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ЕФЕКТИВНІСТЬ І ЕКОНОМІЧНИЙ ПОТЕНЦІАЛ ҐРУНТІВ В СЛОВАЧЧИНІ

На основі дев'тирічних даних урожайності з 281 агропідприємств Словацької Республіки за допомогою регресійного аналізу виведено залежність потенційної продуктивності ґрунтів. Підтверджено високу ефективність і продуктивність потенціалу ґрунтів. Високу залежність встановлено для 265 даних по озимій пшениці (r = 0,634) і ярому ячменю (r = 0,617). Відносно низька (хоча статистично достовірна) ця залежність для картоплі і кукурудзи на силос.

У ґрунтових одиницях було показано об'єднання у відповідні категорії врожайності основних сільськогосподарських культур (озимої пшениці, озимого жита, ярого ячменю, кукурудзи, гороху, ріпаку, картоплі, цукрових буряків, кукурудзи на силос і багаторічних кормових культур), залежність від типів ґрунтів, типолого-виробничої категорії сільгоспугідь, кліматичної області, ризику ерозії ґрунту.

Результати аналізування доводять, що високий потенціал продуктивності за типом ґрунту в Словаччині мають чорноземи, потім слідують лучно-чорноземні ґрунти, бурі лісові лесивовані ґрунти, алювіальні ґрунти, слаборозвинені ґрунти, підзолисті ґрунти, псевдопідзолисті ґрунти, дерново-борові ґрунти і, нарешті, дерново-карбонатні ґрунти. При знанні реальної продуктивності для конкретного місця (з відомими характеристиками ґрунту) може бути отримана фактична потенційна продуктивність.

Неоднорідний потенціал ґрунтів продемонстровано на формуванні врожаю культур з економічним диференціюванням параметрів. Без державних субсидій приблизно близько 60 % ґрунтів нерентабельні для кукурудзи і цукрових буряків. Для картоплі це майже 75 %. Загалом для всієї продукції рослинництва в Словаччині за нинішньої економічній ситуації без субсидій, не рентабельні приблизно 54,4 % ґрунтів, 13,9 % з низькою рентабельністю, 7,3 % із середньою рентабельністю, 10,6 % з високою і 13,8 % ґрунтів з дуже високою рентабельністю.

Ключові слова: *потенціал продуктивності ґрунту, параметри ґрунту, врожайність.*

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ЭФФЕКТИВНОСТЬ И ЭКОНОМИЧЕСКИЙ ПОТЕНЦИАЛ ПОЧВ В СЛОВАКИИ

На основе девятилетних данных урожайности с 281 агропредприятия Словацкой Республики с помощью регрессионного анализа выведена зависимость потенциальной продуктивности почв. Подтверждена высокая эффективность и производительность потенциала почв. Высокая зависимость установлена для 265 данных по озимой пшенице (r = 0,634) и яровому ячменю (r = 0,617). Относительно низкая (хотя статистически достоверная) эта зависимость для картофеля и кукурузы на силос.

В почвенных единицах было показано объединение в соответствующие категории урожайности основных сельскохозяйственных культур (озимой пшеницы, озимой ржи, ярового ячменя, кукурузы, гороха, рапса, картофеля, сахарной свеклы, кукурузы на силос и многолетних кормовых культур), зависимость от типов почв, типолого-производственной категории сельхозугодий, климатической области, риска эрозии почвы.

Результаты анализирования доказывают, что высокий потенциал продуктивности по типу почвы в Словакии имеют черноземы, затем следуют лугово-чернозёмные почвы, бурые лесные лессивированные почвы, аллювиальные почвы, слаборазвитые почвы, подзолистые почвы, псевдоподзолистые почвы, дерново-боровые почвы и, наконец, дерново-карбонатные почвы. При знании реальной производительности для конкретного места (с известными характеристиками почвы) может быть получена фактическая потенциальная продуктивность.

Неоднородный потенциал почв продемонстрирован на формировании урожая культур с экономическим дифференцированием параметров. Без государственных субсидий приблизительно около 60 %

почв нерентабельны для кукурузы и сахарной свеклы. Для картофеля это почти 75 %. В целом для всей продукции растениеводства в Словакии при нынешней экономической ситуации без субсидий, не рентабельны приблизительно 54,4 % почв, 13,9 % с низкой рентабельностью, 7,3 % со средней рентабельностью, 10,6 % с высокой и 13,8 % почв с очень высокой рентабельностью.

Ключевые слова: *потенциал производительности почвы, параметры почвы, урожайность.*

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PRODUCTIVITY AND PROFITABILITY POTENTIAL OF SOILS IN SLOVAKIA

Based on yield data of 281 agricultural subjects of the Slovak Republic for the period of 9 years, by help of regression analyses, the yield dependence from soil productivity potential was determined in the paper. High evident yield and soil productivity potential was confirmed. Highest dependence for balanced 265 data set show winter wheat (r = 0,634) and spring barley (r = 0,617). Relatively lowest (although statistically high evident) is this dependence for potatoes and ensilage maize.

By soil units aggregation into proper categories was expressed yields of main agricultural crops (winter wheat, winter rye, spring barley, maize, pea, rape, potatoes, sugar beet, ensilage maize and perennial fodder crops) dependence not only from soil types, farmland typological-productivity categories, climatic region, sloping and soil erosion risk, was expressed.

The results instructively prove, highest productivity potential by soil type have in Slovakia Chernozems followed by Phaeozems, Orthic Luvisols, Fluvisols, Regosols, Luvisols, Pseudogleys, Cambisols and finally Rendzinas. By knowledge of real productivity assumptions, for concrete location (with known proper soil characteristics) actual productivity potential can be derived.

Heterogenous our soils yield forming potential is demonstrated on crop production economical parameters differentiation. Without governmental subsidies is approximately 60 % soils not profitable for maize and sugar beet, respectively. At potatoes this is almost 75 %. Generally for the crop production can be stated, without subsidies is for cropping in Slovakia, at present economical situation 54,4 % soils not profitable, 13,9 % low

profitable, 7,3 % medium profitable, 10,6 % high profitable and 13,8 % very high profitable.

Keywords: *soil productivity potential, soil parameters, productivity of land.*

Introduction. The manner o rural country use is/will be considerably influenced by soil productivity potential. It is logic, also at very good structure o soil productivity potential use, will still be dominant yield and economical results differentiation depending on conditions heterogeneity and concrete soil. Soil quality relationship to crop production attained used to be expressed by the fertility or soil productivity potential. Soil quality relationship to economical parameters reached can be assessed based on profitability (economical suitability) o given crop.

Several authors were dealing in relationship yield – soil in the past. Hraško, 1983 mentioned, soil grouping and zoning by their suitability for concrete crops and in correspondence with it elaboration rational structure o cropped areas, is one of most important conditions of arable land productive capability increase and reaching high stable yields. Džatko et al., 1979 stressed, genetic soil types productive capability is influenced also by climatic and orographic conditions, their effect used to be more marked than the differences among two or three genetic soil types in the same climatic, natural conditions.

Today is shortage of such works – concentrated with soil grouping by their suitability for the crops, and in case they are available, the solution is only qualitative position, whereby is stated, whether the soil is or not suitable. Only rarely is defined suitability rate or degree (Džatko, 1981, 1985, Džatko, Vilček, 1993, Klečka, Korbíni, 1975, Vilček, 1999, Hronec, 2000, Lisnyak, 2010) and almost totally are absenting economical characteristics.

This paper content and target is yield testing of crops in relationship to soil quality, determination of soil properties, selected for soil productivity potential differentiation and soil categorization from the view of given crops profitability.

Materials and Methods. With the aim of the targets fulfilling we were coming out of following data:

- the Soil Science and Conservation Research Institute database – the System of Bonited Pedo-ecological Units (BPEJ) and their point assessment in 100-point basis (Džatko, 1979),
- the typological production farmland categorization (Džatko, Dubovcová, 1985, Džatko, Vilček, 1993), soil categorization by erosion risk (Jambor, Ilavská, 1998), and bonity soil parameters categorization (Linkeš, Pestún, Džatko, 1996),
- really reached yields of main crops (winter wheat, winter rye, spring barley, maize, pea, winter rape, potatoes, sugar beat, ensilage maize and perennial fodder crops),
- really attained economical parameters (receipts, profits, cost) main crops and crop production total.

Concrete yield data and crop production economics data were obtained for the

period 1990 to 1998 directly from agricultural enterprises. We have balanced data obtained from 281 agricultural subjects farming in heterogenous natural conditions, totally on area 556 thous. ha farmland, i.e. 23 % total farmland of Slovakia.

The indexes studied dependence from soil production capability of the farms expressed by mean point BPEJ evaluation in 100-point scale, was tested by non linearly polynomic regression analysis. Based on this dependence, we have determined regression equations for every crop, by help of them every BPEJ yield potential option was coordinated as well as its potential economical parameters (profits, costs, yield or loss). Profitability rate was calculated in % as ratio profit/costs. By help of software filters for the soil representatives soil parameters and categories and real possible mean yields, and predicted profitability rate were subsequently calculated. By means of Geographic Information System (GIS) ARC INFO were on back ground of vector bonity maps planary differentiated and quantified in scale 1:5000 potential profitability rate of crop production and selected crops upon of Slovakia.

Results and discussion. Crop production level most often is expressed by attained hectare yields. This is indicator affected by many factors. Main yieldcreating factor is introduced by a location pedoclimatic conditions. Yieldforming process is multi-depending from human factor, however in this work is only expressed relationship of soil point value or value of selected parameters to main crops hectare yields.

Relatively considerable yield database of balanced enterprises enabled us to determine their dependence from soil productivity potential (expressed by point-value). Polynomic regression dependence confirmed high significant yield correlation with soil productivity potential. Most close dependence in assessed set of 265 data was calculated for wheat (r = 0,634), and spring barley (r = 0,617). Relatively lowest (though statistically high significant) was demonstrated by potatoes and silage maize. The regression dependences calculated were in further step used for determination of potentially optional yields of the crops for soil point scale, and based on it also for every of Bonited Pedo-ecological Units (BPEJ). Instructively was here confirmed and concretized the fact, yield height in large extent is depending from soil quality.

In this way is possible to derive really possible some soil productivity parameters (BPEJ) for concrete crop. Real yield values in the level of Main Soil Units (HPJ) were published by Vilček, 1999 and in the level of the BPEJ they are for our disposal in the Soil Science and Conservation Research Institute database at Bratislava.

By the BPEJs cumulation by required parameters was subsequently possible to determine the crops analysed predicted yields. In this way were determined potential productional assumptions for farmland by soil types, typological-production categories of arable land, sloping, climatic region and erosion risk category.

The results show instructively, highest yieldforming potential is consecutively typical for Chernozems – Mollic Fluvisols – Orthic Luvisols – Fluvisols – Regosols –

Luvisols – Pseudogleys – Cambisols – Rendzinas. Concrete yield values by the soil types for given crop set is presented in Tab. 1.

Presumposed hectare yield differenciation in dependence from the typological-production soil category is highlighted in Tab. 2. E.g. there is presented, on most productive Slovakian soils 1 ha could produce up to 5,78 t wheat, while low productive soil only 3,88 t, i.e. here is more than 32 % production decrease. Also from this view, furthermore if present economical profitability rate is at wheat yields above 4 $t.ha^{-1}$, one of decisive aspects at cropping structure decision is just soil production capability.

Our soils yieldforming potential analysis in various climatic regions of Slovakia is confirming and concretizing assumptions of soil productivity potential decrease in the direction towards less productive climatic conditions. Yield decrease is objective reality that should be considered at crop zoning and crop production, as a whole, structure. E.g. at winter wheat is assumption of yield decrease in least beneficial climatic region 1,7 $t.ha^{-1}$, i.e. 32 %, when compared to the best region.

Soil productivity potential decrease takes place also under influence of arable land sloping increase. Terrain configuration also plays important role. Objectively worse productional conditions occure at more complicated and sloping arable land. E.g. at winter wheat is typical fact, with sloping increase 1^{o} yield is reduced approximately by 0,15 $t.ha^{-1}$.

Table 1. Potentially production assumptions for soil types [$t.ha^{-1}$]

Crop	Chernozem	Phaeozem	Fluvisol	Orthic luvisol	Regosol	Albic luvisol	Pseudogley	Cambisol	Rendzina
winter wheat	5,45	5,22	4,87	4,88	4,66	4,43	4,15	4,08	3,90
winter rye	4,05	3,91	3,73	3,73	3,62	3,51	3,38	3,35	3,28
spring barley	4,64	4,41	4,09	4,09	3,92	3,70	3,48	3,43	3,29
maize	4,84	4,55	4,27	3,99	4,10	3,71	3,54	3,51	3,45
pea	2,72	2,52	2,27	2,27	2,16	1,99	1,85	1,82	1,73
winter rape	2,64	2,53	2,36	2,37	2,24	2,13	1,97	1,93	1,82
potatoes	16,38	14,93	13,51	13,35	13,19	12,32	12,06	12,10	12,08
sugar beet	33,58	33,32	32,71	31,88	31,62	29,59	27,59	26,90	25,72
ensilage maize	28,05	26,30	24,51	24,34	24,00	22,88	22,39	22,39	22,23
perennial fodder crops	8,72	7,94	7,15	7,07	6,93	6,44	6,23	6,23	6,17

With sloping are narrowly connected processes of water erosion that have been resulting to annual runoff of most fertile soil particles at more than 55 % farmland. This negatively influences soil productivity and economical parameters attained. From our calculations is resulting rapid yield reduction, particularly between the

category of land without erosion and moderately or weakly eroded soils (at winter wheat this is approximately 17 %). Among other erosion categories (severely and extremely eroded soils) these differences are not so sharp.

Table 2. Potentially production assumptions for soil typological-productivity categories [t.ha^{-1}]

Crop	typological-productivity categories of soils									
	O1	O2	O3	O4	O5	O6	O7	OT1	OT2	OT3
winter wheat	5,78	5,62	5,28	4,87	4,55	4,23	3,88	4,32	4,03	3,76
winter rye	4,36	4,16	3,94	3,72	3,56	3,42	3,27	3,46	3,33	3,22
spring barley	4,98	4,81	4,46	4,08	3,80	3,54	3,27	3,62	3,39	3,18
maize	5,35	5,02	4,44	3,92	3,62	3,52	-	-	-	-
pea	3,03	2,87	2,56	2,26	2,06	1,88	1,72	1,93	1,78	1,67
winter rape	2,78	2,72	2,57	2,36	2,19	2,01	1,81	2,07	1,90	1,74
potatoes	18,76	17,43	15,10	13,33	12,49	12,05	12,03	12,18	12,01	12,13
sugar beet	33,43	33,71	33,43	31,40	28,43	26,52	-	-	-	-
ensilage maize	30,87	29,31	26,53	24,31	23,15	22,44	22,16	22,65	22,26	22,18
perennial fodder crops	9,98	9,28	8,04	7,06	6,55	6,24	6,14	6,34	6,17	6,15

O1 - most productive arable soils; O2 - high productive arable soils; O3 - very productive arable soils; O4 - productive arable soils; O5 - medium productive arable soils; O6 - less productive arable soils; O7 - low productive arable soils; OT1 - medium productive arable soils and very productive grassland; OT2 - medium productive arable soils and medium productive grassland; OT3 - low productive arable soils and less productive grassland

It is logical, heterogenous yiledforming potential of our soils, as a rule, is demonstrated in crop production economical parameters differentiation. From this view surely is interesting overview of farmland presentation with aspect on economical profitability of the crops grown (Tab. 3). based on our calculation it is revealed, without any government subsidies approximately 60 % soils is not profitable for maize sugar beet, respectively. At potatoes this is almost 75 %.

Generally for all the crop production can be stated, without subsidies, in conditions of present economical situation, is in Slovakia 54,4 = soils not profitable, 13,9 % low profitable, 7,3 % medium profitable, 10,6 % high profitable and 13,8 % soils very high profitable (Fig. 1).

Table 3. Soils share from economical profitability view point of cultivated plants in %

Profitability category	winter wheat	maize	sugar beet	winter rape	potatoes	Crop production total
Soil non profitable	36,3	59,5	61,0	31,3	74,9	54,4
Soil low profitable	15,8	3,1	1,3	31,2	4,9	13,9
Soil medium profitable	13,7	12,9	3,4	17,3	6,1	7,3
Soil high profitable	21,4	15,4	22,4	13,6	9,3	10,6
Soil very high profitable	12,8	9,1	11,9	6,6	4,8	13,8

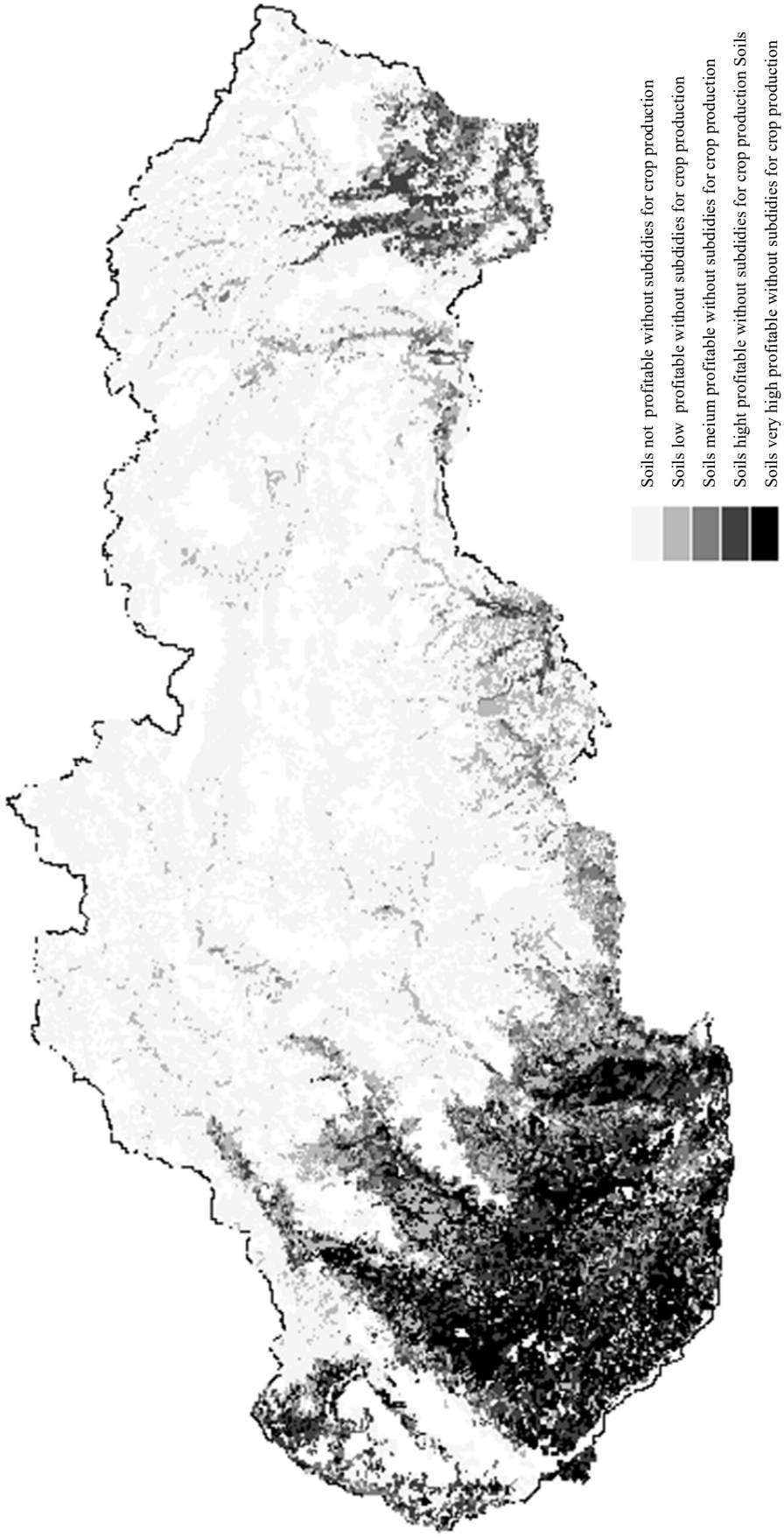

Figure 1. Farmland categorization with aspect to crop production potential profitability

Conclusions. The data obtained confirm, one of the causes of different yields is heterogeneity of soils and their characteristics. This phenomenon should therefore play decisive role at farming planning. By knowledge of productional presumposions, presented in this paper, is possible for concrete site (with well know soil characteristics) to derive soil potentially optional yield forming potential.

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