EVOLUTION OF GRAY FOREST SOIL IN AGRICULTURAL USE IN CENTRAL PART OF REPUBLIC OF MOLDOVA

Marina LUNGU[1]

e-mail: seamarinkam@gmail.com

Abstract

With deforestation and employment in the agricultural cycle the forest soils begins another stage in its development. But a great scientific interest presents the evolution of these soils in agriculture use under climatic conditions different from those in which they were formed. To highlight and evaluate changes of arable gray forest soils propreties under anthropogenic factor action, in order to develop and recommend a system of measures to minimize adverse consequences and increasing production capacity of these soils while long-term preservation of their quality, in the specific conditions of Moldova, we aimed to investigate changes occurred in the morphology, properties and the elementary processes of gray forest soils (grayzems), employed in the agricultural cycle, in climatic conditions favorable for the development of steppe vegetation and formation of chernozem on Ivancea village, Orhei district, Moldova`s Codrii area. To achieve this research we investigated using the method of comparison grayzem under forest, grayzem aside employed in agriculture about 100 years ago and grayzem that before being used systematically in agriculture had a long period of development under steppe.

Key words: soil evolution, gray soil, grizom, anthropogenic factor, agriculture, pedogenesis.

Being formed around the end of Pleistocene and early Holocene when the climate was colder and more humid, favorable for forest vegetation growth development **(Adamenco O.M. and others, 1996)**, and developed in the present time in semiarid climatic conditions corresponding to the chernozems area, gray forest soils from Republic of Moldova is an interesting and peculiar object of research in point of view of their development both under the forest and as farmland. Thus now in the forests continues to evolve gray forest soils due to the biological factor, but under the climate regime typical for chernozem area. It gives them some characteristics that distinguish them from other regions. **(Grati V. P., 1977).** In addition to it, during subatlantic period, at the end of holocene when soils reached maturity anthropogenic factor started its influence on this area, influenced here during more than 3000 years and led to massive clearing of forests to get wood or use released land for growing crops. **(Adamenco O.M. and others, 1996)**. Once forest land was cleared, there is established steppe vegetation, because there were no longer the conditions to return the forest. But if land cleared and it is used in agriculture how evolves these soils? Peculiarities of pedogenesis processes and soil properties changes as a result of changing conditions of gray soils development by use in agriculture are the questions which are discussed in this article.

MATERIAL AND METHOD

As the object of study were selected gray soils from the forest and those which were employed in agricultural use on the village Ivancea, Orhei district, in the central part of Moldova`s Codri area that are evolved on clayey-loamy loess deposits placed on the the pliocene alluvial deposits. The central part of Moldova is located between the 150-250 m height, in the warm and semihumid climatic area. For research and comparison have been chosen four groups of the soil profile:

- ✓ gray soils of primary forest with semiprofound humus profile
- ✓ gray arable soil with semiprofound humus profile (used as arable land about 100 years);
- ✓ gray arable soil with moderately profound humus profile (free from the forest vegetation more than 100 years).
- ✓ cambic arable chernozem regradated from gray soil during prolonged pedogenesis under the steppe vegetation

[1] Institutul de Pedologie, Agrochimie și Protecție a Solului ”Nicolae Dimo”, Chișinău, Republica Moldova.

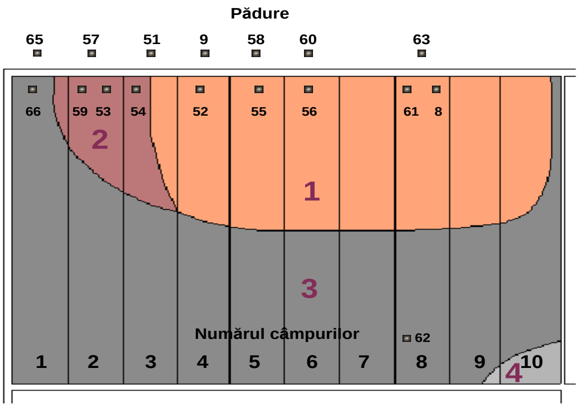

Figure 1 **Sole distribution scheme of investigated areas in the experimental field**

1 –gray arable soil semimoderately humiferous with semiprofound humus profile (used as arable land about 100 years);
2 - gray arable soil semimoderately humiferous with moderately profound humus profile
3 - cambic arable chernozem moderately humiferous with deep profound humus profile
4 –eroded arable leached chernozem with moderately profound humus profile

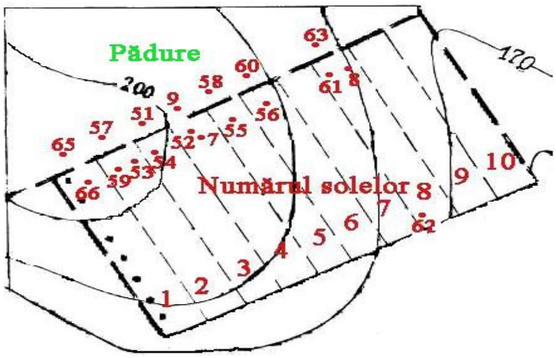

Figure 2 **Topographic map of the soil profiles location to study the evolution of gray soil as the result of human impact in central part of Moldova.**

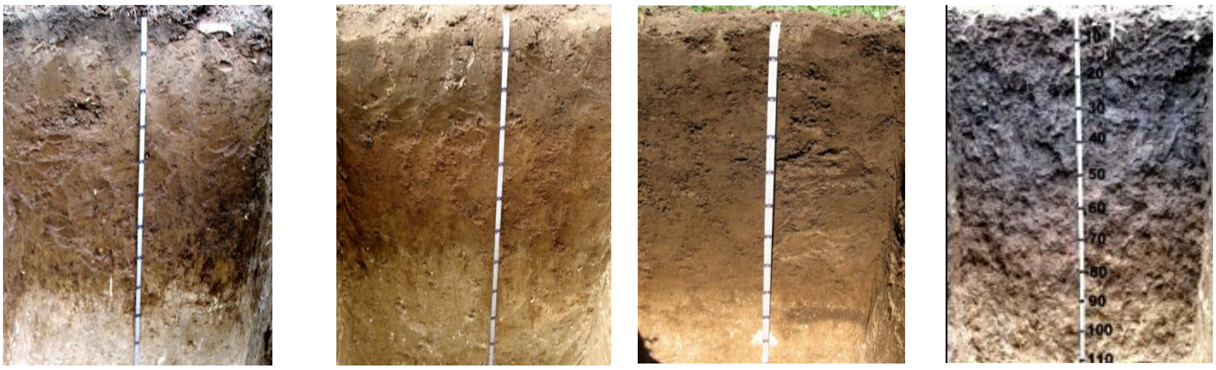

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Figure 3 **Soil profiles of forest and arable gray soils**.

RESULTS AND DISCUSSIONS

Conducted research (**Grati V. P., 1977, Lungu M., 2010**) has shown that gray soil from the forest is characterized by a clear differentiation of the profile. During the 0-31 cm depth outlined three genetic horizons: AEhţ, AEh and Behtw with medium texture and low compaction, under which is located iluvial very compacted horizon. It was established that the loss of clay (90 t / ha) from eluvials horizons (AEhţ, AEh, BEh) of gray forest soil is about nine times smaller than its accumulation in iluvial horizons (835 t / ha). It confirms the leading role of weathering "in situ" processes in the textural profile differentiation of these soils (**Grati V. P., 1975, Lungu M., 2010**). Forest soils are characterized by good structural state and hidrostability of soil aggregates in 0-20 cm layer. Humus profile of forest soils is characterized by thin swarded horizon on surface (8 ± 2 cm) with 8.52 ± 0.56 % average humus content. In deep humus content decreases sharply and is equal to 2.93 ± 0.20 % in AEh horizon. Average value of hydrolytic acidity for 0-34 cm layer of gray forest soil is 6.9 ± 2.9 me/100g.

A common feature for both gray forest soils and the arable land is comparatively small depth (about 80 cm from surface) of occurrence of iluvial carbonate horizon extremely highlighted; the maximum carbonate content varies within 20-28%. Carbonates are shaped in massive accumulation of carbonate concretions and veined. This is a consequence of contrast warmer hydrothermal regime under which influence soils were formed. It should be cautioned that in forest soils carbonate accumulations are more expressed than in arable soils. Hydrothermal regime changes to a more humid on arable gray soils have led to a more homogeneous distribution of carbonates in the all parental rock.

Arable layer of the gray soil permanently used in agriculture around 100 years consists from mixture of genetic material from three forest soil surface horizons AEhţ, AEh şi BEhtw. This layer has lost initial favorable structure and became rough and highly compact, texture has changed from the middle to middle-fine and the color from gray to reddish brown. Arable and postarable layer (0-30 cm) practically lost its ability to keep the loose state after basic processing. Balanced bulk density (Fig. 4) of the arable layer at 10-30 cm depth (below the periodic tillage layer) to mid-summer reach values equal to 1.50 to 1.55 g / cm ³, and the degree of compaction - 17 - 18%. As a result, the state of physical quality of this layer has become unfavorable for growth of crop plants.

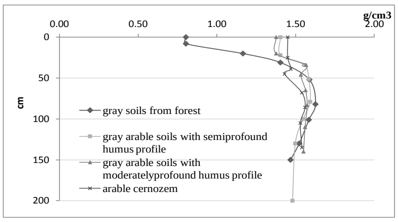

Figure 4 **Values of soil bulk density of forest and arable gray soils.**

Under arable layer is placed iluvial horizon highly compacted identical to the the same horizon of the forest soil. As a result of use in agriculture the hydrolytic acidity (Fig. 6) in arable soils decreased with more than 2 times (from high to low), which in contrast hydrothermical regime conditions stopped the eluvial-iluvial process.

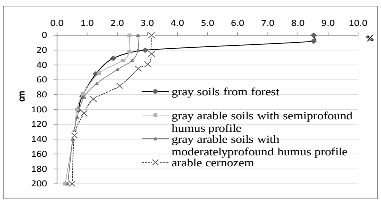

Figure 5 **Humus content of researched soils (average data)**

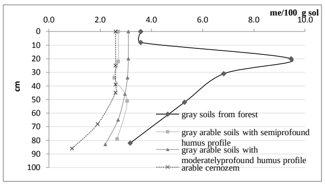

Figure 6 **Hydrolytic acidity values of researched soils (average data).**

As a result of use in agriculture humus content (Fig. 5) in arable land has decreased in the profile section 0-34 cm on average by 1.43% or about 38% (about 70.5 t / ha) of initial humus content in this section of forest soil, having values of 2.33 ± 0.07%. The weighted average content of humus in the arable and postarable layer (0-34 cm) of gray arable soil with moderately profound humus profile is 2.61 ± 0.09%. In the profile of these soils humus content decreases with depth more slowly than the other two. Arable gray soil with moderately profound humus profile is very similar to those with semiprofound humus profile but differs from them by: thicker and darker humus profile and the presence of AB horizon more structured and less compact. As we found that gray forest soils being employed in agricultural production shall be subject to dehumification, and in forest soils humus is concentrated in the first 0-8 cm being easily mineralized after grubbing, we consider that gray arable soil with moderately profound humus profile has passed a stage of development under steppe in its development.

Gray arable soils throughout the profile are low in total phosphorus content, unlike the forest gray soils which are characterized by high content of total phosphorus in AEhţ horizon as a result of biological accumulation of this element from litter and other organic debris. It was determined that remediation of the properties of these soils should be directed towards increasing the content of organic matter in arable layer and improving the unfavorable structural condition in plowed layer.

So during the research were determined three stages of degradation and gray soil regradation in the investigated region what corresponds to identified soil types:

I. stage of conservative degradation - at this stage takes place the homogenization of the upper part of the profile, dehumification, destructuring of structural aggregates and soil compaction, reducing soil acidity, stopping eluvial-iluvial and cambic processes what led to the decreasing of humusoaccumulative processes intensity and morphological and textural differentiation in the profile.

II. Stage of partial regradation as a result of the short phases of arable gray soil pedogenesis in steppe vegetation (long swarding). It is characterized by intensification of humification process and increasing of humus profile thickness without significant changes in humus quality.

III. Stage of regradation in chernozem under the influence of pedogenesis process under the steppe vegetation. Among characteristic features of soil at this stage are listed the intensification of humus accumulation, higher humus quality and the formation of the deeper humus profile.

CONCLUSIONS

1. Soils evidenced on the research area are characterized by the following morphological characteristics and common features: comparatively small depth of carbonates leaching (80-90 cm from ground surface) followed by formation of a highlighted iluvial carbonate horizon very compact when is dry; strong argilization in the middle part of the profile; the similar way of the clay distribution on the profile; existence of the special formation inherited from pedogenesis stage in forest vegetation (holes of the former roots of trees, Fe_2O_3 and MnO_2 cutan on the walls of these holes)

2. Gray soils used about 100 years in agriculture are characterized by following changes in morphological characters and properties:

- formation of the arable layer with average thickness 34 cm from the genetic material of the former three horizons of gray forest soil (AEhț + AEh + BEhtw);
- increase in arable layer by about 6.0% clay content compared with the analog section of the forest soil as a result of increasing "in situ" weathering process followed by the reduction of the textural differentiation on the profile;
- decrease of humus content in arable layer 0-34 cm on average by 1.74% (43 percent of initial content) compared to the humus content in the same section of the forest soil;
- loss of resistance to compaction of arable layer, balanced bulk density achieve values to the 1.55 - 1.57 g/cm3 (strong compaction) and poor physical condition as the result of dehumification and weaker structure;
- reduction of 2-3 times the value of hydrolytic acidity in arable layer and stopping the eluvial-iluvial process and textural differentiation of the profile (positive change);

3. cambic arable chernozem is characterized by intensification of humus accumulation process, higher quality humus formation (humato – fulvic or humatic) and the deeper humiferous profile.

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