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KONŠTANTÍN ZELENSKÝ

INFLUENCE OF THE GEOGRAPHIC ENVIRONMENT IN SLOVAKIA ON THE DEVELOPMENT OF AGRICULTURAL PRODUCTION

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Sur la base de 44 variables (18 sur l'environnement géographique, 26 sur l'agriculture), au moyen de l'analyse factorielle, on a étudié la répartition de la culture et de la récolte des produits par rapport à l'environnement géographique. Par la méthode de Warimax on a tiré 9 facteurs:

1. Le facteur du relief et du climat,
2. le facteur de l'altitude au-dessus du niveau de la mer,
3. le facteur de la profondeur du sol,
4. le facteur de la granulométrie,
5. le facteur des trèfles,
6. le facteur des pommes de terre hâtives,
7. le fecteur de seigle,
8. le facteur du potassium accessible dans la terre labourée,
9. le facteur de la profondeur des labours.

Few are the productions that are influenced by so many factors as is just the agricultural one. On the one hand, it is the human society which tries to gain from the soil as much as possible for living, and on the other hand, they are the geographic conditions which limit the agricultural production. Even at present, in the actual modern world, in spite of the technical progress, the geographic conditions are an important regulator of the agricultural production. The geographic conditions act on the agricultural production as a complex. For these reasons it is incorrect to study independently the relationship of individual components of the geographich environment to the agricultural production. If we study only one component of the geographic environment we will not obtain a correct answer to the causes of growth or lagging ot the agricultural production. For example: If we study only the relationship between the altitude above sea level and the agricultural production we will find, it is true, on the whole that when the altitude a.s.l. increases the agricultural production decreases, but simultaneously we find that the lowest lying plains are not the most fertile, but the lowest crope is not either in the highest situated basins. In the lowest lying flat lands the agricultural production is affected by hydrologic-substratic conditions and in high situated basins the production growth is influenced by the „size of the space“, which conditions the proper basin local climate, influencing the formation of more advantageous soils for the agricultural production. We see it best in the Liptovská, Popradská and Oravská basins, which are almost on the upper limit of ploughed agriculture. The local climate and soils differ from the climate and soils of the narrow mountain basins at an equal altitude a.s.l.

Further on, if we follow the change of the climate, we observe, it is true, with the change of the climate also the change of the agriculture, but simultaneously we observe in one type of climate a varied agricultural production, conditioned by other components of the geographic environment.

It is similar also in the relationship of soil and production. For ex.: We know that the greatest production is attained in soils with neutral to basic soil reaction. However, not in all soils with this reaction similar production is attained. Likewise, neither in soils with similar grain size a similar production is attained. The soil is a complicated organism, which forms under the influence of the climate and geomorphological processes. By the change of these conditions and climate change also the soil and by it even the agricultural production. Thus we could name all the components of the geographic environment and we would find exceptions in all of them. By changing but one component of the geographic environment, the geographic environment acquires qualitatively a different character, other laws act in it, a different connection of components of the geographic environment takes place and by it also a different influence on the agricultural production.

For these reasons we tried to study the influence of the agricultural landscape as a complex on the agricultural production. Slovakia presents a character of mountains and plains and by it there is also a varied agricultural landscape. The study of a complex influence of the landscape on the agricultural production is a very complicated problem and very difficult to solve sometimes for lack of data. Important here is the digitalization of individual components of the landscape. Not each value of the landscape component can be expressed numerically so as to enable its entering an equation. One of such characteristics of the geographic environment which cannot be digitalized is the genesis of the relief, climate and soils. For these reasons, in delineating the geographic environment we had to be satisfied with the properties of the relief, climate and soils.

METHOD OF PROCESSING

In order to achieve the proposed aim we used the method of the factorial analysis. The factorial analysis is an arranging and hypothesis forming method and its objective is to derive hypothetic factors from the quantity of observed variables. The factorial analysis enables to form a differentiated hypothesis on the structure of mutual relationships between the variables and factors without knowing beforehand or assuming a certain structure. The factorial analysis enables also a certain arrangement and structuralization of a vast set of data. From the factorial analysis we used 3 outputs: the correlations of variables, the extracted factors and the factorial scores.

INPUT VALUES

In order to be able to study the relationships between the agricultural production and the geographic environment,, we divided the agricultural landscape of Slovakia into the smallest units from the relief point of view (types of relief, altitude above sea level, dips and articulations), climate and soils (physical and chemical properties)[1]. In Slovakia we have delineated

CORRELATIONS OF VARIABLES

If we want to know the agriculture in a given landscape, we must know the landscape, we must know the individual components and their influence on the differentiation of the agricultural production. Obviously the knowledge of the influence of individual components of the geographic environment is very difficult to gain for they do not act independently on the agricultural production, but in the context with other components of the geographic environment. The mutual relationship of individual elements of the geographic environment can be studied by means of correlations. We have calculated the correlation coefficients according to the following equation

$$r_{jk} = \frac{S_{jk}}{S_{ii} \cdot S_{kk}},$$

S_{jk} — sum of mixed deviations,
S_{ii} — sum of square deviations for X,
S_{kk} — sum of square deviations for Y,
r_{jk} — correlation coefficients.

The mutual correlations are given in Tab. 1. From the table we can see how great is the positive or negative influence of individual characteristics of the geographic environment on the distribution of individual products and their production. From the considerable quantity of relationships we will pick out only the principal ones which fundamentally influence the agricultural production.

1 *Gross plant production*

1.1. Negatively acting elements: landscape dip (—0.67), sum of temperatures under —0.1 °C per year, (—0.64), excessive moisture (—0.67), above sea level altitude (—0.59), vertical articulation (—0.51).

1.2 Postively acting elements: reserves of acceptable phosphor (0.67), sum of temperatures above +0.1 °C per year (0.63), soil reactions (0.63), absorption saturation (0.60), depth of humus horizon (0.54).

Of considerable influence on the gross plant production, apart from the 327 homogeneous units for which we have calculated the average values of the agricultral production.

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[1] The list of variables is given in Tab. 1 and 2.

geographic environment, is also the quantity of fertilizers introduced in the soil (0.74). Further on we observe that the extent of production is conditioned also by the structure of plant production. We observe that the plant production increases with the increase of the %: of ploughed field (0.85), sugar beet (0.77), clover (0.74), maize for corn (0.62), wheat (0.33) and decreases with the increasing portion of hardier products: clovers (—0.59), oat (—0.58), late potatoes (—0.44).

2 *Direct material expenses*

2.1 Negatively acting elements: excessive moisture (0.67), landscape dip (0.65), negative temperature (0.65), altitude above sea level (0.56).

2.2 Positively acting elements: sum of temperatures above +0.1 °C per year (—0.63), content of accessible phosphor (—0.58), soil reaction (—0.53), depth of humus horizon (—0.50).

3 *Wheat*

3.1 portion of cultivation

3.1.1. Negatively acting elements: altitude a.s.l (—0.70), temperature below —0.1 °C per year (—0.59), excessive moisture (—0.49).

3.1.2. Positively acting elements: temperature above +0.1 °C per year (0.65).

3.2 Crope

3.2.1 Negatively acting elements: temperature below —0.1 °C per year (—0.64), landscape dip (—0.59), excessive moisture (—0.57), altitude a.s.l (0.59) (—0.51).

3.2.2 Positively acting elements: temperature above +0.1 °C per year (0.56), temperature since sowing to +5 °C in Autumn (0.55), absorption saturation (0.50), soil reaction (0.48), content of acceptable phosphor (0.46), depth of humus horizon (0.42).

4 *Barley*

4.1 Portion of cultivation

4.1.1 Negatively acting elements: tmperature above +0.1 °C pre year (—0.38).

4.1.2 Positively acting elements: altitude a.s.l (0.44), temperature below —0.1 °C per year (0.33).

4.2 Crope

4.2.1 Negatively acting elements: temperature below —0.1 °C per year (—0.53), landscape dip (—0.53).

4.2.2 Postively acting elements: soil reaction (0.53), content of acceptable phosphor (0.53), absorption saturation (0.49).

Maize for corn

5.1 *Portion of cultivation*

5.1.1 Negatively acting elements: excessive moisture (—0.56), altitude a.s.l. (—0.55), temperature below —0.1 °C per year (—0.54), landscape dip (—0.48).

5.1.2 Positively acting elements: temperature above +0.1 °C per year (0.61), content of accessible phosphor (0.60), soil reaction (0.47), absorption saturation (0.47), content of $CaCO_3$ (0.46), depth of humus horizon (0.44).

5.2 Crope

5.2.1 Negatively acting elements: excessive moisture (—0.68), altitude a.s.l. (—0.63), sum of temperatures below —0.1 °C per year (—0.60), landscape dip (—0.56).

5.2.2 Positively acting elements: temperature above +0.1 °C pre year (0.68), content of accessible phosphor (0.55), depth of humus horizon (0.49).

6 *Sugar beet*

6.1 Portion of cultivation

6.1.1 Negatively acting elements: altitude a.s.l. (—0.55), landscape dip (—0.51), temperature below —0.1 °C per year (—0.56), excessive moisture (—0.53).

6.1.2 Positively acting elements: content of acceptable phosphor (0.56), depth of humus horizon (0.51), soil reaction (0.49), absorption saturation (0.45).

6.2 Crope

6.2.2 Negatively acting elements: altitude a.s.l. (—0.63), excessive moisture (—0.62), temperature below —0.1 °C per year (—0.61).

6.2.3 Positively acting elements: temperature above +0.1 °C per year (0.64), content of acceptable phosphor (0.51), soil reaction (0.46). (Table 1).

FACTORS AFFECTING THE AGRICULTURAL PRODUCTION

By means of the Warixmax method we extracted from 44 variables 9 factors clarifying 70 % of deviation with the proper value greater than 1.

Of the greatest importance is the first factor which we called the relief factor and of the climate. The factor contains 19 variables whose weight is greater than 0.60 and 4 variables with the value between 0.50—0.60. The factor clarifies 35 % of deviation.

The delimited factor clarifies the fundamental relationship between the geographic environment and the plant production on the one hand, on the other hand the relationship between the relief and climate and the soil chemism. From these relationships it is seen which elements of the geographic environment affect positively and which negatively the development of the plant production and of the soil chemism. Further on, from these relationships we can see the connection between the individual products and as to the individual elements of the geographic environment. The greatest connection with this factor has the landscape dip ($F_{2,1} = 0.71$). A relatively great relationship with this factor have also the altitude a.s.l. ($F_{1,1} = 0.55$) and the landscape articulation ($F_{3,1} = 0.54$). From the climate have with the factor a directly proportional relationship the temperature below —0.1 °C ($F_{17.1} = 0.64$) and the excessive moisture ($F_{18.1} = 0.66$).

Positively acting elements on the plant production have an indirectly proportional relationship with this factor. From the climatic characteristics the greatest indirectly proportional relationship with this factor shows the sum of temperatures above 0.1 °C ($F_{16,1}$ = —0.61) and from soils reserves acceptable phosphor ($F_{11,1}$ = —0.68), absorption saturation ($F_{9,1}$ = —0.52), soil reaction ($F_{10,1}$ = —0.57) and depth of humus ($F_{5,1}$ = —0.54).

The factor clarifies the relationship of cultivation of individual products and their productions with the geographic environment. Directly proportional with the factor is the cultivation of hardy products, such as oat ($F_{28,1}$ = = 0.58) and clovers ($F_{40,1}$ = 0.63). With this factor directly proportional are also the direct material expenses for the plant production ($F_{20,1}$ = 0.80).

Distribution of the cultivation of individual more thermophile products, their crope, as well as the gross plant production have an indirectly proportional relationship with this factor: the gross plant production ($F_{21.1}$ = = —0.94), wheat crope ($F_{23,1}$ = —0.77), barley crope ($F_{27,1}$ = —0.78), maize crope for corn ($F_{30.1}$ = —0.80), sugar bret crope ($F_{37.1}$ = —0.79) cultivation of clover ($F_{42.1}$ = —0.75) and the portion of arable soil from the agricultural soil ($F_{44.1}$ = —0.82). Indirectly proportional with this factor is also oat crope ($F_{29.1}$ = —0.56).

The second factor clarifies 8 % of deviation and we called it the factor of the altitude a.s.l. This factor contains 6 variables with weight of coefficients above 0.60 and one variable with the weight of coefficient between 0.50—0.60.

The factor clarifies the relationship between the cultivation of hardy products, mainly late potatoes, barley, then maize for green fodder and partially also wheat, and the altitude a.s.l. and the sum of tmperatures below —0.1 °C related to the altitude. This factor expresses the weight of influence of the altitude a.s.l. and the sum of negative temperatures on the cultivation of the mentioned products.

With the factor the most directly proportional relationship has the altitude a.s.l. ($F_{1,2}$ = 0.64) and the sum of temperatures —0.1 °C per year ($F_{17.2}$ = = 0.62). Further on a directly proportional relationship with this factor have the cultivations of barley ($F_{26,2}$ = 0.77), late potatoes ($F_{32,2}$ = 0.67) and the crope of late potatoes ($F_{33,2}$ = 0.48) which means that the mentioned products increase their values with the increase of the altitude a.s.l. and with the increase of negative temperatures.

An inderectly proportional relationship with this factor shows the cultivation of wheat ($F_{22,2}$ = —0.58), as well as the cultivation of maize for green fodder ($F_{38.2}$ = —0.65), which means that the cultivation of the said products decreases with the increase of the altitude a.s.l. and of negative tempertures.

The third factor expresses 5.7 % of deviation and we called it the factor of the soil depth. It contains three variables with the weight of coefficients above 0.60. The greatest relationship with this factor shows the soil depth ($F_{14.3}$ = 0.67). The factor clarifies the mutual relationships between the soil depth, the absorption capacity ($F_{8.3}$ = —0.63) and the humus portion ($F_{6.3}$ = = —0.78).

The fourth factor, the factor of the soil grain-size, expresses 5.0 % of deviation. The greatest relationship with the factor has the grain-size of the ploughed field ($F_{13.4}$ = —0.77) and the grain-size of the soil basement ($F_{15.4}$ = = —0.71) and the absorption capacity ($F_{8,4}$ = —0.53). The factor clarifies the relationship between the grain-size of the soil and the absorption capacity.

The fifth factor, the factor of clover cropes, expresses 3.9 % of deviation. With this factor the greatest relationship has the crope of clovers ($F_{41,5}$ = = 0.68) and the maize crope for green fodder ($F_{39,5}$ = 0.66). A lesser, but directly proportional relationship shows also the cropes of: clover ($F_{43,5}$ = = 0.47), late potatoes ($F_{33,5}$ = 0.49), oat ($F_{29,5}$ = 0.40) and barley ($F_{27,5}$ = = 0.47). From the interpretation of this factor it results that the bigger the crope of clovers the higher is the crope of maize for green fodder and the remaining mentioned products, although the cultivation of maize for green fodder has a very small relationship with this factor.

The sixth factor, the factor of early potatoes, clarifies the cultivation and the crope of early potatoes. It expresses 3.7 % of dispersion. With the factor the greatest relationship shows the cultivation of early potatoes ($F_{34,6}$ = 0.80) and their crope ($F_{35.6}$ = 0.64) With this factor partially corresponds also the cultivation of rye ($F_{24\ 6}$ = 0.37). A lesser, but indirectly proportional relationship with this factor shows the content of $CaCO_3$ ($F_{7.6}$ = —0.37) which means that the content of $CaCO_3$ is a certain limiting element of the cultivation and crope of early potatoes.

The seventh factor, the factor of rye, expresses 3 % of dispersion and clarifies the cultivation and crope of rye ($F_{25.7}$ = 0.60), ($F_{24.7}$ = 0.59).

The eighth factor, the factor of reserves of acceptable potassium in the ploughed field, expresses 2.8 % of dispersion and clarifies the distribution of potassium in the ploughed fields ($F_{12.8}$ = 0.72). Partially with this factor corresponds also the landscape articulation ($F_{3.8}$ = 0.52), the landscape dip ($F_{2.8}$ = 0.33) and the altitude a.s.l. ($F_{1.8}$ = 0.30). According to these relationships it is possible to judge that reserves of acceptable potassium correspond in a certain way with a higher situated and more articulated landscape.

The ninth factor, the factor of the ploughed field depth, expresses 2.5 % of total dispersion. It is a factor with the smallest relationship. The ploughed field depth relates only on the factor ($F_{4.9}$ = 0.57). (Table 2).

CONCLUSION

The landscape study by means of the factorial analysis is very important, for by means of correlations we found on the one hand the laws of the geographic environment and on the other the influence of individual components of the geographic environment on the distribution and production of agricultural products.

The knowledge only of correlations of the natural environment and production is not sufficient for the zonation of the agricultural production. for we do not know the spatial value of individual relationships. The spatial value of relationships of the geographic environment and the agricultural production represent the weights of individual factors, which should be the fundamental starting value for the zonation of the agricultural production.

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Konštantín Zelenský

VPLYV GEOGRAFICKÉHO PROSTREDIA NA SLOVENSKU NA ROZVOJ POĽNOHOSPODÁRSKEJ VÝROBY

Na základe 44 premenných (18 o geografickom prostredí, 26 o poľnohospodárstve) sme pomocou faktorovej analýzy študovali rozmiestnenie pestovania a úrody hlavných plodín vo vzťahu ku geografickému prostrediu. Pomocou Warimexovej metódy sme vyextrahovali 9 faktorov: *1* — faktor reliéfu a klímy, *2* — faktor nadmorskej výšky, *3* — faktor hĺbky pôdy, *4* — faktor zrnitosti pôdy, *5* — faktor ďatelín, *6* — faktor skorých zemiakov, *7* — faktor raži, *8* — faktor prístupného draslíka v oráčine, *9* — faktor hĺbky oráčin.

Tabuľka 1. Korelačné koeficienty.

Tabuľka 2. Rotovaná faktorová matica (počet faktorov 9).