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THE STATE LAND QUALITY IN THE VINEYARDS OF REPUBLIC MOLDOVA

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Abstract

There are identified the main causes that conduct to the degradation state of land quality in vineyards. These are the subject of natural and anthropogenic factors, leading to varying qualitative and quantitative of soil indicators. Reforms in agriculture led to the extension of the forms of soil degradation of vine plantations. The worst and most widespread form of soil degradation is erosion by water (surface and depth, with various intermediate stages). Anthropogenic factors favoring the growth rate of erosion processes are: irrational land parceled, excessive exploitation, deforestation of erosion protection forest belts, and abandonment of anti-erosion complex works. The paper reflected the soil protection measures in vineyards. The erosion protection is based on organizational, agro-technical, phyto-technical and hydro- technical measures. The direct effect of this system is reduced leakage and erosion processes, increase the soil water reserves and productivity of vineyards. One of the most effective phyto-ameliorative measures of soil erosion protection in the vineyards is grassing the spaces between vines rows.

Key words: *degradation, measures, protection, soil quality, viticulture*

INTRODUCTION

On January 1st, 2011 Moldova's total area was 3384.6 thousand ha, including: 2498.3 thousand ha (73.8%) of agricultural land, of which 1812.73 thousand ha (72.6%) - arable land, 298.8 thousand ha (12.0%) - perennial plantations, 352.55 thousand ha (14.1%) - meadows and pastures, 34210 ha (1.4%) - fallow land. From the total agricultural land, in the management of agricultural land owners were 2008.7 thousand ha (80.4%), including 115.8 thousand ha of vineyards [2].

In Moldova the viticulture is one of the most important branches of agriculture. The main importance of viticulture is superior capitalization of land, production value achieved per hectare, equivalent to that obtained on 5-10 hectares of cereal crops, efficient use sloping land, low productivity, unsuitable for other crops, serves as a base material premium economy, source of income and food, jobs for the rural population [3, 4].

Land reform in Moldova, in result of inappropriate strategies, has not created conditions for increasing soil fertility in vineyards, sustainable land use, increasing agricultural production, exerting therefore a negative impact on the economy. The main causes leading to aggravation of the situation in agriculture are general, and with particular consequences for the viticulture sector:

• Irrational plots of agricultural land and liquidation of techniques units through privatization of former farms (kolkhozes, sovkhozes, agricultural state institutions - schools, colleges, universities etc.)
• Significant decrease of soil fertility in the vineyards due to lack of funds to combat soil erosion, to compensate the loss of nutrients;
• Abandonment of over 50 thousand ha of vineyards because of low yield (2.0 to 2.5 t/ha of grapes) and lack of financial funds, state subsidies for their deforestation (about 4-5 thousand MDL/ha);
• Excessive spread of many species of harmful herbs for vine culture, as a result of unsatisfactory work of plantation land, deficit

of manpower and financial resources to purchase herbicides;
• Relocation of new industrial vine plantations (over 20 thousand ha of the country's total of 30 thousand ha) from typical vine growing hills (with old vineyards) to land of valleys, meadows, alluvial soils with clay texture;
• Soil pollution of vineyards with pesticide (Cu^{+}, Cu^{2+}, Fe^{2+}, etc.) and herbicides residues;
• Increasing soil salinization threat of vine nurseries (over 22 licensed businesses in this area) as a result of use of local water from unconditional resources, with high mineralization, excessive use of sprinkler irrigation method;
• Diminishing of soil fertility in vine plantations caused by preparation due to cleaning without fertilization included in projects to create new ones;
• Frequent loss of multiples areas of vineyard land, once used successfully to create plantations of perennial crops (including grapes) because of the development of swampy process (recurrence of coastal springs, surface water, reed bushes).
• Deforestation of erosion protection belts on the considerable areas, leading to increased wind and soil erosion on land with grown fruit plantations.

RESULTS AND DISCUSSIONS

Land reform has radically changed the structure and use of land ownership, ensures land solvency, increased number of participants in land relations, led to a variety of many forms of land ownership and management. However, these and other land changes have not created conditions for increasing soil fertility and increase agricultural output, which fell during the agrarian reform 2 times (Table 1).
Concomitant there is an adverse change in the structure of agricultural uses. The total area of perennial plantations in 2000 compared with 1989 decreased by 112.1 thousand ha (orchards and vineyards was clearing by new land owners). At the same time appeared 7.8 thousand ha of fallow, arable land area increased by 68.5 thousand ha, pastures - with 38.4 thousand ha. Irrigation systems have been damaged over an area exceeding 200 thousand ha of irrigable previous, inclusive in viticulture [3, 4].

Table 1. Comparative situation of land use in 1989 (up to land reform), in 2004 (after the land reform) and present - 2011

Category of land	1989		2004		2011	
	Thous. ha	%	Thous. ha	%	Thous. ha	%
Total land	2578.9	76.4	2528.3	74.9	2498.3	73.8
Arable	1819.7	53.9	1845.4	54.5	1812.7	53.6
Perennial, including:	410.4	12.2	298.0	8.8	298.8	8.8
Orchards	190.7	5.7	134.8	4.0	133.3	3.9
Vineyards	182.1	5.4	153.0	4.5	149.6	4.4
Meadows	3.7	0.1	2.8	0.1	2.2	0.1
Pastures	345.1	10.2	374.1	11.1	350.4	10.4
Fallows	-	-	8.0	0.2	34.2	0.9

Small agricultural land management in terms of an economic crisis does not allow owners to carry out protection, improvement and rational use of land, including vineyards. Dynamic of vineyard surfaces [1] is presented in table 2.

Table 2. Dynamic of vineyards surfaces

Years	Surface, thousand ha
1945-1950	98.5
1951-1960	83.0
1961-1965	233.8
1966-1970	237.8
1971-1975	259.0
1976-1980	275.8
1981-1985	236.2
1986-1990	202.6
1991-1995	169.4
1996-2000	156.0
2001-2005	143.8
2006-2010	152.6

Unclogging soils

For vineyard founding is made obligatorily unclog soils. Currently, the total land area with unclogging soil on depth of 50-60 cm is 550 thousand ha (Table 3).

Table 3. Dynamic of unclogging and anthropic transformed soil surface, thousand ha

Soil/years	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**2010**
Unclogs	376	423	474	502	526	546	550
Antropic transformed	0.5	1.4	5.5	13.5	20.8	33.4	176

Unclog land for vineyards led to disruption of natural stratification of genetic horizons and

surfacing weak humifer underlying horizons with high carbonates content. Erosion resistance of soils as a result of unclogging and removing on the surface of loess clays is very low. The soil cover in vineyards located on sloping land, during spring - summer period is unprotected state of black field, in the early years is subject to very intensive erosion processes. Therefore, preparations of land for the establishment of vineyards on the slopes have made the general direction of the slope contour.

Handling capacity of agricultural machinery in vineyard is low, leading to their passage on one and the same way, forming areas with increased soil compaction as a result of reduced water permeability, while increasing soil erosion and drainage on the slopes. The deterioration of soil structure and secondary compaction spreads all over the surface included intensive agro-technical works in vineyard plantations.

The antierosion organization of arable land and vineyards the relief conditions are often ignored. Roads, soles and areas of land are located along the slopes; the result is formed gullies and ravines. Frequently, the conditions for concentration leakage is created as various irregularities of the soil surface - potholes, incorrect leveling of longitudinal roads, transversal plowing along the upper litter of forest bands, divided furrows, which comprising water runoff from areas located above and moving it to a second tilt at a distance of 300-400 m in a gullies, which then formed ravines.

It required constant supervision of soils surface in vineyards, in order to carry out the appropriate order to avoid concentration of water flow and increase their fertility. Also, be made uniform dispersion of flow water without damage by forest belts, buffer strips of grass for water discharge and other plantings protection. Surface runoff must be regulated both during rainfall, and after heavy rains, preventing formation of gullies, gutters, leading to initiation of ravines [2, 4].

Damaged soils of vineyard are not announced in the inventory lists. This does not allow being estimated losses of organic matter and nutrients from soil, processes of soil compaction and secondary deterioration of the structure. The annual losses of fertile soil and nutrients in perennial plantations caused by erosion processes are presented in table 4.

Table 4. Annual losses of soil nutrients in perennial plantations caused by erosion, thousand tons

Zone	Area	Fertile soil	Humus	N	P_2O_5	K_2O	Production
North	84	893	12,3	0,9	0,6	9,1	14,3
Central	127	1220	32,7	2,4	2,2	24,2	19,0
South	26	251	7,2	0,5	0,5	4,7	3,7
South East	114	1401	38,6	2,7	2,7	25,5	19,7
Total	351	3765	90,8	6,5	6,0	63,5	56,7

Unclogging soils have a very different fertility compared to soils with integrity profile. Fertility of unclogging soil used for field crops is lower on average by 10-20% compared with similar natural soil fertility.

Unclogging soil properties are varying widely, depending on soils and horizons origin. Content in different particle size fractions (sand, dust, clay), humus, nutrients, pH values, density, etc. appear as weighted averages values of the characteristics of mixed types or subtypes horizons. To assess the conditions and quality state of unclog and anthropogenic damaged soil in vineyards it is necessary to conduct special investigations to establish the rational exploitation and mitigation measures for their fertility within the Soil Quality Monitoring [2].

The average weighted rating note of agricultural land is currently equal to 65. This index has an essential downward trend. According to the results of evaluation works conducted at the beginning of the ‘70 years, the average weighted rating note of agricultural land was equal to 70 points. Now, for some districts the rating note was reduced by 10 points. Fertility decline is caused primarily by increased soil degradation processes: erosion, solonetization, salinization processes, swampy, landslides [1, 3].

Agricultural crops, according to their physiological particularities, react differently to the decrease of soil fertility, and change their physical and chemical properties.

For example, the field crops productivity level is reduced proportionately of erosion, and the vineyards on these soils develop normally and give good harvests. To assess soils used in

vineyards, and location of these plantations was developed another level of evaluation, which takes into account the reaction of vine to different properties of soil. The calcareous chernozem clay-loam that has 100 points is considered as standard soil. According to this scale the evaluation note of soil quality status for the location of the vines is considered high [4]. The average weighted rating note of soils used in vineyards is 70 points (Table 5).

Table 5. The weighted average rating note of arable and vineyards on the climatic zone

Pedoclimatic Zone	Arable	Vineyards
North	76	70
Central	64	69
South	64	62
South East	69	67
R. Moldova	68	67

Average reduction of productive capacity of soils as a result of the degradation factor action – unclogging land and use it's for field crops is 5-10%. Damage as a result of using of these soils in the field crop rotations is equal on average to 200 MDL/ha and 35 million MDL for the entire area used for arable sloppy. The weighted average annual yield losses of eroded land in perennial plantations with an area of 139, 6 thousand ha are 30%. Damage caused by erosion, in cash, on land occupied by perennial plantations (139,6 thousand ha) is - 1350 MDL/ha. The distribution of vineyard surfaces depending on the soil erosion degree is presented in table 6.

Table 6. Distribution of vineyards in dependence of soil erosion degree

Erosion soil degree	Vineyard	
	Thousand ha	% from multiannual plantation
Non eroded	68.6	3.7
Weakly eroded	39.8	2.2
Moderately eroded	22.0	1.2
Highly eroded	6.8	0.4
Investigated surface of agricultural land, total	137.2	7.4

Suitability of soil resources of Republic Moldova in terms of use in vineyards in perspective extends to 755 ha or 31.0% of the land. Nowadays the arable land and vineyards areas are in decline. Currently, the 10-15% of the vineyard plantations are located in depressions (valleys, meadows); have high content of carbonates in the soil, more than 17%; high soil density, greater than 1,5 kg/cm³; high clay content, more than 60%; pH less than 6.5; presence of groundwater closer to 1.5 m above ground (Table 7).

Table 7. The surface of agricultural land and perennial plantation during 2009-2011

Category of land	2009		2010		2011	
	thous. ha	%	thous. ha	%	thous. ha	%
Agricultural land, from which:	2504	74.0	2501	73.9	2498	73.8
arable	**1821**	**53.8**	**1817**	**53.7**	**1813**	**53.6**
Perennial plantations, from which:	303	8.9	301	8.9	299	8.8
vineyards	**156**	**4.6**	**154**	**4.5**	**159**	**4.4**

Agropedoclimatic zones and land suitability for agricultural use

Affiliation of the most territory of Moldova to the under humid zone with frequent droughts during the growing season of plants requires a total adaptation of the agriculture to the dry conditions taking into account the peculiarities of each agroclimatic area [2].

Northern Zone of Moldova I - includes North Moldavian Plateau. Main zonal soils are grey soils, chernozem clay-alluvial and leached. Soils are characterized by high fertility, can be used for: apple plantation, potatoes, vegetables under irrigation, sugar beet, sunflower, grain, vegetable crops (soybeans), rape, etc. *Soils are not suitable to vine.* Factors limiting production capacity of soils are erosion, coastal swamps, degradation of structural stability and secondary compaction recently arable layer (0-25cm) and post arable (25-35cm) as a result of agro-technical tillage, destructuration, dehumification, low content of humus and mobile phosphorus.

Northern Zone of Moldova II - comprises the Moldavian Northern Plain and Dniester Hills. Mainly soils are typical and leached chernozem, grey soils, clay-loamy texture. Relief fragmentation leads to natural vertical setting of the soils. On the terraces of rivers Dniester and Prut, located less than 150 m attitudes are spread the ordinary chernozem

with clay or clay-loamy texture. These lands are suitable for use, primarily for irrigation.
Soils are characterized by very high fertility and are recommended for the following uses: sugar beet, irrigated vegetables, cereals, sunflower, vegetable crops (soybeans), apple and pear, nuts; on the lower terraces of Dniester and Prut - for watering gardens, *vineyards* and orchards. The restrictive factors of productive capacity of soils are: erosion, swamps, salting processes, dehumification, low content of phosphorus, compaction.

Central Zone of Moldova II - divided into two zones. However, within the zone there is pronounced the vertical soil natural setting. At altitudes up to 200 m dominate ordinary chernozem, between 200 – 300 m - typical and leached chernozems, above 300 m - brown and grey soils.

Zone "Codri" (II) occupies the Central Moldavian Plateau at altitudes of 300-400 m, mainly zonal soils are gray and brown. The landscape is highly fragmented. Soil fertility is medium and low. Soils are recommended for use primarily *for vineyards* and orchards, meadows and forests. The area is an extremely favorable ecological niche for the most precious vine varieties, useful for high quality fine wines. The main problem of zone is combating surface and deep erosion processes.

Central Zone of Moldova (II), (steppe and forest-steppe) occupies the hilly outskirts of Central Moldova Plateau and large terraces of rivers Dniester, Prut, Raut Ichel, Bic Botna, Lapusnita, at an altitude of 50-250 m. Main zonal soils are chernozem ordinary, sometimes typical chernozems (at altitudes greater than 200 m). Soils are characterized by good fertility. Due to more arid climate the land of this area can be used for: *vineyards,* orchards, grain, irrigated vegetable crops etc. Limiting factors are: erosion, coastal hydromorphism, salinization in meadows, gleyzation, primary and secondary compaction, and dehumification.

South Zone of Moldova (III), occupies the South Plain and Tigheci hills of Moldova at altitudes of 50-250 m. The main soils are ordinary, southern and carbonate chernozem. The landscape is moderately fragmented. This is the most dry and driest area requiring irrigation of agriculture. Soils are characterized by a good and moderate fertility and are recommended for *precious vine varieties,* cereals, stone fruit orchards, meadows, etc. Irrigation land presents the main measure to intensification of agriculture in this area. For the south zone is characteristic the natural setting of the vertical soil and climate:

- Southern chernozems, occupies river terraces Ialpug and its tributaries up to altitudes of 140 m. Land recommended to be irrigated by drip or other method and used for gardens, orchards of peach and apricot, varieties of grape.
- Ordinary chernozem, occupies hills of altitudes between 140-200 m. These lands are suitable for all varieties of vines, winter cereals, irrigated vegetables, plants to produce essential oils, etc.
- Typical and xero-forest chernozem occupies small areas at higher altitudes Tigheci peaks of 200 m. These lands are the most suitable for orchards and winter cereals.

The main restrictive factors of soil productive capacity of South Zone are: drought, erosion, sodium enrichment, salinization and compaction, dehumification.
Agricultural land use in accordance with the potential of soil and climate of each agropedoclimatic zone will contribute to adapt agriculture of Moldova to drought conditions and ensure food security of the country.

Soil protection in vines plantations [3, 4]
The geomorphologic conditions of Moldova determines location of perennial plantations on sloping land, after their suitability for these cultures are, in most cases, higher plane upper land. In these conditions it is necessary to develop measures to protect soil against erosion and deterioration. To achieve this goal were developed and implemented the most effective protective measures that favors water retention and soil fertility conservation of the upper layers.
Developed erosion protection system is based on the application of organizational, agro-, phyto- and hydrotechnical measures. The direct effect of this system is reflected by reducing leakage and erosion, increase soil water reserve

and increase productivity of vineyard perennial plantations.

Antierosion measures in the vineyards placed on slopes with inclination of 2-5^0 are:

• Vine plots are designed with the long part transversal to slope at 1.5 to 2^0;
• Water evacuation channels are set as terraces with inclination opposed to 3-4^0;
• Distance between channels is determined by the volume of water discharged;
• Leakage control strips have width of 3 m;
• Deep loosening of each 3rd row at a depth of 50-60 cm;
• Grassing of each 6 to 8-th row;
• Grassing outlets and road network with mixed gramineous.

For the vine plantations located on slopes with an inclination of 5-12^0 is recommended:

• Vine plots are designed with the long part transversal to slope of 1.5 to 2^0;
• Water evacuation channels are set as terraces with inclination opposed to 3-4^0;
• Distance between channels is determined by the volume of water discharged;
• Leakage control strips have width of 3 m;
• Cracking soil at a depth of 18-20 cm during June to August;
• Grassing of each of the 4-5-th row;
• Grassing road network and drainage sites;
• Deep loosening of each 2nd row at a depth of 50-60 cm;
• Planning diffuser leakage.

For plantations of vines situated on the slopes with inclination of 12-15^0 provides:

•Drainage channels and leakage control strips;
•Deep loosening of each 2nd row at a depth of 50-60 cm;
• Cracks between rows of 3-4 times between June to August;
• Grassing each 3rd row with a mixture of grasses;
• Grassing network roads and drainage sites;
• Planning diffuser leakages.

In the highly eroded soils are necessary to apply mineral and organic fertilizers, compost, to improve fertility and structure. Quantity of mineral fertilizer requirements to founding vineyards are presented in table 8.

Table 8. Industrial fertilizers needs to founding vine plantations [3]

Years	Surface, thousand ha	Tones, active substance			
		total		average annual	
		P_2O_5	K_2O	P_2O_5	K_2O
North Zone					
2011-2015	1.4	560	560	112	112
2016-2020	1.0	400	400	80	80
Central Zone					
2011-2015	16.8	6720	6720	1344	1344
2016-2020	12.4	4960	4960	992	992
South Zone					
2011-2015	16.8	6720	6720	1344	1344
2016-2020	12.4	4960	4960	993	992
Republic of Moldova					
2011-2015	35.0	14000	14000	2800	2800
2016-2020	25.8	10320	10320	2064	2064

CONCLUSIONS

Implementing new processes and technologies in sustainable agriculture of Republic Moldova, including viniculture sector, requires solving all impediments hampering efficient whole complex of vines and horticultural based on maximum mechanization of agro technologic processes.

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