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SOILS OF MOLDOVA IN DIFFERENT HISTORICAL PERIODS AND POSSIBILITIES TO RESTORE THEIR QUALITY STATUS

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Abstract

The paper aimed to present the historical evolution of quality status of Moldovan soils. Chernozems in Moldova consists about 80% of the total arable land. Food security, environment and health status of the population depends on soil quality. In the last 3-4 decades overexploitation of soil resources led to intensification of land degradation. More than half of agricultural land is affected by erosion, compaction, landslides. Estimates show that in different historical periods, soil resources were affected by various natural disasters, both natural and anthropogenic degradation processes. Anthropogenic degradation of soils manifested in Moldova currently requires to development and implementation the processes and technologies to stop and improve their quality status.

Key words: *chernozem, degradation, remediation, protection, humus.*

INTRODUCTION

Soil cover represents the space involving the whole natural, socio-economic and cultural factors. Soil fertility is the main value of the land. As regards to the intensification of anthropogenic pressure on the environment, the correct distribution of the national economy, management and sustainable land use is one of the main strategic objectives in achieving environmental and economic issues related to climate change, desertification, biodiversity conservation, poverty alleviation. Land resources requires a management motivated and aimed to protect the soils - as natural multifunctional object and important means of agricultural production that cannot be replicated.

MATERIALS AND METHODS

The research methodology was provided under existing standards in the Republic of Moldova. Were used physical and chemical methods, research of soil in the field, systematization, generalization and statistical processing of the obtained information.

RESULTS AND DISCUSSIONS

The use of soil resources in Moldova highlights some important historical period.

The period up to 1812. The small areas of arable soils are used from the surrounding of villages located in forest-steppe zone (Bejan, 2006). This natural conditions ensured a better security and opportunity to population survive. The negative impact of anthropogenic pressure on the soils was comparatively weak in this period and spread only about 10% of the total territory (Table 1).

Table 1. Dynamics of the structure land in Bessarabia and Moldova in the years 1812-2014, thousand ha /%

Years	Total	Arable	Perennial plantation	Other lands
1812	4511 100	516 11.4	46 1.0	3949 87.6
1900	3509 100	2320 66.1	109 3.1	1080 30.8
1950	3296 100	2124 64.4	177 5.4	995 30.2
1990	3376 100	1820 53.9	410 12.2	1146 33.9
2013	3385 100	1816 53.7	295 87	1274 37.6

Sources: Annual Land cadastres

The main factor of land degradation used in agriculture, was linear erosion and landslides - the result of deforestation and land use as arable around the villages. Humus loss, destructuring and secondary compaction of soil arable layer (thickness of which did not exceed 15-20 cm) occurs slowly.

However, as a result of frequent invasions and occupation of the territory by nomadic peoples on the land used as arable produced changes occur in pedogenesis phases and soil quality status was restored. Brown and gray soils of forest-steppe zone, low productive in arable, being abandoned by the natives, gradually evolved into chernozems under the influence of natural steppe vegetation. As a result, in the contemporaneous steppe zone of Moldova formed a polygenetic soil cover.

Second period, the years 1812-1900. Comparatively stable political situation during this period favors the massive increase of population and practical use of arable land suitable for agriculture (Table 1). This fact has led to the intensification of land erosion, primarily, the linear erosion. Nevertheless, due of extensive agriculture, both the surface erosion and other soil degradation processes (humification, destructuring and compaction of arable layer) evolved slowly.

Third period, years 1900-1950 (1965). In these years, as a result of intensification of anthropogenic pressure on arable soils and lack of adequate territorial organization measures, continues to expand the surface of eroded soil and erosion processes in depth. From 1911 to 1965 the number of ravines increased more than 3 times, and in some districts - 5-6 times. As a result of extensive soil tillage farming system, usually with fallow, dehumication, destructuring and secondary compaction of arable layer continued to evolve slowly.

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Fourth period, years 1950 (1965) - 1990. This is an implementation period throughout the whole territory of Moldova the intensive agricultural system that included: frequently soil tillage with heavy machinery; performing deep plowing until 35-40 cm; massive use of chemical and organic fertilizers; land planning in large sole that not always meet the requirements of land erosion protection; almost total lack of planning hydrological land organization (Leah, 2012). The activities led to increased surface and depth erosion on the area of arable land. Also in this period greatly increases most dangerous soil degradation processes: loss of humus, destructuring and secondary compaction of arable layer which in previous periods evolved slowly (Figure 1, 2).

Figure 1. Chernozem typical fallow, glomerular - grainy structure of Ah horizon

Figure 2. Chernozem typical arable, with destructuring and strongly compacted arable layer

Increasing land productivity as a result of chemicalization of agriculture towards at the end of this period practically stopped, arable layer of soil lost the natural ability of resistance to compaction.

Fifth period, the years 1991-2014. During this period, land reform is carried out; land fund was divided into 2,5 million individual lots of land without soil planning and organization of antierosion, pedoameliorative necessary measures. Degradation processes of soil cover were extended on about 56 percent of agricultural land: continue to increase erosion processes and surface affected by landslide, the processes of humus loss, deterioration of the structure and soil compaction, alkalization, salinization and swampy; intensified droughts.

Performing the necessary measures in small farms is impossible. Agriculture become again extensive, agricultural production volume has decreased practically 2 times (Cerbari, 2013a).

The existing system of farming the land does not contribute to long-term preservation of the production capacity of soils and requires a radical change. Calculations on the balance of humus and carbon in the soils, showed that the annual irreversibly lost from arable soils consists 1 t/ha/year of humus, which is equivalent to the 0.58 t/ha/year of carbon accumulated historical and atmosphere elimination about 2.13 t/ha/year of CO_2.

Possibility of creating a equilibrated balance of humus in soils and remediation their degraded characteristics are:

Transition from arable land to fallow and gradual restoration of steppe vegetation under the action which formed chernozems. Research conducted on the strip of land with restored steppe vegetation, founded 15 years ago on the Experimental Fields of Research Institute of Field Crops "Selectia", established that in the regime of non utilization of vegetation air mass during 15 years, the organic matter content in arable layer 0-30 cm of soil increased by 0.90% (0.52% of carbon) or 0.06% annually (0.035% of carbon), (Cerbari, Balan, 2010). The balance of carbon in the 0-30 cm soil layer turned positive - +1.3 t/ha/year (0,035 x 1,25 g/cm^3 x 30 cm). This method of restoring the quality status of soils in Moldova cannot be accepted due to the lack of a surplus of arable land.

Use of arable land in rotation with five fields where one field is occupied with a mixture of alfalfa + steppe ryegrass. Experimental data confirmed that over 5 years on the parcel with mixture of perennial herbs, legumes and grasses returned about 25 t/ha (absolutely dry mass) of organic debris and roots of alfalfa and ryegrass (5 t/ha/year), the average nitrogen content 1.9% (Cerbari, 2013b).

Organic matter content in the 0-30 cm layer increased by 0.20% or 0.04% (0.023% of carbon) annually. Annual soil carbon balance turned positive - +0.9 t/ha/year (Leah, Cerbari, 2013a). This accumulation of organic matter in soil over a period of 5 years provides for next 4 years an equilibrated balance of humus for field crops sown after alfalfa + ryegrass. This method for restoring the soil quality status can be accomplished in about 10% of arable land in terms to restoring the livestock sector.

Application in the soil about 10 t/ha/year of manure. Currently, according to statistical data from 2013, in the agricultural soils are introduced about 30 kg/ha/year of manure (that means anything) and about 30-45 kg/ha/year of mineral fertilizer, 75-80% from these are nitrogen fertilizers (Leah, Cerbari, 2013b). That fertilization level cannot ensure profitable agriculture that would lead to the reproduction of soil fertility. In the 1981-1990 period were incorporate into the soil about 6.7 t ha/year of manure, that ensured a weak negative balance of organic matter in the soils.

Currently, the livestock has decreased 6 times. This quantity of cattle ensures the production of about 3 million of manure which is collected from farms, composted and introduction into the soil. This fact, would enable to solve the problem of humus balance in the soil and remediation the soil quality status in about 10% of lands arable. Simultaneously it would solve the problem of sanitary-epidemiological status of the rural environment.

Use as fertilizer the green mass of annual herbs mixture (legumes and grasses), intermediate culture. This process gives the possibility to increase the flow of organic matter in the soil, to create a equilibrated balance of humus and to remediated and maintain for a long-term status of chernozems while reducing CO_2 emissions in the agricultural sector (Table 2 and 3).

The most successful culture used for this purpose is autumn and spring vetch.

Table 2. Harvest of green mass of winter vetch + wheat (20%) and its chemical composition

Harvest	Green mass, t/ha	Humidity, %	Absolutely dry mass, t/ha	Ash	N	P_2O_5	K_2O	C	C:N
				% from dry mass					
Vetch	30.0	81.5	5.6	9.5	4.1	1.1	2.7	39.1	9.5
Roots, total mass in 0-30 cm			2.4	15.2	1.8	0.5	0.5	38.9	21.6
Total mass of organic residues and roots			8.0	11.2	3.4	0.9	2.0	39.0	11.5

Table 3. Status of the arable layer characteristics of chernozem ordinary, until incorporate (numerator) and after incorporation into the soil a crop of green mass of vetch by disking

Horizon and depth (cm)	The bulk density, g/cm^3	Total porosity, % v/v	Sum of favorable aggregates 10-0.25 mm, %	Hydrostability of favorable aggregates, %	Organic matter, % g/g	Mobile forms	
						P_2O_5	K_2O
Ahp1 0-12	1.27 1.08	51.3 58.6	71.2 86.6	30.4 38.6	3.03 3.24	2.3 2.5	24 27
Ahp1 12-20	1.46 1.34	44.3 48.9	55.0 67.2	34.2 37.0	2.92 3.02	2.0 1.9	21 22
Ahp2 20-35	1.50 1.44	42.7 45.0	48.0 53.0	36.4 35.6	2.82 2.83	1.9 1.8	20 20

This culture is characterized by high content of nitrogen in the dry mass up to 5%. The existence of two types of vetch makes possibility to use its green mass in the following cases: i) as intermediate crop sown in autumn and incorporated into the soil in April of the following year, with 4-5 days before sowing the base culture; ii) sown on the field by 2 times, autumn and spring, after incorporation into the soil the green mass of vetch in a rotation with 5 fields.

CONCLUSIONS

Incorporation into the soil of a crop of green mass of vetch roots (8 t/ha of organic debris) will be approximately synthesis 2.0 t/ha of humus in the soil, will be accumulate about 270 kg/ha of biological nitrogen, 50-60% (160 kg/ha) which is the symbiotic nitrogen. Described procedure should be repeated every two years.

On the plot where was incorporated into the soil the vetch green mass, along with remediation of soil characteristics, was registered an increase of corn harvest 1.1 t/ha/year in the first year and 0.4 t/ha of sunflower in the second year (compared to the control plot).

The systematic use of green mass of vetch as organic fertilizer is a chance to save gradually the degraded chernozem, which annually is poorly observed in existing agriculture.

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