FERTILITY LIMITATIVE PEDOLOGICALFACTORS APPROACH AND SOIL YIELD CAPACITY RECOVERY ACTIONS IN ARAD COUNTY

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Abstract: *The paper refers to an acreage of 755409 ha, of which 511520 ha arable terrains. This area is situated in Western Romania and gathers 75 cadastral territories belonging to Arad County. The authors present a description of hydrological, geological, geomorphological condition diversity, which had effect on soil cover structure (comprised soil yield capacity), found to be very heterogeneous in space and time. In its activity, OSPA Arad performed numerous pedological and agrochemical studies. This survey, developed on mentioned area had shown the following categories of soils: Reaction: moderate and strong acid over 150.000 ha, moderate alkaline over 45.000 ha, strong and excessive alkaline 16.000 ha.;Humic reserve (0-50 cm): low 180.000 ha, very and extremely low 125.000 ha; Mobile potassium (0-20, or Ap): middle: 155.000 ha, low: 42.000 ha, Mobile phosphorous (0-20, or Ap) low and very low: 225.000 ha, Humidity excess: 150.000 ha, Erosion: 125.000 ha, Secondary compactness: 370.000ha, Humidity deficit: 250.000 ha.Having in view this situation, we state that structure recovery, fertility degree improvement, prevention and fight soil phenomena and degradation processes, could be designed only through detailed acknowledge on area characteristics, which means structural and functional aspects of climatic and telurico-edaphic factors offer.*

Key words: *factor, edaphic, resources, limitative, productive*

INTRODUCTION

Representing a well defined environment condition, having a wide variability in space, but being relatively stable in time, pedological factors, through their major components have an essential role in land quality characterization.

In time, conception upon soil and their function evoluate, displaying various modifications.

Nowaday it is widely accepted the fundamental role of soil through its functions in biodiversity and climatic modifications, in environmental protection, economic and social development.

Soils of any kind no matter their destination, juridical status (public or private domain) constitute the land fund of a certain administration area, part of national territory.

The soil, natural form, shaped during millenia, at the interference of four spheres of our planet, constitutes the 1st and the most sure mean of production, able to guarantee nation food security and also physical and geographical space needed for human society development.

Shaped in very diverse natural circumstances, soils vary in a large range regarding fertility their capacity to sustain plant growing, yield level in agriculture or forestry areas of different zones). Since ancient times there existed and evolved the concern to choose the "fit" place or to "fit" the chosen place to certain utilities or crops. Experience demonstrate that both small or large agricultural companies require in the first place knowledge and rational soil exploitation.

Agriculture through its role and functions is the major element of natural resources with high impact on environment which through its long term stability assures the base for durable resources.

Incorrect, not complete, wrong agricultural exploitation affects deeply, quantitatively and qualitatively not only crop yield but also soil resources. Soil thesaurus represent a stategic natural resource which is regenerating in case of rational exploitation, providing food security.

Having this considerations in mind, the authors try to present some aspects that refer to limitative or restrictive yield factors, both on their present manifestation and capacities improvement possibilities. In this paper we ely on data issued from personal research themes and also from the impressive amount of OSPA Arad archive.

MATERIALS AND RESEARCH METHODS

The approached issues refers to an area of 775.409 ha, from which 511.520 ha are agricultural areas (tab 1). Situated in western Romania, including a number of cadastral territories belonging to Arad county

Table 1

Area representation on utility structures

	Arable	Pastures	hay fields	Vineyards	Orchards	Agriculture	Forests	Other	Total
Area(ha)	348324	128102	25293	3814	5987	511520	212182	51707	775409
%	44.92	16.52	3.26	0.49	0.77	65.96	27.37	6.67	100
%	68.09	25.04	4.95	0.75	1.17	100.00	-	-	-

Being a very particular region of Romanian territory, from geomorphological and also of soil envelope point of view, the area we took into consideration suffered in the last 3 centuries significant human interventions that marked their futher evolution. We must especially mention the aspect of agricultural terrain employment which present a major interest for pedological and agrochemical research activity, already of 50 years old.

The ecopedological description of agricultural terrain (511.520 ha), limitative and restrictive factors analysis was conducted accordingly to "Pedological Studies Elaboration Methodology" conceived by ICPA Bucharest in 1987 .

In our study we use pedological and agrochemical data accumulated in OSPA Arad archive and specific themes papers issued by ICPA Bucharest.

RESULTS AND DISCUTIONS

The territory we took into consideration is situated near 45^0 latitude parallel and exhibits a large diversity of geologic , geomorphologic and hydrologic conditions

Situated in the western part of Romania, Arad county lays from Apuseni Montains core to the subsidence and plain generated by Mures, Crisul Alb and Crisul Negru.

Arad county relief in a general view is characterized by the existence of relief forms variable proportional, set in steps starting from west to east and represented by : old deltas and flood plains (altitudes 80-85 m) semidrained plains (85-100m), foothills plains, plateaus and foothills, high hills, sub and intramountainous depressions, as well as mountains reaching altitudes up to 1486 m (Vf. Gaina of Bihor Mountains) with specific geological and paleogeographical structures, linked to western Romania evolution in time and space (fig. 1).

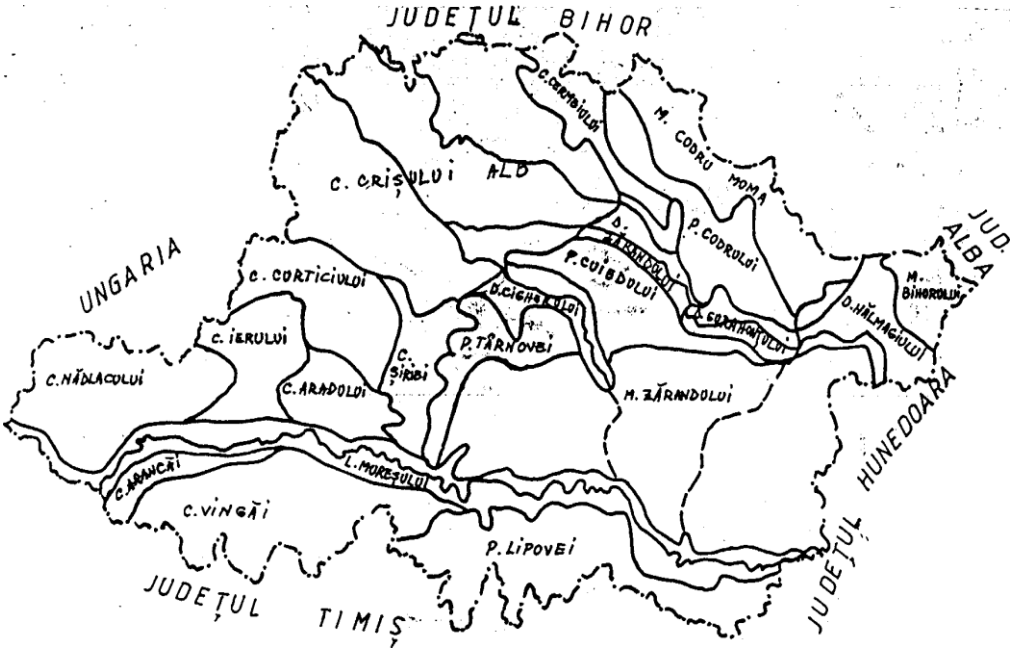

Figure 1. Main physical and geographical unities in arad County

Dominated in east and south-east by mountainous units, of Codru Moma, Bihorului, Zarandului Mountains, our area is confined in the southern part by Lipovei Plateau, the mountainous zone passing toward plain through a chain of peripheral hills, this plain advancing in a gulf-like shape toward mountain base (Zarand, Gurahont, Beliu depressions, etc). To already mentioned depressions we have to add a well defined corridor in the south (Mures corridor). This short descriptions shows a wide diversity of hydrogeographical, geological and geomorphological conditions.

Hydrographic net, represented by rivers, lakes, a complex system of canals (channels) for irrigation or drainage organizes its basins on both southern and northern banks of Mures river and belongs to Danube basin.

Most important rivers are: Crisul Negru, Crisul Alb, Teuzul, Cigherul, Muresul and their tributaries. This hydrographic system that crosses our surveyed area is east-west oriented determined by relief configuration being (genetically) contemporary to this. The genesis of this perimeter complex took place in pliocen-cuaternar by Pannonic lake withdrawal and land raise.

Climatic (solar radiation, radiative balance, air circulation, precipitations), genetic factors in strong correlation to geographical position, altitude, active area character determine a moderate continental temperate climate with oceanic influences in Arad county, having sectorial characteristics situated between banatic and somesan climate.

Floristic particularities are emphasized by endemic elements, mediterranean thermophile species widely represented, conferring a mosaic aspect to this area, that's why county's flora is classified in East Carpathian province (dacic) Codru-Zarand-Trascau district, and West Plain county.

The vegetation is characterized by silvosteppe and highly antropic modified forest, formation predominance (associated on small area with even steppe).

As a consequence of relief and pedoclimatic conditions arable area gathers 68,14% of total agricultural acreage, respectively 44,9 %, of total county acreage (775.409 ha, see tab.2).

Table 2

Use cathegory distribution in main relief forms

Relief	Arable		Pastures and hayfilds		Vignards and orchards		Agriculture		Forest		Other		Total	
meadow and low plains	ha	251701	ha	59689	ha	300	ha	311410	ha	30178	ha	13707	ha	355295
	%	72.3	%	38.9	%	3.1	%	60.8	%	14.3	%	26.5	%	45.8
high plains and terraces	ha	61455	ha	11978	ha	600	ha	74033	ha	9647	ha	12000	ha	95680
	%	17.7	%	7.8	%	6.1	%	14.7	%	4.5	%	23.2	%	12.3
hills and teraces	ha	33953	ha	45646	ha	8580	ha	88459	ha	77928	ha	10000	ha	176387
	%	9.8	%	29.8	%	87.5	%	17.2	%	36.7	%	19.4	%	22.7
mountains and depressions	ha	1215	ha	36082	ha	321	ha	37618	ha	94429	ha	16000	ha	148047
	%	0.3	%	23.5	%	3.3	%	7.3	%	44.5	%	30.9	%	19.2
Total	ha	348324	ha	153395	ha	9801	ha	511520	ha	212182	ha	51707	ha	775409
%		100		100		100		100		100		100		100
%		44.93		19.78		1.26		65.97		27.36		6.67		100
%		68.10		29.99		1.91		100		-		-		-

Pasture (lawn) acreage covers 29.9% of total agricultural area, distributed on main relief formations as follows: 38.9 % in flood and low plains ,7.8 % in high plains, 29.8% on hills, 23.5 % in mountains and mountainous depressions.

Orchards and vineyards cover only 1.9 % of total agricultural area.

Forest fund is relatively well represented covering an area of 27.4% of total County surface. Their distribution on relief formations is as it follows: 14.3 % in flood and low plains, 4.5% in high plains, 36.4 % on hills and 44.5 % in mountainous zones.

Most large forest acreage is met in Codru Moma Mountains, which is quite totally covered with forests (His name tells it all). This region exhibits its specific and very few modified mountanous forest landscape. This is the reason why in this region was constituted as Nature Reservation of Moneasa. This reserve covers an area of 6273 ha and represents one of very few European forest covered carsts (a relic that asks action to protect and preserve it).

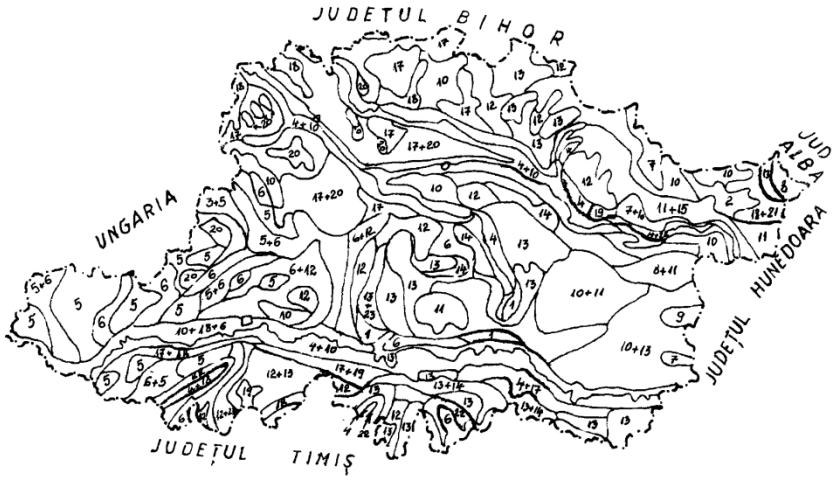

Figure 2. Types and soil associations in Arad County

Terrain use intensity reach almost maximum land resources parameter values. Agricultural terrains cover 66% of total surface of which 68.1% is implied various activities specific to cereal, and technical plants growing. This percentage is due to improvement works developed at the and of the XVIII th century when water courses (of Crisul Alb, Crisul Negru,

Teuz, Cigher rivers and their tributaries) were regularized diminishing drasticallly marshes area (which was broadly spread) and reclaiming arable land.

As a consequence, soil cover fundamental geographical characteristics in our research area follows the same step distribution as relief or climate. Pedogenetic factors interaction generate a numerous soil population with specific characteristic evolution.

Accordingly to Romanian Soil Taxonomy System (SRTS 2013) we identified in our area 18 classes and 23 Soil Types (table 3) (figure 2) in which we discriminate numerous detailed categories.

Table 3

Main types and soil associations in Arad County,
(hectares and percentage of agricultural terrain)

Nr. crt.	SRTS	FAO/UNESCO 1988	ARAD	
			Ha	%
1	Litosol (di,eu,pr,rz)	Leptosol	6650	1,30
2	Regosol (di,eu,mo,um,li)	Regosol	23581	4,61
3	Psamosol (eu,mo,gc)	Arenosol	2353	0,46
4	Aluviosol (en,eu,mo,gc,vs,sc,ac)	Fluvisol	43684	8,54
	Protisoluri		**76268**	**14,91**
5	Cernoziom (ti,gc,ka,vs,sc,ac)	Chernozem	121857	23,82
6	Faeoziom (ti,vs,gc,st,cl)	Phaeozem	33938	6,63
7	Rendzină (li,cb,ka)	Rendzic Leptosol	409	0,08
	Cernisoluri		**156204**	**30,53**
8	Nigrosol (ti,cb,li)	Humic Cambisol	1637	0,32
9	Humosiosol (ti,cb,li)	Dystric-Humic Cambisol	205	0,04
	Umbrisoluri		**1842**	**0,36**
10	Eutricambosol (ti,mo,vs,ro,al)	Eutric Cambisol	27212	5,32
11	Districambosol (ti,um,ep,li)	Dystric Cambisol	7570	1,48
	Cambisoluri		**34782**	**6,80**
12	Preluvosol (ti,mo,rs,vs,ca,st)	Haplic Luvosol Chromic	53581	10,48
13	Luvosol (ti,rs,ab,vs,pe,st)	Luvisols	68443	13,38
14	Planosol ((ti,ab,vs,st)	Planosol	6394	1,25
	Luvisoluri		**128418**	**25,11**
15	Prepodzol (ti,um,tb,li)	Cambic Podzol	153	0,03
16	Podzol (ti,um,fe,tb,li)	Haplic Podzol	205	0,04
	Spodisoluri		**358**	**0,07**
17	Vertosol (ti,gc,st,br)	Vertisol	60462	11,82
	Pelisoluri		**60462**	**11,82**
18	Gleisol (eu,di,ka,mo,ce,ca,pe,al)	Gleysol	12328	2,41
19	Stagnosol (ti,lv,ab,vs,pl)	Stagnic Luvisol	4041	0,79
	Hidrisoluri		**16369**	**3,20**
20	Soloneț (ti,mo,lv,ab,sc,gc)	Solonetz	23416	4,58
	Salsodisoluri		**23416**	**4,58**
21	Turbosol (di)	Histosol fără Folic Histosol	205	0,04
	Histisoluri		**205**	**0,04**
22	Erodosol (ca,cb,ar,sp,li)	(faze puternic erodate)	10588	2,07
23	Antrosol (ro,aq) si Entiantrosol (ar,ru,co)	Anthrosol	2608	0,51
24	**Antrisoluri**		**13196**	**2,58**
	TOTAL		**511520**	**100**

As a result of this huge physical, geographical, soil embedded characteristics diversity, as well as of anthropic interventions developed in time, soil productivity displays a large variability in space and time.

Based on pedological and agrochemical studies data from OSPA Arad archive and processed accordingly to Pedological Studies Elaboration Methodology (ICPA Buc 1987) and to other updated standards by MAAP 223/2002 Order, agricultural terrain in mentioned area were distributed in the following suitability classes in "Arable" land use category as it follows:

1. No restriction or limitations terrains (land evaluation works between 81-100 points). These terrains are represented by Kernozems and cambic Kernozems (tipical, freatic-

wet, moderate and low gleyic). This terrains require only correct soil preparation (agrotechnic) adapted to crop assortment and relief characteristics.

2. Low restriction and limitation terrains(land evaluation works between 61-80 points). Due to sandy low texture, low alkaline acid reaction, periodically humidity excess (38.70% of considered area respectively 197.958 ha). This acreage requires periodically water excess preventions and cure fight, semifermented organic and green fertilizations spread at 1-2 years intervals, lime and dolomite treatment (accordingly to agrochemical indexes).

3. Average limitations and restrictions terrains (41-60 points) representing 36.46 % or 186.10501 ha in area. Represented by low or moderate acid reaction, with periodically stagnant water regime of precipitations origin, low or moderate erosion affected. This lands bear a high acidification risc, N and K nutrition malfunction especially in cold springs (due to P absorbtion rate decrease at low temperatures), Mo absorption disturb in case of high or unilateral N quantities spreading as well as Al toxicity in most crops and even Mg toxicity in sensitive plants. For such situation it is recommended dolomitic and lime (in corelation to agrochemical indexes amendaments amounts) spreading, and terrain revisiting once at every 5-7 years. Also, semifermented organic fertilizers once at 3-4 years, N, P, K fertilizers after previous favorable oxido-reductive soil environment setting as a results of a adequate pedoameliorative works (coast canals, drainage, ridges, etc).

4. High restrictions and limitations terrains (marks: 21-40 points).This cathegory covers , respectively 39387 ha and includes halohidro and hydromorphic soils with unfavorable phyisical, hydrophyisical and chemical-physical properties. For arable use, these terrains require a characteristic complex of ameliorative measures : drainage, gyps amendation, specific agrotechnic application, adequate plant assortment (wheat, barley, alfalfa). Due to high restriction, these areas will remain natural pastures, or in future, for superior rate of measure, will be transformed into fish pounds or rice producing terrains.

5. Severe limitations and restrictions terrains (works 1-20 points) Gathers soils with tough and excessive erosion , with landslides, excess of stagnant humidity, representing 3-5 % respectively 17.903 ha in checked area. This categories present a strong risk of slope sliding fertilizers thus leading to macro and microelement nutrition disorders determined by parental material. This areas demand radical fertilization measures, adequate to soil characteristics and plant species demand (organic fertilizers in solid quantities, green fertilizers, etc). A good management of this soils , their protection and preservation requires terracing works, grass stripes, protection curtains, coast channels, ridge consolidations etc.

6. Very severe limitation and restriction terrains (not appropriate to agriculture). In this case we encounter excessive and strong eroded terrains with deep erosion formations, with bare hard rock, situated on highly inclined slopes, representing 2.64 % respectively 13.504 ha. To fight deep erosion on excessive surface erosion it is recomended forest plantation works. Same solution is recommended in dam protected areas.

CONCLUSIONS

Although ecological potential appears to be good, general situation of soil quality in considered area is unsatisfactory: most soil acreage is affected by one or several restrictive or limitative factors.

General soil utility distribution is in accordance to the nature of pedoclimatic conditions. But terrain employment is not always fit for durable management of land fund .

In agricultural practice nutritive element compensation (after element extraction by the crop) is neglected. This quantities were not yet evaluated in Romania , although we know that in every pound of yield we find a part of soil disponible chemical elements

In this conditions, keeping or improving soil fertility through equilibrate fertilizer application, the only action that assures present and future efficiency, requires a detailed knowledge of territory

Based on this reality, soil structure recovery (restoration), fertility level improvement, preventing and fighting against erosion measures, can be achieved by mean of restoration areas organization, or reconfiguration of existent areas.

Surveyed area, component of South-West Development Region, is a county with solid rural development potential and resources. It is connected to important projects and programs in rural amenity and development sustained both by EU and Romanian Government , through governmental institutions or agencies which contribute to infrastructural development in various activity range of mentioned area.

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