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BIOLOGIZATION OF AGRICULTURAL SYSTEMS – PREMISES AND OPPORTUNITIES

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Abstract

The genesis and evolution of chernozems in the Carpathian-Danubian-Pontic area were conducted synchronized with the evolution of steppe ecosystem; their driving forces are the soil-plant relationships. The substitution of natural biocenosis with agrophytocenosis led to the minimization reduction of biological component in development of chernozems on the agricultural regime. As a result, chernozems have lost a number of mechanisms for self regulation (self loosening, reproduction of aggregate composition, conservation and rational use of moisture). Their restoration is only possible through renaturation process of pedogenesis by restoring the soil-plant mutual relations. The present research has shown that basic elements of renaturation processes included in the pedogenetical processes are restoration of structural-functional integrated elementary processes in the soil ecosystem.

Key words: *agroecosystem, chernozems, renaturation processes.*

INTRODUCTION

The biological component function in the agroecosystem management is continuously increasing. Among economic and environmental opportunities which justify anthropogenic component substitution with biological we mention: transition to economical and environmentally safe technology resources; continuously increasing instability of the climate variability and respectively, size and quality of crop (main crop yield requires genetic and adaptive characteristics); insertions of multiple values of soil parameters at the critical level; need to increase not only the productive functions of the agroecosystems but as well the environmental (soil protections, extended reproduction of phytoresources, etc); weight increasing of agricultural uses belonging to less favourable climatic conditions due to climatic instability and soil cover aridization; adaptation of agroecosystems to potential climate change (ability to resist at extreme factors by applying agrotechnologies with high precision rational soil tillage (no plowing) and paraplow with discs); using plants as energy and fertilizer, technological requirements to diversify consumption by increasing assortment and quality of raw material; necessity to preserve and to create structures and mechanisms of agroecosystems.

In the context of above the biologization and ecologization of biological system characteristics are: self reproduction, self restoring and self remediation as well characteristics of natural phytogenesis. The biologization and ecologization is based on the maximum efficiency in the use of potential species and varieties of cultivated plants. In this context is known as the landscape conditions are drastic as more genotype agroecosystem and agricultural landscape should be higher. The fact is that the procedures mentioned are favoured by bioclimatic condition of Republic of Moldova and provides greater opportunities for a wide spectrum of cultures. Methods for assessing crops adaptability are based on evaluation of limitative factors given by particularities species. On these conceptual principles and practical approaches are stated: organization of crop rotation based on adaptive landscape condition with respect to plowing strictly differentiated according to topography and soil characteristics; maximum biologization of crop rotation by saturating with annual grasses and expanding intermediate beans; crops rotation are able to ensure self reproduction and self remediation of landscape; cropping should provide closed energy

substantial balance that means maximum return of biofile elements.
The principles outlined are registered in the regional resource-reproductive biotechnologies models adapted bioclimatic conditions of the Carpathian-Danubian-Pontic (Figure 1).

MATERIALS AND METHODS

The researches have been conducted in the north part of the Republic of Moldova during 2007-2012 under farming conditions units "Civea-Agro" (Edinet district), "Gospodarul-Rediu" (Falesti department), "Vatmol-Agro" (Donduseni district) and "JLC AGRO-MAIAC" (Ocnita district). In all the cases, soils have been represented by clay loam typical moderated humiferous chernozem (Table 1).

Table 1. Research methods

Analysis	Methods
Bulk density	In the field Kacinschi compact meter
Particle size composition	Fractional dry, Savinov method
Aggregate stability	Fractionation in water, Savinov method

RESULTS AND DISCUSSIONS

In the context of the specific models agroecosystems biologization represents a complex of agrotechnical measures, phytotechnical and agrochemical adapted to landscape local conditions. The landscape conditions are targeted on the optimization of soil-plant relationships (crop) aiming to renaturate the pedogenesis process and the rehabilitation and enlarged reproduction of soil ecosystem as well its functionality. Pursuant to this objective agroecosystems biologization presupposes displacement of the emphasis from plant and agroecosystems productivity to soil agroecosystems and its functionality. In the context of the above biologization is based on the following conceptual principles:

1. Restoration of energy flows within processes functioning of agroecosystems and respectively pedogenesis process.

The present agroecosystem characteristic is substitution of solar flux transformed into chemical energy through the phytosynthesis energy from the combustion of fossil fuels. This supposes diminishing of the weight of natural components within the pedogenesis process and soil ecosystem functioning. Inside agroecosystems the soil is subordinated to technological components. Therefore we are faced the situation where on the background of soil degradation the agroecosystem productivity is increasing.
Thus, within agroecosystem the soil is transformed into an inert layer modeled by agrotechnical measures, agrochemical administration amendment and irrigations. Investigations conducted in this field has shown that all mentioned aspects enhance soil degradation process thus deepening the difference between agroecosystems and natural ecosystems (Jigău, 2001, 2009; Dumitru et al., 1999) thereby favouring the desertification processes.

2. Favoring integration and functional structural organization processes of the soil ecosystem.

In terms of the integration processes concept and structural-functional organization of the ecosystem, the latest is distinguished from others bio-routinist system by its structure. As integrated product of all the constituent processes and development of soil phase components. The substitution of natural biocenosis with the agricultural phytocenosis and involvement of soil tillage led to the simplification of structuring processes and in same time initiated the degradation process of the structure materialized in boulders and breaking structure (Jigau, 2009).
The data presented in Table 4 indicate that extended plowing involves two opposed processes in the evolution of aggregate composition contrary to typical chernozems located in the northern part of Republic of Moldova – bouldering and spraying. Bouldering is oriented to the considerable enhancing compared to the uncultivated version of the aggregate content >10 mm. Contrary spraying is oriented on shredding soil structure and therefore the content of micro aggregates (<0.25 mm) increased compared to uncultivated version at 1.3 to 1.5 times. Following concomitant achievement of specified processes are reduced considerable content of agronomical valuable aggregate (10-0.25 mm).

Table 2. Resource reproductive impact of intermediate soil

No.	Resource reproductive impact
1	Ensures extended coverage of the soil, protecting it from various forms of degradation
2	Enhances the quantity of soil organic matter
3	Intensifies the microbiological activity
4	Improves the aggregation degree of soil mass and reduces the degrading impact of raindrops on soil
5	Reduces compaction and increases porosity of the soil
6	Reduces the physical evaporation on the soil surface
7	Enhances water infiltration into the soil, therby compensating the quantity of water used by intermediate crops
8	Ensures fertiliziers function for the soil and provides nutritive substances of succeeding crops
9	Protects the soil from weeds and retains weeds growth
10	Destroying parasitical circuit
11	Some of them (rye) helps soil clean, others contribute to the phosphorus accumulation in the upper and lower horizons and its transfer from the unassimilated mineral forms in the assimilated organic forms

Table 3. Resource reproductive impact of hidden crops

No.	Resource reproductive impact
1	Soil loosening through improvement of aggregation degree, porosity, water permeability and hydraulic conductivity
2	Ensuring stability and porous space conductivity
3	Reduction of soil cohesion and resistance to penetration
4	Radicular system of some hidden crops (sweet clover, lucerne) function as "biological plugin" and assures compaction of loosening layers
5	Improvement of soil water capacity
6	Formation of mulch protective layer on the soil surface
7	Formation of mulch protective layer on the soil surface
8	Weeds oppression
9	Accumulation of nitrogen in the soil through the biological fixation (legumes), restoring the nutritive substances flow, reducing losses of nutrients through the leaching
10	Creates favourable conditions for developing organisms in the soil and improving the soil biota
11	Creation of favorable conditions for water and nutritive substances assimilation by succeeding crops
12	Saturated crop rotations with different species of hidden crops which ensures biological balance and circulations as well contributes to the reduction of issues related to insects-pests and pathologies, constantly addition of organic debris contributes by increasing the organic matter content and soil reserves

The engagement into the agricultural circuit seriously affects aggregate stability of typical chernozems. From Table 4 we notice that extended plowing leads to reduction at 2 to 2.5 times the aggregates stability (>5 mm). The latest ensures determinable pores of regimes (hydrothermal, air-hydric, oxidation-reduction and biological). At the same time, aggregates water stability from 5 to 0.25 mm is reduced at 1.3 to 1.5 times. Therefore, over time within pore space is reduced the pore conductors volume of moisture which seriously affects the soil moisture regime. In contrast, increased aggregate content <0.25 mm, and therefore increased soil mass at specific area and lead to increased capacity of crusting arable layer.

The stability over time of the reorganization processes of structural aggregates of arable soil leads to formation of the soil profiles agrogen transformed, where horizons is clearly distinguished: arable (A_p) and sub arable (A_{ph}) that forming agrogen layer of arable soil profiles by which soil profiles is radically detached from the genetic profiles of the typical chernozems (Table 5). Agroecosystems biologization integration processes lead to reanimation of aggregates soil mass with restoration of structural aggregates of typical chernozems (Table 4).

Renaturation of pedogenesis processes and soil ecosystem functionality are materialized in the restoration of soil organic profile. The specified processes included the restoration of organic soil profile, expanded reproduction, optimization of biogeochemical volume and substances composition and enlarged reproduction of the soil fertility (Tables 6 and 7).

Table 4. Aggregate composition and hydro-stability aggregate within the various biotechnologies models resource-reproductive

Model	Depth, cm	Aggregate composition, %			Hydro stability composition, %		
		> 10 mm	10-0.25 mm	< 0.25 mm	> 5 mm	5-0.25 mm	< 0.25 mm
Natural (uncultivated)	0 – 10	6.3	85.6	8.1	27.0	52.0	21.0
	10 – 20	8.7	84.0	7.3	21.0	59.6	19.4
	20 – 30	11.3	79.2	9.5	23.6	58.2	17.6
Ecobiologic (5 crops)	0 – 10	11.3	80.3	8.4	9.7	52.6	37.7
	10 – 20	13.7	77.0	9.3	11.8	56.7	31.5
	20 – 30	14.8	75.5	9.7	10.4	53.0	36.6
	30 – 40	10.7	79.9	9.4	9.3	55.0	35.7
	40 – 50	9.4	82.0	8.6	9.3	61.5	29.7
Biologic (5 crops)	0 – 10	12.5	78.5	9.0	9.5	51.1	38.4
	10 – 20	14.7	74.6	10.8	11.4	52.0	36.6
	20 – 30	16.6	70.4	13.0	9.0	49.6	41.4
	30 – 40	15.0	73.6	11.4	9.9	48.3	42.7
	40 – 50	12.0	77.0	11.0	7.0	55.7	37.3
Bioorganic (5 crops)	0 – 10	13.8	76.0	12.2	7.1	33.3	59.6
	10 – 20	17.7	70.5	11.8	8.8	31.4	59.8
	20 – 30	21.8	66.8	11.4	9.4	36.1	54.5
	30 – 40	27.0	61.8	11.2	9.7	37.8	52.5
	40 – 50	18.0	61.0	11.0	10.3	47.0	52.7
Plowing 53 years	0 – 10	13.9	73.6	12.5	7.4	53.0	39.6
	10 – 20	19.7	65.0	14.3	4.4	49.0	46.6
	20 – 30	31.7	58.2	10.1	11.8	41.9	46.3
	30 – 40	30.3	56.9	12.8	10.7	44.4	44.9
	40 – 50	17.8	69.8	12.4	10.9	47.9	43.0
Plowing 47 years	0 – 10	12.5	68.0	19,5	7,7	52.0	40.3
	10 – 20	19.4	68.5	12.1	6.1	47.0	46.9
	20 – 30	30.7	58.0	11.3	9.7	42.0	48.3
	30 – 40	30.,3	56.9	12.8	10.3	41.5	48.2
	40 – 50	14.7	73.0	12.3	9.1	47.9	43.0

Table 5. Anthropogenic models of typical chernozem moderate humiferos in the profiles

No. field	Genetic horizon Thickness, cm	Bulk density		Aggregates composition, %			
		g/cm^3	Specifications	Polygonal	Block	Grain	Dusty
1	A_p 0-10 15-20	1.11 1.54	optimal extremely unfavorable	30 95	35 5	30 -	5 -
	A_{ph} 25-30 38-42	1.44 1.32	unfavorable favorable	85 70	15 20	- 10	- -
	A_m 50-55	1.26	optimal	-	30	70	-
	A_mB 70-74	1.26	optimal	-	55	45	-
3	A_p 0-10	1.16	optimal	35	20	30	15
	A_{ph} 15-20 30-35	1.63 1.46	extremely unfavorable unfavorable	80 60	20 20	- 20	- -
	A_m 50-55	1.39	acceptable	25	30	40	5
	A_mB 70-75	1.34	acceptable	15	60	25	5

Table 6. Comparative assessment of various models of ecological systems

Ecological systems		
Natural	No-Till	Traditional
Closed system	Quasi-closed system	Open system
Balanced	Quasi-balanced	Unbalanced system
Biogeochemical circuit volume and high reproductive resources	Biogeochemical circuit volume and significantly reproductive resources	Biogeochemical circuit accompanied by losses of P, Ca, Mg, K, Na, etc.
Assurance enhancement with organic matter and nitrogen	Assurance increasing with organic substance and nitrogen	Losses of organic matter and nitrogen
Balanced amount of biomass	Active enhancement of biomass amount	Insufficiency of biomass
Optimal use of water from rainfall	High recovery of water from rainfall	Unsatisfactory recovery of water from rainfall
Minimal erosion	Insignificant erosion	Noticeable erosion
Attenuated variability in time of hydro-thermal regimes, air-hydric, oxidation-reduction and biological	Attenuated variability in time of hydro-thermal regimes, air-hydric, oxidation-reduction and biological	Contrasting variability in time of hydro-thermal regimes, air-hydric, oxidation-reduction and biological
Enlarged reproduction of soil fertility	Enlarged reproduction of soil fertility	Accelerated reduction of fertility
Self-management system	Self-management system	Anthropomanagement system

Table 7. Ecosystem development stages of the No-Till

Incipient stage	Transition stage	Constitution stage	Stabilization stage
Structural aggregates stabilization	Enhancing soil bulk density	Large quantity of vegetal residues	Accelerated accumulation of the vegetal residues
Low organic matter content	Increasing the content of organic debris	Increased coefficient of carbon content	Continuous variability of nitrogen and carbon
Restoring soil microbiota biomass	Increasing phosphorous content	Enhancing moisture content	Enhancing moisture content
Increasing nitrogen content	Nitrogen immobilization, mineralization	Nitorgen immobilization, mineralization reduction, intensification of biological substances cycle, optimization and increasing its volume	Proportion circuit of nutritional substances, consumption reduction of nitrogen and phosphorus
Time, years			
0-5	5 – 10	10 – 20	> 20

CONCLUSIONS

Agroecosystems biologization leads to renaturation of the pedeogenesis processes in the chernozem types. The basic elements of renaturation phenomenon are self-loosening, micro and macro structure of the soil, porous space optimization and pedogenesis regimes.

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