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SOIL DEGRADATION AND ASSESSMENT OF LAND PRETABILITY FOR ORGANIZATION OF ORGANIC FARMING SYSTEM IN THE REPUBLIC OF MOLDOVA

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Abstract

The paper studied the impact of unfavorable factors on agriculture land, pretability and measures to reduce negative consequences. Nowadays, there are about 40 anthropogenic factors of soil degradation, but the erosion is the main factor of soil cover degradation in the Republic of Moldova. This type of degradation is manifested from old times as a natural process depended on the accidental relief and torrential rains. The present quality state of the soil cover denotes that the fields with a high reliability note of 80-100 points occupy about 27% of the total area of agricultural lands. The soils with medium reliability note of 70 points or less occupy 52% from the total area of agricultural fields and are moderate degraded. The soil with low rating are completely destroyed by ravens and active earth flows with a surface of 178 thousand ha and have a very low productivity. The complex of measures and technologies regarding the conservation and the increase of eroded soils fertility includes: the antierosion organization of the territory; the formation of forest framing, including the protection curtains against the erosion provoked by waters and winds; recovering of the hardly eroded soils by grassing and foresting; settling ravens and earth flows by regulating water drainages, their and limitary field grassing and foresting, cultivation of field cultures in bands on the slopes; the formation of protection bands from perennial herbs; the implementation of antierosion crop rotations; the unconditioned apply of antierosion soil works on slopes, agrotechnical actions etc.

Key words**:** *agriculture land, degradation, pretability, soil protection, sustainable measures*

INTRODUCTION

Soil is a living environment support for humans, plants and animals, energy storage, battery of nutrients and water reserves. The production process is indispensable linked by soil. In the agriculture, soil acts as an active factor being the object of production and the result of human labor. A rational and sustainable agriculture can not be conceived without any protective measures of soil quality status and long-term preservation of its fertility. Organic farming is a particular economic activity in that the long-term maintenance of soil fertility is the main problem. Passing from traditional agriculture to organic farming there is a risk to reduce soil fertility. In this connection it is necessary to develop, test and adopt a scientific augmented system to highlight and assessing the soil resources suitable for organic production and measures to maintain the soil quality and fertility in the specific farming.

According to the Statistical Yearbook of Moldova on January 1, 2012 [1], the total area amounts the 3.38 million ha; including agricultural land - 2.50 million ha (73.8%), forest resources – 463.1 thousand ha (13.7%). From the total agricultural land of 2.50 million ha the arable land is 1.81 million ha (72.6%), orchards – 133.3 thousand ha (5.3%), vineyards – 149.6 thousand ha (6.0%), pastures – 350.4 thousand ha (14.0%). The data presented shows that the share of agricultural land is unacceptably high (73.8%), the forest resources - less than 5 times as the optimal one. Unbalance between natural and anthropogenic ecological systems makes amplification of different types and forms of soil degradation.

The territory of the Moldova is characterized by rugged relief. Absolute average altitude of Moldova surface is 147 m, maximum - 429 m and minimum - 5 m. Predominance of the slopes on the 80% of the territory creates favorable conditions for the development of erosion processes. The area of eroded soils that have lost from 20 to 70% of their original fertility is about 36% [2].

Moldova's climate is temperate continental with short mild winter (January average temperature is 3-5^{0}C), and long hot summer

(July average temperature is +20-22^{0}C). The amount of rainfall varies between 500-630 mm in the North and 450-500 mm in the South. Amount of temperatures higher than 10^{0}C in the North area is 2750-2850^{0}C and 3100-3350^{0}C in the South [3]. Hydrothermal coefficient *K* (*ratio of annual precipitation and transpiration (evaporability) potential calculated according to formula Ivanov-Vâsoţkii*) in the North is 0.7-0.8 and in the South - from 0.5 to 0.6. Frequency of droughts in 10 yrs is once the North, 2-3 times in the Center and 3-4 times in the South zone.
Compared with values of the climatic indexes the territory of Moldova was divided into three agropedological areas, which are also the climatic zones: North, Central and South.

MATERIALS AND METHODS

The paper is based on the statistical data provided by Republic of Moldova's Statistical Yearbook and the specific methods for such a study.
The following aspects have been approached: status of soil quality, soil degradation and its determinants regarding natural and anthropogenic conditions, assessment of land suitability for organization of organic farming system, land management and soil protection.

RESULTS AND DISCUSSIONS

The issue of soil quality state

The main practical and unique natural wealth of the Republic of Moldova is soils. Soil cover structure is quite complex. The main types and subtypes of soils are: chernozems occupying 70%, brown and gray soils - 10.2%, alluvial and deluvial soils - 14.2% [4, 6], (Fig.1).
High fertility soils and favorable thermal regime allows cultivating a wide range of valuable crops: grape-vines, ether-oleaginous crops, fruit, nut, vegetable, sunflower and so on with high quality productions. The current state of quality soil cover is shown in Table 1. Creditworthiness note of soils between 80 - 100 points occupies about 27% of the total agricultural land [6].

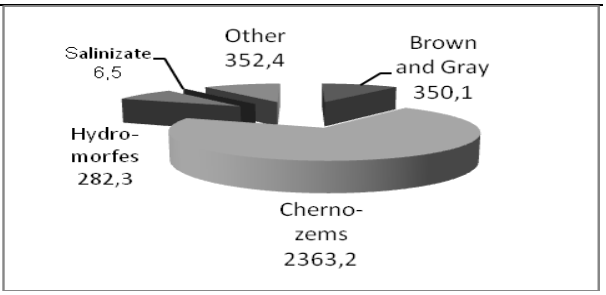

Figure 1: The structure of soil cover of Moldova

Table 1: Soil quality state (creditworthiness)

Class of credit-worthiness	Note of credit-worthiness, points	% of agricul-tural land area	Surface, thousand ha	Winter wheat yield, t ha^{-1}
I	81-100	27	689	3.2-4.0
II	71-80	21	539	2.8-3.2
III	61-70	15	382	2.4-2.8
IV	51-60	15	382	2.0-2.4
V	41-50	9	303	1.6-2.0
VI	21-40	6	153	0.8-1.6
VII	<20	7	178	-
Average	**65**	**100**	**2556**	**2.6**

The soils with high productivity, usually presented by typical and leached chernozems (standard soils) containing 3.6 to 4.5% of organic matter can be obtained at the expense of actual fertility from 3.2 to 4.0 t ha^{-1} of winter wheat. The soils from II and III classes of creditworthiness within the limits of 60-80 points occupy 36% or 918 thousand ha. Productivity of these soils is also quite high and obtaining 2.4 to 3.2 t ha^{-1} of winter wheat. The soils of these two classes of creditworthiness are commonly affected by processes of humus loss, lack of nutrients, dismantling and secondary compaction, biological degradation, and partial surface erosion. Soils from classes IV-VI occupies 30% of total, have a note of creditworthiness of 20-60 points, respectively, have a low productivity, from 0.8 to 2.4 t ha^{-1} of winter wheat. These soils are poorly, moderately and heavily degraded, especially by erosion [5].

Natural and anthropogenic conditions favoring manifestation of soil degradation

Geological construction. Moldova is characterized by a very complicated geological construction of the territory, soil formation rocks of continental or marine origin of diverse age and texture. The soil rocks contribute to the manifestation of the following soil degradation processes:

• *Argillaceous rock surface texture* - the appearance of excess moisture with stagnated character and formation the swamps with saturated soils on the slopes, the manifestation of gleysolic processes and appearance of the stagnogleyic soils, the occurrence in evolving linear erosion processes;

• *The texture of underlying argillaceous rock* – the groundwater accumulation, the formation and manifestation of sliding faces and landslide processes, the spread on the slopes the swamps and soil with excess of moisture and salts;

• *Medium and easy texture of soils and soil formation rocks* - the evolution of the surface erosion by water and deflation, the desertification and land desertification.

• *Rocks saline soil formation* - the formation of solonetzes on the slopes, increasing the mineralization of groundwater as result of soil salinization in the meadows.

Relief. The relief exercises its influence especially on the forms and intensity of erosion and sliding manifestation – the main factors of land degradation. The relief indicators, which make the intensity of soil erosion processes, are: the total degree of fragmentation of the territory, local base erosion depth, average slope length, steepness, and slope shape. In developing specific land using schemes and erosion control measures it is necessary to consider every relief quantitative parameters (slopes) and characteristic of specific territories.

Climate. To assess soil erosion hazard assessment are important the data concerning rainfall character. During the summer predominate the heavy rains with high intensity (erosion), accompanied by hailstorm, lasting 1-2 days. The torrential character of rains makes the unnecessary large water spills on the slopes. Terrain and torrential character of rainfall causes the intensive manifestation of soil erosion in surface and depth on the agricultural slopes.

General character of arid climate, frequent repetition of dry periods (drought), predisposition of the territory to manifestation of desertification processes require full adoption of agriculture to the dry arid conditions, especially in the South zone.

Vegetal cover. Cultivation of annual and perennial grasses on the slopes is an effective measure for soil protection against erosion. Vegetal cover reduces erosion manifestation or totally prevent. The intensity of soil erosion in hoeing crop can be 3-4 times higher than in cultures with compact vegetation.

In terms to increasing the share of hoeing cultures in crop rotation decreases sharply the coverage and soil protection. Therefore, on the slopes is necessary to apply special anti-erosion crop rotation which prevails in the composition of compact vegetation cover crops and perennial grasses.

Human factor. Anthropogenic factors leading to degradation of soil cover are: maximum involvement the territory under plowing, cutting strips of forest, tillage along the slope, improper placement of roads network, insufficient protection of soil with vegetation cover, excessive share of hoeing crops in crop rotation, soils compaction with mechanisms.

Overgrazing leads to complete degradation of the vegetal cover and soil compaction, the water permeability decreases as result of torrential rains on the slopes forming runoff that erodes soil cover.

Land privatization led to increasing the soil degradation. Excessive fragmentation of the productive sectors and their location along the slopes, activity in economic crisis does not allow new landowners to take basic measures for the protection, improvement and rational use of the land.

Using mineralized alkaline water for irrigation from tanks and small rivers exert a negative impact on soil characteristics. After the first irrigation season sodium adsorbed content exceeds to 5% of the cation exchange capacity and after 10 years of land irrigation this indicator exceeds to 14% [6].

Factors of soil degradation processes

Main factors of soil degradation are water erosion, affected surface– 878 thousand ha; dehumification of land surface - 2.5 million ha; soil nutrient depletion - on the 2.1 million ha; alkalization and salinization of soils, affected surface – 220 thousand ha of land; land slides area – 85 thousand ha; secondary soil compaction on the 2.1 million ha.

Soil erosion. Degree of agricultural land affected by erosion in Moldova increased from 28.1% in 1965 to 49.8% until now. Annual average surface of eroded land is 8000 ha. Eroded soil productivity decreases below: low eroded - 20 percent; moderately eroded - 40 percent; strongly eroded - 50 percent; very strongly eroded - 70 percent; excessively eroded (complete) - 90 percent. The presence of large areas of eroded soils conditioned a potential risk of erosion intensification on the whole agricultural lands.

During 1911-1965 yrs the ravines surface increased from 14 thousand ha to 24 thousand ha (approximately 2 times), the number of ravines increased 3 times. After 1965 some of the lands affected by ravines were excluded from agricultural fond and listed in forest resources, and in some areas were performed flatwork of gullies. This led to a drop in the number of gullies on agricultural land area to 8 thousand ha in total of the country. The cessation liquidation of ravines works and irrational management in agriculture generates growth in recent years in the number and surface of ravines. Average growth rate of ravines surface is 180 hectares per year.

Land deterioration as a result of landslides. Dynamic of growth landslide areas is follows: from 21 thousand ha in 1970 to 84 thousand ha in 2010. The main factor of intensification of sliding during this period was unreasonable slope terracing. Currently, one slide returns every 200 ha of land; annual growth of landslide areas in Moldova is about 1000 ha.

Destruction of soil covers by excavation. Until 1990 the exploitation works of quarries were made without the projects concerning restorations of destroyed land. As result, today on the entire territory are recorded 5000 ha of land with ground cover destroyed by excavation, which can be called "industrial desert territories" (3600 ha of large quarries, with state importance and 1400 ha of communal small quarries and abandoned silage pits having surface with 1-3 ha).

Clogging soils with low humus content deposits materials. Sudden intensification of erosion on the slopes caused clogging of cumulative soil with a layer of diverse thick deposits or low humus materials, which caused damage and reducing their productive capacity. Surface of agricultural land with deluvial and alluvial soils are periodically subject of clogging process, their surface is 51 thousand ha, and average yields on these soils decreased by 10 percent.

Primary compaction of soils. Gleysolic soils (7700 ha) and compact marshes from meadows (10 thousand ha) covers about 17.8 thousand ha and are characterized by unfavorable physical characteristics: fine texture with high content of fine clay (> 35%), high compaction and bulk density, small structural hydrostability, very low water permeability, high variation of infiltration and contraction by soaking in water and drying. In terms of soil resistance to plowing are very heavy. Due to unfavorable physical properties its have a low fertility that compared with similar no compacted soils, 20-40 percent lower. Approximately half of the surface of these soils is engaged in plowing and the other half is used as pasture.

Secondary deterioration and compaction of soil structure. The secondary deterioration of soil structure and compaction extends over the entire surface of soils, ranging from intensive agro-technical works on the arable land, in the vineyards and orchards perennial plantation. Deterioration of the soil structure is conditioned by intensive losses of humus from arable layer.

Mechanical degradation of soil structure due to soil compaction occurs by pointless circulating of tractors, heavy machinery, livestock, etc. Physical-chemical degradation occurs due to rain water, resulting in replacement of calcium by hydrogen cation in adsorption complex. Biological degradation is due to the decomposition of humus by the action of microorganisms. Arable soil fertility as result of secondary compaction was reduced on average by 10 percent.

Unclogging soils. In the foundation of vineyards and orchards plantations were unstopped (or deep plugging) to a depth of 50-60 cm approximately 546 thousand ha. As result of unstopped were disordered the ordination the natural genetic horizons and were brought to the earth's surface underlying horizons with low humus content and high carbon content. This process led to degradation fertility overlying layer (0-30 cm) of unclogging soils, process of clogging is very pronounced on the moderately

and strongly eroded soils. Unclogging land use for field crops after deforestation fruit trees plantations showed a decrease in their productive capacity essential to 5-10 percent. Currently under field crops are 176 thousand ha of unclogging arable soils.

Dehumification of arable soils. Soils dehumification as result of their use in arable is a global process, to stop that under the present system of agriculture is problematic. There is a risk that the next few decades, the humus content of arable soils to decrease on average by 10-25 percent, with very harmful effects on soil physical properties and even microorganisms in soil biodiversity. The most significant annually loss of soil humus from erosion land records 700 thousand tonnes.

Soil degradation as a result of alkalization and salinization. The total area of alkaline soils - 107.5 thousand ha, of which about 35 percent is arable land and 65 percent - pastures. The total area of saline soils is 112.2 thousand ha, 30 percent is arable land and 70 percent – pastures. Environmental damage caused by alkalization is calculated based on the weighted average soil productivity on non alkalization soils. Average of saline soils productivity decreased by 25 percent.

Soil degradation as a result of irrigation. The total area of irrigated land is 306.5 thousand ha. Currently can be irrigated only 85 thousand ha of land because the irrigation installation was destroyed in the privatization period. The reduction of irrigated soil surface caused by the economic crisis that now continues. The factors limiting production capacity of irrigated soils are deteriorating structure and compaction of arable layer and the underlying horizon, salinization and alkalization, raising groundwater and mineralization content.

Biological degradation of soils. Intensive use of arable land, widespread manifestation in association with physical and chemical degradation processes leading to biological degradation of soils. They intensified microbiological processes that contribute to the humus mineralization, decreased activity level of saprophagous 4-10 times, the rate of humus accumulation decreased from 1.7 to 3.3 times, the number of toxic biotic species increased significantly.

Land desertification and degradation as result of overgrazing. In recent years on the land occupied by pastures were intensified destruction processes of grass cover and disappearance of natural vegetation.

Overgrazing is conditioned by the increase in the number of cattle in the private sector and the lack of basic rules of exploitation process of grasslands. Unregulated grazing, early spring until late autumn, both natural and artificial grassland ones, leading to a reduction of about 40 percent of production and quality of grasses and accelerated degradation of grassland by thinning and loss of plants, by strong soil compaction and increase erosion on the slopes.

Assessment of land suitability for organization of organic farming system

Highlighting of land suitability, soil research and land cadastre suitable for organic farming organization is mandatory preventive action, which is done in stages:

I - performance assessment and feasibility study on the premises of Moldova to organize organic farming include: determining and reasoning of subjects as required geo information systems; developing placement schemes items in the agropedoclimacteric areas depending on crop zoning priority; collection of soil, water, plants, manure samples according to the scheme; their packing, shipping and analyzes; assessing the feasibility of the territory for organization of ecological agriculture.

II - assessment of ecological and pedological indicators necessary to delimits land suitable for organic farming organization. The researches allow to formulate preventive following obligations: the average credit-worthiness note of agriculture land - more than 60 points to confirm high fertility and self-purification capacity of soils; slope arable land - less than 5° to effectively combat soil erosion; soils - are not polluted with heavy metals, pesticides, fertilizers, petroleum products, pathogenic micro flora; agricultural land must be located at a certain distance from pollution sources (0.5 km from urban, 8-10 km from cement, metallurgical, chemical plants, 12-15 km from thermal power stations, 0.5 km from large livestock complexes).

III - highlighting possible prior of land suitable for organic farming on the based of earlier

research, mapping, environmental materials; conducting field research and development of soil, agrochemical, pollution and land evaluation maps; generalization of research materials, developing certificates of quality, pollution and ecological suitability of land for organic faming organization and training to producers of organic production; development of ecological certificate of suitability land in organic farming.

IV - development of methodology and monitoring soil quality status in the operation of their farming system to correct production technologies; development and implement-tation of measures for protection, improve-ment and sustainable use of soils under organic farming: methods of obtaining and/or preparation of ecological organic fertilizer from variety local sources, systems of crop rotation and fertilization of agricultural soils in ecological corresponding, monitoring of the effectiveness of recommended measures.

Land management and soil protection

Rational land management means combining technologies and activities in such a way as to achieve simultaneously: bioproductivity, food security, protection of soil quality, economic viability and social acceptability. This can be done if it acts primarily on the main goal - protection of soil quality. Maintaining long-term productive capacity of the soils, increasing its fertility, combat desertification are the primary strategic goals of the humanity. To protect soil resources was recommended the following actions:

- territorial organization of the villages and farms on soil research findings, review structure for agriculture and forestry uses in dependence of the nature of degradation processes and the necessary to maintain the ecological balance of natural and anthropo-genic ecosystems;
- management of soil resources corresponding to the requirements organic farming;
- implementation of soil erosion protection measures through antierosion projects of organization and development of agricultural land and water basins.
- improving degraded land by salinity and alkaline based on the projects concerning development of natural areas and watersheds, land reclamation works and implementation of agropedoameliorative measures.
- land fertilization in purpose to conservation and enhancement of soil fertility; ecological reconstruction of grassland vegetation.

Soil conservation and ecological restoration should take into account the particularities of local soil cover, degradation factors, forms of land ownership based on the set of economic and political mechanisms to stimulate and regulate soil protection activities.

CONCLUSIONS

The necessary for research in this field – organization of organic farming is determined largely by the lack in the Republic of Moldova the *Methodology of management, use, protection and improvement of soil fertility in organic farming system*. The main requirements when selecting the land for organic farming are:

- Land farming system must meet specific environmental potentials and ecological limits of the soil;
- System of selecting land for organic farming should allow maintaining the balance of natural and agricultural ecosystems and stimulate the natural processes of self-purification and revitalize the soils and the varieties of crops are established under land suitability for these crops.

REFERENCES

[1] Anuarul Statistic al Moldovei, 2012. Chişinău, 210-216, (rom).
[2]Cadastru Funciar al Republicii Moldova, 2012. Chişinău: 985, (rom).
[3] Агроклиматические ресурсы Молдавской ССР, 1982. Ленинград. Гидрометеоиздат: 198, (rus).
[4]Почвы Молдавии, 1984, Т.1. Кишинев: Штиинца, 352, (rus).
[5]Program complex de valorificare a terenurilor degradate şi sporirea fertilităţii solurilor, 2004, Partea I. Ameliorarea solurilor. Chişinău: Pontos, 212, (rom).
[6] Monitoringul solurilor Republicii Moldova (baza de date, concluzii, prognoze, recomanări), 2010, Chişinău: Pontos, 476, (rom).