GRASSLANDS AND FORAGE CROPS - IMPORTANT FACTORS FOR REMEDIATION OF DEGRADED SOILS IN THE REPUBLIC OF MOLDOVA

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Abstract

Meadows, pastures and hayfields in the Republic of Moldova are considered the vulnerable zones within which indicators are exceeded systematic environmental quality compared to standardized norms, causing serious damage to the state's environmental consequences. Area of spontaneous grassland is growing, while arable land and permanent crops decreased. This increase was mainly the failure to culture of arable land, which was abandoned after 1990. Another cause, which led to changes in grazing areas, it is the property. Pastures are not privatized, they are in public ownership. In the 1995 the owned privately pasture area made up 58300 ha, in 2012 - 2100 ha. Forage production consists: 5% - production of grasslands, 95% - production of cereals, legumes, secondary production of agricultural plants. The main cereal crops and legumes used as animal feed are winter barley, oats, mixed cereals crops, grain legumes, and fodder vetch. From 1980 until 1992 the main production of forage crops – maize, silage and green fodder, sugar beet fodder had a significant increase, and after 1992 - a considerable decreased. Currently, the sown annual and multiannual grasses surfaces in the all categories decreased by 6 times, compared with 1990. In recent years there is a trend of growth the annual and perennial grasses surfaces, but this area does not cover the needs of the country in feed because yields are very low. Reducing the areas of grassland and forage crops will lead to further degradation of soils and environment.

Key words: grassland, fodder crops, soil degradation, anthropogenic factors

In the historical aspect, in the land structure of Moldova was occurred significant modification. Until the XVIII century the territory of Moldova have a low agricultural use. Arable land was located just around the rural areas. Natural grasslands and forests predominated. The situation changed sharply after the 1812. Economic development, political stability, population growth has led to the intensive land exploitation. Capitalization of agricultural land has increased especially in the second half of the XIX century. As a result of extreme expansion of arable land along the 50 years (1850-1900), were cleared about 100 thousand ha of forest and about 1.5 million ha of pasture (Cerbari, 2010). This has led to massive increased the soil erosion and environmental degradation of all environment components. Humus losses, damage of secondary soil structure and compaction are interdependent factors of soil degradation.

The physical, chemical and biological degradation of chernozems contribute to the expansion processes of land desertification and reduction of the volume of agricultural production in the country. The existing system of agriculture does not ensure long-term preservation of the state of soil quality and lead to worsening economic and environmental situations in the country. To overcome this situation is possible only through the gradual implementation of the system of conservative agriculture based primarily on the use of natural processes on biological resources and renewable household and only the second – on the purchased inputs. Fertility remediation of highly degraded soils, low productivity and anthropic transformed soils is outstanding feature of sustainable agriculture and therefore combating land degradation and desertification. In the absence of the necessary volume of organic fertilizers to address the characteristics of degraded soils, the only way to restore their quality status is implementing agro and phytotechnical measures - grassland and forage crop (Cerbari, Leah, 2001).

RESULTS AND DISCUSSIONS

Pastures and hayfields are considered the vulnerable areas, in whose territory is exceeded systematic environmental quality indicators, against standardized norms, causing serious damage to the state's environmental consequences. Grassland area is growing, while arable land and

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permanent crops - falling. This change was produced in particular by not taking into the growing of the arable land after 1995 *(fig. 1)*.

Another reason, which leads to the changes in grassland areas, is the type of ownership. Pastures and hayfields are not privatized; they are in the public ownership *(fig. 2, 3)*.

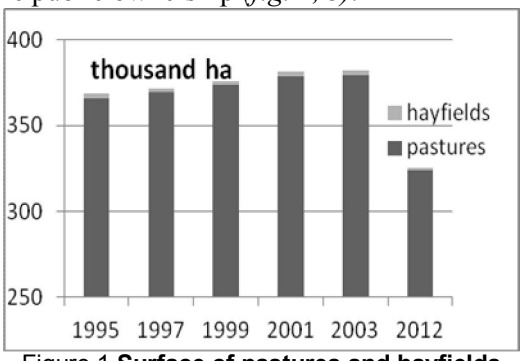

Figure 1 **Surface of pastures and hayfields**

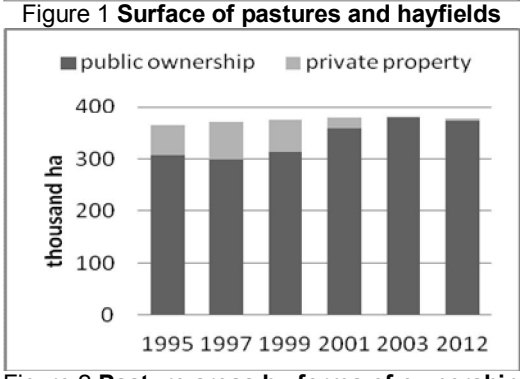

Figure 2 **Pasture areas by forms of ownership**

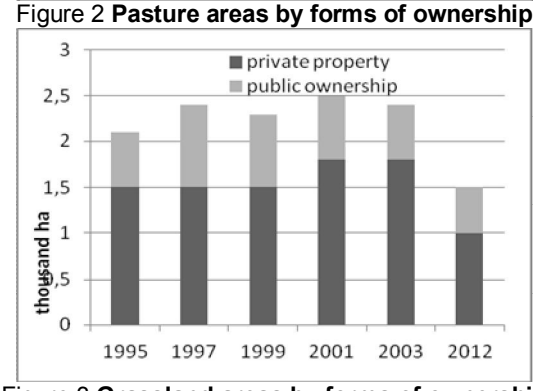

Figure 3 **Grassland areas by forms of ownership**

In the countries where pastures are privatized they have a stable surface and regulated grazed on them. If in the 1995 the pasture surface area in the private ownership made up 58,3 thousand ha, in 2012 – 2,1 thousand ha, decreased 27 times (*fig.4*).

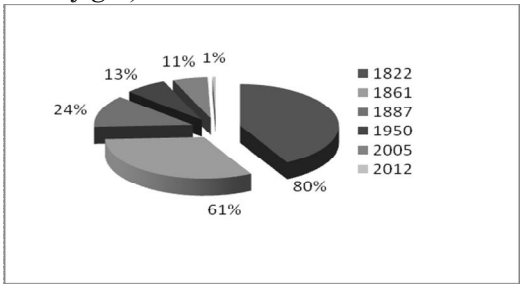

Figure 4 **Share of grassland in the Republic of Moldova**

Natural grasslands are considered highly vulnerable natural ecosystems. They constitute the dominant elements of rural areas with greater biological diversity than cultivated areas, especially if you are in a natural system. In the past 20 years their area is growing at the expense of arable degraded, abandoned or left fallow land, on which develops spontaneous natural herbaceous vegetation. After grassland spreading areas the Moldova ranks last in the Europe (*fig.5*).

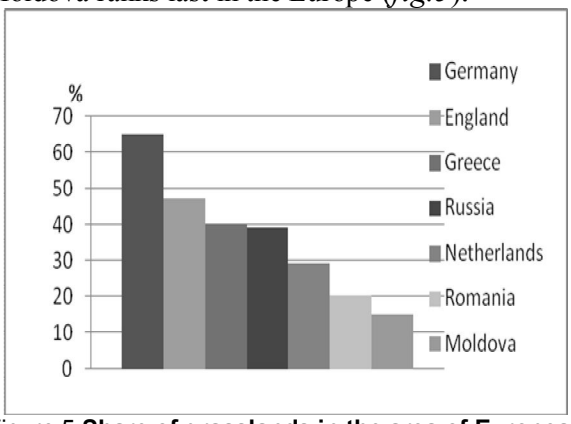

Figure 5 **Share of grasslands in the area of European countries**

Worldwide the permanent grassland areas occupy the surface of 2 times more, than the arable land. In Moldova grasslands area is about 50 times smaller than arable land. Nowadays in Moldova has been preserved about 1200 sectors with natural grassland. The surface of these sectors ranging from 0.3 to 300 ha. These are the grasslands on the strongly inclined slopes, where can not works with agricultural machines, as well as the fields in the depression with excessive water regime, caused by the superficial flood or groundwater (Rusu, 2003).

Throughout the capitalization period, as today, the natural grasslands not apply even the most basic maintenance measures. Grasslands are used from early spring to late autumn with a large number of animals, in good weather and bad weather. As a result, grasslands productivity decreases from year to year, there is vegetation degradation. Species with high nutritional value and high productivity progressively evolves low forage value species that required fewer animals. On the slopes during dry periods is completed with a pronounced soil moisture deficit, and those with heavy rains - the destruction of vegetation and erosion of the soil cover (Lupascu, 1998).

Harvests of grasslands are low on the slopes and is 400-600 kg/ha of hay. Productivity of meadows is higher - 2000-2600 kg/ha of hay. In the existing conditions of exploitation from this potential capacity is using only 10% (Program, 2001). So, the natural grasslands give only 5% of the amount of the forage required to maintenance

the livestock. As a result of ignoring the role of natural grasslands, the majority of forage produced on the arable land which now occupies 170 thousand ha or 10% of arable land. But the annual crops for forage from the lack to fullest possible use of ground water reserves, forming 20-40% lower yields than perennial grasses. Thus, the annual forage plants can serve as alternative perennial grasses. It should be reviewed and attitude towards the meadows and use their great rational potential of production, due to the long period of biological activity. Good agricultural practice to economic and environmental reasons is the development of a controlled animals grazing in the summer and ensure wintering in their households with basic multi floral herbs as hay.

Forage crops. Grasslands production is 5% and the production of cereal crops, legumes, and secondary production of agricultural plants - 95%. The main cereal crops and legumes are used as animal feed are winter barley, oats, mixed cereals crops, grain legumes, fodder vetch and vetch for grain. From 1980 until 1992 the main production of forage crops – maize for silage and green fodder, sugar beet fodder had a significant increase, and after 1992 - a considerable decrease (Cadastru, 2012), *(fig.6)*. The comparative surfaces of main crop cereals and leguminous used as forage is showed in *fig.7*.

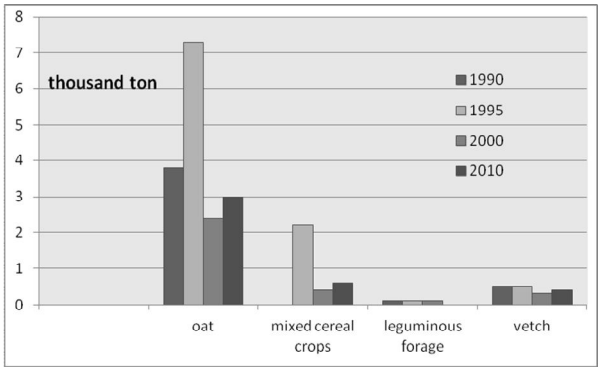

Figure 6 **Main crop cereals and legumes used for animal feed**

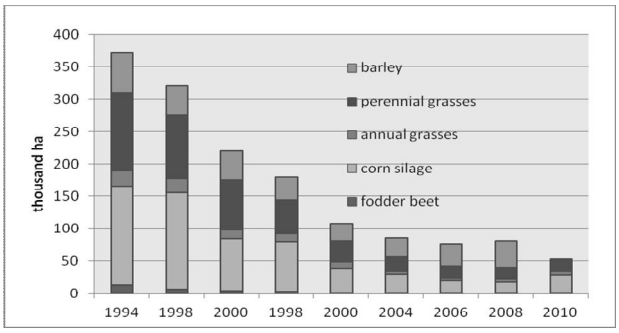

Figure 7 **Comparative surfaces of the main fodder crops grown in all categories of farms**

If we consider these surfaces, then each animal (the feed) has the on average 0.30 ha.

Winter barley remains one of the plants most commonly grown by farmers in Republic of Moldova by virtue of several factors. Even if the level of profit is lower than of other cultures, benefits in the case of barley related to the high degree of mechanization and, respectively, less labor, simple technology of cultivation, average income, but guaranteed (Boincean, 2003).

The areas planted with barley in 2005 were 119 thousand ha, and in 2012 were 80 thousand ha. Gross harvest in the country amounted to 261thousand tonnes in 2009 and 208 thousand tons in 2012. Global harvest of barley ranks in the top of three grown crops, after winter wheat and sunflower. On the world market barley demand is growing. At the same time, barley enjoys on the domestic demand, is widely used especially in animal feeding.

Winter barley is grown in areas with mild winters, because culture has a low resistance to frost. Spring barley has a wider spread area, but his productivity is much lower than winter barley. The countries growers barley largest widely are Canada, Russia, Germany and France. Worldwide, barley occupy 55 million ha, with an average yield of 2600 kg/ ha and global production of 142 million tons (Rusu, 2003).

Barley prefers the neutral or weakly alkaline soils. Not recommended for sandy-loam land, compacted, wetlands and saturated soils. The highest yields are obtained in the all climatic zone of Moldova. In the *fig. 8* is presented the harvest of winter barley used as animal feed, in percent of forage global crops. Compared with 1990 the crop of barley decreased 5 times.

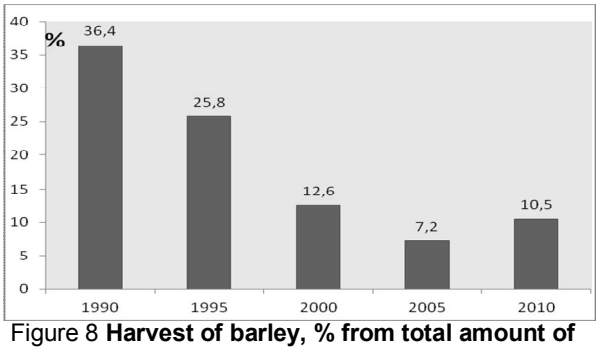

Figure 8 **Harvest of barley, % from total amount of forage crops**

Leguminous. The most common and convenient legumes for sown pastures in conditions of Moldova is alfalfa. Two species are cultivated, blue alfalfa *(Medicago sativa)* and yellow alfalfa *(Medicago falcata)*. Lucerne blue is more productive than the yellow, but has a lower resistance to drought, frost and flooding. Both species have a high degree of expendability and very good forage value (Lupascu, et.al., 2003, Lupascu, 2004).

Sainfoin. Taking into account the relief and the degree of soil erosion, sainfoin is superior to alfalfa, because it is resistant to drought, less demanding on soil fertilization. From the large number of wild species in culture are applied only three: *Onobruchis viciefolia* - resistant to winter and middle drought, *Onobruchis arenaria* - sainfoin for sand soils, very resistant to frost and drought, *Onobruchis Transcaucasus* - resistant to drought and frost. Sainfoin is recommended primarily for grassland created on eroded soils in central and southern part of Moldova (Starodub, Burdujan, 2003).

Clover. Are among the most productive plants feed and form very good quality forage with high coefficient of digestion and increased consumption. In condition of Moldova it is more effective to grown early red clover ensuring higher yields than late clover. Resistance of clover to frost is high, especially when is covered with snow. Grazing or late mowing in autumn weakens the frost resistance of plants (Starodub, Burdujan, 2003).

Grasses. The most common and most productive grasses of the sown grasslands from steppe area are *Bromus inermis leyss*. It is characterized by good quality forage. It is used as pasture and hay. It is the most suitable grasses for forage cropping (Graneanu, 1973).

Couch grass (*Agropyrum pectiniforme*) - perennial grasses, vegetates over 10 years. Due to high resistance to drought is indicated as a component of sainfoin on sloping soils, contributing to combat the erosion and increase fertility of these soils. It also recommends the introduction of couch grass to growing in salty soils sown in mixtures, the species tolerant to the presence of salts in the soil. It has high resistance to grazing and consumed over all animals. Ensure stable yields. After the productivity the couch grass in years with rainfall does not give other grasses, and in dry years - not exceed them.

Couch grass without rhizome *(Agropirum tenerum)* is recommended for sown pastures in slope. The grass and hay of *couch grass free rhizome* it exceeds by quality production of couch and twitch. The animal consumes it very well when is mixed with legumes. It is less resistant to frost and drought than couch grass.

Meadow fescue (*Festuca pratensis*) is among the most valuable fodder plants. It has a large capacity to recover; supports animal deterioration; regenerates quickly after sewing and after grazing.

It is maintained in sustainable grassland vegetation due to rapid growth. It spread to the fertile meadows and wetlands. Responds to irrigation and fertilization increased the production, but grows well in non irrigated conditions. Often is used to establish pastures sown on eroded soil and landslides (Dumitrescu, 1996).

Areas sown with grasses in all categories of farms decreased considerably compared to 1990. In recent years there is the trend of increasing annual and perennial grasses surfaces, but this area does not cover the needs of the country in forage feed because yields are very low.

The structure of sown areas with annual and perennial grasses has changed considerably. Compared to 1990 these areas were reduced to 6 times. Decreasing the areas under fodder plants will lead to further degradation of soils.

Perennial grasses - an important factor for remediation of degraded soils properties *(Case study)*

The existing system of agriculture led to increase areas with degraded soils (Leah, 2013a). The distribution of grassland surface on the main type of soils is shown in the *fig.9.*

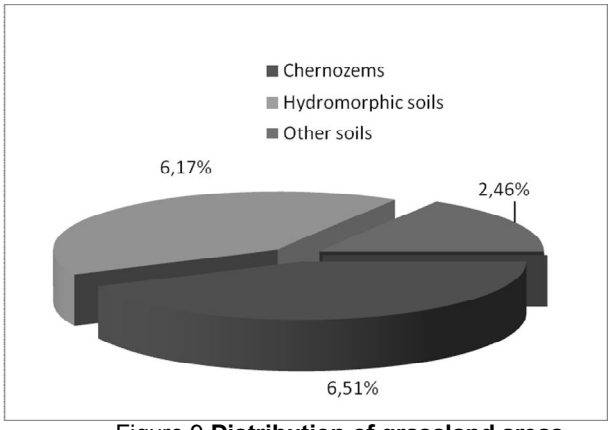

Figure 9 **Distribution of grassland areas depending on soil type**

One of the factors to remedy degraded chernozems characteristics is the factor that led to the formation of this type of soil - steppe vegetation in that component dominates grasses and legumes with fasciculate root system (follow). Given the fact that in Moldova is excluded the remediation of soil quality status by fallow (0.4 ha of arable land per capita) currently is being developed and tested methods for remediation of soil characteristics without disrupting agricultural production process – by implementation the agro and phytotechnical measures and procedures (grassland and forage crop).

To assess the changes in status as physical, chemical and biological quality of cambic chernozems from Central Moldova (Ivancea,

Orhei) and ordinary chernozems from South Moldova (Tartaul de Salcie, Cahul) under influence of different agrophytotechnical methods, in each of these two climate zones were founded by four experimental groups in which were tested environmentally friendly agricultural practices: ryegrass + alfalfa, sainfoin + ryegrass, vetch as a successive crop; manure 50 t/ha once in 5 years (Leah, 2013a).

Results of experiments:

1. In the result of using the cambic and ordinary chernozems under perennial grasses mixed grasses and legumes (alfalfa + ryegrass steppe), crop production which was used as fodder, it was established that this process along the 5-year state influence positive changes in quality arable layer of degraded chernozem cambic:

- returning in 0-35 cm soil arable layer of about 25.5 t/ha of organic remains absolutely dry (5.1 t/ha annual with average nitrogen content of 1.9 %) have created conditions to synthesis about 5.6 t/ha of humus (1.1 t/ha per year); the content of organic matter in this layer increased on average by about 0.20% and 0 04% annually.

- the 0-12 cm soil layer formed by disking, enriched with organic matter (0.43% in 5 years or 0.09% per year), became biological active, the structure status was improved, to start formation of fallow layer with a thickness of 3-5 cm *(fig.10)*.

Figure 10 **Strip with vetch**

2. A widely remediation of humus content and natural structure of chernozems is possible by using the successive crop of vetch in term used as green manure:

- is formed a equilibrated or positive balance of organic matter and nitrogen into the soil, annual is return in the arable layer with the crop vetch about 7 t/ha of dry vegetable waste (containing 3.3% of nitrogen) which provides the synthesis of 1.75 t/ha of humus or 1.0 t/ha of carbon and sequestration of 3.7 t of the CO_2;

- in the result of a once soil incorporation of vetch crops as green manure the content of organic matter in the arable layer 0-35 cm increased by 0.11%, improved physical quality status of 0-12 cm layer formed by disking, the volume of agricultural production increased by 20-30%.

- winter vetch as intermediate crop used as green manure is recommended to be sown every two years, as the basic culture that creates this possibility *(fig. 11)*.

Figure 11 **Strips with steppe ryegrass + alfalfa in the third year of harvest**

3. As a result of incorporation into the soil of 50 t/ha fermented manure of sheep in the arable layer 0-25cm soil the organic matter content increased by 0.20%. Simultaneously there is a tendency to improve deterioration soil structure and increasing phosphorus content. Incorporation into the soil 50 t/ha of sheep manure led to the increase the sunflower yield by 0.4 t/ha.

4. Influence of perennial grasses and gramineae mixture, sown for hay, on the soil quality after the third year of vegetation is comparatively small and will be assessed in the coming years. Visual and quantitative assessments are possible finding that in condition of South Moldova productivity mixture of herbs (sainfoin + ryegrass) is much higher than the productivity mixture of herbs (alfalfa + ryegrass).

Wide implementation of this procedure to remediate the quality status of chernozems is possible only to restore the livestock sector and the allocation under perennial grasses of about 13% to 15% of the land area of degraded soils (about 200 thousand ha).

The advantages of these measures:

- perennial grasses possess the highest degree of adaptation to soil and climate conditions;

- compared with annual forage plants, the perennial grasses have higher productivity and profitability of 1.5-2.0 times higher;

- grasses creates a balance of organic matter accumulation, nutritive elements and structural elements status in the soils;

- perennial grasses are the best precursor for wheat and technical plants (corn), ensuring their productivity increasing by about 20% compared to other predecessors;

- have the greatest capacity to protect soil against the erosion processes;

- is the least expensive feed, nutrient unit cost is about four times less than the cost of unity nutritious of oat grains.

CONCLUSIONS

South and South - East regions of Moldova are most vulnerable to climate change, leading to land degradation and desertification of agricultural land (Leah, 2012). In these zones is expected that considerable negative effects will be reflected on meadows and pastures, which are already in a degraded state under pressure from anthropogenic factors, for example, changes in land management. There may be an increased risk of natural disasters, the extinction of plant species valuable as animal feed. Projected climate changes are expected to result in a significant extinction of plant species throughout the all area of Moldova.

Increasing productivity of grasslands and increasing the surfaces with perennial grasses in crop rotations will improve the ecological situation in the livestock and plant growing sectors, in natural ecosystems, will remedy qualities of degraded soils less productive and protect the land by erosion processes.

ACKNOWLEGMENTS

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