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GRASSLANDS OF MOLDOVA: QUALITY STATUS, VULNERABILITY TO ANTHROPOGENIC FACTORS AND ADAPTATION MEASURES

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Abstract

The paper aimed to present the evolution and quality state of grasslands, pastures and hayfields in Republic of Moldova. Pastures and hayfields are considered the most vulnerable ecosystems to climatic conditions and anthropogenic factors. Their share is 10% of the country territory. Quality status of grasslands is unsatisfactory, being influenced by anthropogenic factors: overgrazing, erosion and landslides, salinization and waterlogging. During 2000-2015 the surface hayfields decreased by 1.6 thousand hectares, which are plowing. Pasture areas tends to increase, thus increasing the expense of uncultivated and abandoned land. The main cause that led to pasture degradation is the way to use - now they are not privatized, not have a stable surface, the animal grazing is not regulated. Vulnerability is directly proportional to soil degradation factors and natural conditions. Existing adaptive measures are concentrated in combating erosion processes and increasing soils fertility, therefore, planning and implementation of adaptation measures in the agricultural sector must be addressed and while referring to grasslands and pastures.

Key words*: grassland, pastures, hayfields, degradation, Republic of Moldova.*

INTRODUCTION

The grasslands are agricultural areas of pastures and hayfields, natural or cultured, used for the grass production or other herbaceous forage that have not been included for at least five years in the system of crop rotation and used for grazing and feed production, in compliance with good agricultural and environmental conditions. The grasslands, pastures and hayfields are considered natural ecosystems and dominant elements of the rural environment with greater biodiversity than cultivated areas, especially if they are as natural ecosystem (Dumitrescu, 1996).

In the past, grasslands occupied 80% of the current territory of Moldova. The grubbing-up of areas occupied by grasslands was performed gradually, but very accelerated after 1822. Towards 1861 the steppes and water-meadows area was reduced to 61% of the territory (890 thousand ha), over 26 years - in 1887 the area covered with perennial herbaceous vegetation amounted 444 thousand ha (Postolache, 1995). In Moldova, these ecosystems are currently a small percentage - 10% of the territory or 384 thousand ha (Cadastrul Funciar, 2015).

This is due to anthropogenic factors of land degradation and climate change condition that affecting the most vulnerable ecosystems.

The main forms of land degradation used as grasslands are erosion processes, overgrazing, excessive humidity, landslides, salinization, and alkalization etc.

Climate change has a serious impact on pastures and meadows, manifested by changes in the environment (soil quality and herbs productivity, biodiversity of pastoral vegetation and animals); by changes in livestock (feed resources and areas of vegetation spread, reducing forage yields and vegetation period, reducing animals nutrition and productivity); by changes on the socio-economic sector (production and food security, changes driven productivity, changes in land use, water availability and quality, reduction of recreation land and quality of agricultural land etc.).

MATERIALS AND METHODS

In order to characterize the evolution of grasslands surface and degree of degradation, the following indicators were used: surface in different period, quantity of feed productivity, most anthropogenic factors influence their

quality, adaptation measures. The data have been analyzed and interpreted in this work.

RESULTS AND DISCUSSIONS

The grasslands, pastures and hayfields in Moldova are considered vulnerable areas on whose territory systematic indicators are exceeded environmental quality versus standardized rules, causing serious damage to the state's environment with consequences. Worldwide permanent grassland occupies an area of 2 times the arable land. In the Republic of Moldova the surface of grasslands is approximately 5 times lower than plowing area, their share is 10% of the country territory (Figure 1).

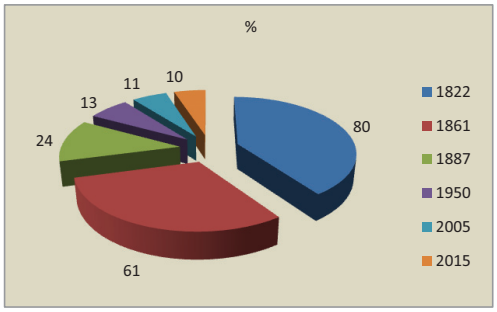

Figure 1. The share of grasslands in Moldova

In the last 25 years the area of grasslands has increased at the expense of arable land left as fallow or abandoned plots (Figure 2).

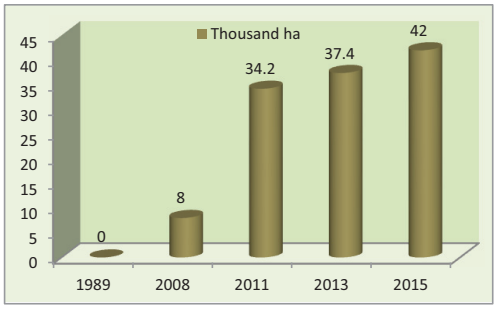

Figure 2. The surface of areas set aside in Moldova

Up to now, in Moldova have been preserved 1200 natural grassland areas. Surface sectors ranges between 0.3 ha and 300 ha. These are hayfields on the strongly abrupt slopes, where cannot be worked with agricultural machines, as well as those on the low lands with excessive water regime, caused by flood or superficial level of groundwater (Rusu, 2003).

Throughout the exploitation period, just as today, on the natural grasslands not apply even the most basic maintenance measures. The grasslands are used from early spring to late autumn with a large number of animals, in good and bad weather. As a result, the productivity of grasslands decreases from year to year, the vegetation degradation occurs. The species with high nutritional value and high productivity progressively evolves species with low feed value that less is required of animals. On the slopes during dry periods is completed with a pronounced soil moisture deficit and those with heavy rain - with erosion damage to vegetation and soil cover (Program, 2001).

Yields of grasslands on the slopes are small and of poor quality and consists 400-600 kg/ha of hay. Productivity of meadows is higher - 2000-2600 kg/ha of hay. But considering the high fertility of floodplain soils and good water plant supply, it is considered that the productive potential of meadows is about 20,000 kg/ha of hay. So the actual conditions of exploitation of this potential capacity use are only 10% of hay.

The natural grasslands in Moldova give only about 5% of the quantity of forage needed for the maintenance of the country's livestock. The US provides 33% of the forage grasslands and Romania over 50% (Rusu, 2003).

As a result of ignoring the role of natural grasslands in Moldova the mostly fodder produced on the arable land which now occupies more than 170 thousand hectares or 10% of arable land. But annual forage crops, due lack of more fully possible use of ground water reserves, forming 20-40% lower yields than perennial grasses (Rusu, 2003).

Thus, forage annual plants cannot serve as alternative perennial grasses. It is necessary to revisit attitude toward rational grasslands and use their high production potential, due to the long period of vast biological activity and plasticity to the climatic conditions.

Good agricultural practice, with economic and environmental reasons is the development of controlled grazing animals in summer the henhouse and providing wintering in their farms, with natural multiflora herbs (hay) as basic food (Simota, 2014).

The area of pastures and hayfields is growing (Figures 3 and 4) while arable land and permanent crops decreases.

This increase resulted in particular by failing to growing of arable land under agrarian reform after 1990.

Another cause, leading to changes in grassland areas is type of ownership. Pastures are not privatized, they are in public ownership. In countries where grasslands are privatized they have a stable surface and regulated grazed. If in 1995 the pasture area in privately owned made up 58.3 thousand ha, in 2004 - 2.1 thousand ha, i.e. they decreased by 27 times, in 2014 - consist about 4.6 thousand ha.

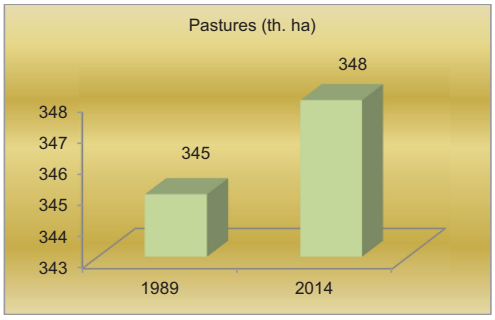

Figure 3. Comparative pastures area in Moldova

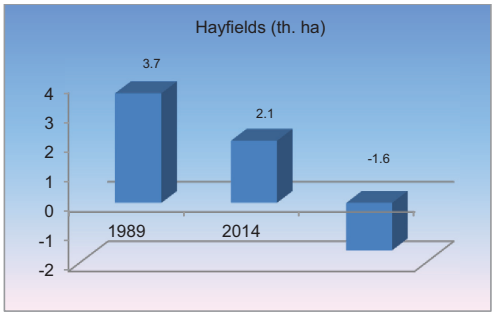

Figure 4. Comparative hayfields area in Moldova

In Moldova the surface of *natural hayfields* decreased considerably. If in 1960 the hayfields extending over 30 thousand ha, in 1966 their area constituted 10 thousand ha, in 1978 - only 2.4 thousand ha. Evaluation of hayfields areas during the years 1995-2005 demonstrates a minimum stability compared with grassland areas. In 1995 the hayfields areas made up 1.5 thousand ha, in 2004 - they increased to 2.3 thousand ha, reaching level of 1978, in 2014 - 2.2 thousand ha (Cadastrul Funciar, 2015).

Due to low productivity, part of hayfields has been plowing and included in aside and elsewhere - turned into grasslands. Currently hayfields are located on steep slopes and in large and small river meadows and their surface is not taken into account.

The hayfields on the slops have a vegetable coating consisting from xerophytes plants that are consumed by animals only in early spring. During summer and autumn period these plants are dried and give low yields. In dry periods, occurs abundant growth of weed species harmful for sheep, goats and other species of animals. This type of hay is very vulnerable to climate change, especially to long drought.

Floodplain meadows have a vegetal cover composed from mesophilic and hydrophilic plants with a much higher forage value. In the composition of plant species predominate perennial grasses with a high resistance to flooding, salinity and drought (Ionel, 1999; Rusu, 2003).

Land reform and changes in land relations characteristic of this reform led to the degradation of pastures and hayfields. Erosion processes continues, occurs secondary compacting of arable layer, salinization, alkalization, excessive humidity and the formation of marshy meadows, expanding humidity areas on the slopes, reduction of humus reserves in soil layer and other nutrients, degradation of pastures and hayfields.

It creates a situation when addressing any social problems requires coordination with measures to protect the biosphere and its main component - the soil.

Pastures and hayfields distribution analysis shows that these are spread over different types of soil: chernozems - 6.5% of the total area, that makes up 15.1% or 280.122 ha; hydromorphic soils - 6.2%; other soils (gray soils, dilluvial, compacted, damaged, deformed, landslides) - 2.5% (Figure 5).

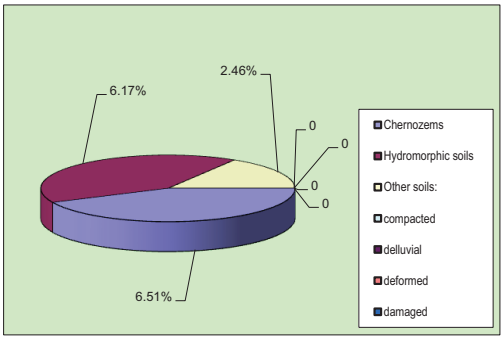

Figure 5. Distribution of pasture areas depending on the type of soil

Considering that most pastures are located on the chernozems and hydromorphic and semi-hydromorphic soils (soils of meadows) is required to orient adaptation measures system towards increasing the fertility of these soils and combat their degradation (Program, 2004). Moldova's pastures suffer most from over-charging of animals. Research has revealed the existence of areas with intense critical exploration environment. These are land from river meadows, on the slopes, near the forests, fallow land, landslides (Photo 1).

Photo 1. Natural pastures in Orhei district, Moldova

Currently in Moldova the total area of pastures is 384 thousand ha, 99% of them are used as grassland for animals (Cadastrul Funciar, 2015).

Free grazing is an extensive system of exploitation, in that the grasslands are used in early spring to late autumn, without taking into account grass production and the need to allow for plant recovery periods after they have been consumed by animals. The number of animals does not correlate with production capacity of pastures and occurs the livestock overload. In Moldova free grazing is practiced extensively and traditionally (Photo 2).

Photo 2. Free grazing of animals in the Răut river meadow in Orhei district, Moldova

Parceled grazing or rational is a modern system of pastures use, which removes the drawbacks of free grazing, but unfortunately not used in Republic of Moldova. Grazing plots involves applying a series of measures that relate to the determination of pasture production, establishing capacity and density, grazing pasture parcels division.

Vulnerability is the degree to which a community, population, species, ecosystem, region, agricultural system or other entity is sensitive or is unable to cope with the adverse effects of climate change. The vulnerability comprises a set of conditions and processes related to physical, social, economic and environmental conditions that increase the susceptibility of different sectors from the impact of climate change (Florea, 2003).

The vulnerability highlights exposures of grasslands, pastures and hayfields to various environmental changes. Vulnerability of grasslands, pastures and hayfields is directly proportional to the degree of manifestation of soil degradation factors (erosion, salinization, excessive humidity) and natural conditions.

The positive factors that increase the ability of vegetation and animals to adapt and effective resist to climate action is called *adaptive capacity.*

Adaptation measures relates mainly to processes of decrease vulnerability of natural grasslands to climate change. Existing adaptive measures are concentrated to combating erosion and increasing soil fertility, therefore, planning and implementation of adaptation measures in the agricultural sector must be addressed and while referring to pastures and hayfields (Program, 2004).

A much greater attention must be given to measures required to adapt (Program, 2001):

- *Long-lasting actions* (combating erosion, chemical amelioration of salty soils, landslides stabilization);
- *The average temporary actions* (land leveling, over seeding, deforestation of woody vegetation);
- *Annually performing actions* (fertilization, weed control, cleaning of garbage).

Adapting the pastures to conditions and climate change phenomena are carried out by measures to improve grasslands without replacing existing vegetation (Jones, 1989; Rusu, 2003):

- cleaning grasslands by the unfavorable
- vegetation, mounds, garbage and stones;
- combating erosion processes;
- correct nutrition regimes;
- over seeding grasslands.

Measures above mentioned have the highest effect if performed in complex and after a comprising preventive plan to care the pastures. Given Moldova stand out as the most essential and absolutely necessary, care grasslands measures (Program, 2001):

- removing water excess from meadows;
- combating erosion;
- eradication of weeds and worthless plants;
- fertilization and grasslands over seeding.

To achieve the development programs of herbs production, impact and risk reduction an important role is establishing the *models of grasslands rational use.* This requires grouping the lands. The models are developed on climatic zones and regional soils (Grâneanu, 1973; Rusu, 2003).

Grouping land for grazing is carried out based on the suitability of their degree of slope, erosion, landslides, depth of the ground water level, the degree and depth of gleyzation, salinity, alkalinity, content of stones, texture of upper horizon (Program, 2004).

The models of crop rotation and recovery technologies proposed crop rotations with perennial grasses in crop protection for all climatic zones of Moldova. Choosing the right crop rotation is determined not only by biological and ecological factors, but also by a number of other economic factors. Thus, developing models of rational use of land resources, including grasslands is a creative work, ready-made recipes are not, given the diversity of natural and economic conditions. Cultivation of perennial grasses technology is known and applied in crop rotations more often in recent years. Anti-erosion field-cropping model for different climatic and farmland conditions are very useful in areas with fragmented relief, where are spread meadows and pastures (Jones, 1989).

The *models works on land improvement* depending on the form and degree of degradation have as their object marshes that are spread to all districts. They cover compact areas, well outlined, with sizes ranging from 2-4 ha to 70-80 ha. Marshes have a pronounced microrelief, hydrological and lithology specific conditions, by vegetal cover, characteristic to wetlands. In normal regime marshes often become weeds outbreaks. Regarding these soils are often applied the models on drained soils without salting potential drained (Şecun, 1972).

Protection models of grasslands depending on the erosion degree of the slope. These models are implemented only in land erosion control planning. Their implementation is less efficient separate.

In the cumulative meadow landscapes soils affected by salinity or salinization occupies 80% of the salting areas. For differentiated implementation of complex ameliorative measures for recovery and exploitation salinity soils are also proposed appropriate groups. According to the group is developed operating model (Metodologia, 1999).

Models for improvement and recovery are developed for natural grasslands and soils with low fertility. Grasslands occupy, usually soils affected by factors make it impossible to growth the field plant: strong erosion, landslides, covered with silt, salty, with excess humidity - 90-99% of the total area of grassland used as pasture.

Radical restoring less productive grasslands and grassing eroded soils, taken out of field crops rotation is a method applied more frequently in recent years. On the meadows where vegetation cover is degraded, rarity, invaded by weeds, thorns, where improve works by surface measures are not effective, the grubbing and seeding need arises. Over seeding grassland and arable soils strongly eroded not require large capital investments and complies with existing technique in the farms. Expenses recovered in 2-3 years. Create sown grassland provides a production increase of at least 3 times compared to the natural ones.

Planning and implementation of adaptation measures must be addressed significantly in other areas, land used for grazing. Currently, adaptation to climate change is subject to a series of challenges.

These challenges include:

• improving climate models and scenarios at detailed regional level, especially in terms of extreme weather events, to reduce the high degree of uncertainty; application of these models on fields, sectors, grasslands etc.;

• registration the progress in the understanding of ”best practice” in adaptation measures through exchange of information on the feasibility, costs and benefits;

• involve public and private sector and the general public both locally and nationally level;

• to improving coordination and collaboration at national and international level, to ensure coherence of adaptation measures with other policy objectives and the allocation of adequate resources (Program, 2001).

Good agricultural practices, with economic and environmental benefits, it is rational exploitation grazing by animals and organic fertilization. It needs to be aware that these ecosystems are particularly sensitive and fragile. Good practices, with economic and environmental reasons is the development of grazing animals in summer at the sheepfold and assurance in the winter season within their own farms, having as basic nutrition the natural multiflora hay.

CONCLUSIONS

Grasslands of Moldova is currently only on the slopes affected by erosion and landslides, salinization and in the valleys degraded by excess moisture. In the category of meadows remained only those lands that were not currently plowing and are in poor condition. On the slopes coverage of soil with vegetation is 5-70%. Production of grass in the meadows does not exceed 10% of the soil biopotential.

In Moldova natural grasslands provide only 5% of the feed. To increase the amount of forage production and improve soil fertility is necessary to increase production of existing natural grass of meadows and create pastures on the eroded soils. Only through over seeding and organic fertilization the grassland production will increase 4-5 times. The sown grassland of meadows increases crops by at least 2 times the natural ones.

In Moldova the greatest difficulty in creation and improvement the pastures is lack of herbage seed basis. It is necessary to create the basis of herb seeds as: Vetch, Fescue, Ryegrass, Alfalfa, Sainfoin, and other grasses adaptation for our climate conditions. It is also necessary enlarged existing ones - Sainfoin and Alfalfa. This should motivate the expansion of sectors with meadows, compensation by the State a part of the seed cost and other advantages.

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