CHANGES OF THE GREY FOREST SOILS PROPERTIES AFTER LONG TERM UTILIZATION IN CONVENTIONAL AGRICULTURE

Tamara LEAH, V. CERBARI

Institute of Soil Science, Agrochemistry and Soil Protection "Nicolae Dimo"
Ialoveni St. 100, Chisinau, 2070, Republic of Moldova
Corresponding author: tamaraleah09@gmail.com

Abstract. *The arable Grey soils from Northern area of the Republic of Moldova compared to the natural (virgin) ones, are characterized by a moderate degradation of the properties as a result of the dehumification, destructured and considerable decrease of biophilic elements content. The texture of the arable and virgin grey soils is practically analogous - clayey in the upper part of the profile and clayey-loamy in the illuvial or illuvial-cambic horizons. In the recent conditions of the arable layer structural state of these soils, the clay texture can be appreciated as good in terms of soil tillage. Due to the clayey texture the arable layer works comparatively easily, the ploughing is less bulky than in the case of the fine texture (clayey-loamy, clayey or loamy-clayey). The texture of illuvial horizons Bhtw and Btw is clayey-loamy. The medium-fine texture and the monolithic structure have led to the excessive compaction of these horizons and formation an unfavorable physical quality state. The arable grey soils are relatively poor in humus and nutrients; the presence of compacted illuvial horizons leads to decreasing the water permeability and, as a result, they are periodically influenced by the temporary excess of humidity; they have a comparatively weakly anti-erosion stability (soils with medium texture, medium-coarse and coarse); their natural fertility is relatively low. The acidity of the arable grey soils decreased considerably, which led to stopping the eluviation-illuviation process, but it remained enough high. The illuvial horizons of virgin and arable grey soils are characterized by unfavorable chemical and physical properties - excessive compaction, acid reaction, low nutrient content. The continued use of arable grey soils under conditions of organic and chemical fertilizer deficiency will lead to further depletion of nutrients and organic matter, to aggravation of their quality status. The main pedoameliorative measures for these soils are: increase the organic matter content in the arable layer using mineral and organic fertilizers, green fertilizers, organic residues and waste, implementation of zonal crop rotation; improvement of the soil tillage system - once in 3-4 years the ploughing at a depth of 35 cm to crush the newly strongly compacted postarable layer, the periodic tillage with the chisel at a depth of 40-50 cm for partial loosening of the extremely compacted natural illuvial horizon.*

Key words*: grey soil, compaction, organic matter, texture, northern area of Moldova*

INTRODUCTION

The beginning of the study regarding grey forest soils was laid by V.V. Dokuchaev, who not only described them, but also gave a characterization of soil formation (genesis), indicating, in particular, that they form under oak forests with a rich grassy cover studied (БАЛТЯНСКИЙ, 1979; РОЗОВ, 1964; РЯБИНИНА, 1968; УРСУ, 1977). A systematic study of these soils in Moldova began in 1946 under the guidance of academician Nicolae Dimo. As a result of the work, the confinement of their occurrence to certain physical and geographical conditions, the distribution area, as well as chemical and physical properties were studied (АЛЕКСЕЕВ *et al.*,1977; РЯБИНИНА *et al.*,1966; ГАНЕНКО, 1978). The grey soils occupy the surface of 123.7 thousand ha or 6.7% of the total area and are mostly found in the Northern Plateau of the Republic of Moldova (CERBARI & LEAH, 2010). The Northern Plateau is a primary denudation surface, formed in Pliocene. The surface rocks are composed of clayey-loamy loess deposits of wind origin with layer thickness - 1-2 m, below are placed loamy-sandy Pliocene deposits with large fragments of calcareous rocks (ХОЛМЕЦКИЙ & ГАНЕНКО, 1970; РЯБИНИНА, 1984).

This geomorphological district (or region) is characterized by the linear forms of relief, which determines the weak manifestation of erosion processes. The absolute altitudes make up 250-300 m. Horizontal fragmentation in the valleys - 1.5-2.0 $km \cdot km^{-2}$, the average vertical fragmentation 50-100 m, and in the west, in the fossil reef chains - up to 150 m (ВЗНУЗДАЕВ, 1960; ХОЛМЕЦКИЙ, 1969).

The soil cover consists of grey soils formed under the vegetation of deciduous forest under temperate climate conditions (sum of temperatures >10°C=2700-2800°, annual precipitation quantity - 550-650 mm, humidity coefficient, K=0.7-0.9). The grey soils have been used as arable land during different historical periods as a result of the clearing the forests. The largest areas of forests have been cleared and passed to agricultural land during the last 250 years. Parental rocks are predominantly represented by the loess deposits, characterized by a clear differentiation of the texture on the profile studied (CERBARI, 2000; LEAH, 2016; ЛЯХ, 2018A).

MATERIAL AND METHODS

In order to determine the changes in the quality status of the grey soils in the northern zone of the Republic of Moldova in comparison with the natural ones (virgins), two monitoring key-polygons were placed - on the arable land and in the forest, both on the horizontal surface.

Monitoring key-polygon 1: Grey soil on the arable use (Profile 1). The purpose of the polygon - to carry out periodic observations on the changes in the quality state of the typical arable grey soils under the influence of the local agrotechnics. The soil profile is located on the horizontal surface of a wide ridge on the Northern Plateau of Moldova. Absolute altitude - 234 m studied. The soil cover on the arable land is composed by grey soils submoderated humiferous with semi-deep humiferous profile loamy 0-35 cm and clayey-loamy 35-100 cm. The arable land is used under field crops. The natural degradation factors are: the eluvial-illuvial process of textural differentiation of the soil; excessive compaction of the underlying illuvial layer. The anthropic factors of soil degradation are: dehumification, destructuration of the arable layer and secondary compaction of the post-arable soil layer as a result of unreasonable agricultural exploitation (CERBARI & LEAH, 2010; ЛЯХ, 2018).

Monitoring key-polygon 2: Grey soil, natural or virgin (Profile 2). The polygon is located on the horizontal surface of a wide ridge of the Northern Moldavian Plateau, in the primary forest - southern part of the arable land on which the Profile 1 was placed. Absolute altitude - 239 m. The climatic conditions, relief and underlying rock are analogous to those of Polygon 1. The soil cover is formed from grey soils with moderate humiferous profiles, loamy 0-26 cm and clayey-loamy from 26-120 cm. The soil profile served as an absolute standard for comparing and evaluation in the changes of the arable grey soils properties as a result of the anthropical impact of the conventional agriculture.

The polygons (profiles) are located in the moderately warm semi-humid climate zone. Solar period (sunny days) - 280-290. Duration of the sun, hours - 2000-2050. Average annual temperature, °C - 7-8°. Sum of t°>10° - 2700-2800°. Annual amount of precipitation - about 600 mm. Potential evaporability - 650-700 mm. Hydrothermal coefficient after Ivanov-Visotzki - K=0.8 - 0.9. Duration of the vegetation period - 166-167 days exploitation (УРСУ, 1977; LEAH, 2016A; ЛЯХ, 2018A).

RESULTS AND DISCUSSION

Morphological description of the profile 1. The investigated arable grey soil is characterized by the profile type: Ahp1 - Ahp2 - Bhtw - Btw - BCtw - CRk (*Figure 1*).

The depth of soil profile - 120 cm. At the depth of 100 cm, the underlying rock is formed of yellow consolidated loamy-sandy material with large fragments of sandstone.

Ahp1 (0-24 cm) - freshly arable layer, moistly, dark gray with brown color, loamy, crumb-cloddy structure, weakly compacted 0-10 cm, compacted 10-24 cm, porous 0-10 cm and moderately porous 10-24 cm, many vegetal debris, clear crossing between horizons after compactness.

Ahp2 (24-35 cm) - the postarable layer, the lower part of the former arable layer 0-35 cm. Wet, grey-brown, loamy, differs from the previous layer by strongly compaction and practically monolithic structure, small cracks, aggregates break down hard, rare and thin roots, crossing clear between horizons by color.

Bhtw (35-53 cm) - illuvial or iluvial-cambic horizon, weakly humiferous, brown with reddish hue, clayey-loamy, damp, naturally highly compacted, prismatic structure, practically massive, rarely fine pores, very rarely insect holes, rarely thin roots, gradual passage.

Figure 1. Grey soil submoderatly humiferous, loamy 0-35 cm and clayey-loamy 35-100 cm, arable (Profile 1)

Figure 2. Grey soil moderatly humiferous, loamy 0-26 cm and clayey-loamy 26-120 cm, natural (Profile 2)

Btw (53-71 cm) - continuation of the illuvial-cambic horizon, very weakly humiferous, brown-reddish, clayey - loamy, monolithic structure, very compacted, crumbling very hard, rarely fine pores, very rarely thin roots, gradual passage.

BCtw (71-100 cm) - decarbonated parental rock subjected to cambic process of alteration "in situ", light brown-red, wet, clayey-loamy, monolithic structure, very compacted, cracks hard, rarely fine pores, clear passage after color, texture and compaction.

CRk (>100 cm) - clayey-sandy Pliocene deposits with large fragments of calcareous sandstone, yellow, wet, unstructured, porous, fine pores, carbonatic.

After clearing the forest and using the land in the arable, as a result of the modification of the hydrothermal regime and the biological circuit of the substances, the eluviation-illuviation process in the profile of these soils has ceased.

Morphological description of the profile 2. The grey soil virgin is characterized by the type of profile: Ahţ - AEh –BEhtw - Bhtw - Btw - BCtw - CRk (*Figure 2*).

The basic profile is located in the primary forest with respect to profile 1, at 100 m south from the northern limit of the arable land. Effervescence - beginning from the depth of 120 cm. After 120 cm, carbonates appear in the form of pseudo-micelles and vines, small and medium fragments of sandstones.

Ahţ (0-9 cm) - the fallow horizon covered with a thin layer of trees leaves, moist, dark grey, loamy, excellent glomerular - grains structure, weakly loosened, very porous, grass roots and many vegetable debris, passing clear between horizons by color and structure.

AEh (9-26 cm) - the eluvial - humiferous horizon, humid, light gray, loamy, differs from the previous layer by accumulation of SiO_2, grainy-nut form structure, weakly loosened, very porous, many roots of grasses, bushes and trees, clear passage.

BEhtw (26-37 cm) - eluvial - illuvial transition horizon, moist, brown with grey color, weakly humiferous, clay-loamy, weakly compacted, porous, medium and small pores, insect holes, many roots of trees and bushes, grasses, gradual passage.

Bhtw (37-54 cm) - illuvial horizon weakly humiferous, clayey-loamy, moist, dark brown, monolithic structure, very compacted, cracked hard in small cracks, rarely fine pores, frequently tree roots with diameter of 1 -2 cm, gradual passage.

Btw (54-72 cm) - continuation of the illuvial, or illuvial – cambic horizon, radish, light brown, moist, clayey-loamy, unstructured (monolithic structure), extremely compacted practically slit, rarely fine pores, rarely thin roots of trees, gradual passage.

BCtw (72-120 cm) - parental rock modified by the pedogenesis process, moist, clayey-loamy, brown-reddish, unstructured, extremely compact, rarely fine pores, very rarely thin tree roots, sudden passage.

CRk (120-140 cm) - the underlying rock, sandy-loamy Pliocene deposits of yellow color, weakly compacted, rare carbonate veins, and small and medium sandstone fragments.

The processes that led to the cardinal change of the clay content in the Btw layer of the investigated soil are both the illuviation of the clay from the 0-26 cm layer, as well as the cambic process of alteration "in situ" of the initial parental material of this horizon. The comparative characteristic of the properties of the arable and virgin grey soils on the layers with standard depths is presented in *Table 5*. More information in this regard can be obtained also as a result of comparing the statistical average parameters of the soils characteristics presented in *Table 1-4* for arable and virgin grey soils. The heterogeneity of the structure, composition and even coloring of grey soils is due to the redistribution of the silt fraction in the process of soil genesis and, therefore, a change in the granulometric composition of the entire soil profile. The texture of the arable and virgin soils is practically analogous - loamy in the upper part of the profile and clayey-loamy in the illuvial or illuvial-cambic (Bhtw and Btw) horizons (*Table 1*).

Table 1

The texture of the Grey soils on genetic horizons

Genetic horizons and depth, cm	Limits of granulometric fractions, mm; content, %						
	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01
Profile 1. Grey soils - arable							
Ahp1 0-24	2.2	23.6	31.2	9.6	13.2	20.2	43.0
Ahp2 24-35	2.4	23.4	31.1	9.2	13.9	20.0	43.1
Bhtw 35-53	2.1	21.7	28.3	8.2	12.5	27.2	47.9
Btw 53-71	1.6	21.5	27.8	8.7	10.8	29.6	49.1
BCtw 71-80	2.4	22.2	26.3	8.4	10.9	29.8	49.1
BCtw 80-100	2.8	26.4	23.0	9.7	10.1	28.0	47.8
CRk 100-120	9.7	63.7	9.2	5.1	5.3	7.0	17.4

Table 1 (continuation)

Profile 2. Grey soils - natural							
Ahţ 0-9	1.1	23.3	32.9	11.0	12.4	19.3	42.7
AEh 9-26	0.7	22.9	32.8	10.8	12.0	20.8	43.6
BEhtw 26-37	0.9	22.4	30.2	10.2	11.3	25.0	46.5
Bhtw 37-54	1.0	22.7	28.9	9.9	10.0	27.5	47.4
Btw 54-72	0.8	22.8	27.4	9.9	10.9	28.2	49.0
BCtw 72-100	1.1	28.1	23.7	9.5	9.9	27.7	47.1
BCtw 100-120	2.4	31.3	20.7	9.1	8.9	27.6	45.6
CRk 120-140	1.5	55.2	18.5	5.7	6.3	12.8	24.8

In the recent conditions of the structural state of the arable layer of these soils, the loamy texture can be appreciated as good in terms of soil tillage. Due to the loamy texture the arable layer works comparatively easily, the plough is less cloddy than in the case of fine-textured soils (clayey-loamy, loamy-clayey, clayey), the cloddies break down comparatively easily. The medium-fine texture and the monolithic structure have led to the excessive compaction of these horizons and the formation of an unfavorable physical quality state.

The structure of the grey soil arable layer is good - moderate quality and the hydrostability of the aggregates is low quality on the whole profile. Therefore, a favorable state of physical quality of this layer can be created only by periodic soil works during the entire vegetation duration of the crop plants. The upper horizons Ahţ, AEh, of the virgin soil are characterized by very good structure consisting by hydrostabile aggregates. Thus, the use of grey soils in arable land led to the destruction of the structure initially favorable of the virgin grey soils (*Table 2*).

Table 2

The average statistical parameters (X ± s) of structural composition of Grey soils on genetic horizons

Horizons and depth, cm	Content of structural elements (size, mm) - numerator and hydrostable aggregates (%) - denominator,				Quality of the structure (sieving dry)	Hydrostability of the structure (wet sieving)
	>10	< 0.25	∑ 10 – 0.25	∑ >10 + < 0.25		
Profile 1. Grey soils - arable						
Ahp1	23.8±8.0	8.5±5.6	67.7±3.9	32.3±3.9	Good	Low
0-12	-	64.6±3.5	35.4±3.5	64.6±3.5		
Ahp1	39.6±1.6	4,3±0.7	56.2±2.0	43.9±2.0	Moderate	Low
12-25	-	64,1±3.3	35.9±3.3	64.1±3.3		
Ahp2	34.5±6.1	3,5±2.2	62.3±7.5	38.0±7.5	Good	Low
25-35	-	69.4±4.7	30.6±4.7	69.4±4.7		
Bhtw	22.3±5.3	2.9±0.8	74.9±4.6	25.2±4.6	Good	Low
35-53	-	64.9±2.8	35.1±2.8	64.9±2.8		
Profile 2. Grey soils - natural						
Ahţ	7.2±1.1	9.3±1.8	83.5±2.0	16.5±2.0	Very good	Very good
0-9	-	26.1±1.6	73.9±1.6	26.1±1.6		
AEh	9.5±2.4	5.2±1.8	85.2±2.2	1.7±2.2	Very good	Very good
9-24	-	17.8±1.5	82.2±1.5	17.8±1.5		
BEhtw	31.0±2.6	3.6±0.6	65.4±2.1	34.6±2.1	Good	Good
24-35	-	23.7±3.2	70.2±12.3	23.7±3.2		
Bhtw	46.1±11.4	4.7±3.3	49.2±11.8	50.8±11.8	Moderate	Good
35-53	-	33.5±2.3	66.5±3.5	33.5±2.3		

Destruction of the soil structure essentially reduced the compaction resistance of this layer. Towards the end of the vegetation period the apparent (bulk) density of the arable layer reaches values of 1.4-1.5 g·cm^{-3} and of the underlying postarable layer - greater than 1.5g·cm^{-3}

which creates unfavorable conditions for plant growth. The illuvial horizons Bhtw and Btw of the arable and virgin grey soils are analogous and are characterized by a practically monolithic structure, apparent density consists 1.61-1.66 $g \cdot cm^{-3}$ and very high value of compaction degree - 22-25 (*Table 3*).

Table 3

The average parameters of the physical properties of Grey soils on genetic horizons

Horizons and depth, cm	Thickness of the horizons, cm	Hygro-scopicity, % g/g	Hygro-scopicity coefficient $g \cdot cm^{-3}$	Density, $g \cdot cm^{-3}$	Bulk density, $g \cdot cm^{-3}$	Total porozity, %	Compaction degree, %
Profile 1. Grey soils - arable							
Ahp1 0-12	12	4.1	5.2	2.60	1.30	49.9	0
Ahp1 12-25	13	4.1	5.2	2.60	1.45	44.4	11
Ahp2 25-35	10	3.8	4.9	2.62	1.52	41.2	17
Bhtw 35-53	18	3.5	4.6	2.66	1.61	39.5	22
Btw 53-71	18	3.6	5.5	2.68	1.61	39.9	22
BCtw 71-80	29	3.4	4.8	2.69	1.62	39.8	22
BCtw 80-100	29	3.0	4.3	2.69	1.61	40.1	21
CRk 100-120	-	0.8	1.3	2.68	1.51	43.8	6
Profile 2. Grey soils - natural							
Ahţ 0-9	9	5.2	6.3	2.51	1.19	52.8	-6
AEh 9-24	15	4.2	5.3	2.59	1.27	51.1	-2
BEhtw 24-35	11	3.9	5.3	2.65	1.42	46.2	8
Bhtw 35-53	18	4.1	5.6	2.67	1.63	39.1	23
Btw 53-72	19	5.1	6.3	2.69	1.67	37.9	25
BCtw 72-00	48	5.6	6.8	2.70	1.66	38.5	24
BCtw100-120	48	5.3	6.5	2.70	1.62	40.0	21
CRk 120-140	-	2.5	3.7	2.71	1.51	44.3	12

Some remediation of the physical quality status of the illuvial horizon is possible only by subsoiling at depths 35-70 cm. The humus content in the surface layer (Ahţ) reaches almost 6.16% in natural grey soils, but already in the next horizon (AEh) it decreases by more than half (3.14%). Such a sharp drop in the humus content is observed to a depth of 53 cm. Below this limit, the amount of humus decreases to 0.15% (120-140 cm). This, apparently, should be attributed to the penetration of the root system of trees. The arable grey soils differ sharply in humus content from those under the forest (*Table 4*).

Table 4

The average indices of the chemical properties of Grey soils on genetic horizons

Horizons and depth, cm	pH	$CaCO_3$, %	P_2O_5 total, %	Humus, %	N total, %	C : N	Mobile forms, mg $100g^{-1}$		Hydrolytic acidity, $meq100g^{-1}$
							P_2O_5	K_2O	
Profile 1. Grey soils - arable									
Ahp1 0-25	6.4	0	0.104	2.28	0.114	11.6	2.0	14	3.6
Ahp2 25-35	6.3	0	0.086	2.07	0.107	11.2	1.7	12	3.2
Bhtw 35-53	6.5	0	0.059	1.44	0.077	10.8	1.2	10	2.4
Btw 53-71	6.8	0	-	0.84	-	-	-	-	-
BCtw 71-100	7.1	0	-	0.40	-	-	-	-	-
CRk 100-120	8.0	9.7	-	0.17	-	-	-	-	-
Profile 2. Grey soils - natural									
Ahţ 0-9	6.4	0	0.147	6.16	0.272	12.9	7.6	39	2.4
AEh 9-24	5.6	0	0.095	3.14	0.153	12.2	3.1	17	6.3
BEhtw 24-35	5.5	0	0.075	2.12	0.112	11.5	2.1	14	5.4
Bhtw 35-53	5.6	0	0.057	1.25	0.067	10.9	2.2	12	3.9
Btw 53-72	5.6	0	-	0.75	-	-	-	-	-
BCtw 72-120	5.8	0	-	0.35	-	-	-	-	-
CRk 120-140	7.5	4.5	-	0.15	-	-	-	-	-

The humus content in the 0-25 cm layer of arable soils (2.28%), compared to the humus content in the same layer of virgin soils (in average 4.65%), decreased by 2 time. Arable grey soils have lost up to 49 percent of the initial humus content. Such, the noticeable decrease in the humus content is associated with a rapid decomposition and mineralization caused by a more uniform distribution of the organic matter in the arable layer and a change in the complex of physical conditions after plowing. The decrease in humus reserves negatively affects the nutritive regimes and physical properties of grey soils. The humus content of grey soils is also closely related to the particle size distribution, with its relief the amount of humus is reduced. *(Table 5).*

Table 5

Weighted average parameters of the main properties of arable and virgin Grey soils on agronomical important standards layers

Standard layers, cm	Fractions <0.001 mm	Fractions <0.01 mm	CH*	D*	DA*	PT*	GT*	Humus, %	pH	AH*
P.1. Grey soil submoderately humiferous, loamy 0-35 cm and clayey-loamy 35-100 cm, arable										
0-30	20,2	43,0	5,2	2,60	1,40	46,2	8	2,23	6,4	3,5
30-50	25,4	46,7	4,7	2,65	1,59	40,0	21	1,60	6,4	2,6
0-50	22,3	44,5	5,0	2,62	1,48	43,5	13	1,98	6,4	3,2
50-100	28,9	48,5	4,8	2,68	1,61	39,9	22	0,61	7,0	-
0-100	25,6	46,5	4,9	2,65	1,55	41,5	17	1,30	6,7	-
P.2. Gray soil moderately humiferous, loamy 0-26 cm and clayey-loamy 26-100 cm, virgin										
0-30	21,2	43,9	5,6	2,58	1,28	50,4	-1	3,84	5,8	5,0
30-50	26,9	47,3	5,5	2,66	1,58	40,6	20	1,47	5,6	4,3
0-50	23,5	45,3	5,6	2,61	1,40	46,3	8	2,89	5,7	4,7
50-100	27,9	47,8	6,5	2,69	1,66	38,3	24	0,57	5,6	-
0-100	25,7	46,6	6,1	2,65	1,53	42,3	16	1,73	5,7	-

Note: *CH - hygroscopicity coefficient; D - density, $g \cdot cm^{-3}$; DA - bulk density, $g \cdot cm^{-3}$; PT- total porosity, %; GT - compaction degree; AH - hydrolytic acidity, $meq \cdot 100g^{-1}$ of soil.*

The virgin grey soil are characterized by a significant accumulation of biophilic elements (N, P, K) in the overlying horizons (above), and the arable ones - with a considerable decrease in the content of these elements in the ploughed layer. The reaction of the virgin grey soil is acidic (pH = 5.5-6.4, hydrolytic acidity - 2.4-6.3 meq), and of the arable grey soil - weakly acidic (pH = 6.3-7.1, hydrolytic acidity - 2.4-3.6 meq), which led to stopping the eluviation-illuviation process in these soils. Despite the acid reaction, the degree of saturation with bases is high (83 - 96%). The profile of grey soils from carbonates is full. Carbonates are found at depths ranging from 100 cm in arable (9.7%) and 120 cm in natural (4.5%) grey soils.

These soils are relatively poor in humus and nutrients; the presence of compacted illuvial horizons leads to decrease of water permeability and, therefore, they are periodically influenced by the temporary excess of humidity, they have a comparatively weakly anti-erosion stability, their natural fertility is relatively low. The soil dehumification and tillage, in turn, caused the destruction and compaction of the arable grey soil and worsened their physical quality. As a result of physical degradation, the water permeability and capacity, conductivity and accessibility for water of arable grey soils decreased.

CONCLUSIONS

The arable grey soil from northern area of the Republic of Moldova, compared to the natural ones, are characterized by a moderate degradation of the properties as a result of the dehumification, destruction and considerable decrease of biophilic elements content. In agrotechnical conditions corresponding to sustainable agriculture, on the arable grey soils, due to the favorable regime of atmospheric humidity, high yields of agricultural crops can be obtained.

The continued use of arable grey soils under conditions of organic and chemical fertilizer deficiency will lead to their further depletion in nutrients and aggravation of their quality status. The pedoameliorative and agrotechnical measures needed for these soils are: improvement the organic matter content in the arable layer by applying the organic and green fertilizers, using organic residues and waste, implementing zonal crop rotation; introduction the chemical fertilizers into harmless doses; improvement the soil tillage system (once in 3-4 years the ploughing at depth of 35 cm to crush the strongly compacted postarable layer, the periodic work with the chisel at depth of 40-50 cm for partial loosening of the extremely compact natural illuvial horizon).

BIBLIOGRAPHY

CERBARI V., 2000 - Fondul Funciar. Solurile. În: Strategia Națională pentru Dezvoltare Durabilă. Chișinău, pp: 21-24.

CERBARI V., LEAH T., 2010 - Solurile cenușii din zona moderat călduroasă semi-umedă a Moldovei de Nord. Monitoringul calității solurilor Republicii Moldova (baza de date, concluzii, prognoze, recomandări). Pontos: Chișinău, pp: 58-70.

LEAH T., 2016 - Caracteristica comparativă a compoziției chimice a solurilor cenușii tipice virgine și arabile din Moldova Centrală. *Rezumate* ale comunicărilor. Științe ale naturii și exacte. CEP USM. Chișinău, pp:142-145.

LEAH T., 2016A - The influence of agriculture on the chemical composition of grey soils from Central Moldova. Environment and the Industry. Proceedings Book. Bucharest, pp: 261-265.

АЛЕКСЕЕВ В.Е., ГРАТИ В.П., СИНКЕВИЧ З.А., 1977 - Глинистые минералы в лесных почвах Молдавии. В кн.: Генезис и рациональное использование почв Молдавии. Штиинца: Кишинев, с.76-82.

БАЛТЯНСКИЙ Д.М., 1979 - Почвы Центральных Кодр. Штиинца, Кишинев, 176 с.

ВЗНУЗДАЕВ С.Е., 1960 - Геоморфологическое районирование среднего и нижнего Днестровско - Прутского междуречья. Изд. Молд. филиала АН МССР, 5(71), Кишинев, с.22-28.

ГАНЕНКО В.П., 1978 - Изменение содержания гумуса в серой лесной почве и черноземах под влиянием удобрений. В кн.: Почвы Молдавии и их использование в условиях интенсивного земледелия. Штиинца: Кишинев, с.180-186.

ЛЯХ Т.Г., 2018 - Особенности варьирования содержания гумуса в серых почвах эрозионных ландшафтов. CEP USM, Chișinău, pp: 335-338.

ЛЯХ Т.Г., 2018А - Мониториг качества зональных почв: серые лесные почвы северной зоны Молдовы. Системы контроля окружающей среды. Изд: ФГБНУ Институт природно-технических систем. Вып.8 (28), ИПТС: Севастополь, с.118-123.

РОЗОВ Н.Н., 1964 - Серые лесные почвы Европейской части СССР. Почвы Юго-восточной Европы. София, с.340-352.

РЯБИНИНА Л.Н., 1968 - Серые лесные почвы Центральной Молдавии. Автореф. дис. канд. географ. наук. Кишинев, 16 с.

РЯБИНИНА Л.Н., 1984 - Лесные почвы. Почвы Молдавии. Генезис, экология, классификация и системное описание почв. Том 1. Штиинца: Кишинев, с.173-204.

РЯБИНИНА Л.Н., СИНКЕВИЧ З.А., СТРИЖОВА Г.П., 1966 - Об оподзоленности серых лесных почв Центральной Молдавии. Сб.IV: Вопросы исследования и использования почв Молдавии. Кишинев, с.68-73.

УРСУ А.Ф., 1977 - Природные условия и география почв Молдавии. Кишинев, 292 с.

ХОЛМЕЦКИЙ А.М., 1969 - Почвы Северо-запада Молдавии и пути их рационального использования. Автореферат канд. диссер. Кишинев, 16 с.

ХОЛМЕЦКИЙ А.М., ГАНЕНКО В.П., 1970 - Лесные почвы Северомолдавской лесостепи и состав их гумуса. Сб.V: Вопросы исследования и использования почв Молдавии. Кишинев, с.12-18.