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SOIL CLASSIFICATION AND ASSESSMENT OF THEIR PRODUCTIVITY POTENTIALS IN IMPORTANT REGIONS OF CEREAL CROPPING

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Abstract. Our paper explains the classification and functional assessment of agricultural sites by using uniform criteria and indicators. This information could be useful for over-regional comparative assessments of overall soil quality and site-specific sustainable agricultural use of soils. We studied some representative soil profiles in globally important regions of cereal cropping. These regions are Europe, Northern China, Prairie regions of North America, and steppes of Western Siberia and Kazakhstan. Soils were classified acc. to the World Reference Base for Soil Resources (WRB 2006) [1], and their quality was assessed by the method of the Muencheberg Soil Quality Rating (M-SQR) [2]. The majority of sites under study were agricultural research sites. Their management system and crop yield data were well documented. In case of experimental sites on farmers' fields, these data were estimated by the farm manager.

The taxonomic soil classification acc. to the WRB 2006 and national soil classification keys allocate names to soils. These names are associated with typical processes and properties but do not provide much information about soil quality and crop yield potentials. The indicator-based M-SQR was practicable and yielded in plausible soil quality scores. Depending on land use intensity and data availability, M-SQR scores can explain about 50-80 % of the crop yield variability. We conclude that this method has potential for the estimation of the overall soil quality and crop yield potentials of small grain cereals, consistently over different scales and regions. The combination of the WRB 2006 with M-SQR scores provides sufficient information about both soil properties/processes and their quality for cereal cropping. This kind of soil characterisation meets the basic conception of V.V. Dokuchaev [3].

Key words: soil classification, soil functions, soil quality, crop yield, sustainable agriculture, land rating.

INTRODUCTION

Global key issues of the 21st century, such as feeding the uncontrolled growing world population, scarcity of water and energy, desertification, environmental pollution or loss of biodiversity are closely associated with soil use and management [4, 5]. There is strong demand for sustainable land use strategies and systems. This requires a reliable characterisation and assessment of soils in the trans-national scale. Suitable classification systems should be developed, tested and established. Already Dokuchaev pointed on the need to classify soils in a way that comprises information about crop yield potentials[3].

There were some successful efforts to create a framework for the international classification, correlation and communication of soils (WRB 2006) over the past 15 years. This international classification system like most national soil classification systems, provides soil names. These names include information about typical processes, features and properties of most soils but do not provide enough information about the overall soil quality and crop yield potentials [6]. There are also a number of soil quality evaluation or rating systems existing in almost all countries of the world. However, different site conditions and empirical assessment scales prevent their applicability in the trans-national scale. Rating systems of overall soil quality that are practicable over different scales, ranging from field scale to the global scale, were not yet known. The Muencheberg Soil Quality Rating [2] shall close this gap. It shall provide a reliable and simple evaluation of soil quality and crop yield potentials. This approach has been successfully tested on some soils in important agricultural regions of the world [7, 8]. We report on results on major global cereal cropping regions.

MATERIAL AND METHODS

We dug soil profiles on experimental sites in main regions of cereal cropping: Europe, Western Siberia and Kazakhstan, Northern China and in North America. Profiles were classified according to national keys and the World Reference Base for Soil Resources (WRB 2006). Soil quality was evaluated based on the field manual of the Muencheberg Soil Quality Rating [2]. The M-SQR provides a rating of the overall soil quality in a 100-point scale. It is based on a set of crop-yield relevant indicators and comprises criteria of soil texture, structure, relief, soil moisture, temperature and others (Figure 1). Monthly data of temperature, precipitation and potential evapotranspiration, which are required for the assessment of the soil temperature regime and the drought risk, came from the FAO climate data basis New Loc Clim 1.10 [9].

We followed basic rules of site assessment given by Dokuchaev [3] and tested the relationships between soil quality and crop yields. As sites were located on agricultural research stations or experimental fields, crop yield data were provided by research reports. In case of experimental fields on practical farmer`s paddocks, we accepted the estimates given by the farm owners or local managers. Date of cereal yield were stratified according to the level of inputs of fertiliser input into 0) Non-fertilised, 1) low to medium fertiliser rates (< 100 kg/ha N) and 2) High-input integrated farming (> 100 kg/ha N). Table 1 gives an overview of sites under study sorted by the aridity index (precipitation divided by potential evapotranspiration).

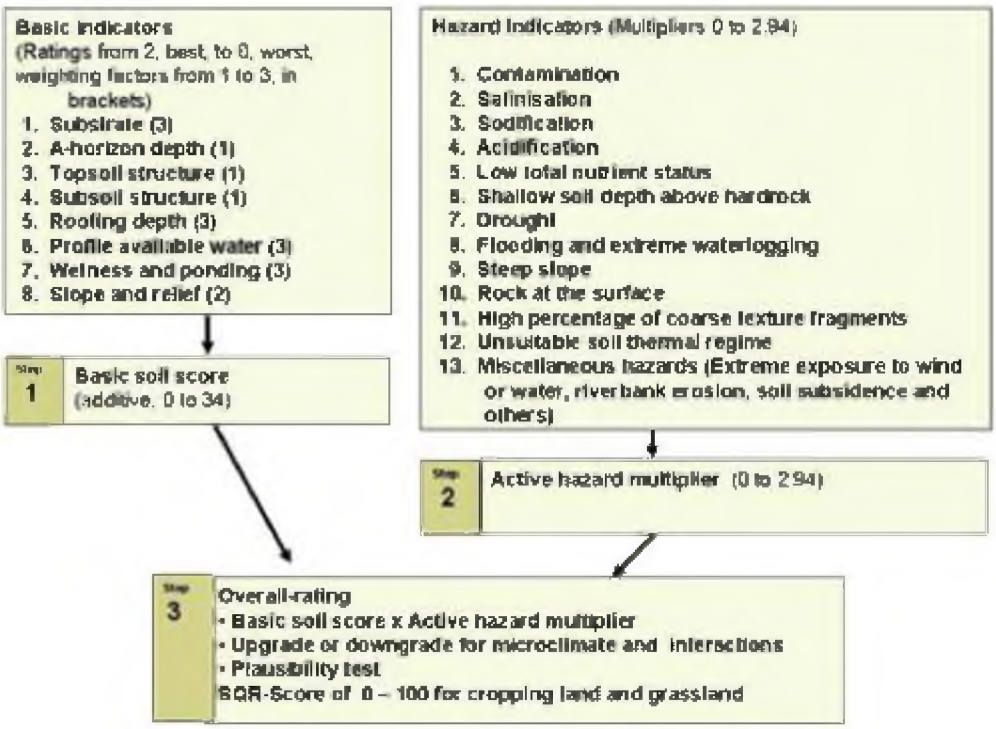

Figure 1: Scheme of the Muencheberg Soil Quality Rating [2]

Table 1- List of sites under study
a) Europe

Location (State. region)	**Geo-Position**[1)]	**Climate**[2)]	**Vegetation zone**	**Soils/ Parent material**[3)]
Schuby (DE)	54.52/9.44/20	925/8.0/1.76 (humid)	Mixed forest	Podsols/ LPO
Dalheim (L)	49.55/6.27/332	875/8.3/1.47 (humid)	Mixed forest	Cambisols/ UW
Vyatkino (RF. Vladimir)	56.06/40.49/152	698/3.5/1.44 (humid)	Mixed forest	Albeluvisols/ M
Shebanzevo (RF. Moscow	55.31/37.81/179	688/4.9/1.43 (humid)	Mixed forest	Luvisols/ DL
Edinburgh (UK)	55.83/-3.20/200	670/8.6/1.32 (humid)	Broadleaf forest	Stagnosols/ M
Haus Duesse (DE)	51.63/8.18/81	828/9.0/1.30 (humid)	Broadleaf forest	Luvisols/ Loe
Colmen (F)	49.35/6.55/236	802/8.7/1.23 (humid)	Broadleaf forest	Luvisols/ SW
Lechenich (DE)	50.80/6.76/85	776/9.5/1.12 (humid)	Broadleaf forest	Luvisols/ Loe
Panino (RF. Kursk)	51.53/36.11/250	608/5.6/1.08 (humid)	Steppe	Chernozems/ Loe
Gonki (RF. Belgorod)	50.74/36.52/230	610/7.4/0.99 (subhumid)	Steppe	Chernozems/ Loe
Ostritz (DE)	51.04/19.93/250	657/8.2/0.95 (subhumid)	Broadleaf forest	Luvisols/ Loe
Krasnodar (RF. Krasnodar)	45.06/38.85/20	694/11.5/0.92 (subhumid)	Steppe	Chernozems/ Loe
Oktjabrskij (RF. Krasnodar)	45.20/38.30/8	694/11.5/0.92 (subhumid)	Steppe	Fluvisols/ A
Guelzow (DE)	53.81/12.07/8	591/8.4/0.91 (subhumid)	Broadleaf forest	Stagnosols/ M
Thyrow (DE)	52.25/13.23/42	585/8.7/0.91 (subhumid)	Broadleaf forest	Cambisols / LPA
Flakkebjerg (DK)	55.31/11.39/40	494/8.3/0.91 (subhumid)	Mixed forest	Luvisols/ M
Dedelow (DE)	53.37/13.8/47	571/7.9/0.89 (subhumid)	Broadleaf forest	Luvisols/ M
Seelow (DE)	52.54/14.45/7	471/8.3/0.83 (subhumid)	Broadleaf forest	Fluvisols/ A
Muencheberg (DE)	52.52/14.12/35	533/8.5/0.83 (subhumid)	Broadleaf forest	Albeluvisols/ M
Buttelstedt (DE)	51.06/11.32/228	568/8.2/0.79 (subhumid)	Broadleaf forest	Phaeozems/ Loe
Methau (DE)	51.07/12.87/286	504/8.7/0.78 (subhumid)	Broadleaf forest	Luvisols/ Loe
Bad Lauchstaedt (DE)[6)]	51.39/11.87/116	474/8.8/0.74 (subhumid)	Steppe	Chernozems/ Loe

b) Western Siberia and Kazakhstan

Location (State. region)	Geo-Position[1)]	Climate[2)]	Vegetation zone	Soils/ Parent material[3)]
Ust-Kamenka (RF. Novosibirsk)	55.02/83.85/265	514/0.1/1.11 (humid)	Northern forest steppe	Phaeozems/ Loe
Krasnoobsk (RF. Novosibirsk)	54.92/82.95/133	514/0.0/1.11 (humid)	Northern forest steppe	Chernozems/ Loe
Plotnikovo (RF. Tomsk)	56.89/83.05/119	482/0.1/1.06 (humid)	Southern Taig	Phaeozems/ Loe
Ordinskoje (RF. Novosibirsk)	54.40/81.37/149	410/0.1/0.81 (subhumid)	Northern forest steppe	Phaeozems/ Loe
Omsk (RF. Omsk)[6)]	55.07/73.33/100	390/1.4/0.64 (subhumid)	Southern forest steppe	Phaeozems/ Loe
Nautschnij Gorodok (RF. Altayskij Kray)	53.42/83.47/225	423/1.9/0.70 (subhumid)	Steppe	Chernozems/ Loe
Almalybak (KZ. Almaty)	43.23/76.69/796	385/9.1/0.69 (subhumid)	Dry steppe	Kastanozems/ Loe
Slavgorod (RF. Altayskij Kray) [6)]	53.161/78.72 /220	313/-0.2/0.59 (trocken subhumid)	Dry steppe	Kastanozems/ Loe
Shortandy (KZ. Akmola) [6)]	51.71/71.01/374	317/2.7/0.59 (trocken subhumid)	Dry steppe	Chernozems/ Loe
Grushevka (RF. Novosibirsk)	53.91/77.15/99	310/-0.2/0.58 (trocken subhumid)	Steppe	Chernozems/ Loe
Besagash (KZ. Zhambyl)	42.80/71.41/620	330/8.9/0.2 5 (arid)	Dry steppe	Calcisols/ Loe

c) Northern China

Location (State. region)	Geo-Position[1)]	Climate[2)]	Soils/ Parent material[3)]
Linfen (Shanxi)	36.10/111.55/460	617/12.1/0.66 (subhumid)	Cambisols/ Loe
Tai Han (Hebei)	37.90/114.25/342	528/13.2/0.58 (trocken subhumid)	Cambisols/ Loe
Luancheng (Hebei)	37.89/114.69/43	528/13.1/0.58 (trocken subhumid)	Cambisols/ Loe
Beijing North (Beijing)	40.17/116.44/41	576/11.8/0.54 (trocken subhumid)	Cambisols/ Loe
Nanpi (Hebei)	38.68/116.68/9	614/13.1/0.52 (trocken subhumid)	Cambisols/ Loe
Wuquiao (Hebei)	37.62/116.42/15	575/13.8/0.50 (trocken subhumid)	Cambisols/ Loe
Dong Yuang (Shanxi)	37.55/112.67/800	456/9.5/0.47 (semiarid)	Cambisols/ Loe-weathered
Gu Yuan (Hebei)	41.90/115.85/1356	369/2.4/0.46 (semiarid)	Kastanozems / S-Loe
Xilingere (Inner Mongolia)	43.54/116.65/1265	369/2.4/0.46 (semiarid)	Cambisols/ S-Loe

d) Northern America

Location (State. region)	**Geo-Position[1)]**	**Climate[2)]**	**Soils/ Parent material[3)]**
Elora (Canada. Ontario)	43.15/-79.60/260	922/7.7/1.28 (humid)	Luvisols/ M [3)]
Hoytville (USA. OH)	41.40/-83.70/200	832/9.4/0.87 (subhumid)	Hoytville C. Epiaqualfs / GD
Pullman (USA.WA)	46.78/-117.08/ 803	530/7.8/0.49 (semiarid)	Palouse SiL. Haploxerolls/ Loe
Nesson (USA. ND)	48.16/-103.10/ 584	388/3.5/0.38 (semiarid)	Lihen SL. Haplustolls/ GD
Pendleton (USA. OR)	45.72/-118.62/ 436	414/10.1/0.38 (semiarid)	Walla Walla SiL. Haploxerolls/ Loe
Froid (USA. MT)	48.26/-104.49/ 656	356/5.1/0.35 (semiarid)	Dooley SL. Argiuborolls/ GD
Sidney (USA. MT)	47.73/-104.14/ 599	352/6.3/0.34 (semiarid)	Savage C. Argiustolls/ A
Rasmussen (USA. MT)	47.77/-104.25/ 684	352/6.3/0.34 (semiarid)	Williams L. Argiustolls/ GD
Lind (USA. WA)	47.00/-118.86/ 498	236/9.8/0.22 (semiarid)	Shano SiL. Haplocambids/ Loe

RESULTS

Soil classification and Soil Quality Rating

Table 2 contains classification results of soils, and Figure 2 shows some soil profiles. Names of soils comprise the designation of the Reference Soil Group (RSG), for example Podsol or Luvisol. These RSG are often identical with soil types of national classification systems. They indicate dominant pedogenetic processes like podsolization or lessivation. Prefix-qualifiers characterise typic soil properties of the RSG or typical transition features to a neighbour RSG. In case of the Prefix-qualifier „Haplic" it is the common variant of the RSG. Suffix-qualifiers following the RSG in parantheses characterise typical properties of the soil texture, substrate, humosity, nutrient status or others. The soil name of the Krasnodar location is Haplic Chernozem (Pachic, Clayic). It contains the main information: Typical Chernozem having a particular thick humus horizon and a clayey texture.

Other columns of Table 2 characterise the soil quality for cropping of small grain cereals. The Upscaled Basic Score (UBS) of M-SQR reflects mainly properties of the texture and structure of soils. Very high scores (>80) are typical for soils of Loess or loess-like soil material, medium or low scores (< 60) for sandy or stony soils. Those experimental sites are rare.

The overall score (M-SQR Score) includes Hazard Indicators (extremely crop yield limiting factors) and characterises the relative crop yield potential of the soil in the given environment. Most common Hazard Indicators are lack of water in the main vegetation period (agricultural drought) or drought in combination with an unsuitable temperature regime (soils too cold, too short vegetation period). Loess soils in a temperate climate or under irrigation have highest M-SQR Scores (> 80). If no Hazard Indicators occur (some locations in Northern China or Western Europe), UBS Score and M-SQR Score are identical.

Table 2 - Classification results of sites

Location	Name-giving taxonomic classification (WRB 2006)	Muencheberg Soil Quality Rating		
		Basic-Score (UBS)[1)]	M-SQR-Score [2)]	Most limiting Hazard Indicators [3)]
1	2	3	4	5
a) Europe[4)]				
Schuby	Histic Podsol (Hortic, Drainic)	72	72	None
Dalheim	Haplic Cambisol (Colluvic, Dystric)	63	47	Tro, WE
Vyatkino	Cutanic Albeluvisol (Dystric, Densic, Arenic)	56	32	Tro+Temp
Shebanzevo	Albic Cutanic Luvisol (Siltic)	85	65	Temp.
Edinburgh	Haplic Stagnosol (Eutric, Arenic, Drainic)	76	76	None
Haus Duesse	Stagnic Luvisol (Siltic)	81	81	None
Colmen	Haplic Luvisol (Clayic)	63	48	Tro
Lechenich	Cutanic Luvisol (Humic, Hypereutric, Profondic, Siltic)	93	93	None
Panino	Haplic Chernozem (Siltic)	85	65	Tro, WaE
Gonki	Haplic Chernozem (Siltic)	93	89	Tro
Ostritz	Haplic Luvisol (Siltic)	70	69	Tro
Krasnodar	Haplic Chernozem (Pachic, Clayic)	94	88	Tro
Oktjabrskij	Haplic Phaeozem (Siltic)	78	74	Tro
Guelzow	Endoleptic Regosol (Calcaric, Eutric, Drainic)	66	60	Tro
Thyrow	Haplic Cambisol (Humic, Dystric)	58	39	Tro
Flakkebjerg	Stagnic Luvisol (Densic, Arenic)	70	67	Tro
Dedelow	Colluvic Regosol (Humic, Eutric, Siltic)	72	66	Tro
Seelow	Gleyic Fluvisol (Humic, Eutric, Clayic, Drainic)	69	66	Ver
Muencheberg	Cambic Albeluvisol (Eutric, Arenic)	62	42	Tro
Buttelstedt	Haplic Chernozem (Siltic)	92	89	Tro
Methau	Colluvic Regosol (Eutric, Siltic)	78	73	Tro
Bad Lauchstaedt	Haplic Chernozem (Siltic)	93	88	Tro
b) Western Siberia and Kazakhstan [4)]				
Ust-Kamenka	Haplic Phaeozem (Siltic)	88	34	Temp+Tro
Krasnoobsk	Haplic Chernozem (Siltic)	98	42	Temp+Tro
Plotnikovo	Luvic Phaeozem (Siltic)	87	37	Temp+Tro
Ordinskoje	Haplic Phaeozem (Siltic)	86	29	Temp+Tro
Omsk	Haplic Chernozem (Siltic)	96	41	Temp+Tro
Nautschnij Gorodok	Calcic Chernozem (Siltic)	96	41	Temp+Tro
Almalybak	Haplic Kastanozem (Siltic)	89	38	Tro
Slavgorod	Haplic Kastanozem (Arenic)	83	28	Temp+Tro, WE
Shortandy	Haplic Chernozem (Siltic)	89	38	Temp+Tro
Grushevka 1	Calcic Chernozem (Arenic)	78	20	Temp+Tro, WE
Grushevka 2	Gleyic Mollic Solonchak (Chloridic, Sulphatic, Siltic)	53	5	Sal/Sod
Besagash, irri	Haplic Calcisol (Sodic, Siltic)	74	57	Tro, Sod
Besagash	Haplic Calcisol (Sodic, Siltic)	72	12	Tro, Sod

Continuation of table 2

1	2	3	4	5
c) Northern China				
Linfen, irri	Haplic Cambisol (Calcaric, Eutric, Siltic)	90	90	None
Tai Han, irri	Haplic Cambis ol (Colluvic, Calcaric, Eutric, Siltic,)	81	79	**Tro**
Luancheng, irri	Haplic Cambisol (Eutric, Siltic)	94	94	None
Beijing North, irri	Haplic Cambisol (Eutric, Siltic)	87	84	**Tro**
Nanpi, irri	Haplic Cambisol (Sodic, Eutric, Siltic)	80	60	Sod
Wuquiao, irri	Haplic Cambisol (Eutric, Siltic)	89	74	**Tro**
Dong Yuang, irri	Haplic Cambisol (Calcaric, Siltic)	85	85	None
Gu Yuan	**Haplic Kastanozem (Arenic)**	80	25	**Temp+Tro,** WE
Xilingere	**Haplic Kastanozem (Arenic)**	81	24	**Temp+Tro,WE**
d) Northern America				
Elora	Albic Luvisol (Siltic)	80	78	**Temp+Tro**
Hoytville	Stagnic Luvisol (Humic, Clayic)	68	67	**Tro**
Pullman	Haplic Kastanozem (Siltic)	80	33	**Tro, WE**
Nesson	Haplic Calcisol (Siltic)	83	35	**Temp+Tro**
Nesson, irri	Haplic Calcisol (Siltic)	83	56	**Temp+Tro**
Pendleton	Haplic Calcisol (Siltic)	88	48	**Tro, WE**
Froid	Calcic Kastanozem (Siltic)	83	36	**Temp+Tro**
Sidney	**Calcic Fluvisol (Eutric, Clayic, Drainic)**	83	40	**Temp+Tro**
Sidney, irri	**Calcic Fluvisol (Eutric, Clayic, Drainic)**	83	55	**Temp+Tro**
Rasmussen	Calcic Kastanozem (Siltic)	73	31	**Temp+Tro, WE**
Lind	Haplic Calcisol (Siltic)	83	15	**Tro, WE**

1) Basic Score, includes texture, structure and relief, upscaled (100 = optimum, classes are <40 very low and low, 40–60 medium, 60–80 good, >80 very good. Basic indicators are 1=Soil substrate, 2=Depth of A horizon, humosity, 3=Topsoil structure, 4=Subsoil structure, 5=Rooting depth, 6=Plant available soil water, 7= Wetness and ponding, 8 =Slope and relief. 2) Includes all indicators of Figure 1, 100-Ball scale: 100 = best soil for mesophile small grain cereals, ratings do not yet contain corrections of meso- and microclimate, and interactions of Hazard factors, classes like UBS. 3) Tro= Drought, Temp. = Thermal regime (soil too cold), Ver=Flooding, extreme waterlogging, Sal=Salini sation, Sod=Sodification/extreme high pH, WE=Wind erosion, WaE=Water erosion, irri=irrigated, 4) data of these sites were already published by Smolentseva et al [7].

a b c d

Figure 2 - Examples of soils from Loess

a) *Location Krasnoobsk*, Haplic Chernozem (Siltic). Very high potential fertility but limitations due to drought in combination with an sub-optimum thermal regime, 42 Rating points, grain yield 35 dt/ha spring wheat by 70 kg/ha N fertiliser

b) *Location Haus Duesse*, Stagnic Luvisol (Siltic). Temporal wetness in spring, No extreme limitations, 81 Rating points, grain yield 75 dt/ha winter wheat by 220 kg/ha N fertiliser

c) *Location Grushevka*, Calcic Chernozem (Arenic). Topsoil degraded by wind erosion, extreme limitations by thermal regime and drought, 20 Rating points, grain yield 10 dt/ha spring wheat without N-fertilisation

d) *Location Krasnodar*, Haplic Chernozem (Pachic, Clayic), small limitations by drought, 88 Rating points, grain yield 52 dt/ha winter wheat by moderate N fertilisation, 73 dt/ha by high fertilisation

Rating results and grain yield

Climate based soil water and temperature regimes are decisive for soil formation processes, soil functions and the production of cereals. The Muencheberg Soil Quality Rating significantly reflects those differences in the crop yield potential. It correlates with grain yields well (Figure 2).

The upper part of Figure 2 shows the correlation of M-SQR rating points with yields of unfertilised plots. The data basis is still low. The lower part shows the correlation at a moderate N-fertilisation (< 100 kg N/ha). It confirms results already given by Smolentseva et al [7] and Mueller et al [10]. The results of highly fertilised plots is not shown here. Results coincide with those given by Smolentseva et al [7]. Their regression line is y=0.96 x, but with some none-linearity at high soil quality. On good soils (> 60 Rating points of M-SQR) the grain yield is largely determined by the fertilisation level and other agrochemical inputs.

M-SQR rating results of Table 2 and Figure 2 are crude scores which do not yet consider up- and downgrades due to meso- and microclimate and interactions of Hazard factors. Within regions of a relatively uniform climate, the Basic rating procedure (UBS) would already by correlated with grain yields.

Assessment of cropping regions

Europe: Suitable climate conditions like a long vegetation period and mild winters provide cropping of winter cereals on all agricultural lands, sandy soils included. Moderate drought is the main crop-yield limiting factor. Because of nutrient leaching over the humid winter period and high nutrient withdrawals by harvested products permanent high fertiliser inputs will be required. Nutrient surpluses bear risks for water quality. Highest crop yields (>10 t/ha winter wheat) can be

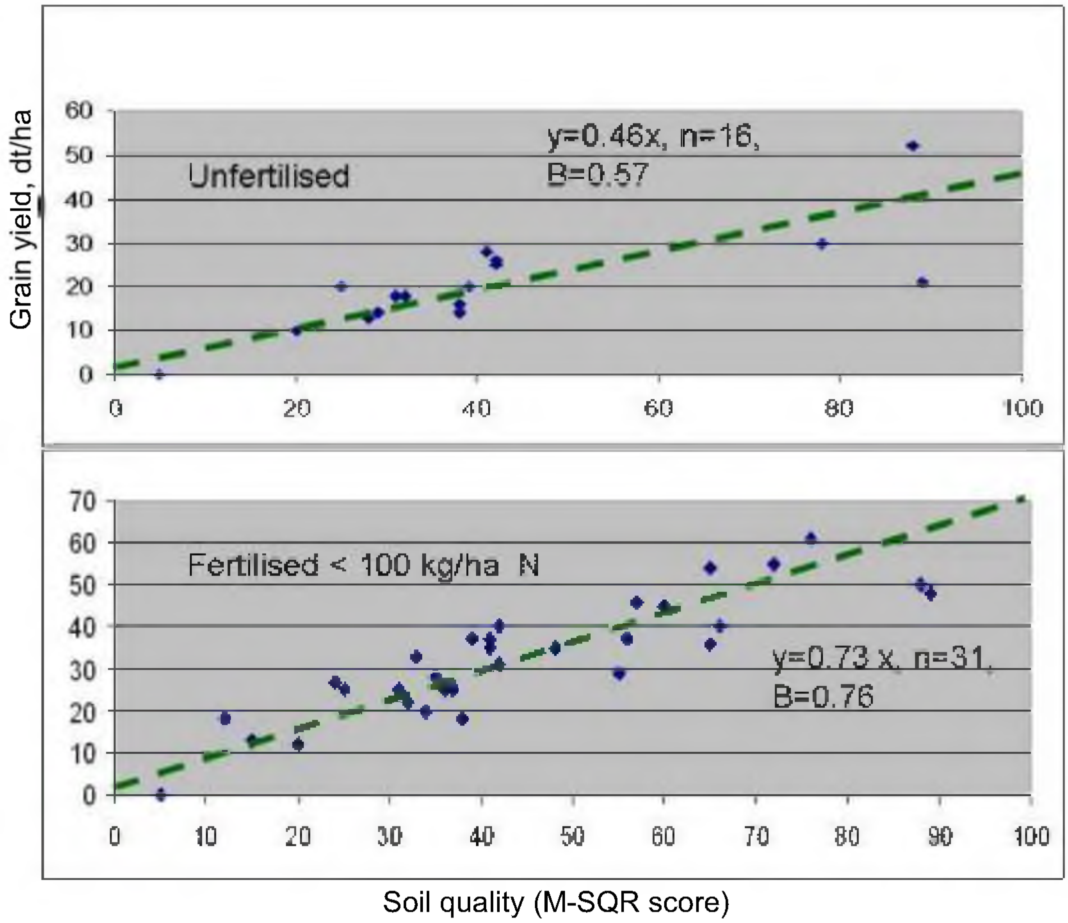

Figure 2 - Regressions between M-SQR Score and grain yield

achieved on Loess soils of low humus content in a humid climate (Luvisols). In North East Europe drought in combination with a shorter vegetation period and stronger winters limit the crop yield potential of sandy agricultural soils markedly (Example Vyatkino site). In South East Europe (Example Krasnodar site) Loess or loess-like soils in a mild winter climate provide best conditions for cereal cropping despite moderate drought. Risks of agrochemistry to water quality are relatively low in this region.

West Sibiria and Kazakhstan: Soils rich in humus from Loess (Phaeozems, Chernozems, dark Kastanozems) have very suitable inherent properties for cereal cropping (very high Basic Scores, UBS). Also Calcisols (Syrozems) of lower humus content can be good soils for cereal cropping. Harsh winter climate prevents winter wheat cropping, thus spring wheat having a shorter vegetation period, a shallower rooting system, and a lower crop yield potential is dominant. Drougth in combination with unsuitable thermal regime (soils too cold) are most crop-yield limiting. Overall soil quality scores (M-SQR-scores) and current soil productivity potentials are thus low. Climate warming may improve the situation slightly, but drought will remain a problem of raising significance. The risk of sodification and salinization problems will increase.

Northern China: Young Loess soils rich in mineral nutrients have highest soil quality scores. Low humus contents provide high effects of mineral nitrogen fertilisation. The long vegetation period enables cropping of wheat and maize in one season. Irrigation and high fertiliser rates provide crop yields higher than 10 tonnes per hectare. Water resources have degraded both in quantity and quality. Sandy Loess soils in the North of the Hebei province (Gu Yuan site) and in Inner Mongolia (Xilingere site) have less suitable soil structure and are severely prone to wind erosion. Main crop yield limiting factors are drought and a short vegetation period at altitudes > 1000 m above sea level.

Northern America: Cropping sites of Prairie regions of the North and Northwest (Example Pendleton site) are located on Sand-Loess and Loess soils and have a high Basic Rating. Monoculture, wind erosion and tillage erosion have led to degradation of the soil structure. Thus, the score of Basic Rating (UBS) is slightly lower than those of most Loess soils in Eurasia. Drought is the most limiting factor. In regions of a more continental climate (example Froid site) winters are very cold and the snow cover is shallow. Winter wheat cannot be grown there and the vegetation period is short. Overall soil quality scores (M-SQR score) are thus low or medium. Humid and sub-humid regions (Elora und Hoytville sites) have higher overall soil quality, which is comparable with those of sites in Central Europe.

CONCLUSIONS

- A classification of soils by WRB 2006 in combination with M-SQR provides sufficient information about soil properties, processes and productivity potentials.
- Soil quality scores characterise productivity potentials of sites at a defined level of inputs.
- Yields of small grain cereals reflect soil quality best
- Drought (lack of plant-available water in the vegetation period) is the most crop yield limiting factor worldwide.
- The Muencheberg Soil Quality Rating is practicable and reliable. It has the potential for being applied as a global reference system of soil quality.

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ТҮЙІН

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ТОПЫРАҚТЫҢ ЖІКТЕМЕСІ ЖӘНЕ МАҢЫЗДЫ АСТЫҚ ӨНДІРУ АЙМАҚТАРЫНЫҢ ӨНІМДІЛІК ЫҚТИМАЛДЫҒЫ

Біздің мақала ауылшаруашылық жерлерін бағалау үшін әмбебап белгілер мен индикаторларды қолданғанда олардың жіктелуі мен функционалды бағалауын түсіндіреді. Бұл ақпарат топырақ сапасын аймақ аралық салыстырмалы бағалау үшін және топырақты ауылшаруашылығына тұрақты аймақтық пайдалану үшін пайдалы болар еді. Біз астық өсіруде ғаламдық маңызы бар облыстардың кейбір өздеріне тән топырақ кескінін зерттедік. Бұл облыстарға Еуропа, Солтүстік Қытай, Солтүстік Американың прериясы, Батыс Сібір мен Қазақстан жатады. Топырақтар Топырақ Ресурстарының Дүниежүзілік Анықтамасы негізіне сәйкес жіктелінді (WRB 2006) [1]. Олардың сапасын Бағалау Muencheberg (M.SQR) [2]. Көптеген учаскелер ауылшарушылығы мақсатында ғылыми- зерттеу жұмыстары жүргізілген аумақтарда болатын. Олардың басқару жүйесі мен өнімділігі өте жақсы белгілі еді. Кейбір эксперименталдық учаскелер шаруалар қожалығының аумағында болған жағдайда олардың мәліметтерін қожалық менеджерлері бағалады.

Таксономиялық жіктеме (WRB 2006) мен топырақтың ұлттық жіктемелері топырақ атауын анықтауға мүмкіндік берді. Бұл атаулар типтік үрдістерімен және қасиеттерімен байланысты, біракта бұл топырақтың сапасы мен өнімділік потенциалы жайында толық ақпарат бере алмайды. Индикаторлық көрсеткіштерге негізделген M.SQR әдісі қолданысқа ыңғайлы және топырақ сапасын есептеуде үйлесімді. Жерді пайдалану қарқынының белсенділігіне байланысты және беріоген мәліметтердің қолжетімділігіне байланысты M.SQR әдісі астық өнімділігінің ауытқуын шамамен 50-80 % аралығында болатынына түсініктеме береді.

Сонымен қорыта келгенде бұл әдіспен топырақтың сапасын толық бағалауға және әртүрлі аймақтар мен әртүрлі ауқымдағы аумақтардағы астық өнімділігінің потенциалын бағалауға болады. WRB2006M.SQR есептерімен қисындаса топырақ қасиеттері мен ондағы жүріп жатқан үрдістері жайында жеткілікті ақпарат береді; сонымен қатар астық өндірісі өнімділігінің сапасын анықтайды. Бұл әдіс В.В.Докучаевтың негізгі концепциясын толық бейнелейді [3].

РЕЗЮМЕ

КЛАССИФИКАЦИЯ ПОЧВ И ОЦЕНКА ИХ ПОТЕНЦИАЛА ПРОДУКТИВНОСТИ В ВАЖНЫХ РЕГИОНАХ ПРОИЗВОДСТВА ЗЕРНА

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Наша статья объясняет классификацию и функциональную оценку сельскохозяйственных земель при использовании универсальных критериев и индикаторов. Эта информация могла быть полезной для межрегиональной сравнительной оценки качества почвы и территориального устойчивого сельскохозяйственного использования почв. Мы изучили некоторые характерные профили почвы в глобально важных областях выращивания зерна. Эти области - Европа, Северный Китай, прерии Северной Америки, степи Западной Сибири и Казахстана. Почвы были классифицированы в соответствии с Мировой Справочной Основой Почвенных Ресурсов (WRB 2006) [1]. Их качество было оценено методом Качественной Оценки Почвы Muencheberg (M. SQR) [2]. Большинство участков было территориями научных сельскохозяйственных исследований. Их система управления и данные об урожае были хорошо известны. В случае экспериментальных участков на территориях фермерских хозяйств, эти данные были оценены менеджерами ферм.

Таксономическая классификация (WRB 2006) и национальные классификации почвы позволяют определить названия почвы. Эти названия связаны с типичными процессами и свойствами, но не дают большую информацию о качестве почвы и потенциале урожая. Основанный на индикаторных показателях метод M. SQR более практичен и приемлем для расчетов качества почвы. В зависимости от интенсивности использования земель и доступности данных, метод M. SQR может объяснить приблизительно 50-80 % изменчивости урожая. Мы приходим к заключению, что у этого метода есть потенциал для оценки полного качества почвы и потенциала урожайности зерновых злаков для территорий различного масштаба и для разных регионов. Комбинация 2006 WRB с расчетами по M. SQR предоставляет достаточную информацию и о свойствах/процессах почвы, и об их качестве для зернового производства. Этот метод отражает основную концепцию В.В. Докучаева [3].