Scientific Papers. Series A. Agronomy, Vol. LIX, 2016
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

THE BASIC FRAMEWORK FOR CONCEPTUAL-METHODICAL BIOENERGY RESOURCES OF CHERNOZEMS

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Abstract

Anthropization of chernozems pedogenesis process involved a stable trend of bioenergetic degradation in chernozems. Through the renaturation concept, self-restauration and self-regeneration processes of biorutinar systems, restauration of bioenergetic resources of chernozems involves a new paradigm for soil resources management in the integrated process of agricultural production.

Key words*: chernozems, biorutinar systems, bioenergetic resources, soil resources management.*

INTRODUCTION

Through the concept of "biorutinar system of soil" organic matter provides the bridge between the living substance and abiotic and is materialized in biological functions and physical which ensuring optimal eco-pedogenetic ambience for the living organism in the soil. Management of soil resources is facing two major problems: climate change and bioenergetic soil degradation.

Climate changes involve modification of interaction between the pedogenetic, biologic and geomorphologic factors. Under circumstances when geological factor (parent rock) is not affected by climate change, the modification received only pedogenetic factor where is affected the active layer that involving the modification of direction and intensity of the pedogenesis processes. In natural regime specified implications are attenuated as the biological factor, due to adaptive capacity is more inert to these changes, a way as genetic-functional modification are slow and to a smaller extent are reflected on the functionality and stability of landscape.

Under anthropogenic pedogenesis the role of biologic factor in the landscape functioning is significantly reduced. This is reflected in the first line on typogentic processes: the formation and accumulation of humus, biogenic accumulation of chemical elements, especially those biofile, and structuring. These are materialized in the bioenergetic degradation of soil which involves dehumification, depletion and soil exhaustion, restructuring and degradation of pore space. In these conditions, the system losses accelerated the biorutinar ability to self-organization and self-restoration. Integrated index of these changes are the bioenergy resources.

Instead, in the anthropogenic pedogenesis significantly increases the role of geomorphological factor. As a result anthropogenic pedogenesis is controlled by the geomorphological and climatic factor. It is realized in the intensification of water and wind erosion, accelerated increasing of over-wetted surfaces in some periods of the year, aridization and intensification of pedogenetic active layer. All of this engage degradative trend to contemporary pedogenesis.

Under specified conditions the bioenergy resources of soil ecosystem are determined by a number of factors including:

- Drastic reduction in the quantity of organic debris framed in the pedogenesis processes as a result of biocenosis substitution with agrocenosis.
- Reducing to a minimum of the amount of biologically nitrogen available for framing in the process of humification, following the exclusion of leguminous in the crop structure and its replacement by mineral nitrogen.

- The intensification of the humus mineralization.

The last two processes are favored by the modification of airhydric regimes and oxidation-reduction through systematic performance of the agricultural work in the arable layer where lies organic debris, and the decomposition-transformation processes.

- Increasing processes of humus loss with water and wind erosion.
- Humus decomposition and biodegradation under the influence of mineral fertilizers and activation of microflora from the account of applied fertilizers.
- Reducing intensity of the formation processes and humus accumulation as a result of physical degradation of soils.

As a result in the soils of the region there is a stable trend of humus content reduction (Tables 1 and 2).

From Table 1 we noticed that decreasing humus content lead to stable increase of soil areas with a very low degree of humus assurance from the account of areas with high degree of assurance and relatively optimal. This leads to homogenization deterioration of agro-landscape soil functionality and reduced their bioproductivity.

Table 1. Surface dynamics with varying degrees of humus assurance within some pedogeographic district (% of district)

No. district	Predominant soils	Evaluation period	Degree of humus assurance				
			Very low	Low	Moderated	Optimal	High
1.	Gray soils, clay illuviated and levigated chernozems	I	0.5	23.3	63.6	10.1	2.5
		II	1.0	18.7	57.6	17.2	5.4
		III	1.6	14.1	51.6	24.3	8.4
		IV	1.8	13.3	41.2	35.6	1.1
		V	-	17.0	37.3	44.7	1.0
2.	Typical moderated humus chernozems	I	0.4	15.3	55.7	28.6	-
		II	1.5	13.4	47.6	40.3	7.2
		III	2.3	11.5	39.5	43.2	3.2
		IV	1.6	15.8	45.5	34.5	2.6
		V	1.6	11.0	46.5	38.9	2.0
10.	Typical moderated humus chernozems and levigated	I	-	18.8	54.6	26.6	-
		II	2.6	21.8	50.0	15.6	-
		III	4.6	24.9	55.4	15.1	-
		IV	10.2	40.2	41.8	4.8	-
		V	16.9	43.4	36.5	3.2	-
5.	Typical moderated humus chernozems and levigated	I	-	19.4	62.7	17.9	-
		II	8.3	29.1	50.1	12.5	-
		III	9.4	38.9	43.7	7.1	-
		IV	12.5	44.8	38.1	4.5	-
		V	13.6	34.9	47.6	3.9	-
9.	Levigated chernozems and clay illuviated and gray soils	I	-	22.7	55.8	21.5	-
		II	4.3	28.6	50.3	16.8	-
		III	9.0	35.0	43.9	12.1	-
		IV	8.5	36.2	45.3	9.8	-
		V	11.0	43.0	46.7	9.3	-
Sub district 11 a	Typical low humus chernozems	I	1.4	18.7	58.5	20.3	0.6
		II	4.2	19.3	53.2	21.9	1.3
		III	6.0	19.8	46.0	23.0	5.2
		IV	8.9	35.1	52.0	3.3	0.8
		V	8.1	30.9	56.5	4.5	-
Sub district 13 b	Carbonated chernozems	I	5.0	41.5	45.1	6.6	1.8
		II	20.0	42.0	30.1	6.3	1.6
		III	22.9	42.9	27.1	5.5	1.8
		IV	18.8	44.0	29.7	5.6	0.9
		V	19.4	51.5	28.0	1.0	-

Table 2. State and dynamics of humus content in the soils of agro-landscapes, % of period 1965-2013

Agricultural unit	No. flield	Predominant soils	Evalution period					
			I	II	III	IV	V	VI
AGROSFERA-BM (Parlita, Ungheni)	1	Typical siltic-clay chernozems	4.9	4.5	4.5	4.2	4.1	4.1
	2	Typical clay-siltic chernozems	5.1	4.7	4.6	4.4	4.1	4.1
	3	Typical siltic-clay chernozems with solonetzs areas	4.9	4.6	4.3	4.5	4.3	4.0
	4	Typical clay-siltic chernozems with eroded areas	3.8	3.4	3.0	3.1	3.0	2.9
	5	Typical siltic-clay chernozems with eroded areas	4.1	3.8	3.6	3.2	3.0	2.9
Vindex-Agro (Malaieşti, Orhei)	1	Typical siltic-clay chernozems	5.3	4.9	4.6	4.3	4.2	4.0
	2	Typical clayey chernozems	5.1	4.7	4.6	4.4	4.2	4.0
	3	Typical clayey chernozems	4.9	4.6	4.3	4.6	4.3	4.0
Podgoreni (Lingura, Cantemir)	1	Typical low humus chernozems low moderated eroded	3.6	3.3	2.9	3.1	3.0	2.9
	2	Typical low humus chernozems low eroded	3.9	3.6	3.4	3.1	3.0	3.0
	3	Typical low humus chernozems moderated eroded	2.8	2.4	2.1	2.0	1.9	1.9
	4	Typical low humus chernozems low moderated eroded	3.7	3.4	3.1	3.1	3.0	2.9
MAVIL-AGRO (Rujnita, Ocnita)	1	Typical chernozems clay-siltic	5.7	5.3	5.1	4.7	4.5	4.4
	2	Levigated chernozems siltic-clay	5.9	5.5	5.2	5.0	5.0	4.7
	3	Typical chernozems clay-siltic low moderated eroded	5.3	4.6	4.5	4.2	3.9	3.8

In this respect the data presented in Table 2 presents that even within agricultural units in which is practiced an efficient management of soil resources, humus content have reached the critical threshold (14 %) and in some cases present values below it.

The current state of soil cover and evolution trend involves the conclusion that agricultural systems practiced are not able to ensure the conservation and reproduction of bioenergy resources of soil although this objective it has been permanently targeted by agricultural policies and decision makers.

This implies the need for a new paradigm of soil resources management in the agricultural practices which involves reproduction of bioenergetics resources in the framework of integrated production process by supporting natural processes.

For the purpose of this paradigm in the framework of agricultural systems reproductive-resource emphasis is placed on the optimization of agro-landscape functionality (Figure 1).

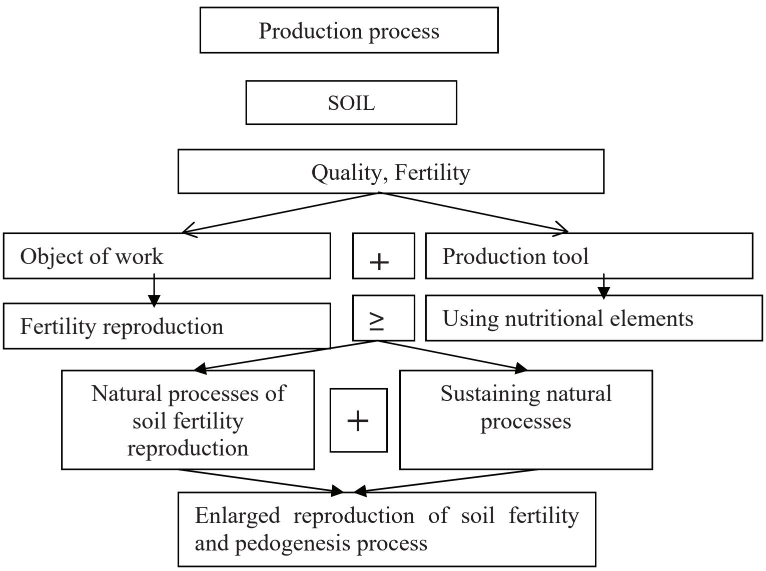

Figure 1. Paradigm of the soil fertility reproduction in the production process

Achieving the proposed objectives of the new paradigm involves:

- Measures oriented on accelerated accumulation of organic matter in soil.
- Measures focus on ensuring an optimal airhydric ambience and hydrothermal to conduct at formation processes and migration of humus.
- Ensure source of nitrogen necessary for the formation process of humus by framing mandatory legumes in cropping patterns.

At the present stage for development of the food market is appropriate that surface to compose about 30 % of the area with technical cultures and optimization of physical characteristics and regimes of agrogen layer in arable soils. For the purpose of technological components specified an essential element of resource-reproductive agricultural systems is their adaptation to the landscape conditions. The latest involves creating a report as close to natural quantity of crop residues deposited on the soil surface and deposited in the profile.

To achieve this objective it is very important to know the mechanism of the agro-landscape in each part and the structural adjustment of cultures and deposited in the profile.

MATERIALS AND METHODS

The conceptual methodological framework of this study is provided by adaptation and development of the renaturation concept and disturbed geosystems by stimulating the self-capacity and self-restoring capacity of biorutinar systems (Goleusov, 2012; Ursu, 2011; Burlacu, 2000).

Through this prism of ideas in its capacity as biorutinar system, soil is a special type of natural formation formed as a result of the interaction of biotic systems (biologic factor which represents an integrated system of external and internal biocenoses (soil biota)) and abiotic (climate, parent rock and relief) over time. In this respect biorutinar systems are natural-history formations formed in concrete conditions of landscape and include energetic-informational and physical structure.

Energetic-informational structure is the information carrier, concerning the conditions in which was formed and was performed development and evolution of biorutinar system. The physical structure implies a certain form of soil substance organization (structural-functional organization) in accordance with the concrete condition of landscape. In the biorutinar system structural-functional organization is the product of soil matter modeling (abiotic substance) by the biologic factor in accordance with own needs. Therefore structural-functional organization of biorutinar system corresponds to actual conditions but bears and footprint, features relict, materialized in previous stages. This implies the conclusion that certain energetic-functional structure carries the program of self-organization and self-restoration of biorutinar system.

Energetic-functional structure of soil ecosystem interaction is analog to neighboring structures changing with their modification and opposite influencing them. Modification of energetic-informational program in the development of soil biorutiar system can be determined by internal changes (pedofunctionl regimes) and external factors.

Thank to this fact in the pedogenetic rotation (cyclic) of biorutinar systems do not return to its initial state. For them is characteristic progression development. Through this prism of ideas anthropogenic modification is a response to the program’s bioenergy deregulation of the biorutinar system by substituting biocenosis with agrocenosis and soil biota degradation.

Anthropogenesis in this regard represents transfer processes of biorutinar system from a structural-functional form to another. Its restoration in stability conditions through abiotic factor (mineral component) is possible only by restoring the bioenergetic component.

RESULTS AND DISCUSSIONS

The objective of the evolutionary renaturation process of soil biorutinar system is based on the “sustainable concept”, concept which requires supporting natural processes and mechanisms of soil ecosystem functioning for the purpose to extend its reproduction, maintaining soil fertility at a high level and rigorous control for pest, pathology, weeds with moderate energy expenses, while maintaining a high level without disturbing the environment.

In this regard in a spirit of sustainable development concept of sustainable agriculture system include organic agriculture, biological agriculture and ecological agriculture systems. Among them preferentially in Moldova are used ecological systems, biological and integrated.
The dynamics monitoring of humus content in arable layer shows that in the period 2009-2015 there has been a slight tendency for increasing humus content.
In this regard, more pertinent are biological system which requires incorporation into soil organic debris, treating them with biological preparation which represents the fraction of labile humic substances resulting from the biohumus production and annual administration of 800 kg/ha. Under this system more efficient work system is superficial incorporation of organic matter to a depth 10-14 cm.
Furthermore superficial tillage system is the most effective and into other agricultural system monitored (Table 3). Notable perspectives offers and integrated agricultural system where the emphasis is placed on the reduction mechanical pressures on soil, management of water reserves and organic reserves. Under ecological system effects are mitigated as a consequence of the larger share of weeding in the crop structure.

Table 3. Dynamics of humus content in the 0-30 cm layer under various agro-technologies (typical moderated humus chernozems clay-siltic)

Agro-technologies	Tillage system	Humus content, %					
		2009		2012		2015	
		At the beginning of vegetation	At the end of vegetation	At the beginning of vegetation	At the end of vegetation	At the beginning of vegetation	At the end of vegetation
Conventional (control) (Cosnita, Dubasari)	Differential	4.18	4.09	4.15	4.09	4.16	4.07
	Deep loosening	4.10	4.02	4.07	4.03	4.11	4.06
	Plowing	4.08	4.01	4.04	4.00	4.10	4.02
	Superficial	4.21	4.11	4.17	4.12	4.17	4.13
Ecological (Cosernita, Criuleni)	Differential	4.20	4.16	4.17	4.14	4.21	4.13
	Deep loosening	4.12	4.09	4.13	4.06	4.13	4.04
	Plowing	4.18	4.12	4.17	4.14	4.20	4.11
	Superficial	4.23	4.18	4.20	4.16	4.21	4.16
Biological (Iurievca, Cimişlia)	Differential	4.36	4.32	4.38	4.35	4.40	4.35
	Deep loosening	4.20	4.03	4.18	4.04	4.20	4.08
	Plowing	4.21	4.00	4.18	4.02	4.16	4.00
	Superficial	4.53	4.49	4.47	4.38	4.56	4.47
Integrated (Parlita, Ungheni)	Differential	4.28	4.24	4.23	4.25	4.31	4.24
	Deep loosening	4.16	4.06	4.17	4.05	4.16	4.06
	Plowing	4.19	4.06	4.18	4.08	4.18	4.02
	Superficial	4.40	4.28	4.34	4.27	4.38	4.32

Monitoring the evolution process of bioenergy resources of typical moderated humus chernozem under various management technologies of soil and vegetal residues showed that in all variants in the first 4 years additions of organic matter were insignificant and were no big differences between the versions. Increasing organic matter reserves and their differentiation through the practiced system practically starts from the second crop rotation (after 4-5 years).
It draws attention the fact that organic matter content increases in the agricultural system practiced, first in the 0-30 cm layer, a phenomena probably caused by the concentration of crop plants root system in the first 0-30 cm from the surface (Table 4).
Accelerated restoration of organic matter reserves is supported entirely by increased reserves of fresh organic matter in soil in great extent by creating more favorable conditions for decomposition – transformation of organic substances accompanied by formation and accumulation of humus.

Table 4. Content and reserves of organic matter in typical moderated humus chernozem under different agricultural systems (average data) (SRL Civea-Agro, Edinet)

Tillage system	Soil layer, mm	Organic matter content, %	% reported to plowing version	Organic matter reserves t/ha
Plowing at various depths	0-10	3.81 ± 0.06	0	40.0
	10-20	3.74 ± 0.04	0	38.3
	20-30	3.71 ± 0.03	0	36.4
	30-40	3.63 ± 0.02	0	35.4
	40-50	3.31 ± 0.02	0	34.0
Mini-Till system reduced (9 year)	0-10	3.93 ± 0.06	+ 0.12	42.7
	10-20	3.87 ± 0.04	+ 0.13	41.3
	20-30	3.81 ± 0.04	+ 0.10	40.0
	30-40	3.65 ± 0.03	+ 0.02	35.8
	40-50	3.31 ± 0.02	0	34.0
Mini-Till system resource-conservative (9 year)	0-10	4.11 ± 0.13	+ 0.30	46.4
	10-20	4.07 ± 0.01	+ 0.33	44.8
	20-30	3.95 ± 0.06	+ 0.24	43.3
	30-40	3.62 ± 0.02	- 0.01	41.4
	40-50	3.31 ± 0.02	0	34.0
Mini-Till system resource-conservative (9 year)	0-10	4.60 ± 0.09	+ 0.79	50.9
	10-20	4.28 ± 0.09	+ 0.54	50.6
	20-30	4.26 ± 0.06	+ 0.55	50.4
	30-40	3.93 ± 0.06	+ 0.30	47.8
	40-50	3.68 ± 0.07	+ 0.37	44.2

Our research showed that evolution of indices of humus state synchronized with evolution of settlement indices (bulk density, total porosity) and soil regimes, expressed by water reserves and differential porosity. At the same time was established that the conditions of humus formation optimized with the following purposes: plowing < MiniTill resource-reproductive (adaptive – landscape – ameliorative technologies).

Within practiced technologies management of vegetal debris can be described through Figure 2 and Table 5 and 6. Through this prism of ideas impact of organic debris can be approved with the impact of livestock manure, this one being reduced only to arable layer.

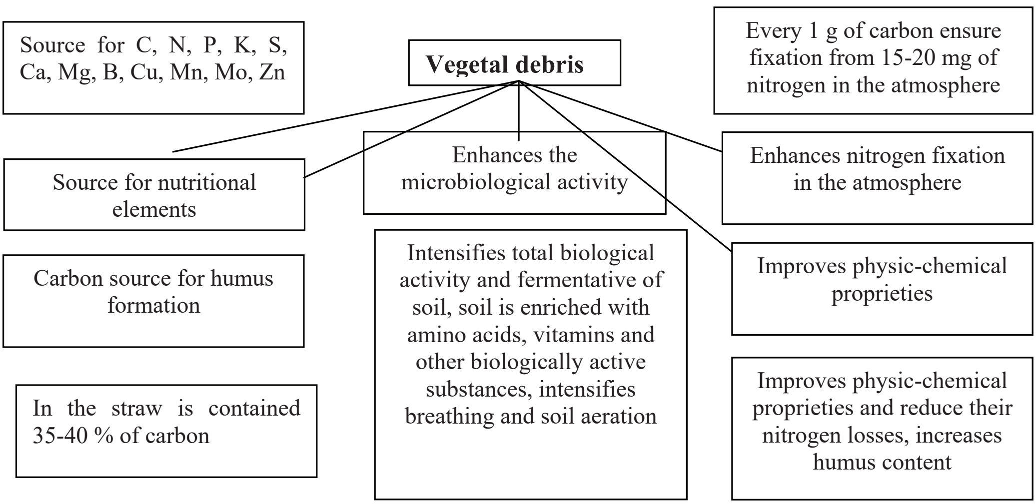

Figure 2. Management of organic waste into agricultural resource- reproductive practices

Table 5. Development stages of organic substances and soil biorutinar system in agricultural practices

Initial stage	Transition stage	Constitution stage	Stabilization stage
Reestablishment of structural aggregates	Enhancing soil bulk density	The large quantity of organic waste	Accelerated accumulation of organic debris
Low organic matter content	Increasing organic debris content	Increased coefficient of carbon content	Continuous variability of carbon and nitrogen content
Restoring biomass, soil microbiota	Enhancing phosphorus content	Increased coefficient of carbon content	Optimization of mobility degree and accessibility of water
Enhancing nitrogen content	Immobilization of nitrogen mineralization	Nitrogen immobilization, mineralization reduction, increased biological cycle of chemical elements, optimization and increase its volume	Circuit scale of nutritional substances, reducing nitrogen and phosphorus content
Time, year			
0 – 5	5 – 10	10 – 20	> 20

Table 6. Restoration stages of biorutinar system in agricultural practices and resource-reproductive

Nr.	Restoration elements	Restoration effect of biorutinar system
1.	Enhancing organic matter content in soil	Reestablishment and enhancing of biological diversity of soil biota, reestablishment of transformation processes and decomposition of organic waste, restoring biogeochemical substances in the pedogenesis, restoring organic matter in soil and ecological reconstruction of pedogenetic processes, a better exploitation, retention and conservation of water in the soil, reducing vulnerability to drought.
2.	Restoration of biogeocenotic functions and development of biodiversity	Porous space optimization, increasing number of animals, plants and microorganism, maintaining a healthy soil and soil fauna, formation processes intensification and humus accumulation, enhancing volume of biogeochemical circuits, processes intensification and biogenic accumulation of biofile elements, restoration capacity of soil biota.
3.	Restoration of ecological functions of soil ecosystem, greening the production process.	Restoration of physical, biological and chemical functions of organic substances system of soil, restoration of soil biogeocenotic functions, pedofunctional optimization of regimes (pedogenetic regimes), optimization of health state of agroecosystems (reducing the revegetation, reduction of risks and vulnerability to pest and diseases), enlarged reproduction of chernozems pedogenesis process.

In the reproductive resources practices which entails the establishment of bioenergy resources of the soil is important to ensure the system operation of organic substances throughout the profile. This requires restoration of soil biorutinar system of the entire thickness of the active pedogenetic layer which providing a humus profile progressive accumulative.

Achieving this goal is possible by providing free migration of mobile humic substances in similar hydro-physical activities but imply the rotation of root system. This implies the inclusion of crops with deep root system (rapeseed, sunflower and maize) in the structure of crop and field occupied that include perennial grasses, intercropping and crop intermediate depending on the concrete landscape condition.

CONCLUSIONS

In conditions of synchronized evolution of pedogenetic factors and the internal functioning of soil biorutinar system, the objective of enlarged reproduction of bioenergy resources of it and restoration capacity of self-regulation and self-organization, required a new paradigm of soil management resources within agricultural resource-reproductive systems.

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