AGRICULTURAL SOIL QUALITY MONITORING IN WEST REGION

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Abstract:. *On the whole agricultural land of West Region, the agricultural monitoring system of level I (16x16 km) totalizes 89 sites. Every site was characterised from morfologic, physical (particle size distribution, structural instability index, the degree of compaction, saturated hydraulic conductivity, resistance to penetration), hydro-physical (wilting coefficient, field water capacity, useful water capacity, total water capacity, maximum transfer capacity) and chemical (soil reaction, soil percentage base saturation at pH8.3, humus content, total nitrogen content, mobile phosphorus and mobile potassium) characteristics. Distribution of monitoring plots by land use shows the most plots are found on arable land (56%) followed by grassland (28%), meadows (14.6%) ad orchards – 1%. At this region level, 9 classes are found from the whole 12 existent classes and 15 of the 32 soil types listed in SRTS, 2012. Compared with soils identified at national level (Dumitru et al., 2011), soil diversity is lower.*

Key words: *soil, monitoring, agricultural, West, region*

INTRODUCTION

Soil is vital non-renewable resource whose condition is essential to ecosystem function and human life (Doran et al., 1996, Morvan et al., 2008). Monitoring is considered essential for the protection and management of natural resources (Kibblewhite et al., 2008) and soil monitoring is defined as a systematic determination of soil variables in order to record the temporal and spatial changes (FAO/ECE, 1994). This is characterized by a set of plots where changes of soil characteristics are monitored by periodic measurements of soil parameters (MORVAN et al., 2008).

In this paper are presented some results of agricultural soil monitoring level I (16x16 km) in West Region (Arad, Caras, Hunedoara, Timis counties) - second determination.

MATERIAL AND METHODS

Methodology the achievement of agricultural soil-land monitoring systems at level I (16 x 16 km) was done in accordance with the Ordinance 38/2002, approved with amendments by Law 444/2002, and with the Order of the Minister of Agriculture, Food and Forestry (MAFF) no. 223/2002. The soil classification was made according WRB-SB 1998 (Bridges et al., 1998).

The soil physical characteristics of the agricultural monitoring sampling plots of Level I presented in this paper are as follows: particle size distribution (soil texture), structural instability index (IIS), the degree of compaction (GT, % v/v), saturated hydraulic conductivity (Ksat, mm/h), resistance to penetration (RP, kgf/cm2) and edaphic volume (Ve, fractions of unity). Particle size distribution, waterstable macroaggregates (structural macrohydrostability) have been determined for all monitoring plots of Level I, while the other properties (the degree of compaction, saturated hydraulic conductivity, resistance to penetration) have been analyzed only for plots where undisturbed samples could be collected. Hydraulic conductivity, degree of compaction, resistance to penetration and structural instability index are presented for several layers: 0-25 cm, 25-35 cm and 35-50 cm.

The main soils hydro-physical parameters for the Level I monitoring plots: wilting coefficient (WC, %), field water capacity (FWC, %), useful water capacity (UWC, %), total water capacity (TWC, %), maximum transfer capacity (CD, %) are presented for several layers: 0-25 cm, 25-50 cm and 50-100 cm. The hydrophysical soils parameters were determined by calculation, based on the formula (Dumitru et al., 2009)

Chemical parameters of soil monitoring plots of Level I are presented in representative layers (0-20 cm agrochemical layer, topsoil) and their average values, weighted taking into account the horizons thickness for the 0-50 cm layer. An exception is the soil reaction, for which the maximum value in the 0-50 cm layer is presented.

The classes of different characteristics or parameters are those in the RISSA Methodology (ICPA, 1987).

RESULTS AND DISCUSSIONS

Representativeness of agricultural monitoring sites in West Region. On the whole agricultural land of West Region, the agricultural monitoring system of level I (16x16 km) totalizes 89 sites, one site for 21196 ha. Distribution of monitoring plots by land use shows the most plots are found on arable land (56%) followed by grassland (28%), meadows (14.6%) and orchards – 1%.

At the West region level, the best represented soil classes: Luvisols (24.7%), Cernisols (23.6%), followed by Cambisols (20.2%), Protisols (13.5 %). Other soil classes, such as Podzolz (5.6%), Gleysols (4.5%), Vertisols (4.5%), Salsodisols (1.1%) and Anthrisols (2.3%) are less common.

As regarding the soil type distribution, the highest percent of plots is given by Chernozems (20.2%), followed by Luvisols (15.7%), Eutric Cambisols (12.4 %), Fluvisols (10.1 %), Haplic Luvisols (9%), Dystric Cambisols (7.8%). Other soil types, such as Entic Podzols (4.5%), Vertisols (4.5%), Gleysols (4.5%), Phaeozems (3.4%), Regosols (2.3%), Anthrosols (2.3), Leptosols (1.1%), Haplic Podzols (1.1%), Solonetz (1.1%) are in a much smaller proportion. At this regional level, 9 classes are found from the whole 12 existent classes and 15 of the 32 soil types listed in SRTS, 2012 (Florea&Munteanu, 2012). Compared with soils identified at national level (Dumitru et al., 2011), soil diversity is lower.

Physical characteristics of agricultural monitoring sites in West Region

Soil texture. For topsoil of agricultural monitoring plots of level I (table 1, fig. 1), the highest proportion is represented by loamy soils (40.5%) and followed by the clay loam soils (33.7%), sandy loam soil (13.5 %), clay soils (11.2%) and loamy sand soil (1.1%). For the next soil layer (0-50 cm), there are some differences compared to the topsoil, dominated are clay loam soils (40.4%) and the tendency being an increase of the fine texture over the coarse texture.

Structural instability index (SII). In the 0-25 cm soil layer, about 40,0% of sample plots have high-extremly high values of structural instability index, 24.7 % of plots have medium values, and only 33.7 % have low-very low values of instability (Fig.1). In the other two soil layers, there is an increase in the number of plots with moderately and high values and a decrease in sites with low values of structural instability index (20.2%, respectively, 15.7). For all three depths studied, structural instability index has high – extremely high values in about 40% of the plots, reflecting the presence of a risk to soil structural degradation.

The degree of compaction (DG, % v/v). In the 0-25 cm soil layer, the non-compacted soils are found in 30% plots, while the slight compacted soils are found in 31.5 % plots. About 16.9% of the plots having the degree of compaction values above 18% require urgent loosening tillage, while 18 % of the plots are in the second category, with values between 11 and 18%

v/v. In the next two soil layers, there is a decrease in non-compacted and slightly compacted soils proportion and an increase of moderately compacted and strongly compacted soils.

Saturated hydraulic conductivity (Ksat, mm/h). In the 0-25 cm layer, most sites belong to medium permeability (30%), followed by low (20%) and high permeability (19%). In the next two layers, the proportion of plots with extremely low – very low permeability increased significantly.

Resistance to penetration (RP, kgf/cm²). In all three layers, most analyzed plots have medium values (67%; 72%; 65%) and the tendency is to decrease the sites proportion with low resistance in favor of sites with high resistance.

Edaphic volume (Ve, fractions of unity). For agricultural sites, the plots with high edaphic volume (39.3%) are predominant, followed by soils with very high (27%) and medium (26%) edaphic volume. The average value in the agricultural monitoring plots is 0.99 unit fractions, being sufficient to a good management of agricultural activities.

Table 1

Statistical parameters of physical characteristics

Statistical parameters	Ksat, mm.h-1			RP, kgf/cm^2			DG, % v/v			IIS			Ve, % v/v
	0-25 cm	25-35 cm	35-50 cm	0-25 cm	25-35 cm	35-50 cm	0-25 cm	25-35 cm	35-50 cm	0-25 cm	25-35 cm	35-50 cm	
n	86	85	82	86	85	82	86	85	82	86	85	82	89
X_{min}	0.2	0.1	0.1	3	1.3	1.3	-43.9	-28.2	-11.4	0.09	0.1	0.11	0.23
X_{max}	98	55.8	42.4	128	129	130	32.7	34	35.2	3.9	5.8	10.4	1.5
$\overline{X}$	11.4	4.6	4.3	35.2	40	42	5.3	10	12.1	0.8	0.8	1.1	0.99
$\pm\sigma$	17.7	9.1	8.3	16.7	18.7	19.6	12.3	11	9.2	0.7	0.8	1.6	0.31
Cv, %	155	196	192	57.4	46.9	46.5	230	108	76.1	84	102	151	31.7
25%	0.88	0.3	0.3	27	30	31	-2.31	5.4	6.9	0.35	0.3	0.41	0.8
50%	4.1	1.2	0.50	32	37	40	5.7	12.7	13.8	0.57	0.6	0.63	1.1
75%	15.1	4.3	3.9	40	43	48	13.5	16.6	17.7	1.0	0.91	0.97	1.2
90%	33	10.0	12.8	47.5	54	58	20	21.6	20.7	1.6	1.5	1.51	1.3

n-total number of samples; X_{min}-minimum value; X_{max}-maximum value; $\overline{X_1}$ - arithmetic mean; $\pm\sigma$-standard deviation; CV,%- variation coefficient; 25%, 50%, 75% and 90% percentiles.

Hydro-physical *characteristics of agricultural monitoring sites in West Region*

Wilting coefficient (WC, % g/g). The values of the wilting coefficient in the 0-25 cm layer vary between 3.2 % and 22 %, with a mean of 11.3% (table 2). The distribution on classes showed that about 36% of plots have moderate values of wilting coefficient, 32% high values, 19% low values and 12% very high values (Fig. 2). In the next two layers, there is a decrease of sites with moderate values in favor of high and very high values. Soils with high-very high values of wilting coefficient are most vulnerable to a lack of soil water.

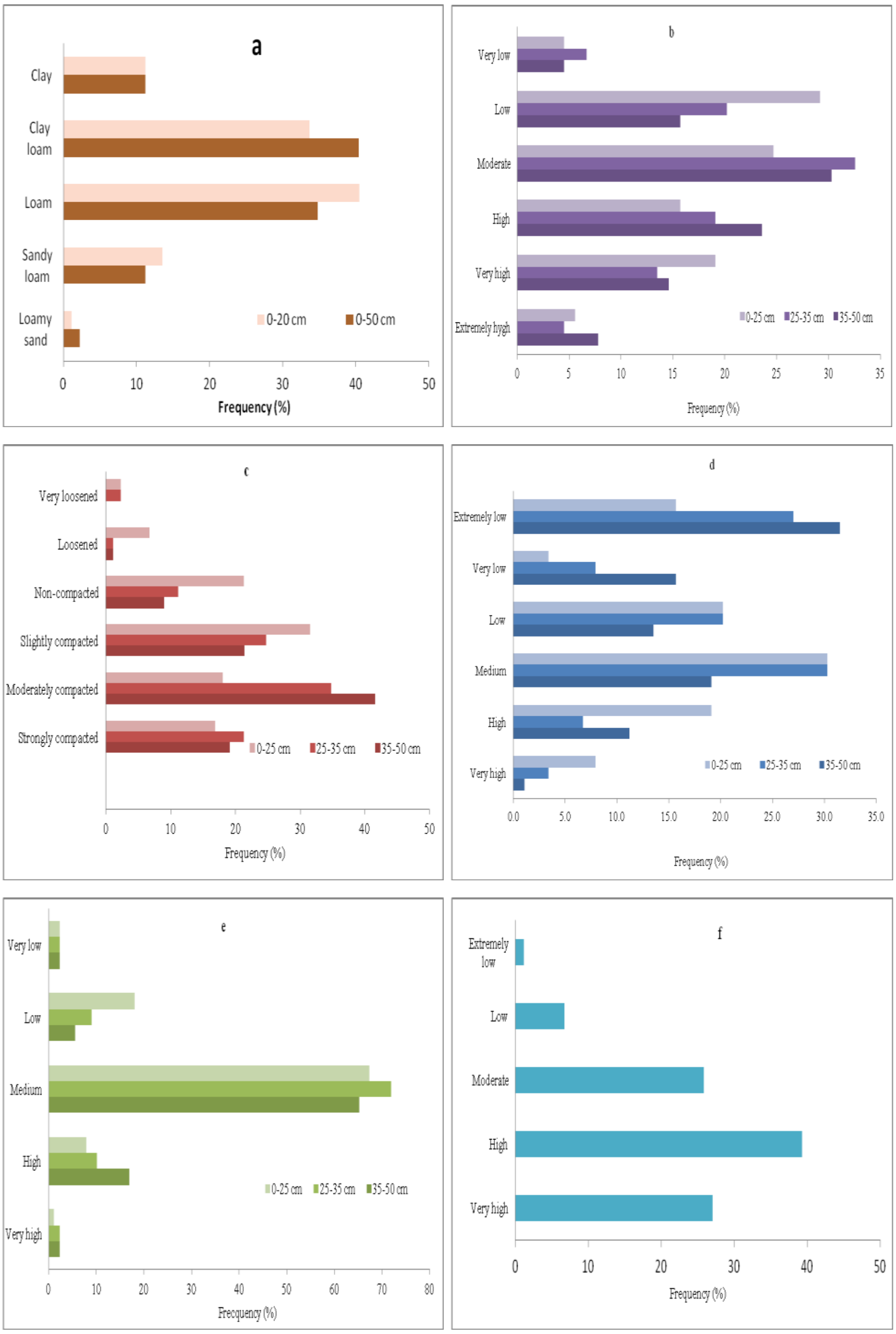

Figure 1. Distribution of agricultural monitoring sites according to particle size distribution (a), *Structural instability index (b), The degree of compaction (c), Saturated hydraulic conductivity(d), Resistance to penetration (e), Edaphic volume (f)*

Table 2

Statistical parameters of hidro physical characteristics

Statistical parameters	WC, %			FWC,%			TC, %		
	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm
n	89	88	79	85	84	72	85	84	72
X_{min}	3.2	3	4.2	18.5	15.9	15.9	21.7	18.9	19.5
X_{max}	22	22.5	22.7	32.3	31.1	27.1	87.3	51.1	47.1
$\bar{x}$	11.3	11.9	12.6	24.8	22.9	21.3	35.0	30.6	29.7
$\pm\sigma$	3.75	4.3	4.6	2.5	2.5	2.4	9.0	6.1	5.5
Cv, %	33.1	35.7	36.2	10.1	11.1	11.4	25.8	19.9	18.7
25%	8.6	8.25	8.3	23.2	21.5	20.0	28.5	26.8	26.1
50%	11.4	12.7	13.2	24.9	23.1	21.5	34.7	29.8	29.3
75%	13.9	14.9	15.7	26.3	24.2	22.7	39	32.1	31.8
90%	16.1	17.1	18.5	27.8	25.6	24.2	44.8	38.7	36.3

Table 2 (continuation)

Statistical parameters	DC, %			UWC, %		
	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm
n	85	84	72	85	84	72
min	1.9	1.7	2.6	4.1	3.6	3
max	61.7	26	24.9	20.9	17.6	15
$\bar{x}$	10.2	7.7	8.4	13.5	10.9	8.7
$\pm\sigma$	7.9	4.9	4.5	3.0	3.0	3.2
Cv, %	77.7	63.8	53.6	22.2	27.4	36.3
25%	4.7	4.7	5.3	12.1	8.9	6.2
50%	9.7	6.2	7.2	13.4	10.8	9.1
75%	13.6	9	10.1	15.8	13.2	11.2
90%	18.1	15.21	13.5	17	15.2	12.6

Field water capacity (FWC, % g/g). In the 0-25 cm layer, field water capacity values range in low – very high interval, the average (24.8%) belong to the class of moderate values. In the 25-50 cm layer, the highest proportion of plots belong to medium values of field capacity (71%).

Compared with the upper layer, the number of plots with high values decreased for those with medium and low values. In the 50-100 cm layer, average value of the studied plots is 21.3%, in the medium class values. Compared to above layers, the proportions of plots with and high values decreased, while that with low values increased.

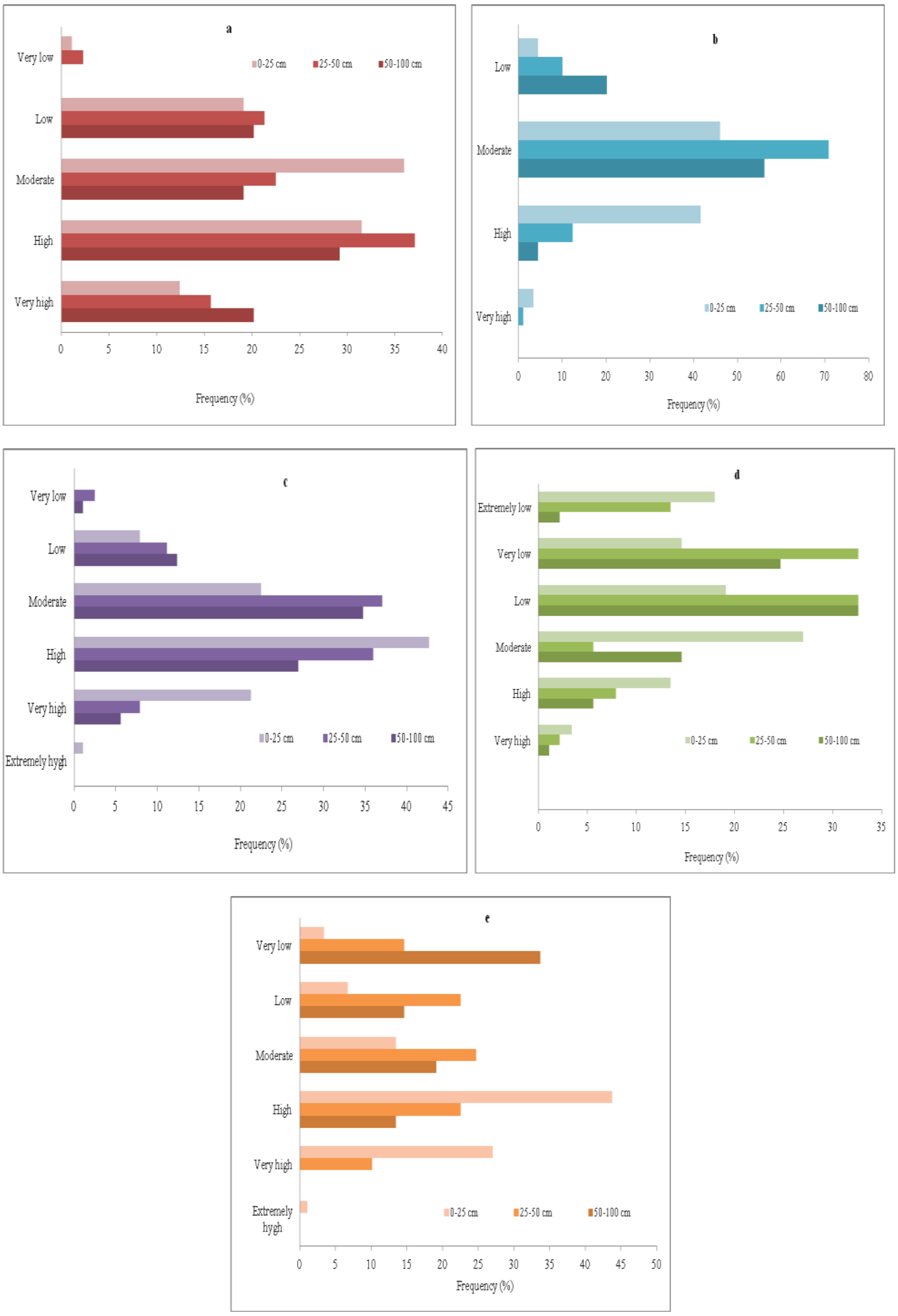

Figure 2. Distribution of agricultural monitoring sites according to *Wilting coefficient (a), Field water capacity (b), Useful water capacity (c), Total capacity of the soil water (d), Draining capacity (e)*

Useful water capacity (UWC, % g/g), in the 0-25 cm layer, ranges from very low values to very high ones, the highest proportion of plots having high – very high values (72%), and only 10 % of plots having low and very low values. The average value in the studied plots is 13.5%, in the high class. In the 25-50 cm layer, useful water capacity ranges from 3.6% to 17.6 %, maintaining the variation of the previous layer, but the proportion of plots with high and very high values is reduced for those with low and very low values. The average value of the studied plots is 10.9 %, in the medium class. In the 50-100 cm layer, the values are in the range from very low to high, but about 48% of plots have low and very low values. The average value is 8.7 %, falling within the low class.

The total capacity of the soil water (TC, % mm), in the 0-25 cm layer, varies in the field of low – extremely high values, the highest percentage being for soils with high and extremely high values (65%), the average being 35%. High values of this coefficient imply important accessible water content. In the other layers, the total capacity for water is reduced in the profile. Thus, the proportion of plots with high and very high values decreases for those with medium and low values.

Draining capacity (DC % mm) of soil is the maximum amount of water that soil could release. Draining capacity of studied soils ranged from extremely low to very high in all three layers. The mean value ranged from 10.2 % in topsoil, to 7.7 % in the second layer, being in the low class. In the 0-25 cm layer, the highest proportion of plots has moderate values (27%), in the following layers dominated are soils with low and very low values of Draining capacity (79% in the second layer, respectively, 60% in the deeper layer). Drained soils with high-very high capacity decreased from 16.9% in first layer to 6.7% in deeper layer.

Chemical characteristics of agricultural monitoring sites in West Region

Soil reaction (pH_{H2O}), in topsoil, of level I monitoring plots (table 3, fig. 3) has a large range of values, from very strong acid soils to strongly alkaline, but the largest classes are those for moderately acid (38%) and slightly acid (34%). Very strongly acid -slightly acid soils characterize the 83% of sites.

Table 3

Statistical parameters of chemichal characteristics

Statistical parameters	pH		$V_{8.3}$, %		H, %		Nt, %		Pm, mg*kg^{-1}		Km, mg*kg^{-1},	
	0-20 cm	max, 0-50 cm	0-20 cm	050 cm	0-20 cm	050 cm	0-20 cm	050 cm	0-20 cm	050 cm	0-20 cm	050 cm
n	89	89	89	89	89	89	89	89	89	89	89	89
X_{min}	4.3	4.3	15	12	0.93	0.76	0.112	0.110	2.4	2.4	15	11
X_{max}	10.2	10.3	100	100	18.5	13.4	0.765	0.566	173	136	840	712
$\overline{x}$	6.1	6.4	73	74	3.69	2.67	0.247	0.200	22	17	151	115
$\pm\sigma$	0.98	1	22	23	2.74	1.73	0.122	0.076	29	24	119	100
Cv, %	16.3	16.1	30	30	74	64.9	49.5	37.9	135	139	79	87
25%	5.5	5.7	66	64	2.30	1.73	0.185	0.157	8	6	85	62
50%	5.8	6.4	78	82	2.94	2.36	0.220	0.183	12	9.0	129	104
75%	6.6	7.	89	91	3.90	2.90	0.252	0.211	25	17	184	145
90%	7.1	7.8	93	95	5.98	3.86	0.363	0.274	43	30	249	175

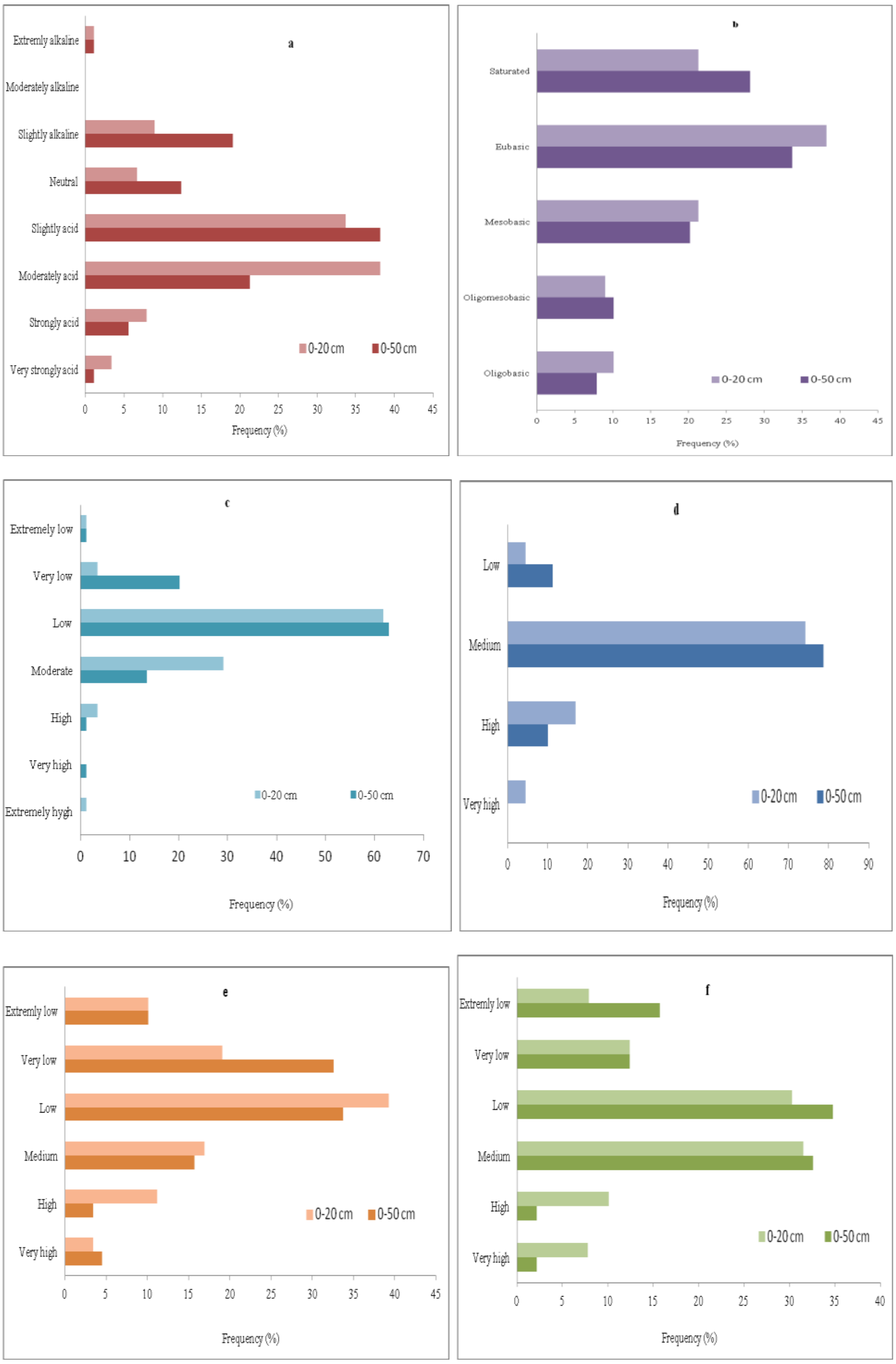

Figure 3. Distribution of agricultural monitoring sites according to pH_{H2O} (a), *V8.3 (b), H (c), Nt (d), Pm (e), Km (f)*

Maximum values of soil reaction in the 0-50 cm layer of agricultural soils are characterized by significantly reducing of strongly acidic – moderately acid soils and increasing of the neutral – slightly alkaline soils.

Humus store in the 0-50 cm conventional soil layer (HS, t/ha). The humus store in the studied plots ranked in very low – very high classes, the predominant sites having low values of humus store (49%), followed by those with moderate (26%) and high (11%) reserves. About 60% of the studied plots have very low – low values for humus store. The mean value is 143 t/ha.

Humus content (H, %), in topsoil, varies from very low to extremely high values, the highest proportion being given by soils with low total humus content (62 %), followed by soils with medium content (29 %). In the 0-50 cm layer, total humus content varies from extremely low to very high values, but compared with topsoil, the proportion of plots with extremely low – low values increased, the higher increases being for soils with very low values, from 3.4 to 20.2%.

The total nitrogen content (Nt, %) varies from the low to very high, but higher proportions are in the medium classes. In the 0-50 cm layer, the proportion of plots with medium and low values increased.

The mobile phosphorus content (Pm, mg/kg) in top soil is variable, from extremely low to very high values. The proportion of plots with extremely low - low content is very high (68.5 % of cases), while that with medium values is 16.9 % of cases, and the other plots have high and very high content (14.6 %). In the 0-50 cm layer, very high percentages have the plots with extremely low – low levels (76.4%), followed by plots with medium values (15.7%). High and very high values characterize 7.9 % of sites.

The mobile potassium content (Km, mg/kg), in topsoil, present a high proportion within the interval of the extremely low – low contents (50.6 % of cases), followed by moderate (31.5%) and high - very high contents (17.9%).

CONCLUSIONS

On the whole agricultural land of West Region, the agricultural monitoring system of level I (16x16 km) totalizes 89 sites, one site for 21196 ha. Distribution of monitoring plots by land use shows the most plots are found on arable land (56%) followed by grassland (28%), meadows (14.6%) and orchards – 1%.

At the West region level, the best represented soil classes are Luvisols (24.7%), Cernisols (23.6%), followed by Cambisols (20.2%), Protisols (13.5 %). Other soil classes, such as Podzolz, Gleysols, Vertisols, Salsodisols and Anthrisols are less common.

As regarding the soil type distribution, the highest percent of plots is given by Chernozems (20.2%), followed by Luvisols (15.7%), Eutric Cambisols (12.4 %), Fluvisols (10.1 %), Haplic Luvisols (9%), Dystric Cambisols.

At this region level, 9 classes are found from the whole 12 existent classes and 15 of the 32 soil types listed in SRTS, 2012. In this region, the soil diversity is lower compared with soils identified at national level.

For topsoil of agricultural monitoring plots of Level I, the highest proportion is represented by loamy soils (40.5%) and followed by the clay loam soils (33.7%), sandy loam soil (13.5 %), clay soils (11.2%) and loamy sand soil (1.1%).

For all three depths studied, structural instability index has high – extremely high values in about 40% of the plots, reflecting the presence of a risk to soil structural degradation.

About 16.9% of the plots having the degree of compaction values above 18% require urgent loosening tillage, while 18 % of the plots are in the second category, with values between 11 and 18% v/v. In the next two soil layers, there is a decrease in non-compacted and slightly compacted soils proportion and an increase in other categories (moderately compacted and strongly compacted).

Soil reaction (pH_{H2O}), in topsoil, has a large range of values, from very strong acid soils to strongly alkalin. Very strongly acid – strongly acid soils characterize the 11% of studied sites and the sites in the range of very strongly acid soil-slightly acid soils characterize 83% of plots.

About 60% of the studied plots have very low – low values for humus store. The mean value is 143 t/ha.

Humus content, in topsoil, varies from very low to extremely high values, the highest proportion being given by soils with low total humus content (62 %), followed by soils with medium content (29 %).

The total nitrogen content varies from the low to very high, but higher proportions are in the medium classes.

The mobile phosphorus content, in top soil is variable, from extremely low to very high values. The proportion of plots with extremely low - low content is very high (68.5 % of cases).

The mobile potassium content, in topsoil, present a high proportion of plots within the interval of the extremely low – low contents (50.6 % of cases), followed by moderate (31.5%) and high - very high contents (17.9%).

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