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SPATIAL-TIME ANALYSIS OF DIVERSIFICATION OF CERTIFIED SEED USING PROGRESS IN POTATOE PRODUCTION IN POLAND

PRZESTRZENNO-CZASOWE ZRÓŻNICOWANIE NA SADZENIAKI KWALIFIKOWANE W PRODUKCJI ZIEMNIAKÓW W POLSCE

Key words: spatial analysis, Moran's coefficient, biological progress
Słowa kluczowe: analiza przestrzenna, współczynnik Morana, postęp biologiczny

Abstract. The paper presents an analysis of certified seed use in the provinces in Poland. The used data come from Central Statistical Office and concern the period 2004-2011. The aim of this study was to determine the regional imbalances present in the used certified seeds. The spatial Moran's correlation: global and local is applied in the paper. Results of the statistical analysis of regional differences were noted for the use of certified seed potatoes in the years 2004-2011. It was also found that despite the low use of certified seeds, there is an increase of its use year by year in most of provinces.

Introduction

The increase of productivity in agriculture is affected by many factors. Today, the dissemination of biological progress is considered as one of the most important. Many authors have reported that the introduction of biological progress resulted in the increase of plant productivity of about 50% in the long term [Duvick 2005, Ingram et al. 1997, Thirtle 1995]. The use of biological progress places it on a higher level than other factors of production such as chemical plant protection, mechanization of production and fertilization. In Poland, the use of biological progress in crop production is has not been appreciated. The undoubted problem of the implementation of biological progress in Poland is the diversity of soil quality and differences in the structure of farms. However, this does not completely explain the occurrence of regional disparities in the use of certified seed.

The aim of this study was verify the opinion of other authors who studied the biological progress concerning the regional disproportion at the NUTS 2 level in the use of biological progress on the base of production of certified cereals and potatoes.

Materials and methods

The data used in this analyses come from Central Statistical Office for the period 2004 – 2011. In order to assess the spatial diversity, statistical methods were applied. In this work the spatial autocorrelation coefficient Moran I_g global and local I_{LISA} is used [Anselin 1995]. Global Moran spatial correlation coefficient is determined in accordance with the proof of Clif and Orda [1981] and presented in a matrix form:

$$I_g = \frac{n}{N_w} \times \frac{z'Wz}{z'z}$$

where:
W – *matrix weight of standardized rows,*
z – *vector of elements* $z_j = x_i - x$,
N_w – *is the sum of all elements of the matrix W.*

Spatial autocorrelation is shown on Moran's scatter plot. This chart is used to visualize spatial relationships and determine the direction of spatial autocorrelation. The graph is divided into four parts to zero values. Plotted on the axes of standardized consumption value of certified seed and the spatial lag variable.

The formula for calculation of the local Moran coefficient of correlation estimator becomes:

$$I_{LISA} = z_i \sum_{j=1}^{n} w_{ij} z_j$$

where:

w_{ij} – *the element of the weight matrix W,*

z_i, z_j – *standardized value of variables.*

Based on crop recommendations, the material consumption of certified seed per 1 ha is assumed in the following way. The use of seed potatoes was established 2500 kg/ha, and for cereals (wheat and triticale) was 200 kg/ha and 180 kg/ha for other species. The total share of sown area in Poland, which uses certified material is defined as an average weighted. This average weighted is share of sown area the surface of individual species, which can be used on certified materials. In the some way calculations were made for each of the province [Wicki,Dudek 2009]. Results of the analysis are presented in tabular and graphical forms. Because of space publishing limitations in the paper, only the results for potatoes are presented.

Results

The previous research by other authors show that the consumption of certified seed of selected cereals and potatoes in Poland has decreased [Nowacki 2005, Wicki, Dudek 2009]. Figure 1 shows use of certified seeds in kg per 1 ha of crops in provinces for the period 2004-2011. Figure 1 is divided into three plots which contain changes in consumption of potatoes in each province during the period of time. Provinces were divided into individual plots by a similar level of seed used in 2004. As you can see, the greatest use of certified seed in 2004 is noticed in the following regions: Śląskie, Warmińsko-Mazurskie, Kujawsko-Pomorskie, Dolnośląskie and Świętokrzyskie (Fig. 1A). During the study period 2004-2011, an increase in consumption of qualified seed potatoes can be observed only in three provinces, namely: Śląskie, Warmińsko-Mazurskie and Kujawsko-Pomorskie. In two other provinces (Dolnośląskie and Świętokrzyskie) a decrease in consumption of certified seed is observed. In the next five provinces there

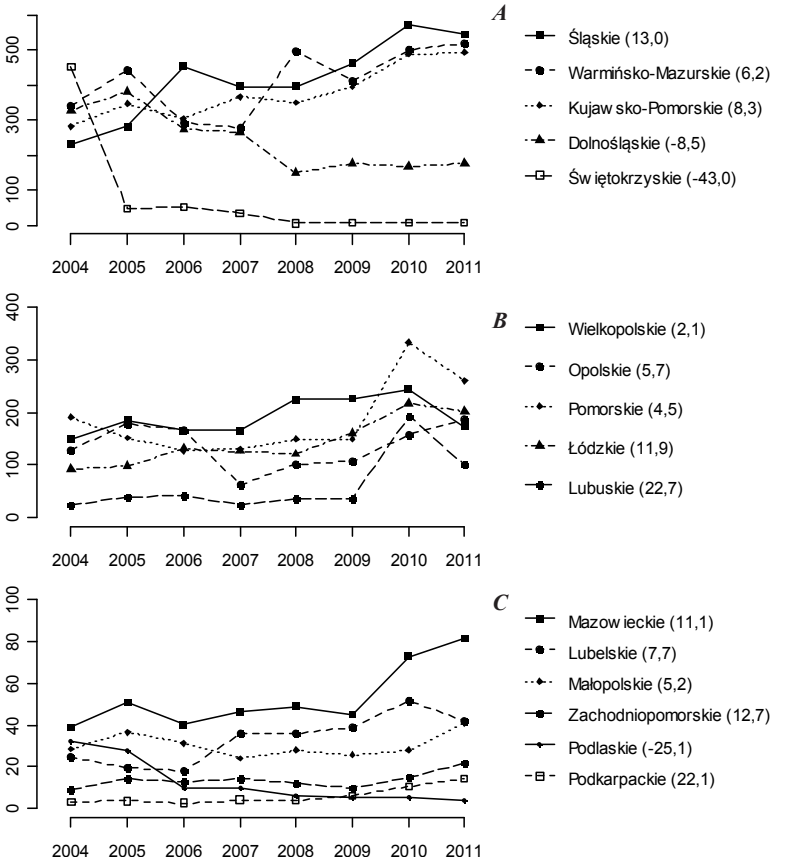

Figure 1. Qualified seed potatoes consumption in kg per 1 ha for crops in the provinces for the period 2004-2011
Rysunek 1. Zużycie kwalifikowanych sadzeniaków w kg na 1 ha pod zbiory w województwach w latach 2004-2011
Source: own study based on CSO data
Źródło: opracowanie własne na podstawie danych GUS

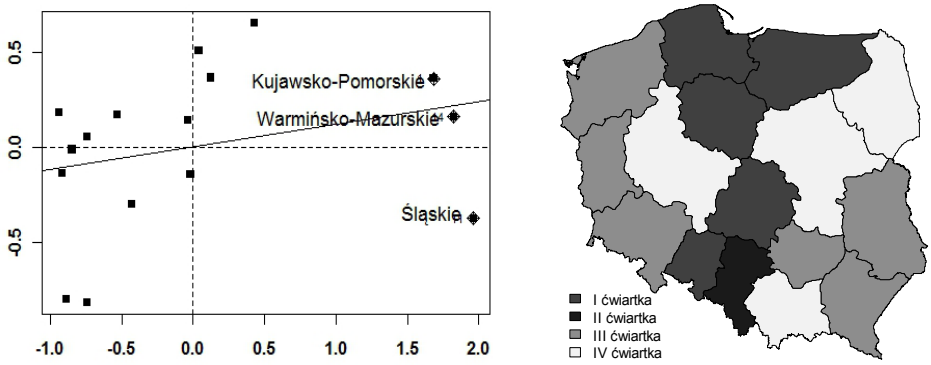

Figure 2. Moran scatter plot and its visualization on the spatial map of Poland
Rysunek 2. Wykres punktowy Morana oraz jego wizualizacja na mapie przestrzennej Polski
Source: own study
Źródło: opracowanie własne

is an increase in consumption since 2004 qualified seed potatoes (Wielkopolskie, Opolskie, Pomorskie, Łódzkie, and Lubuskie). It is also noted a marked increase of consumption of seed in all provinces in 2010. In particular in the province of Wielkopolskie and Lubuskie. In thes five regions a collapse and a decrease of use of certified seed in 2011 was observed (Fig. 1B). As for the last group of six provinces an increase in consumption of seed potatoes excluding Podkarpackie can be seen. (Figure 1C). The third group of provinces are: Mazowieckie, Lubelskie, Małopolskie, Zachodniopomorskie, Podkarpackie, and Podlaskie. On the figure 1 in parentheses the average growth rate over the period for use of certified seed is given. In the first group, the largest increase in the use of certified seed potatoes from year to year of 13% was in Śląskie (fall to 43% in Świętokrzyskie). In the second group, it was Lubuskie 22.7% and Podkarpackie 22.1% in the third. Only in three provinces observed an average reduction in consumption of certified seeds from year by year (Dolnośląskie, Świętokrzyskie and Podlasie). In other provinces more or less average consumption growth of certified seeds from year by year was reported.

In the next part of this study, spatial diversity potatoe using global Moran coefficient of correlation was estimated. We analyzed the use of certified seeds in particular provinces. The hypothesis of random distribution of consumption values between the provinces of quantifiers was verified. As a result of calculations Moran positive correlation coefficient (Ig = 0.1188) was obtained. It turned out to be not significant (p-value: 0.2122). Thus it can be considered as confirmation of previous studies by other authors on the existence of regional differences due to the consumption of certified seed. Figure 2 shows the location of the different provinces of Moran scatter plot (Fig. 2 – left graph) and its visualization on the map of Poland (Fig. 2 – right graph).

Figure 3. Distribution of certified seeds consumption in the provinces according to the values of local Moran statistics in 2011
Rysunek 3. Rozmieszczenie zużycia kwalifikowanego materiału siewnego w 2011 r. w województwach ze względu na wartości statystyk lokalnych Moran
Source: own study
Źródło: opracowanie własne

The provinces which we defined earlier as leading in the use of certified seeds in kg per hectare, have emerged as a so-called "hot spot" on the Moran scatter plot (Śląskie, Kujawsko-Pomorskie and Warmińsko-Mazurskie). Then the local correlation coefficients were calculated to identify spatial clusters of large and small values of seeds consumption, and to define non-standard locations. When the local Moran statistic has a value significantly positive then we talk about the positive autocorrelation. In this case, the province is surrounded by similar ones in terms of consumption of certified seeds. However, if the local Moran statistic has a value which is significantly negative (negative autocorrelation) then the region adjacent to the province differs significantly from the values variable. This region is considered non-standard location.

The results of calculations for the year 2011 are shown in Figure 3. The provinces, which received significant positive local autocorrelation are highlighted in white and the regions of

significant negative local autocorrelation are highlighted in black. Other for which the local autocorrelation was not significant are highlighted in gray. Note that Śląskie had the highest value of use of certified seeds (546 kg/ha) in 2011. As a consequence, it can be stated that the neighboring region explicitly differs in respect to research variable. Podkarpackie and Kujawsko-Pomorskie marked in white, were surrounded by a region with a similar consumption qualified seed potatoes.

Conclusions

As a result of the statistical analysis the regional differences were noted in the use of certified seed potatoes for the period 2004-2011. It was also found that despite the low use of certified seeds, there is a steady increase of consumption in most provinces year by year (each year). Special consideration should be given to remove barriers that prevent biological progress. Regional differences in the use of certified seed can not be fully explained by the fragmentation of farms and soil quality. In the paper, Moran spatial correlation coefficients (global and local) confirmed many research done by other authors concerning the regional diversity and negated low consumption of certified seed potatoes in Poland.

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Streszczenie

Badano zużycie kwalifikowanego materiału siewnego w poszczególnych województwach w latach 2004-2011. Dane wykorzystane w analizie pozyskano z baz danych GUS. W pracy wykorzystano statystyki przestrzenne Morana w celu określenia autokorelacji przestrzennej. W wyniku przeprowadzonych analiz statystycznych stwierdzono występowania zróżnicowania regionalnego dla wykorzystania kwalifikowanego materiału siewnego (sadzeniaków) ziemniaków w latach 2004-2011. Stwierdzono również, że mimo niskiego wykorzystania kwalifikowanych sadzeniaków, systematycznie z roku na rok rośnie ich zużycie w większości województw.

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