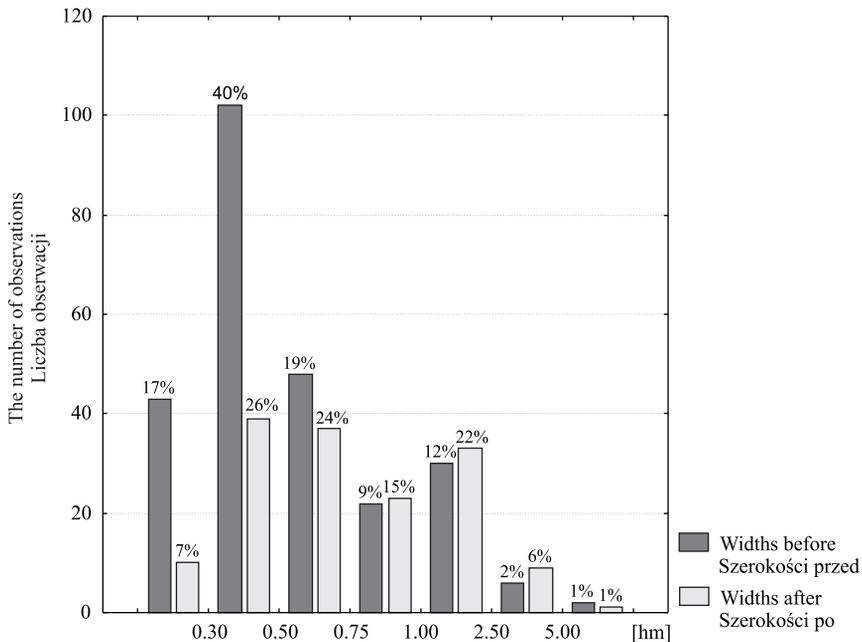


Fig. 5. Widths of plots according to their quantity before and after consolidation of land
Rys. 5. Liczebność działek względem ich szerokości przed i po scaleniu gruntów

As the last parameter of spatial shaping, the elongation coefficient of plots will be discussed. According to the obtained results, elongation of plots in the analyzed area falls within the range from 1 : 2 to 1 : 20 (Fig. 6). The first two intervals of elongation from 1 : 2 to 1 : 4 are characterized by a slight decrease in the number of plots in the state before and after consolidation, however, in these intervals a clear increase (approximately 10%) in the percentage of these of plots in the state after land consolidation is recorded. A different situation applies to the longer plots from the range greater than 1 : 4. The decrease in the number of these plots in relation to the old state is from about 62% to nearly 80%. It can be assumed that this condition is caused by the limitation resulting from the shape of the design complexes whereby the separation of plots with larger areas is done by increasing the widths of projected plots.

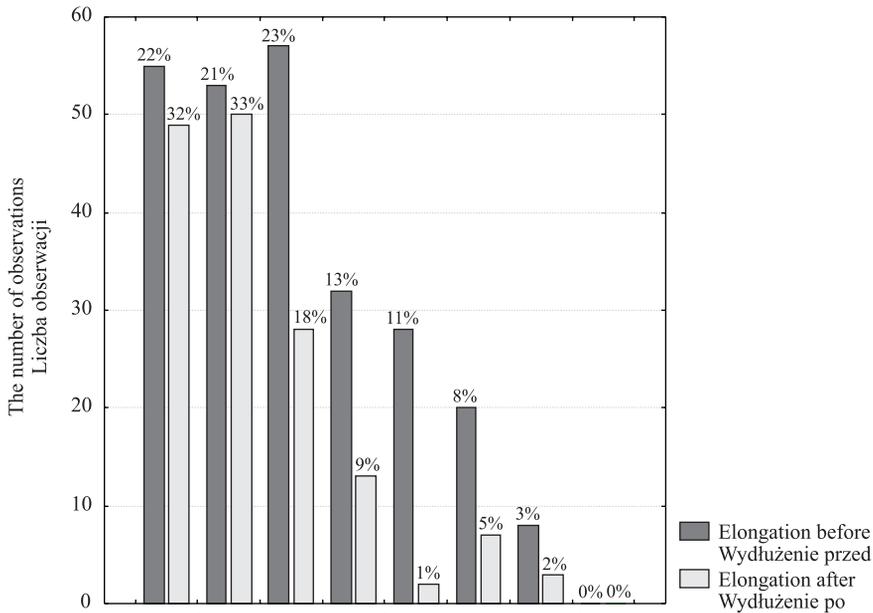


Fig. 6. Elongation of plots according to their quantity before and after consolidation of land
 Rys. 6. Wydłużenie działek względem ich liczebności przed i po scaleniu gruntów

ARRANGEMENT OF PLOTS IN THE VILLAGE

Due to the compact settlement in the studied village, located in the central part of the object (Fig. 1) in the elaboration the indicator of distance between the plots belonging to the individual farms and their settlements was abandoned. This value was replaced by the distance between the center of the village and the nearest corner the plot.

According to research of Dębowska and Lachert [1974a, 1974b], correct distribution of land in relation to the settlement should not exceed 500 m. A different opinion presents Przybyłowski [1989] stating that the correct distance should not exceed 1500 m. The shown in Figure 7 distribution of the quantity of plots in relation to their distance to the center of village proves that with increasing distance of plots from the center of village to 1000 m there is a gradual increase in the number plots. Further increasing the distance of parcels from the village center causes a decrease of this feature. Comparing the number of parcels between the old and the new state obtained in the result of the land consolidation it can be stated that the distribution of plots of land in both cases is very similar. The apparent difference relates only to limitation of the number of parcels in the state after land consolidation although the percentages of population before and after consolidation differ in individual class intervals. The small difference in the percentage increase is present in the range of 250 to 500 m and the decrease is observed in the range of above 2000 m.

The obtained result of research proves that the parcels with less preferred configuration, are located at closer distances from the center of the village, than those with

superior technical and space parameters. As has already been mentioned, this condition is probably caused by a desire of ownership of land by every inhabitant of village as close as possible to his buildings. This pattern can be seen in both cases both in the old and the new land system and the only difference is the degree of compaction of plots in the village.

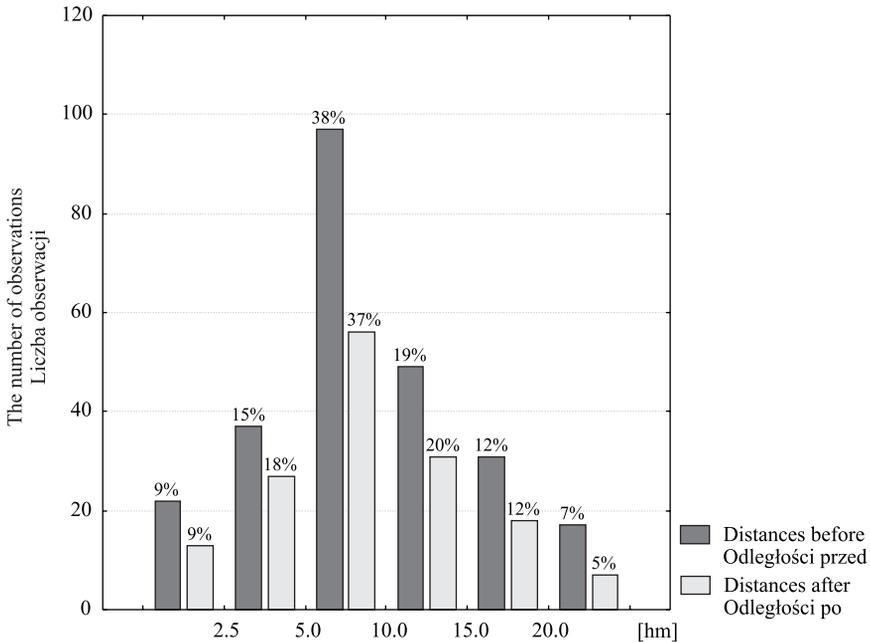


Fig. 7. The number of plots according to their distance from the center of the village before and after consolidation of land

Rys. 7. Liczebność działek względem ich odległości od centrum wsi przed i po scaleniu gruntów

CULTIVATION COSTS DEPENDENT ON THE SPATIAL SHAPES OF PLOTS

The full assessment of the agricultural production conditions, in terms of plots shapes, can be done on the basis of so-called cost of cultivation index, which takes into account all costs and production losses associated with the cultivation, dependent on the spatial configuration of the plot [Harasimowicz 2002]. According to the results of the study, this index for the plots of the optimal surface and the correct shape should not exceed 4 cereal units / 1 hectare.

Figure 8 presents the amount of incurred costs for the arable plots before and after the land consolidation in the village. The obtained values of this index reach up to 20 cereal units / 1 hectare. It should be remembered, that by their determination the losses associated with transport were not taken into account, which may result in an additional increase in the incurred costs. The obtained result refers only to the configuration of plots and the difference of its value between the state before and after the land consolidation, makes

possible determine changes in the efficiency of the production process for the studied land in the terms mentioned above.

In the range of size for the cost of 4 cereal units / 1 hectare, a slight decrease in the percentage with respect to these two states can be observed. This is somewhat surprising despite the positive assessment of changes in configuration parameters for newly separated plots. In the state before the land consolidation, there were 58% of them and after the land consolidation there is 48%. In the interval from 4 to 6 cereal units / 1 hectare a slight increase in the percentage of land in the new state is observed. The intervals from 6 to 8 cereal units / 1 hectare and beyond 15 cereal units / 1 hectare are characterized by the same percentage of plots in both the old and new state. Only the interval from 8 to 10 cereal units / 1 hectare shows an increase in the number of plots in the new state by 5% compared to the old borders system.

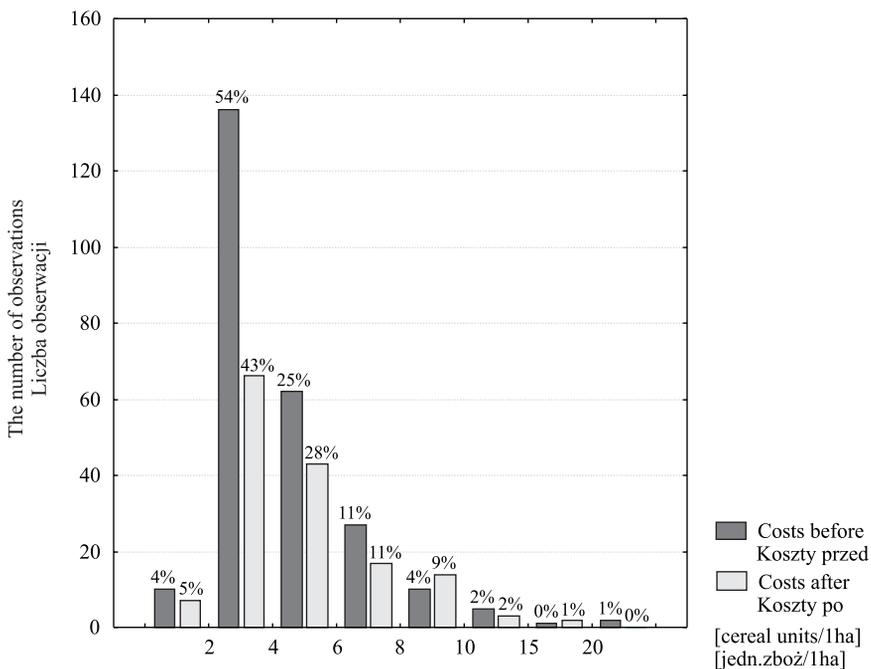


Fig. 8. The cost of cultivation dependent on the configuration of plots before and after consolidation of land

Rys. 8. Koszty uprawowe zależne od przestrzennego ukształtowania działki przed i po scaleniu gruntów

The size of the cost of cultivation obtained for the studied plots indicate their small decrease resulting from the configuration of plots, despite a significant reduction in their numbers caused by land consolidation. Then the question arises - why so impressive change in reducing the number of plots that were obtained in the new state has not resulted in greater decrease in this index. Assuming that half of the plots had previously been properly shaped it can be stated that the improvement of the technical and space param-

ters in the new state related mainly to corrections of the rest of the population. Therefore, if in the land consolidation process were taken into account:

- all the wishes of the parties (which can significantly reduce the possibility for a proper separation of new compact complexes),
- limitations resulting from the length of the design complexes,
- proposals for the new location plots in relation to the farm buildings,
- existing terrain obstacles, both existing and being in the implementation phase of the new project of technical infrastructure (that existed in the village, but were not the subject of research),

then the result of the reconstruction of the borders system of the village should be evaluated as the most positive.

CONCLUSIONS

The discussed results of research involving registry plots and their continuous parts under one form of use confirm a significant change in the former system of land in the village Koźlice. Its reconstruction resulting from the performed land consolidation contributed significantly to the reduction of the number of plots in the village of about 32%. The obtained result of the reduction of the plots quantity taking into account the increase in the area of newly separated plots may be considered impressive. Less interesting seems to be the change of the plots layout in relation to the center of the village. The similarity in both studied ground systems proves the irresistible need to have land as close as possible to the farm buildings. The reorganization of the space carried out in accordance with the wishes of the participants of the consolidation works had to take into account their demands regarding the size and location of new plots, which resulted in the large number of small plots in close proximity to buildings.

Detailed studies of the continuous parts of plots covered by one form of use confirm the change of their shape in the new state, despite minor changes of size and shape of design complexes. Minor changes of the shape of these complexes limited to some extent the possibility of separating the plots of larger areas and favorable spatial and technical parameters, though from the point of view of existing guidelines the values of these parameters are correct. Unfortunately, obligatory and fairly wide range of acceptable elongation of plots in the implementation of land consolidations does not take into account the results of studies, which were carried out after the entry into force of the Act on consolidation and exchange of land. It results from them clearly, that for specific intervals of plots areas there is an optimal elongation, which has a significant impact on the reduction of losses associated with the plots cultivation, resulting from their shape.

One can theoretically assume that a possible increase in the improvement of production efficiency in the studied village would be possible only in the case of changes to the existing guidelines for extending the plots with taking into account their areas, or adoption of cultivation cost index as an indicator of design in the consolidation works. At the current stage of research, such a solution is already possible, though requires a completely different information technology tools than those that are currently used in the consolidation works.

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WPLYW PRAC SCALENIOWYCH NA EFEKTYWNOŚĆ PROCESU PRODUKCJI

Streszczenie. W opracowaniu przedstawione zostaną badania obejmujące ocenę zmiany ukształtowania działek spowodowanej przeprowadzeniem scalenia gruntów w miejscowości Koźlice w województwie dolnośląskim. Materiał badawczy obejmie wszystkie grunty występujące w badanej wsi. Źródłem danych do przeprowadzenia oceny będzie numeryczna mapa ewidencyjna w stanie przed i po scaleniu gruntów. W procesie przetworzenia danych wyjściowych oraz określenia niezbędnych parametrów technicznych dla badanych elementów powierzchniowych, zostaną zastosowane narzędzia informatyczne i statystyczne. Podstawowym elementem badań umożliwiającym porównanie efektywności procesu scaleniowego będą działki ewidencyjne oraz ich ciągłe części, objęte jedną formą użytkowania (grunty orne). Szczegółowe badania dotyczyć będą oceny ukształtowania działek ornich oraz ich rozmieszczenia na terenie wsi. Dla każdej z nich określony zostanie wskaźnik ukształtowania w postaci kosztów uprawowych zależnych od ich rozłogu. Uzyskany wynik badawczy umożliwi stwierdzenie w jakim stopniu przeprowadzone scalenie gruntów we wsi Koźlice wpłynęło na poprawę warunków rolniczej przestrzeni produkcyjnej.

Słowa kluczowe: rozłóg gruntów, struktura przestrzenna gruntów, scalenie gruntów

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