



ANALYSIS OF CHANGES IN THE TECHNICAL MEANS OF PRODUCTION RESOURCES ON AGRICULTURAL FARMS IN THE ŚLĄSKIE VOIVODSHIP

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Summary

The aim of the studies was determining the spatial distribution of premises and the technical means of production resources on farms in the years 1996, 2002 and 2010. The database has been developed for 36 counties of the Śląskie voivodship. The spatial database developed for the analysed voivodships assumed a county as the smallest indivisible unit of the geographical space. The data describing the technical means of production on farms were obtained from inquiries conducted by the European Statistical Office. Diagnostic variables describing the technical equipment on farms included: self-propelled machinery, tractors and usable areas. The analysis of spatial distribution was conducted for the assumed period of time and spatial changes were determined. On the basis of the analysed diagnostic variables the synthetic indicator was determined, which described the multivariate phenomenon by means of one variable. The analysis show that in 1996 agricultural farms were better equipped on the level of the measure of development 0.306 than in 2002, when the measure of development was lower by 0.100.

Keywords: spatial distribution, technical means resources on farms, synthetic indicator

INTRODUCTION

Undoubtedly, technical progress is greatly influenced by the technical infrastructure, mainly the internal infrastructure, which to a certain extent applies also to buildings, machinery, farm equipment and means of transport (Wójcicki, Michałek 2002; Machowski 1998).

Technological progress may be also due to transformation of farms and labour and result from the simplification of technological procedures owing to rational use of material inputs and reasonable exploitation of fixed assets in farmers' disposal (Kowalski et al. 2002).

According to Daelmans (1992) " Good machinery resources are not the best solution to a problem of work mechanisation, since the farm area plays an important role". The disproportion of the saturation and spatial diversity of rural areas regarding the progress of technical farm infrastructure poses problems for the planning of a given region development in the scale of the country or the voivodship. If we consider development strategies, the same for the whole regions and macro-regions, such diversity may cause more intensive difference in the regional development. Estimation of the technical infrastructure resources on farms will help to make the decision concerning the adoption of an appropriate development strategy for the regions (Sikora, Woźniak, 2005).

In the studies on spatial comparative analyses it is convenient to use the methods of multivariate statistics, which allow to determine a synthetic measure. The measures may replace numerous sets of attributes by a single aggregate variable. The variables estimation is possible using one value and also makes possible a segregation of the investigated objects regarding the analysed phenomenon (Krakowiak-Bal, 2005). A number of various methods of synthetic measures forming are encountered in the subject literature, which would make possible determining the measures of the infrastructure development. The first author who presented this measure was Z. Hellwig (1968), who aimed to determine economic development of selected countries. Hellwig's synthetic measure of development, through generalisation of the information from the whole cycle of diagnostic variables, assigns the analysed phenomenon a single aggregate measure (Krakowiak-Bal, 2005).

In their first book published in 1974, J.H.P. Paelick and L.H. Klaasen emphasized the significance of spatial modelling of economic variables. They perceived the fact, that spatial units, such as: voivodships, regions or countries are dependent on other units and economic, political and social transformations occurring there. By juxtaposition of economic, econometric and geographical methods the authors led to a development of spatial econometrics (Suchecky, 2010).

Spatial econometrics aims to generate the information about spatial dependencies of the studied regions and their interrelations regarding variables in various localisations. This method allows to identify clusters, i.e. groups of regions showing similarities and indicate the areas considerably differing from the ones bordering with each other. One should remember that the values studied for a defined area are not dependent on the values of the adjoining area, whereas any spatial standards are equally applicable in all cases (Sikora et al., 2013).

Currently the scope of spatial econometric methods applications extended considerably. Initially spatial econometrics focused mainly on agriculture, since agriculture is the most connected with the area and regionalisation. At present, the United States of America is the main centre of rapidly developing research on the spatial localisation (Sikora, 2009).

The changes connected with the organisation and operation of farms as well as the methods to improve crop and livestock production have been taking place on Polish agricultural farms for years. Different extensive and intensive traditional structures of agronomic production, still prevailing on farms in Poland, have been developing since the historical two-field and three-field crop rotation (Wójcicki, 2008).

Major changes, which are perceivable in Polish agriculture, occurred due to Poland's accession to the European Union. The criteria imposed on some EU structural funds affect the agricultural farms potential, therefore they indirectly influence the changes occurring in the national economy. The agrarian structure is constantly changing, the number of farms is decreasing, whereas their profitability grows. The farms focused on market-oriented agronomic production are clearly distinguishable. Their technical resources are modernised, owing to the target funds for the purchase of among others, farm machinery and construction and furnishing of farm buildings. In result of modernisation processes supported in this way, farmers' incomes are supposed to grow, which will lead to an improvement of work conditions on farms (Czubak, 2008).

In Polish economic conditions, a replacement of "worn-out" and old fashioned technical equipment is difficult, due to among others, low marketability but also a low scale of production on family farms. In result, farmers are still using farm machinery, whose service life has been prolonged over the permissible catalogue standards. Prolongation of the service life of technical means may reduce the unit fixed costs but the following machinery failures increase variable costs. Investments in the machinery are necessary to increase the economic efficiency indicator. The main obstacle to the investments are too high costs of innovative machinery. Poland's accession to the European Union created new opportunities to obtain funding for the investment in agricultural farms. Properly completed machinery should be oriented on specific agronomic production, which to some extent makes farmers equip their holdings in selected groups of machines and tools (Szeląg –Sikora, Kowalski, 2010).

The aim of the studies was determining the spatial distribution of premises and the technical means of production resources on farms in the years 1996, 2002 and 2010.

MATERIAL AND METHODS

The work comprised a compilation of a database for the selected voivodship on the level of a territorial unit, i.e. a county and determining the spatial distribution over an assumed period of investigations. The data obtained from the European Statistical Office for the Śląskie voivodship in the years 1996, 2002 and 2010 were used for the studies. A synthetic indicator was determined on the basis of diagnostic variables in order to conduct the analyses. The analyses aimed to present the relationship of the space and distribution of the synthetic indicator, which describes technical means resources on farms in the selected years.

The selected elements of machinery resources on farms were described by five variables, i.e. the number of trucks, tractors, combined harvesters, potato and red beet harvesters. The other four variables describes the production and farm premises (i.e. the area of barns, pigsties, henhouses and stables). A synthetic coefficient was established on the basis of the above mentioned variables, which allowed reducing a multivariate space illustrating the level of internal farm infrastructure to a single value integrated into the object localisation (the unit – a county of the Śląskie voivodship).

The data were recorded as a spreadsheet, containing the Central Statistical Office code, which allowed for the automatic assignment of the verses from the sheet to the records of the geographical database. The geographical database contains files in the Data Base File format.

Normalisation of the diagnostic variables

The problem of the multivariate comparison analysis concerns among others a classification of the counties regarding their multitude of attributes and indicators which describe the state of saturation with infrastructure. In order to establish the selected objects similarity to one another, their diagnostic features should be led to comparability. It may be achieved by a standard normalization procedure of variables:

$$z_{ij} = \left(\frac{x_{ij}}{\max x_{ij}} \right) \quad (1)$$

Where:

z_{ij} – normalized value of x_{ij} for each object,

x_{ij} – standardized variable.

The comparison analysis makes necessary the application of variables with identical units of measure and approximate orders of magnitude (Sikora, Woźniak, 2005).

In this paper, a synthetic measure of development is based on the term of distance, which is "... a distance of two points in a m-dimensional space in the established positive weights system" (Woźniak, 2001). The analysis accepted the fact that for a general number of variables the weights are equal, which evidences the same diagnostic variables. The state of synthetic measure of development for the conducted investigations was assumed after Hellwig as the product form of a quadratic. That by attributing equal weights to the diagnostic variables it is possible to finally aggregate the measure of development described the following formula:

$$q_i = \left[\sum_{j=1}^m (z_{ij} - z_{(1),j})^2 \right]^{\frac{1}{2}} \quad (2)$$

Where:

z_{ij} – normalized value of x_j for each object,

$z_{(1),j}$ – distance between the disaggregate level of development of the i-th object and disaggregate standard level of development. (Sikora, Woźniak, 2005).

The determined model of synthetisation of fetatures realises the axiom of normalised measure <0-1> and leads the object lienarly from the worst to the best according the the assumed determinants (Sikora, 2009).

The method described in this way allows to estimate the taxonomic structures of the counties set as a configuration of the objects in a multiaspect space of their features. The structure determined in this way allows to place the objects situated closer or further from the selected standard of development (Sikora, 2009).

To each object a development measure q_i was ascribed, forming an aggregate vector in the shape of a single column matrix:

$$P_{[1 \times n]} = \begin{bmatrix} q_1 \\ q_2 \\ \dots \\ q_{36} \end{bmatrix} \quad (3)$$

Vector $P[1 \times n]$ is designated as a synthetic measure of development, which makes possible a division, by means of a single number, of a phenomenon with many features, i.e. the technical infrastructure potential of farms assumed for the counties of the Śląskie voivodship (Sikora Woźniak, 2005).

The classification of rural areas in the presented investigations was made according to Woźniak (2001). It was assumed that the set of the Śląskie voivodship counties was divided into five groups, containing objects with similar values of a synthetic measure. The criterion of the division is presented in Table 1.

Table 1. Characteristics of the object classification regarding the value of a synthetic measure of development

Group	Group characteristics	Range of group variability
I	areas with very low values of the measure of development	$0 \leq qi < \min \{qi\} + 0.2R$
II	areas with low values of the measure of development	$\min \{qi\} + 0.2R \leq qi < \min \{qi\} + 0.4R$
III	areas with medium values of the measure of development	$\min \{qi\} + 0.4R \leq qi < \min \{qi\} + 0.6R$
IV	areas with high values of the measure of development	$\min \{qi\} + 0.6R \leq qi < \min \{qi\} + 0.8R$
V	areas with very high values of the measure of development	$\min \{qi\} + 0.8R \leq qi \leq 1$

qi – the value of synthetic measure determined for the i -th object
 R – the range of synthetic measure of development values

RESULTS

The synthetic measure used in the investigations assumes values within the $\langle 0-1 \rangle$ range. For the studied set of objects in the property space based on diagnostic variables of 1996, this value (q_i) for the movables was within the range: $q_{i, 1996}$ (0.0933-0.9322), $q_{i, 2002}$ (0.0026-0.9673), $q_{i, 2010}$ (0.1344÷0.9867). When an object reaches q_i value approximate to one, it becomes a standard in the selected property space. The analysis shows, that in 1996 Świętochłowice urban district reached the lowest measure, whereas the highest was ascribed to Raciborski county. Like in the previous analysed period, in 2002 Świętochłowice urban district also obtained the lowest value of the measure of development.

The counties ranking regarding the potential of technical means of production was presented in Figure 1. Conducted analysis revealed the highest position of the Raciborski county, where the movables resources were approximating one (the standard object). The objects with the lowest resources comprise almost all urban districts (large cities districts). In the Śląskie voivodship, the dwellers of these counties are mainly employed by industries, moreover these areas are strongly urbanized and agriculture is only a minor activity. During the period

from 1996 to 2002, a decline in technical means of production resources, on average of 0.04 of the development measure, was registered, whereas a growth by an average of $q_j - 0.06$ occurred in the 2002 – 2010 period.

The synthetic measure in the property space describing the agricultural farms property potential on the level of counties ranged from $q_{i,1996}$ (0.023÷0.9534), $q_{i,2002}$ (0.0014÷0.9986) and $q_{i,2010}$ (0.0285÷1). The distribution of the hierarchy in the property space of agricultural farm premises shows the lowest measure of development in 1996 noted for the Pszczyński county and the highest for Siemianowice Śląskie municipality. In 2002 the Zawierciański county had the lowest share in the investigated premises, whereas the Świętochłowice urban district reached the highest. In 2010 the lowest measure of development was registered for the Częstochowski county, while the urban districts of: Piekary Śląskie, Chorzów and Jaworzno reached the top positions. During this period the counties reached the highest values, i.e. reached one and are standards in this property space.

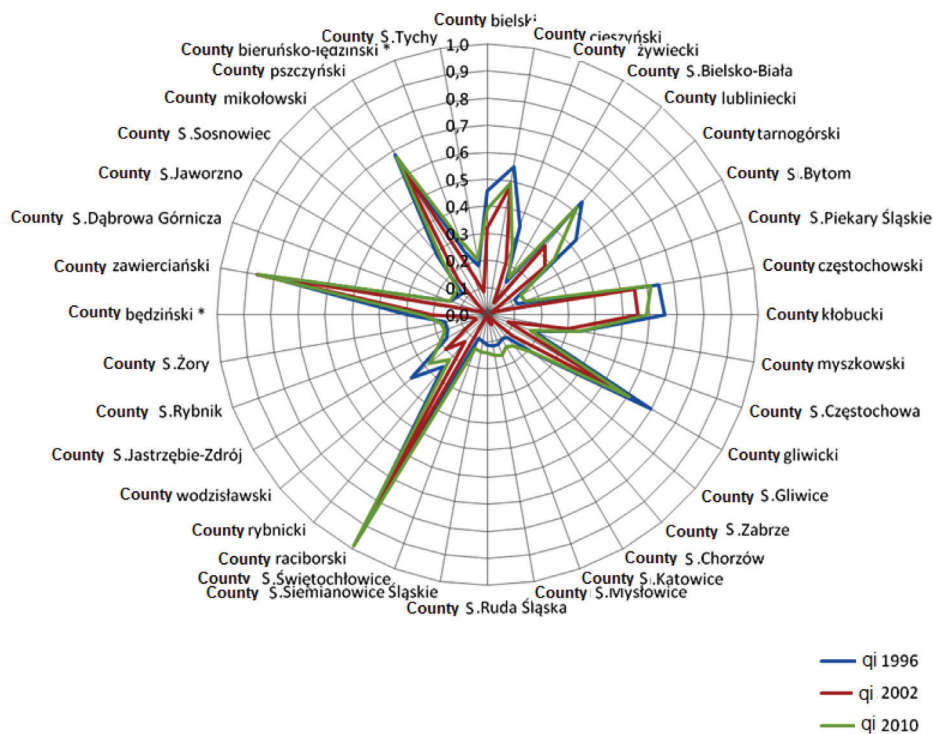


Figure 1. Positions of the counties of the Śląskie voivodship in the property space referring to the movables in the years 1996, 2002 and 2010

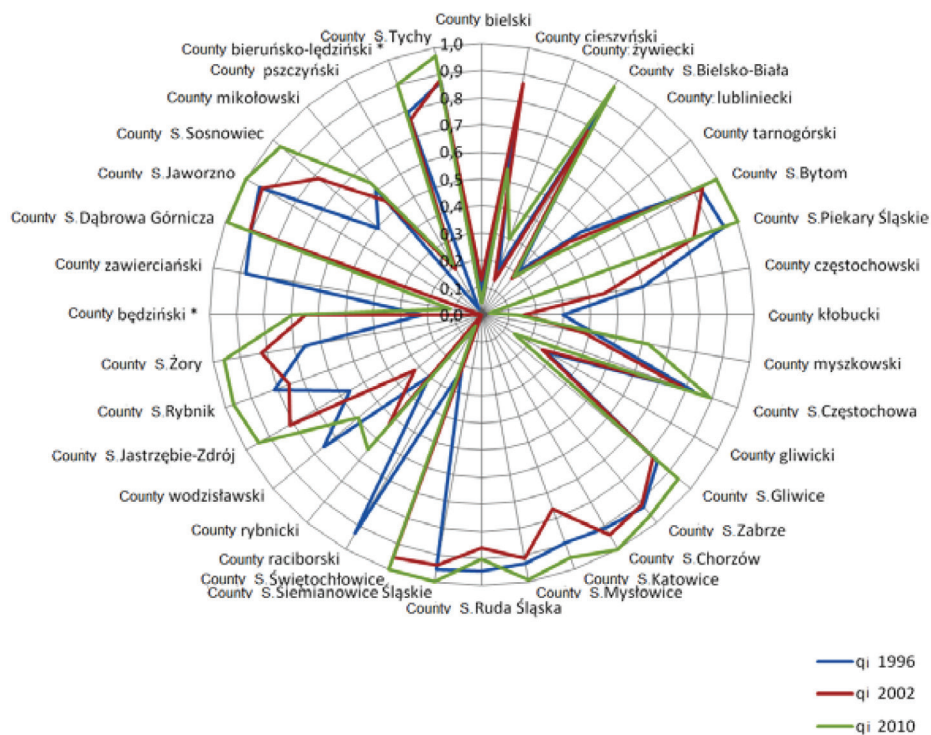


Figure 2. Positions of the Śląskie voivodship counties in the property space regarding the premises in the years 1996, 2002 and 2010

The hierarchy of objects in the property space describing the potential resources of agricultural farm premises was presented in Figure 2. In 2002 the lowest share in the premises (the measure of development $q_{i,2002} = 0.001$) was registered for the Zawierciański and Raciborski counties (which in 1996 occupied high positions with the measure of $q_{i,1996} = 0.9322$).

None of the counties reached the level of standard object, only the Świętochłowice urban district, with its measure of $q_{i,2002} = 0.9516$ was the closest to one. In 2010 the lowest resources of farm premises among all investigated periods was registered for the Bielski, Cieszyński, Częstochowski, Gliwicki and Kłobucki counties and for the urban district of Ruda Śląska. Over the years the measure of development was increasing in Bytom, Chorzów, Świętochłowice, Jastrzębie-Zdrój, Żory, Dąbrowa Górnicza, Sosnowiec and Tychy municipalities and in the Rybnicki county.

For a better illustration of the spatial distribution, the objects were divided into five groups depending on their potential of technical means of production. The division criteria were presented in Table 1.

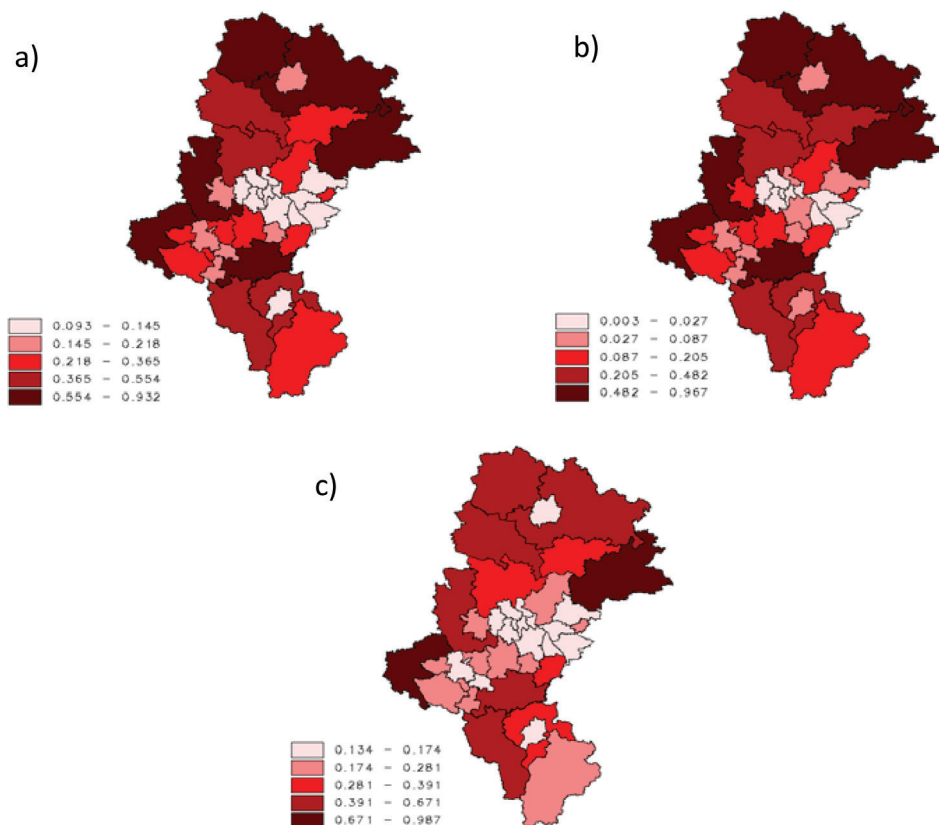


Figure 3. Saturation and spatial diversity of technical means of production resources on farms according to the measure of development obtained on the basis of variables for :
 a) 1996, b) 2002, c) 2010 on the level of Śląskie voivodship counties

Figures 3 show spatial distributions of the aggregate measure of development for the potential of technical means of production resources on farms in the selected multiannual period. The spatial analysis for the technical means in 1996 revealed group I as the most numerous set, comprising the objects with the lowest potential of technical infrastructure. In this group the aggregate measure fell within the q_i 0.093÷0.145 range and covered 36.1% of the counties. These areas include all cities with county rights situated in the centre of the Śląskie voivodship, excluding Częstochowa, Gliwice, Tychy, Rybnik, Żoy and Jastrzębie Zdrój – these counties were classified to group II, which covered 25% of the whole set.

The least numerous set was group IV, where only four areas were classified, i.e. Bielski, Cieszyński, Lubliniecki and Tarnogórski counties with a 11.1% share

of the group in the set and the indicator within the range q_i 0.365 – 0.554. This group is characterised by a good development of technical infrastructure. Group V presents the highest level of movables resources. It comprises among others the counties situated in the northern and western part of the Śląskie voivodship.

The analysis conducted for the property space of technical means of production potential in 2002, revealed the least number of counties in group V, containing the same counties as in 1996, supplemented only by the Myszkowski county which moved from group III. The areas in this group reached the synthetic indicator on the level of q_i 0.205 – 0.482, and share of the group constituted 13.9% of the set. The highest number of counties was noted in groups I and II – 9 objects in each. These are groups with low and very low resources on farms. These groups covered 25% of the whole set. Group I concentrates in the centre of the voivodship forming an island of low values, whereas the objects from group II form spatial anti-standards situated in various parts of the voivodship: to the south (Bielsko-Biała), to the north (Częstochowa) and to the south-west. The same counties as in 1996 invariably remained in the best group V.

The spatial analysis conducted for 2010 reveals that the group of counties characterised by the lowest level of development of farm technical infrastructure was the most numerous (16 counties) and the aggregate measure fell with the range of q_i 0.134 – 0.174. The share of the group in the set was 44.4%. In comparison with the previously studied periods it is the highest number of counties in this range. The highest number of counties in this group is situated in the centre of the voivodship, however the cities with county rights: Częstochowa, Bielsko-Biała, Żory and Rybnik are also included. Group V proved to be the least numerous, with the aggregate range q_i 0.671 – 0.987, while the share of counties in this group was 5.6%. Raciborski and Zawierciański counties invariably remained in this group over the studied years.

The spatial distribution showed in Figure 4 referring to the premises potential during the investigated years 1996, 2002 and 2010 shows the highest potential resources of premises in the urban districts, on the contrary – technical means of production resources potential in these counties is the lowest. This means that these areas are strongly urbanised and agriculture changed its function from production to providing services. The traditional production character is disappearing, in these areas visible as a decrease in the technical means of production potential, whereas the premises potential remains on the same level, because the facilities have been adopted for non-productive (service) purposes. In the urban districts farm premises are used as storage areas for the enterprises unconnected with agricultural sector of economy. A decrease in the potential of farm premises in agricultural counties (western and southern ones) results from a change in agricultural production. A progressive striving for specialised production is observed resulting in abandoning of multidirectional production,

which makes unnecessary possessing animal housing or storage facilities for numerous technical equipment.

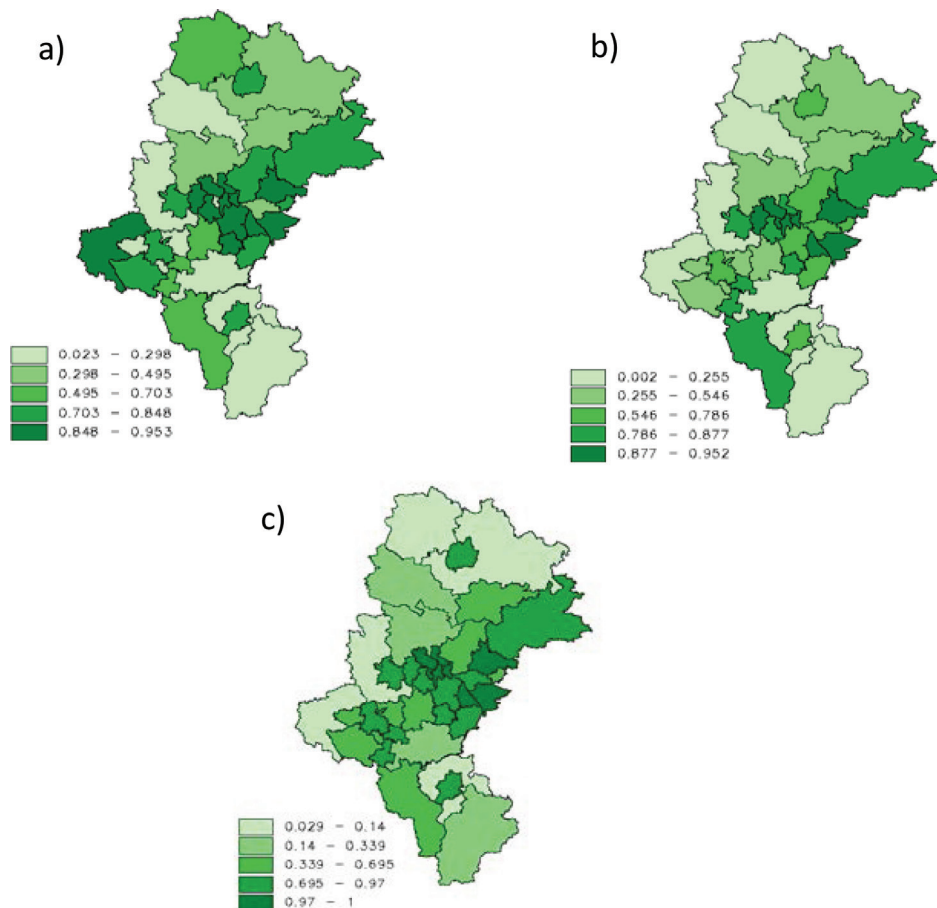


Figure 4. Saturation and spatial diversity of farm premises potential according to the measure of development obtained on the basis of variables of: a) 1996, b) 2002 and c) 2010 on the level of Śląskie voivodship counties

The spatial distribution of the features describing the premises in the analysed years 1996, 2002 and 2010 reveals a decline in the number of counties both in group I and V. The group with very low potential of premises, which in 1996 and 2002 comprised 7 counties diminished to 5 objects in 2010. Similarly, the number of 12 objects in 1996 in the group with a very high potential decreased to 8 in the years 2002 and 2010.

CONCLUSIONS

The analysis of the technical means of production potential on agricultural farms conducted in two property spaces, i.e. the movables and premises space revealed that in 1996 agricultural farms were better equipped on the level of the measure of development 0.306 than in 2002, when the measure of development was lower by 0.100. Regarding the year 2010, when the farms were rebuilding their technical means of production resources, they reached the measure of development $q_i = 0.301$.

The spatial distribution shows that the counties situated in the northern part of the voivodship in all studied years clustered forming islands of high values of technical means of production potential. On the other hand, the counties located in the central part of the voivodship – urban counties, formed an island of low values of the measures of development describing the property space of technical means of production. In these counties, the measure of development ranged from 0.093 – 0.145 and these were the counties, which in the hierarchy of technical means of production potential occupied the lowest positions. In the southern part, medium values of the measure of development were noted for farms on the county level, except Bielsko-Biała municipality where the lowest value of the measure of development for this county was registered and the county was the spatial anti-standard describing the technical means of production. The results can be used to create the regional agricultural policy in the context of the modernization of farms.

ACKNOWLEDGEMENTS

The research was financed by the means from Ministry of Science and Higher Education to statutory activity BM 3619/WIPIE for the University of Agriculture in Krakow.

REFERENCES

- Czubak W. (2008), *Znaczenie czynników wpływających na korzystanie z funduszy rolnych UE*. Roczniki Naukowe tom X, z. 3. Stowarzyszenie Ekonomistów Rolnictwa i Agrobiznesu.
- Daelemans J. (1992), *Justified mechanization in forming*. Hungary. CIOSTA-CIGR V Sem. Proceed. Gyongyos.
- Hellwig Z. (1968), *Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom rozwoju oraz zasoby i strukturę wykwalifikowanych kadr*. Przegląd Statystyczny 15.4.

Krakowiak-Bal A. (2005), *Wykorzystanie wybranych miar syntetycznych do budowy miary rozwoju infrastruktury technicznej*. Infrastruktura i ekologia terenów wiejskich. Nr 2005/03.

Kowalski J., Michałek R. (2002), *Postęp naukowo-techniczny a racjonalna gospodarka energią w produkcji rolniczej*. Kraków. Projekt Badawczy KBN.

Machowski E. (1998), *Wybrane zagadnienia infrastruktury technicznej w organizacji produkcji rolniczej*. Filia AR w Krakowie. Rzeszów.

Paelinck J.H.P., Klaassen L.H., Wageneaar Sj. (1979), (*Spatial Systems*). Farnborough, Hants. : Saxon House, English.

Sikora J. (2009), *Analiza zmian potencjału technicznych środków produkcji gospodarstw rolnych w gminach Polski Południowej*. Infrastruktura i ekologia terenów wiejskich. Nr 2009/09.

Sikora J., Malinowski M., Szelağ M. (2013), *Analiza zależności przestrzennych pomiędzy wybranymi elementami infrastruktury technicznej*. Infrastruktura i ekologia terenów wiejskich. Nr 2013/04.

Sikora J., Woźniak A. (2005), *Zróżnicowanie obszarów wiejskich woj. małopolskiego pod względem wyposażania w środki techniczne gospodarstw rolnych*. Infrastruktura i ekologia terenów wiejskich. Nr 2005/3.

Sucheckie B. (2010), *Ekonometria przestrzenna*. Metody i modele analizy danych przestrzennych. Warszawa. Wydawnictwo C.H.Beck.

Szelağ-Sikora A., Kowalski J. (2010), *Subwencje unijne a modernizacja parku maszynowego w aspekcie typu gospodarstw rolnych*. Inżynieria Rolnicza. Nr 3 (121).

Woźniak A. (2001), *Relacje przestrzenne w infrastrukturze i technicznym wyposażeniu rolnictwa w województwie małopolskim*. Rozprawa habilitacyjna nr 7. Polskie Towarzystwo Inżynierii Rolniczej.

Wójcicki Z. (2008), *Systemy produkcji rolniczej w Polsce*. Infrastruktura i Ekologia Obszarów Wiejskich, Nr 2008/2, Kraków.

Wójcicki Z., Michałek R. (2002), *Uwarunkowanie przemian w rolnictwie polskim do 2020 roku*. Inżynieria Rolnicza 6(39), Warszawa

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Received: 12.12.2015

Accepted: 12.04.2016