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THE AGROGEN EVOLUTION OF CHERNOZEMS UNDER PRUT AND DNIESTER SPACE (REPUBLIC OF MOLDOVA)

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Abstract

Agriculture implies the disturbance of ecological balance and modification of soil, materialized at all levels of the soil structural-functional organization. In this regard, soil science, instituted a special research direction concerned with the study of mechanisms and proportions of these changes. Chernozems are involved in the new phase of evolution determined by modification of external and internal factors. The sustainable management of this new phase requires knowledge of evolutionary mechanisms for soils and its management in agricultural landscape conditions.

***Key words**: chernozems, agrogen evolution, soils, agricultural landscape.*

INTRODUCTION

Agriculture, in any form used, implies the disturbance of ecological balance and modification of soil materialized at all levels of structural-functional organization of the soil. In this respect, soil science, instituted a special research direction concerned with the study of mechanisms and proportions of these changes. Today it is known that all this lead to modification of soil ecosystem functionality. In the same time, how they are interpreted raises a number of problems. The present research is a first attempt to assess these changes in the positions of pedogenesis theory.

MATERIALS AND METHODS

In the literature, frequently, changes in the agricultural soils are considered incoming from degradation phenomena. In our opinion this is a simplistic approach from the positions of their impact on soil productivity. Such approach is coming subsequently with recommendations oriented on mitigation of the impact of certain and other factors/processes on productivity. Frequently these are oriented on creating more favorable conditions for plants and soil; this is considered an object that can be modeled. In reality however, the measures applied in these positions just go to slightly productivity increasing with its most severe decrease in further. This is, in our opinion the main cause why against all efforts to stop or reduce the effects caused by agriculture not obtained results. This approach implies all the changes on the soil under the influence of agriculture as elements of a new phase in the development of soil that suffer cover due to changes in pedogenesis environment.

RESULTS AND DISCUSSIONS

The natural landscape formation within Prut and Dniester rivers is synchronized with the development of soil-plant relationships during Holocene. Most research demonstrated univocally that engagement of chernozems in the agricultural circuit put a new phase in the evolution of chernozems (Jigau, 2013). In this respect our research and other researchers indicated several features of chernozems and these results presented a number of agrogen transformation processes. Through the prism of ideas on the relative stability of mineral substrate (parent rock) the evolutionary contemporary factors of chernozems between the Prut and Dniester can be divided into three groups (Figure 1).

In this point of view the natural factors reduced significantly the role of the biological factor and enhance the role of geomorphological factor. This involves modification of the substances balance in the contemporary pedogenesis in order to reduce the volume and dynamics of biogeochemical substances circuit. For anthropological factors, should be mentioned diminishing of soil-plant relationships and intensification the role of drought, desertification and erosion in the evolution of the landscape.

Systematization of contemporary evolutionary factors of chernozems between Prut and Dniester allows identification of the main elementary processes of evolution of landscapes (Table 1).

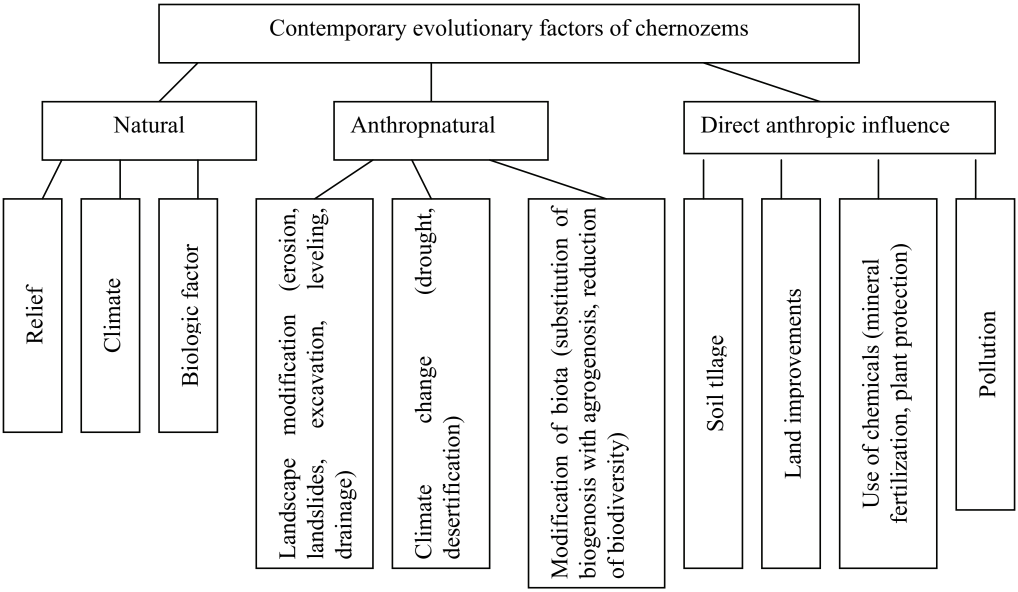

Figure 1. Contemporary evolutionary factors of chernozems under Prut and Driester

Grubbing chernozems and prolonged agricultural use leads to a range of morphological change pronounced, these modification presented in upper segment of the profile supports agrogenesis implications. The latter reached to the degradation and spraying of soil mass in the arable layer, practically the disappearance of total structure of grain, and formation of a new type of aggregate with high density packaging of the soil mass.

When not soaking softens in the dry state and is waterproof for the roots of the plants. Inferior layer in this segment represent a consolidated table (foot plow) with a negative impact on the exchange of substances in the soil profile being also materialized an area with a new aggregate formation materialized in anthropogenic chernozems with rigid packing that reinforced soil mass.

Systematization of several researches during 2003-2013 has highlighted the following morphogenetic modifications of chernozems under agriculture regime:

1. Modification of humus profile materialized in reduction of thickness, color and humus content.
2. Neo-horizons formation as agrogen nature especially arable horizon and sub-arable.
3. Modification of the profile structural organization, materialized in changing the thickness of horizons, aggregate composition and indices of settlement.

The main factors and processes that determine morphogenetic modifications are shown in Table 2.

Table 1. Typification of landscapes between the Prut and Dniester depending on the agrogen evolution and conditions of chernozems

Nr.	Landscape type	Baseline features			Agrogen processes	Agrogenesis forms
		Inclination	Lithogenic composition	Groundwater level, m		
1	Interfluvial plains	< 1-3 °	Clay, loamy clays, silty clays	> 6	Compaction, destructuring, dehumification, exhaustion, deflation	Reduction reserves of humus nutrients and humus. Modification of pedogenesis regimes (airhydric, hydrotermal, oxidation-reduction), etc.
2	Plains	-	Clay, loamy clays, silty clays	> 6	Compaction, destructuring, dehumification, exhaustion	Reserves reduction of humus and nutrients. Instability regimes of pedogenesis (airhydric, hydrothermal). Modification of hydrophysical profile.
3	Interfluvial plateau	< 1-3 °	Clay, loamy clays, clays	< 6	High humidity conditions, destructuring, crimping, fatigue	Structure type modification Airhydric poor regime. Biotic degradation.
4	Slopes	3-6 °	Clay, loamy clays, clays	> 6	Compaction, destructuring, erosion, exhaustion	The thikness profile reduction, reduction of humus layer thikness, humus content and nutritional elements
5	Inclined slopes	> 6	Clay, loamy clays, clays	< 6	Erosion, high humidity, exhaustion	Lower thikness for soil profile with a beginning of humus formation. Gleyic features.

Tabel 2. Factors that determine the morphogenetic modifications of chernozems under agricultural regime

Factors	Processes / morphogenetic effects
Land grabbing	Destructuring. Reduction of role for plant system roots in loosening and structure of soil mass
Soil tillage	Mixing the soil mass. Dusting structure. Agrogen layer formation
Compaction and destructuring	Agrogen layer stratification in arable horizons and sub arable horizons. Establishment of neohorizons
Pseudostructuring	Formation of agrogen aggregates as chernozems types during soil formation
Water and wind erosion	Soil profile truncation. The thikness of humus layer reduction. Basic features modification of humus profile. Carbonate profile modification (depth of effervence), the occurence of visible carbonates, depth of iluvial carbonate horizon.

Specified morphogenetic changes reflect taxonomic affiliation ofchernozems at different levels (subtype, genre, species and subspecies).

In this respect, we mention attenuation and differences between subtypes of chernozems, especially of typical chernozem moderated humus and those leachates, typical chernozem weak humus and carbonated chernozem. Through the development concept of the structure for soil cover agrogen morphogenetic modifications represents an element of soil cover convergence at higher taxonomic levels. In the same time, however, the homogenization provokes compaction of the soil cover structure at lower taxonomic levels. The evolutionary trend of morphogenetic features of chernozems subtypes between the Prut and Dniester involves attenuation level and gender differences and diversification of the species, subspecies, variants, etc.

Assessment of functional-genetic features studied on chernozems is determined by the evolution of types and genetic processes, accumulation and humus formation, structure and migration of carbonates.

The impacts of soil tillage on the process of humification support a multilateral character. On the one hand works, especially plowing helps to form a homogenous uniform distribution of soil and organic material in arable layer, which is positively reflected on the humification processes. At the same time, increases the degree of aeration, increases the rate of decomposition of organic debris and humus.

On the other hand grubbing and soil tillage suppose a considerable reduction in the amount of organic debris that accumulated annually in the soil. However, plowing work leading to the destruction of the dendrite humus, which is the main provider of organic substances involved in the process of humification.

Regarding chernozem there is no a unique point of view on the placement of mineral fertilization in the evolution process of humification. Several researchers argue that increasing of mineral fertilization is useful for crops.

In this respect in the soil increases the amount of organic debris, which leads to increased humus content and reserves. Despite these claims, in the agricultural chernozems was established a stable trend of humus content and reserves reduction. With reference to this subject, our research showed that over time mineral fertilizers leads to soil dispersion and disintegration of soil mass Specific processes adversely affect soil structure. In its composition is significantly reduced aggregate content particularly those agronomic valuable with a diameter of 5-1 mm. As a result, significant modifications suffer pedogenesis regimes (air hydric, hydrothermal, aeration, oxidation-reduction). It is demonstrated that even though mineral fertilizers negatively affect soil life, and fermentation activity.

In our opinion in the first years after framing the land in agricultural use the humus losses are the most significant due to the reduction of humus source as a result of increased mineralization processes. At this stage no significant impacts cause mineral fertilizers on soil biota functionality. Following a relatively short time period, they facilitated enhance and partial restoration of humus content and reserves (1965-1980). As result of negative effects caused by the intensity of the mineral fertilizers, humification is significantly reduced because of a reduction of the amount of crop residues as a result of the significant decline in yields and reduction due to biological activity. Amounts of humus produced annually are decreased, while they are enough to offset losses and elluvial mineralization/erosion.

As consequences the trend of humification is stable and we can conclude that currently practiced technologies received an irreversible trend. Humification process not only reduced the arable horizon. This affects the underlying horizons. In the same time, given the humus genesis condition increases humus mobility and partial displacement occurs in the layer of humus content in underlying sub arable horizons which frequently result in humus content increases while arable horizon is reduced. Processes mentioned are materialized in the formation of humus profiles specific for arable chernozems.

Therefore we consider that in the conditions when anthropogenic and technological energy consumption embodied in mineral and organic fertilizers are ineffective for preserving and extended reproduction of pedogenesis process, priority is given to less expensive processes, which models (stimulates) pedogenetical conditions of natural biocenosis .

In these activities the balance and dynamics of the humus profile differs from the one to other subtypes of chernozems.

In case of typical chernozem with weak humus and carbonated and reductions in humus affects the whole profile. Therefore in the agrogen evolution of these soils easily pass from one species to another.

In typical chernozem humus moderated losses are more intensive in surface and inferior horizon. Therefore apparently profiles of typical chernozem humus moderated get some profile features elluvial-humus-illuvial.

Modification of the chernozem structure, occurs after directed modifications of the processes that determine the structure of the accumulation of humus, leaching - carbonates eluvia, mineralogical composition modification, driven in a materialized dynamic on periodically repeated cycles (inflation-contraction as a result of wetting-drying and freeze-thaws, bioporosity modification due to changes in agrophytocenoses crop rotation, soil tillage). The modification of structure is the result of all evolution processes occurred in the soil.

In this respect the structure evolution requires neoaggregates of chernozem type during soil formation. Their dimensions can be and are being the most different. As a result of their occurrence this lead to increase of aggregate content > 5 mm and those of <1 mm. To support this assertion when is compared to the uncultivated arable chernozems aggregates > 5 mm practically lacking aggregate stability.

Based on the research we consider that this is caused modification of porosity aggregates > 5 mm as a result of their compaction (Jigau, 2009). As well is increasing compaction and the stability of aggregates <1 mm. Thus we come to the following conclusions about the direction and intensity of the processes of structure evolution based on the change in the structure factor calculated by the relation Ks = A / B where:

Ks - Coefficient of structure;

A - Content of aggregate 5-1 mm;

B - Content of aggregated > 5 mm + <1 mm.

To assess the degree of change in their structures on the basis of coefficient of structure the Ks is being proposed to use the following gradations:

- 1.5 to 2 poorly changed structure. A soil does not require any special measures to improve the structure;
- 1.5 to 0.7 moderately modified structure. Soils require measures for agrogen layer biologization;
- <0.7 advanced modification structure. Phytoameliorative and agrochemical measures are necessary special to recovery/restore structural state of aggregates.

CONCLUSIONS

Chernozems between the Prut and Dniester space are involved in a new phase of evolution determined by the modification of external environment of pedogenetic (pedogenesis factors), internal ambience (pedogenesis regimes) and relationships soil ← factors.

The sustainable management of this new phase requires knowledge of evolutionary mechanisms for soils and its management in agricultural landscape conditions.

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