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IMPROVING CONSERVATION PRACTICES TO PROTECT SOIL AND WATER QUALITY IN AGRICULTURE OF MOLDOVA

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Abstract

The paper presents the information on quality state of soil and water resources of Moldova. Currently, over 50% of soils are degraded by different natural and anthropogenic factors. Annual economic damage from soil degradation and land degradation consists 1.5-3.0 billion lei (MDL). Due to anthropogenic activities the content of humus in soils decreased from 5.6% (1870) to 2.5-3.0% (2015), the surface of eroded soils increased up to 850 thousand ha, which represents over 35% of the agricultural land area. It increased land area affected by landslides, which constitutes over 55 thousand ha of active landslides and 350 thousand ha of stagnation landslides. The water quality of small rivers after hydro-chemical indices was worsened. Water quality of small rivers is characterized by a high degree of pollution with ammonium ions, nitrite, oil products, phenols, anion-active detergents, etc. Irrigation with unconditional quality of waters leads to salinization and alkalization of soil cover. Preventing the soil degradation and water pollution can be achieved only through profound changes of awareness, behavioral and population management of natural resources.

Key words**:** *agricultural land, soil degradation, soil management, water quality*

INTRODUCTION

The main objective of Moldova as agrarian country and also for the entire world community is long-term preservation of the quality status and production capacity of the soil cover, along with environmental protection. After their composition and natural fertility the soils of Moldova belong to the most valuable, chernozems - 3/4 of the surface. It is characterized by the large diversity and variations related to horizontal and vertical zonality of relief, climatic and geological conditions [1].

Taking into consideration the global trends in rates of depreciation and irrecoverable losses of fertile soils areas and agricultural development, the problem of preserving soil and agricultural land quality is a strategic concern for food security [5, 8]. Intensive exploitation of soil and water resources in the Republic of Moldova in recent decades has led to their increased damage. Soil degradation and poor quality irrigation of water resources in the Republic of Moldova are the most serious problems existing at present [14, 7].

Agriculture is one of the main branches of the economy of the Republic of Moldova. In 2015, it accounted for 13% of GDP [2]. This sector provides employment to 26% of the working population of the country and welfare depends on the quality status of soil and water resources. The level of soil quality largely depends on crop yields, livestock sector development, export of food products, welfare and ecological situation in the country [1]. Agricultural land continues to be irrationally used and deteriorated, which harms the agriculture sector and environment.

MATERIALS AND METHODS

Research regarding quality status of soil and water resources has been of great interest in connection with considerable increase the surface of their degradation and pollution. The qualitative research methods (the general modality, the strategic approach, the study of reality) were used for analysis the documents and data published by scientist, by the Bureau of Statistics and Land Cadastre on study issues and computer assisted.

RESULTS AND DISCUSSIONS

Quality status of soil resources (Figure 1)**.** According to the situation of 01.01.2015 the land fund of Moldova constitutes 3,384.6 thousand hectares (th. ha). Agricultural land area is 2,500 ha (73.9% of the total area), including arable land - 1,816 th. ha (53.7%), perennial plantations - 295.3 th. ha (8.8%), meadows and pastures - 350.1 th. ha (10.3%), forest plantations - 465.2 th. ha (13.7%). In the Republic of Moldova, as in other countries, take place the reduction of arable land per capita. According to recent data this area is 0.407 ha [3, 9].

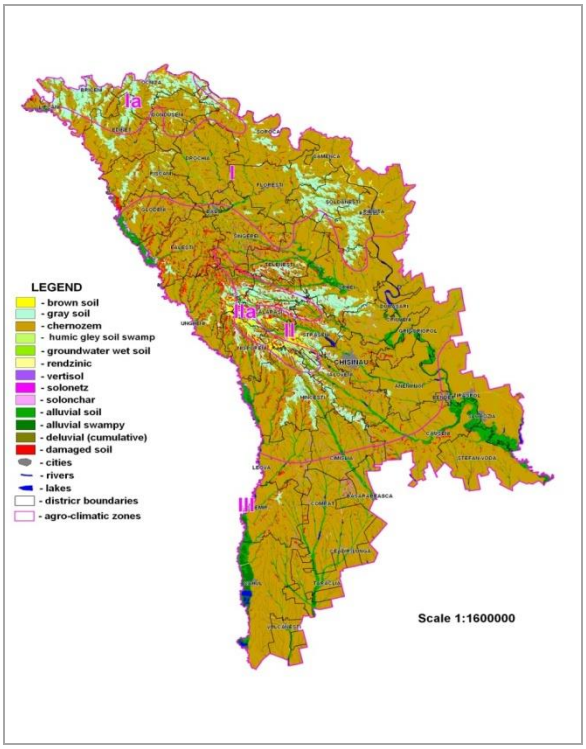

Fig. 1. Soil resources of Moldova

The current status of soil resources remains a concern, its use is inefficient, lack the measures of protection, improvement work is not performed. Thus, at present it is estimated follow facts [7]:

- The soils are subject to various land degradation processes, intensity and negative consequences of which grow from year to year;
- The soil surface affected by erosion processes, exceeding 1 million ha, annual increases by almost 1%;
-Periodically landslides activation occurs over an area of 80 th. ha;
-The humus reserves - the main source of energy and productivity of soils - are reduced, with about 1 ton per ha annually;
- As a result of deforestation of vineyards and orchards plantations over 200 th. ha of soils are used for other purposes, become the subject of active degradation processes, physical and chemical deterioration;
-The floodplain soils are in deplorable condition where they carried out the "leak adjustment";
- The areas under fallow soils (abandoned) increased, up to 250 th. ha.

The main forms of soil cover degradation are: erosion, dehumification, soil nutrient depletion, excessive compaction, salinization, alkalization, etc. Degradation processes and non application of agricultural technologies have led to reducing the production capacity of soils [14]. Dynamic of soil area in the period of 1965-2015 years showed a significant increase of surfaces with eroded land (Fig. 2).

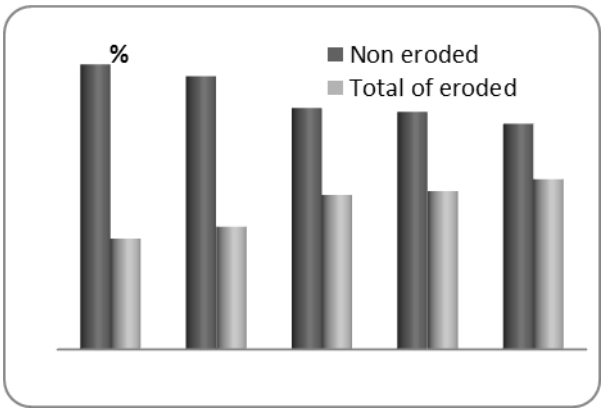

Fig. 2. Dynamic of degraded soils (1965-2015)

Soil erosion In terms of natural factor the soil degradation is caused by the placement of farmland predominantly on the slopes (about 80%), the torrential rains in the warm seasons, the predominance of weeding crops on slopes, emphasized relief. Surface and deep erosion, ravines, landslides, directly affect soil quality. The weak erosion reduces the productive potential (quality) of weakly eroded soil by 20%, moderately eroded - by 40% and strongly eroded - by 60-80% [6].

Over the past 30 years the surface of eroded soils increased by 224 th. ha, advancing by

about 6.4 th. ha annually, and representing currently about 880 th. ha or 26% of the total area. Highest level of agricultural land erosion is registered in Central Moldova - 43-56% [9]. The annual losses of fertile soil from agricultural lands due to erosion processes are estimated to 26 million tons, including: humus - 700 th. tons, nitrogen - 50 th. tons, phosphorus - 34 th. tons, potassium - 597 th. tones [1]. Indirectly, the erosion process has other consequences: siltation the ponds and other water bodies, soil and groundwater pollution by plant protection products and fertilizers, destruction of communication lines and hydraulic structures, etc. Due to the destruction of soil structure, saline and alkaline soils are more easily eroded by water and wind. Salinization induces desertification effects such as loss of soil fertility, soil structure destruction and compaction.

Soil dehumication. Reduction of soil quality is conditioned by dehumification processes (loss of organic substance). In cultivated soils due to the reduction of organic matter, the humus content decreases annually by 0.5-0.7 t/ha. At the same time, systematically reduces nutrient reserves by 150-180 kg/ha, which disturb the balance of nitrogen, phosphorus and potassium in the soils [15].The greatest losses of nutrients occur in the centre and south part of Moldova (Fig. 3).

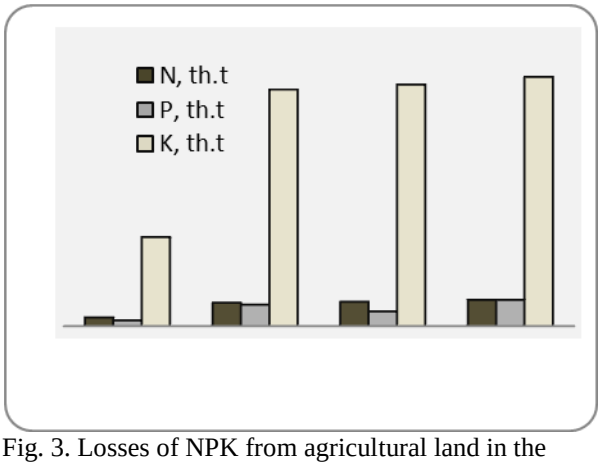

Fig. 3. Losses of NPK from agricultural land in the agropedoclimatical zones of Moldova

Negative balance of humus and nutrients cannot be changed and adjusted in terms of reducing the incorporation of fertilizers. In the 2000 yr. were applied 9 th. tons of fertilizers, in the 2014 yr. were used 53 th. tons, or more 44 th. tons, and organic fertilizers were used in a volume of 41.5 th. tons. At the same time, in many cases the livestock waste stored in landfills with other wastes or scattered on the banks of rivers and ditches in various unauthorized places [1, 7].

Excessive grazing is a specific phenomenon for the country with negative environmental impacts. Livestock of animals over prevail the rules set of heads on the 1 ha of pastures. However, most pastures, located on eroded land, are poorly productive. In these conditions no measures are taken to improve their quality due the lack of financial recourses.

Soil pollution. In addition to physical degradation and desertification processes in Moldova there is the problem of soil pollution. In recent decades the background of soils pollution became less important due to current sizeable reduction of diffuse sources of pollution. Were significantly reduced the quantities of fertilizers and pesticides in agriculture. No longer current the problem of pollution by nitrates and heavy metals. The content of lead in fuel used by transport was reduced, so diminished the soil pollution problem with this metal along the roads. It also produces at local level the soil pollution of farmland with mobile copper, the result of unregulated use of preparations containing copper [6].

But there is also the problem becomes more acute the local pollution of soils with different waste and harmful substances. Around localities is transported and stored chaotic waste of different categories and origin. Apart from waste deposited in places (ramps, platforms and polygons) approved and spontaneous, significant quantities of waste, predominantly solids are transported (thrown) in ditches, forest strips, canals and rivers, roadsides, damaged land. These wastes pollute the rural environment and, above all, the soil and water. Current still remains the local pollution of soils with persistent organic pollutants around former and current chemical deposits, resorts for preparation plant protection solutions. Thus, given the current state of soil resources and their quality the

following issues highlights in this sector [7]:
- Lack of the strategic and institutional framework for management and protection of soil resources;
- Inadequate management of soil resources characterized by a lack of agricultural crop rotation and anti-erosion measures, neglect best practices for soil conservation, excessive land parceling.
- Activation continues of soil degradation processes as erosion, compaction, salinization and alkalization, swamp, dehumification.
- Excessive soil pollution caused by waste and harmful substances, the irrational use of fertilizers and pesticides.
- Obsolete stockpiles of persistent organic pollutants and hazardous chemicals that lead to soil contamination.

But the greatest impact on soil quality favoring activation and intensification of degradation is caused by anthropogenic factor. Thus privatization and parceling of land, lack of agricultural crop rotation and anti-erosion measures, neglect good soil conservation practices, non-compliance of recommendation and necessary conditions to soil protection has complicated the possibility to implement an efficient and economic management of soil and water resources.

On narrow strips placed along the slopes, in the same direction is performed tillage (from hill to valley), which accelerates erosion. After landowners wanted, often with the best quality soils, considerable areas are excluded aside, others are left uncultivated and fallow.

Although, the environmental legislative framework is well developed, it is not correspond to international environmental initiatives and treaties and do not provide adequate management of natural resources to prevent environmental pollution and ensure the right to a healthy environment. This follows from the need for approximation of national legislation with EU directives.

Thus, in 2008 yr. was elaborated the draft of Law of Soil, for regulation the activities to provide protection, conservation and improvement of soil quality, based on scientific principles, agrotechnical and organizational mandatory for public authorities at all levels and landowners, but has not been approved so far.

Quality status of water resources for irrigation (Fig. 4). Compared to Eastern Europe and Romania the Republic of Moldova is a country with low water resources. Despite numerous accumulations achieve, the volume of surface water bodies and river flows is low. The density of the river system in the country is average 0.48 km/km^2. The main sources of supply the rivers are rainfalls and snowmelt precipitation. Rivers Dniester and Prut with corresponding portions of 630 km and 695 km make the border between Moldova, Ukraine and Romania. Annually, Moldova is crossed by 12 billion cubic meters of water on Transboundary Rivers Prut and Dniester.

This amount of water is more than sufficient for farmland irrigation works in our country. However, irrigation is in a deplorable state after 35 years of service.

The total area of irrigated land is 144.6 thousand hectares. Currently, there are 261 pumping stations for irrigation, of which 143 are functional and provide irrigation on the surface of 65 thousand hectares [4].

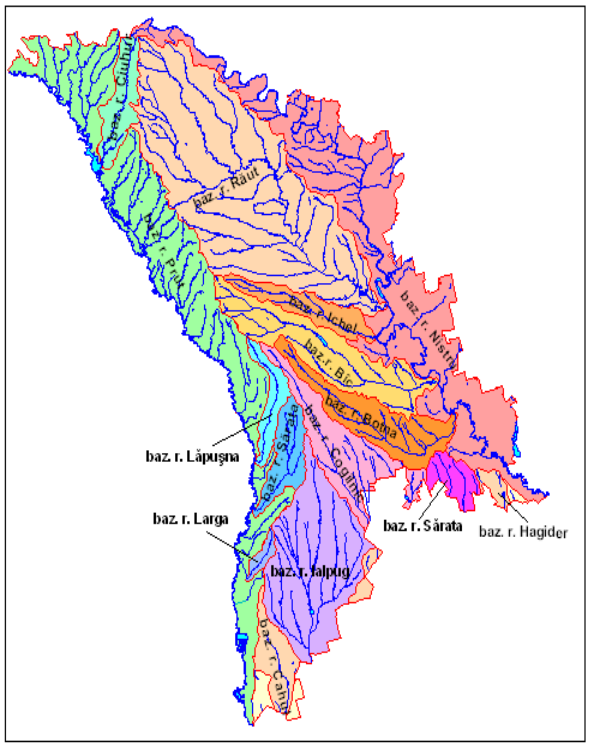

Fig. 4. Water resources of Moldova

It also can be used for irrigation the water from 400 of reservoirs across the country,

with which it can still irrigate 36 th. ha. For comparison, in dry years 2007 and 2009 were irrigated more than 30 th. ha of lands. In the 2012 year, only 14 th. ha are irrigated. A low level of irrigation potential is conditioned by the high price of water, price which in turn is dictated by the small number of users of this service [4].

The South zone of Moldova is most affected by drought and water supply to this area is the river Prut. By the 2020 years it is intend to increase irrigated areas to 300 th. ha, flood protected areas - to 95 th. ha, the irrigation rehabilitated areas - up to 121.6 th. ha, and those with new irrigation systems - up to 116 th. ha, and the creation of 32 water user associations [10].

Currently, however, just 34-36 th. ha are irrigated, i.e. only 2% of the total farmland. Do not use the total capacity due management model of irrigation systems and existing infrastructure. These systems have been designed under a centralized economy, where the irrigated surface was managed by a small number of farmers [10].

Improving agricultural practices of soil and water quality. Choosing improving practices within each category depends on the degradation factor, soil type, agropedo-climatically zone, water quality. Different type of soil and water respond differently to the same practices [13].

Organic matter management. Practices that increase organic matter include: leaving crop residues in the field, choosing crop rotation that include high residue plants and perennial herbs, using optimal nutrient and water management practices, growing cover crops, applying manure or organic residues, etc.

Local sources of organic matter and plant nutrition necessary substances consist of crop residues, organic fertilizers from livestock and individual households, organogenous waste from the processing industry of agricultural raw materials and urban communal household.

Tillage management. Reducing tillage minimizes the loss of organic matter and protects the soil surface with plant residue (alfalfa, sainfoin, ryegrass, and vetch).

Tillage system includes conservation measures for improving soil fertility, implementing on the experimental and production fields. The tillage system of soil fertility conservation are specified in each case, taking into account the total or periodic exclusion of the plowing with furrow return; keeping total or partial (30%) of plant residues on the soil surface; reducing the number of works; conducting the conservation the pedoameliorative works to improve the organic matter in the soils. Tillage system should provide the possibility of incorporating organic and mineral fertilizers in 20-30 cm layer and minimizing erosion processes on the slopes.

Chemical management. Efficient nutrient management means testing and monitoring soil properties, applying only the necessary chemicals at the optimal epochs and doses, and taking advantage of non-chemical approaches to nutrient management such as crop rotation, cover crops and manure.

Compaction management. Mini-till or subsoil tillage is only effective on soil with a clearly defined root-restricting plow pan. In the absence of plow pan, subsoil tillage to eliminate compaction can reduce yield. Prevention, not tillage, is the way to manage compaction [11].

Residue management. Ground cover protects soil, provides habitats for larger soil organisms, can improve water availability. Soil can be coved by leaving crop residue on the surface or by planting cover crops. In additional to ground, living cover crops increase organic matter, and continuous cover and food for soil biota [12]. Ground cover must be managed to prevent problems with delayed soil warming in spring, diseases, and excessive build-up of phosphorus at the surface.

Irrigation water management. Environmental requirements to quality irrigation water provide exclusion the development of degradation processes or worsening of soil properties. Not recommended to use for irrigation the water containing mineralization above 1 g/l.

Diversity management. Diversity is beneficial for several reasons. Each plant contributes a unique root structure and type o residue to the

soil. A diversity of soil organisms can help control pest population, and a diversity of cultural practices can reduce weed and disease pressures. Diversity across the landscape can be increased by using buffer strips, small fields, or contour strip cropping; by using long crop rotations [8, 12]. Changing vegetation across the landscape or over time not only increases plan diversity, but also the soil flora and fauna in the fields.

CONCLUSIONS

Preventing the soil degradation and water pollution can be achieved only through profound changes of awareness, behavioral and population management of natural resources. For reviving the agriculture, improving the land use situation and protection of natural resources are necessary actions for improving the system of tillage, to implement the comprehensive measures to prevent erosion and landslides, creating green protective housing, land improvement and soil fertilization.

Water quality of small rivers, is characterized by a high degree of salinity and pollution. Soil irrigation with unconditional water quality leads to soil and vegetation cover salinization.

Due to the deterioration of soil structure, saline and alkaline soils are more easily erosion. Salinization induces desertification effects such as loss of soil fertility, soil structure degradation and compaction.

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REFERENCES

[1] Андриеш, С., 2014, Процессы деградации почв Республики Молдова, мероприятия по повышению их плодородия и защита окружающей среды. В: Природные и антропогенные факторы воздействия на качество почв и водных ресурсов Республики Молдова. Кишинэу: AŞM, pp. 26-58.

[2]Economic overview (2013). http://miepo.md/about-moldova/economic-overview.

[3]Fondul funciar al Republicii Moldova la 01.01.2015. http://www.arfc.gov.md/files/Nota informativă.

[4]Филипчиук, В., 2014, Деградация чернозема при орошении и методы восстановления плодородия. В: Природные и антропогенные факторы воздействия на качество почв и водных ресурсов Республики Молдова. Кишинэу: AŞM, pp. 108-136.

[5]Gheorghiu Anda, Gheorghiu Anca, Iacob Oana Camelia, Volintiru Ana-Maria, 2014, Sustainable development of national agriculture. Scientific Papers. Series "Management, Economic Engineering in Agriculture and Rural Development", Vol. 14 (4), pp.107-112.

[6]Лях, Т. Г., 2014, Влияние эрозионных процессов на физико-химические и геохимические свойства почв транзитных и аккумулятивных ландшафтов. В: Природные и антропогенные факторы воздействия на качество почв и водных ресурсов Республики Молдова. Кишинэу: AŞM, pp. 59-107.

[7]Лях, Т. Г., 2014а, Современное состояние плодородия почв Молдовы в условиях интенсификации процессов деградации. Агрохимия і Грунтознавство. Міжвідомчий тематичний науковий збірник. К.3. Харків: ТОВ «Смугаста типографія», pp. 46-47.

[8]Martin R. Carter, 2002, Soil Quality for Sustainable land management. American Society of Agronomy. Published in Agronomy J. 94: pp.38-47.

[9]Recensământul General Agricol - 2011 în Republica Moldova (2013). Chişinău, BNS, pp.15-33.

[10]Republica Moldova se usucă, chiar dacă are resurse suficiente de apă (2013). http://www.timpul.md/articol/

[11]Sârb, G. S., Mateoc, T., Mateoc Sirb, N., Duma-Copcea, A., Grad, I., Şuster, G., 2013, Study considering the environmental protection and life quality in Romania in the context of sustainable development. Scientific Papers. Series "Management, Economic Engineering in Agriculture and Rural Development", Vol. 13 (3), pp. 257-262.

[12]Senicovscaia Irina, 2015, Contribution on soil biota to the stability of degraded soils in the Republic of Moldova. Lucrări Ştiinţifice. Agronomie. Vol.58, nr.1. Ed. "Ion Ionescu de la Brad", Iaşi, pp.83-88.

[13]Soil Quality for Environmental Health, 2014, Soil Quality Management: Key Strategies for Agricultural Land. http://soilquality.org/management.html

[14]Ursu Andrei, 2011, Solurile Moldovei. AŞM, Chişinău: Ştiinţa, 34 p.

[15]Wiesmeier, M., Lungu, M., Hübner, R., Cerbari, V., 2015, Remediation of degraded arable steppe soils in Moldova using vetch as green manure. Solid Earth, 2015 (6), 609–620 Published by Copernicus Publications on behalf of the European Geosciences Union. www.solid-earth.net/6/609/2015/.