POTENTIALS OF AGRICULTURAL CROPS CULTIVATION WITH REGARD TO SOIL CONDITIONS

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Abstract: *Soil environment, as integral part of Earth issues, plays important role at defining of ecosystem functioning and life quality of human. This environmental issue significantly influences the state and evolution of ongoing biotic and abiotic processes. Most frequently the soil is related to production of agricultural crops quantity and quality of them is directly affected by soil properties. In the paper the soil environment and its influence on the potentials of arable crops cultivation was analysed through the following parameters: soil type, soil-climatic conditions, sloppiness, slope orientation, skeleton content and texture. With regard to mentioned parameters there were defined areas of very suitable, suitable, less suitable and unsuitable ones for cultivation of 15 arable crops, 12 types of vegetable and 9 types of bio-energetic crops. It is possible to state that potentials of crops cultivation directly reflect the quality of soil environment.*

Key words*: Soil types, site conditions, crop yields, field crops, vegetables, bio-energetic crops, suitability of crop cultivation*

INTRODUCTION

Economic aspects predominate in decisions on structure of agricultural land use and distribution of cultivated crops. Such a way and view on land use induces that in traditional natural conditions there often can be found non-traditional crops. Successfulness of their cropping then is directly related to mutual tolerance of given crop and environment.

Till now presented optimisation systems of spatial crop allocation (e.g. Benda et al., 1963; Korbíni and Facuna, 1978) were based on the need "to meet the plan" or the need to provide to population sufficient amount of food. From this reason there was increased pressure on the soils with highest quality that were earmarked for strategic and economy significant crops. Placing the remaining crops was oriented to worse natural and site conditions.

At present, also with regard to making free of mentioned pressure, it can be seen that to the theory of traditional cropping areas in practice we can have some reservations. As typical example we can mention potatoes as well as other crops cultivation of them is gradually oriented to lowland locations where they were almost non-cultivated. Conversely some thermophilic crops such as grain maize are occurring also in climatically less favoured sub-mountains and mountains areas. It is necessary to take into account also ongoing climate change that may play dominant role at territorial crop distribution. It is noticeable that optimal spatial distribution of crops in agricultural land requires individual

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approach and respecting the features of given crop in concrete site. Such procedure requires sufficiency of information and access to broad base of knowledge from different disciplines.

MATERIAL AND METHODS

Evaluation of soil with regard to cultivation of agricultural crops is based on exact and potential data on given crop. Because the suitability of cropping is qualified especially by really reached production, this factor has played crucial role at categories creation. Concrete data on yields and economic parameters were obtained from more than 250 agricultural enterprises as well as from issues of Statistical office of Slovak Republic (temporal yield series of selected crops). Because production and economic parameters of successfulness of cropping are directly related to soil-climatic conditions there were analysed and used also data on climatic regions of Slovakia, sloppiness, skeleton content, soil thickness, soil types, point value of soil productivity as well as typological-production soil categories. These data were taken from soil information system (containing also spatial distribution of soil-ecological units) that is administrated by Soil Science and Conservation Research Institute (Linkeš et al., 1996, Džatko 2002).

Dependence of observed indicators on soil production function, expressed as point value in 100 points was tested nonlinear polynomial regression analysis. On the base of this relationship were estimated regression equations with help of them to each soil-ecological unit (BPEJ) was assigned potential yield of individual crops, share of these crops within crop rotation as well as potential economic parameters (gain, costs, benefit or loss). With help of geographic information system ArcMap was on the base of vectorized bonity maps in scale 1:5000 as well as aerial distribution of observed factors was differentiated and quantified the degree of suitability of soils for cropping of arable crops. Quantification of suitability of arable crops cultivation was based on the following data:

- database of Soil science and Conservation Research Institute on soil-ecological units (BPEJ) and evaluation of these units in 100 point scale (Džatko 2002)
- soil categorization by climatic region, category of sloppiness, soil texture and skeleton content (Linkeš et al., 1996)
- typological and production categorization of agricultural soils (Džatko 2002) and database of production and economic parameters by BPEJ (Vilček 1999)
- really attained crop yields on the level of farm, district and region
- economic parameters (proceeds, financial gains, costs) at crop cultivation and real crop distribution on arable land.

RESULTS AND DISCUSSION

Agricultural land and especially soil represent great natural potential than can be used by human according to his needs and interests. It is capital that in the interest of sustainable use of natural resources must not be bargain away and degraded, respectively. Global environmental strategy and policy heads towards the landscape use that is ecologically acceptable, economically effective and socially fair. With mentioned philosophy corresponds such use of agricultural soil where crop requirements are in harmony with environment properties.

Knowledge on individual crop demands on surrounding environment as well as knowledge on potential of given site is the basic condition for effective use of landscape. Even from this reason it is necessary permanently refer to suitability of crops/plants cultivation on agricultural soils. Therefore in this paper is focused on crops usually cultivated in our conditions (including vegetable) as well as crops that can be used from view of global problems (energetic crops). For each crop were defined areas very suitable, suitable, less suitable and unsuitable for its cultivation. This categorization is illustrated also by map schemes that with regard to limited space are not introduced. These materials consist of general sources obtained from detail information databases especially on soil properties that were processed in geographical information system ArcMap.

With regard to heterogeneous natural conditions, potential of agrarian land of Slovakia shows to be regionally different. Most favourable conditions for cultivation of agricultural crops are in lowland conditions where also occur the soils with higher quality. It does not mean that other regions can not be competitive to mentioned conditions. In every area it is possible to find the crops for cropping of them are good preconditions and thus also economic interesting.

The results shows that the highest potential for cropping of cultural plants by soil types in Slovakia have Haplic Chernozems, followed by Mollic Fluvisols, Haplic & Calcic Luvisols, Fluvisols, Regosols, Albic & Albi-Distric Luvisols, Planosols, Cambisols and Rendzic Leptosols (by WRB 1994 and Kolektív 2000). More detail soil categorization by sub-types and varieties (taxonomical unit of third order used in Slovak national soil classification) shows that with regard to better moisture regime the most productive soil is calcaric Mollic Fluvisols. Concrete yields of selected crops by soil types are introduced Table 1.

Tab. 1: *Yield potentials by soil types (t.ha^{-1})*

Crop	**Soil type**								
	1	2	3	4	5	6	7	8	9
Winter wheat	5.45	5.22	4.87	4.88	4.66	4.43	4.15	4.08	3.90
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
Grain 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
Oil 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
Silage maize	28.05	26.30	24.51	24.34	24.00	22.88	22.39	22.39	22.23
Perennial forages	8.72	7.94	7.15	7.07	6.93	6.44	6.23	6.23	6.17

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Source: authors

In comparison to arable crops and vegetables, the productivity of soil types with regard to several energetic crops and their different demands on the environment has another hierarchy.

Potentially achievable biomass production of agricultural crops is significantly influenced by climatic conditions. There is observed that dry matter production per hectare of agricultural soils is in very could and moist climatic region lover nearly by half in comparison to very warm and dry climatic conditions of lowlands. It is objective reality that is necessary to take into account at spatial allocation of crops and structure of crop production as whole.

Decline of production due to increasing sloppiness is markedly evident at cultivation of agricultural crops on arable land. Research results confirm inverse relation of crop yields and sloppiness. Especially sensitive on this factor are vegetables. So, most of them are cultivated on flat land because on the slope increases risk of several water erosion.

Slope orientation plays very important role at selection of crops. Especially significant is the productivity difference of soil situated on south oriented slopes in comparison to the soil placed on north-oriented slopes. While on south-oriented slopes the potential of total biomass production of cultivated crops is 9.6 t/ha of dry matter, on north-oriented slopes it is only 6.7 t/ha that means lover by 31%. The factor of slope orientation is especially important at placing of thermophilic crops.

Skeleton content as most coarse fraction of soil texture also significantly influences formation of biomass of agricultural crops. In average soils without skeleton are capable to produce 11.8 T/ha DM of biomass while the soils with high content of skeleton only 2.4 t/ha. Logical differences in observed parameters were noted also at categories of soil depth and soil texture. Distribution of individual suitability categories of agricultural soils for cultivation of main field crops/plants are introduced in the following tables.

Tab. 2: *Categorization of soils by cropping suitability of typical field crops (%)*

Crop	Soils			
	very suitable	suitable	less suitable	non-suitable
Winter wheat	28.7	25.4	9.2	36.7
Rye	12.0	21.2	3.1	29.7
Spring barley	20.0	23.8	24.1	32.1
Oats	23.6	20.1	19.2	37.1
Grain maize	14.4	16.8	17.1	51.7
Pea	15.6	20.9	29.2	34.3
Bean	19.0	11.2	3.8	66.0
Sugar beat	19.9	18.2	3.1	58.8
Potatoes	11.8	12.3	3.8	43.1
Oil rape	23.2	31.0	1.8	32.0
Sunflower	18.8	24.9	1.6	39.7
Soya	25.0	19.9	3.7	51.4
Poppy	18.1	14.7	22.0	45.2
Flax	14.9	24.6	17.4	43.1
Hop	16.7	2.5	0.1	80.7

Source: authors

Tab. 3: *Categorization of soils by cropping suitability of field vegetable (%)*

Vegetable	Soils			
	very suitable	suitable	less suitable	non -suitable
Cabbage, kale, kohlrabi	22.3	4.6	4.9	68.2
Chinese cabbage, cauliflower, broccoli	21.8	3.6	4.6	70.0
Celery	20.3	3.9	1.9	73.9
Carrot, parsley, parsnip	16.8	2.2	3.6	77.4
Redroot	16.6	4.2	3.9	75.3
Cucumber	12.1	5.3	0.1	82.5
Melon	1.7	9.2	2.1	87.0
Pumpkin, courgette, pattypan squash	14.7	5.4	1.0	78.9
Pepper	8.2	3.0	0.8	88.0
Tomato	14.3	5.0	0.4	80.3
Onion, garlic, leek	3.0	15.2	2.0	79.8
Asparagus	2.4	1.2	0.4	96.0

Source: authors

Tab. 4: *Categorization of soil by cropping suitability of energetic crops (%)*

Crop	Soils			
	very suitable	suitable	less suitable	non-suitable
Poplars and willows	23.8	14.8	20.5	40.9
Sorghum	6.2	7.8	18.2	67.8
Amaranth	12.4	5.3	14.7	67.6
Hemp	8.1	9.0	28.7	53.3
White sweet clover	16.0	28.1	14.5	41.4
Giant knotweed	11.5	16.4	7.2	64.9
Sorrel of Uteusch	12.2	13.2	13.9	60.8
Reed canary grass	14.6	3.5	18.3	63.6
Silvergrass	11.7	7.2	11.6	69.5

Source: authors

CONCLUSIONS

Human existence is also on the start of new millennium still dependent on potentials of natural environment. Change in societal, political and social conditions directly influences the landscape use. In this context agrarian landscape and especially soil plays unsubstitutable role especially at provision of trophic function of whole Earth ecosystem.

Although targeted cultivation of cultural plants helps to human to solve his food security, agri-ecosystems are still more and more used for non-food purposes. At present, especially in developed countries that have not problems with food sufficiency, it is forced through the trend of use of agricultural soil for cropping of energetic crops. It is possible to assume that agricultural soil in the future will be used on other non-production or ecological purposes. From this aspect it is useful to know the conformity of given soil to cropping of concrete crops and limiting factors for their cultivation. The paper pointed out on the potential of field crops cultivation from view of soil properties.

Acknowledgement: The paper was prepared on the base of results of APVV project No. 0124-06 and simultaneously isalso the output of VEGA project No. 1/4366/07, and RTD project Multifunctional use of Slovak soils No. 2006 UO 27/090 03 03/090 03 19 supported by Ministry of Agriculture SR.

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POTENCIÁLY PESTOVANIA POĽNÝCH PLODÍN VZHĽADOM NA PÔDNE PROSTREDIE

Zhrnutie

Pôdne prostredie, ako neodmysliteľná súčasť zložiek Zeme, zohráva dôležitú úlohu pri definovaní kvality života ľudí i ostatných ekosytémov. Výraznou mierou ovplyvňuje vývoj a stav prebiehajúcich biotických i abiotických procesov. Najčastejšie je pôda spájaná s produkciou poľnohospodárskych plodín, kvalita i kvantita ktorých sa od pôdnych vlastností priamo odvíja.

V príspevku sme pôdne prostredie a jeho vplyv na potenciály pestovania poľných plodín analyzovali parametrami: pôdny typ, pôdno-klimatické pomery, svahovitosť, expozícia svahu , skelet a zrnitosť (textúra). Vzhľadom na uvedené parametre sme následne pre 15 klasických poľných plodín, 12 druhov zeleniny a 9 tzv. energetických rastlín vygenerovali oblasti Slovenska pre ich pestovanie veľmi vhodné, vhodné, málo vhodné a nevhodné. Môžeme konštatovať, že potenciály pestovania poľných plodín na Slovensku priamo odrážajú kvalitu pôdneho prostredia.

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