LIMITING FACTORS FOR THE PRODUCTIVITY OF AGRARIAN LANDS IN LIPOVA HILLS

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Abstract *Our research has its origins in the scientific and practical preoccupations regarding gathering knowledge about determining the risks of the apparition of limiting factors in the land productivity and estimating values for a series of the considered factors: compactness degree, soil reactivity, granular composition, surface and depth humidity. All these factors influence the workability of the land. The importance of this subject comes from the fact that there are close links between the structure of the land fund with its characteristics and the grown species, links that are various and complex. Thus, the properties of the soil can greatly influence the roots, mineral nutrition, the air and water supply needed for all the physiological processes, and the plants themselves will influence directly and indirectly the fertility of the soil and its productivity. Taking into consideration all these aspects, and based upon the research done throughout the PHD course - 28th of September 2015 to the present with the topic RESEARCH ON THE ECO- PEDOLOGY BASES OF LIPOVA HILLS LAND PRODUCTIVITY AND POSSIBLE PRESSURES UPON THEIR QUALITY, this paper presents a few aspects regarding the establishing othe risk of apparition and intensification of limiting factors in fields productivity, characteristics that define land vocation for certain usages or agricultural practices. Through its geographical position, the area known as LIPOVA HILLS, LIPOVA PIEMONTE OR LIPOVA PLATEAU, is situated in the western part of the country, 21°22'30'' and 22°21'30'' east longitude and 45°55' and 46°15' north latitude, as a transition between Western Carpathians and the lower region of Bega- Timis corridor. Thus, the area has specific characteristics of real interest for scientific research. The research is linked up with the fundamentals of durable agriculture, responding to domestic demands of constituting a scientific database needed for the foundation of technology and management measures of agro-eco systems.*

Keywords: *lands, soil, productivity, factors, hills*

INTRODUCTION

The existence and the economic development of any society is not possible without its natural resources which have had a vital role throughout society progress. Among these resources, the soil as an open ecological system, is directly linked to the environment through a continuous flux of matter and energy. The fertility and the productivity capacity of the soil depends on its agrochemical features, its physical and hydrological properties and on the agricultural and forestry production systems.

In this matter , eco- pedological knowledge of lands is a necessity for a modern and rational agriculture, which transforms the soils (through well defined fertilization and improvements) as well as the plants (by creating new species and hybrids).

Numerous studies and research have shown that between technological agrarian systems, the environment, the level of economic development and quality of life, there are

interdependent relations (Canarache and col. 1980, Coste and col.1997, Craciun 2000, David and col. 2019,Dicu and col. 2013, Dumitru and col. 2000, Florea and col. 1987, Nita and col.2018, 2019, Rauta,1997, Rogobete 1979, Rogobete and col.1997, Teaci 1995, Tarau and col.2019).Taking these into account, the paper presents a few aspects regarding the pedologic and climate environment in which plants grow and produce, each of the soil and land units being characterized based on the METHODOLOGY OF ELABORATING PEDOLOGY STUDIES, 1987, and using the 23 indicators which are the result of research carried between 2015-2020 and are part of the PHD studies completed with a series of data archived at O.S.P.A. in Timisoara and Arad.

MATERIALS AND METHODS

The issue approached here refers to a surface of 309,186 ha, out of which 181,890 ha (58.83%) are arable fields, situated in western Romania, administratively belonging to 26 UAT in Timis county (1. Balint, 2. Bara, 3. Bethausen, 4. Bogda, 5. Brestovat, 6. Faget, 7. Ghizela, 8. Giarmata, 9. Margina, 10. Masloc-Fibis, 11. Manastur, 12. Ohaba Lunga, 13. Pischia, 14. Recas, 15. Remetea Mare, 16. Secas, 17. Topolovatu Mare) and to Arad county (1. Bata, 2. Birchis, 3. Birzava, 4. Conop-Chelmac, 5. Lipova, 6. Savarsin, 7. Sistarovat, 8. Ususau-Dorgos, 9. Zabrani.

Table 1

The Agrarian Land Situation

Town/ Village	Arable	Pastures	Hayfields	Vineyards	Orchards	Total agrarian	Forests	Water	Others	General total
Total TM	77524	33134	10739	2183	2734	126314	37734	2143	8285	174476
Total AR	24944	19404	8329	5	2894	55576	77961	1671	4502	134710
Dealurile Lipovei	**102468**	**52538**	**19068**	**2188**	**5628**	**181890**	**110695**	**3814**	**12787**	**309186**
%	33,14	16,99	6,17	0,71	1,82	58,83	35,80	1,23	4,14	100
%	56,34	28,88	10,48	1,21	3,09	100	-	-	-	-

The research on the eco- pedological conditions has been done according to the METHODOLOGY OF ELABORATING PEDOLOGY STUDIES, Bucharest, 1987, completed with elements from the Romanian System of Soil Taxonomy (SRTS-2003/2012), as well as the legislation normative M.A.A.P.223/2002, MADR 278/2011 and information gathered in over 65 years in OSPA Timisoara and Arad archives. These studies have been completed with recently gathered elements in the field and interpreted in the laboratory and at the office.

RESULTS AND DISCUSSIONS

Even though the data gathered in the present paper refer to a not very wide surface, they can constitute a valuable material for further fundamentals of technology suited to the specific pedologic and climatological conditions of the area, as well for similar regions. Therefore, we will present a few aspects related to the natural frame of the researched area.

LIPOVA PLATEAU is a spread hill area between Mures River in the north and Bega River in the south. It is linked to Poiana Ruscai Mountains by the oldest alluvial cone of Mures River and gradually lowering to Vinga Plain, to the Valley of Beregsau.

The area consists of a series of terraces that lower slightly from an altitude of over 400 meters, the entire region being eroded and having hydrological basins more and more

developed to the west.Although it is bordered in the north by Mures River, the area is part of Bega hydrological basin.

The pedo- phreatic water is at depths of 10- 15 meters in the east and 5- 10 meters in the west and south. Within the valleys, this water reaches depths of 5-10 meters upstream, 3-5 meters downstream, and 1-2, 0-1 meters in the areas with low drainage. Its macro climatological characteristics are determined by its geographical position, having a certain air flow.

This flow is given either by the dynamic centers (azorean anticyclon and the subtropical one) , or the thermic, seasonal centers (Siberian anticyclon, Asian or Mediterranean depression). The entire region is found between the multi-annual average isotherms of 10° and 9° and rainfall values of 650-850 mm, multi-annual average.

The soil layer has the same terraced structure, from west to east, and thus it is strongly related to the climate and vegetation conditions, with the time evolution. The soils in the researched perimeter presents great diversity, continuously evolving under various anthropical interventions.

Each of the 158 units of soil and land have been characterized using the 23 worthiness indicators: climate indicators (indicator 3C- average annual temperatures, indicator 4C – average annual rainfall), indicators of hydro-physical, physical, chemical and morphological characteristics and the volume of soil layer (indicator 14 -gleizare, indicator 15 – stagnogleizare, indicator 16 or 17 – salinity and alkalinity, indicator 61 - CaCo3 content, indicator 63 – soil reaction in Ap or the first 20 cm, indicator 44 – total porosity within the restrictive horizon, indicator 133 – the used edaphic volume), indicators regarding hydrography, hydrology and territory drainage (indicator 40 – floodability, indicator 181 – excessive stagnant humidity, indicator 39 – pedo- freatic water depth), indicators of anthropic interventions (indicator 29 – pollution, indicator 271 – land improvements), as well as the interactions between these natural values and those anthropical ones.

These indicators have been used to establish the genetic and parametric classification units and to study the influence they have upon plants growth. Thus, it shows a series of limiting factors which act upon land productivity: phreatic and surface humidity, compactness, soil reactivity. These are studied here and their analysis brings up a series of improving measures and/or „must do" usages, as well as requirements of implementing new technologies. The water distribution pattern and its movement (surface water and phreatic water) , its presence at the root system, its nature and quantity, mobility and oxygenation, its variability in space and time, determine in the researched territory a various range of manifestation, offering different life and productivity conditions (table 2).

Resultant of a dominant stagnant hydrological regime , on fields with impermeable layers, the stagnant-glazing stage is the indicator that helps separating soil varieties for stagnant subtypes, also determining different variables for plants(spontaneous or crops).When the soil is humid only due to rainfall, it is in condition of humidity specific to the respective climatological region. When the soil gets humidity from rainfall accumulations it has a higher degree of humidity compared to the one of the area. Her we are talking about *excessive surface humidity.*

Within the researched region, according to the landform, permeability and hydro-climatological conditions, the agrarian lands can be grouped (see indicator 181 in M.E.S.P., 1987), in relation to the ***excessive surface humidity*** and the stagnation period (see table 2): ***weak/low*** (2) with 6-15 stagnation days, 35, 049 ha (19.27%), ***moderate*** (3) 16-30 days of stagnation, 34,606 ha (19.03%), ***strong*** (4), ***very strong*** (5), and ***extremely strong*** (6), for time

periods that can exceed 60 days, for a surface 2026 ha, 11.14% which together represent limiting factors on a total of 89,918 ha, 49,44%.

Table 2

Limitative factors in Lipova hills

Total agrarian	soils					
	excessive surface humidity			*humidity excess*		
	weak/low	*moderate*	p*very strong*	moderate	strong	very strong
181890	35049	34606	20263	15735	11136	8765
%	19,27	19,03	11,14	8,65	6,12	4,82
			89918			35636

Referring to the ***hydrological soil status, predominantly phreatic, the glazing condition or the excess of pedo- phreatic humidity*** which separates soil varieties and determines also different favorabilities for certain grown or spontaneous plants, within the researched area there have been defined the glazefication degrees according to which we can talk about the following field groups: **moderate** (3), 15,735 ha, 8.65%, **strong** (4), 11,136 ha, 6.12%, **very strong** (5) and **excessive** (6), 8,765 ha, 4.82%, together representing **limiting factors** on a surface of 35,636 ha , 19.59%.

The two forms of humidity excess represent together limiting factors on a total surface of 125, 554 ha, 69.03%.

One important soil characteristic for the manifestation of humidity excess is ***compactness.*** This is the soil ability to oppose the forces that tend to crumble its particles. It is strongly related to the granular composition, the water content, humus content and its quality, and to the nature of absorbed cations, thus being the main ecological indicator of the general mode of working the land with agricultural machinery and of penetrating the plant roots.

The soil compactness is one of the main physical and mechanical characteristics with large practicability in agriculture. It is expressed through the degree of compactness, respectively through the degree of flatness (GT %)which represents the difference between minimum needed porosity (PMN) and the total porosity (PT) reported to the minimum needed porosity: GT=(PMN-PT/PMN)×100. It is expressed in percentages, setting the compactness classes of soil: very loose, loose, slightly compacted, average compacted, very (strongly) compacted. These are related to a complex indicator of compactness- the flatness degree (indicator 44) which shows the following situation within the studied area (table 4): strongly flattened (+25), 57,944 ha, 31.86%, moderate flatness (+15), 62,709 ha, 34.48%,and slightly flattened (+5), 31,275 ha, 17.19%; these are limiting factors for 151,928 ha , 83.53% (table 3)

Table 3

Limitative factors in Lipova hills

Total agrarian	soils					
	flattened			acids		
	weak/low	***moderate***	**p*very strong***	***weak/low***	**moderate**	**very strong**
181890	**31275**	**62709**	**57944**	**52322**	**71551**	**11461**
%	17,19	34,48	31,86	28,77	39,34	6,30
			151928			**135334**

Regardless of the causes of water excess which affects the upper part of the profile (stagnation due to rainfall) or its lower part (phreatic stagnation), the effects are similar and multiple: physical, chemical, biological, agro- technical. This fact requires bringing the soil characteristics to optimal function parameters, starting with the need for water as well as air for the roots. Canarache A. (1990) shows that the variation limits of the 3 stages of soils in Romania are the following: solid 45-60%, water 15-35%, air 5-40%, normal development of grown crops needing a minimum air volume in the ground of 10-20%of its volume.

Oxygen deficiency and carbon dioxide excess cause in the soil a series of imbalances in nutrients absorption: K>H>Mg. Oxygen lacking affects also aerobe microorganisms, such as nitrogen setting bacteria, nitric and ammonia bacteria. For vital activities, microorganisms create reactions of reducing compounds of trivalent iron and tetravalent manganese to bivalent compounds. These are soluble in water and can reach toxic concentrations for plants.

The soil reactivity status (indicator 63) is resultant of heritage and a complex of factors and physical-chemical characteristics of the soil in its natural development or influenced by man. These factors show the way in which the main biochemical processes happen in the ground and determine the real characteristics of plants growth and development. ***The soil reactivity status*** presents an image of altitude zoning, from west to east, from alkaline soils to acidic ones. According to its values, there are the following groups of fields (table 3): *strongly acidic* (4,7 with values of 4.4-5.0), 11,461 ha, *moderately acidic* 5.1-5.4 (5.2), 5.5-5.8 (5.6), 71,551 ha, 39.34%, weak/low acidic 5.9-6.8 (6.1-6.6), 52,322 ha, 28.77%, together representing limiting factors on a surface of 135,334 ha, 74.41% .

Ground/ soil texture (indicator 23) , one of the most stable eco- pedological conditions, essential for defining the plants growth and giving durable features to the soil, has a vital role in obtaining its productive capacity. Defined as the proportion of mineral particles of different sizes, the granular composition of soil profile is determined by the texture and nature of parental material, by the nature and type of pedo- genesis processes and by their intensity of manifestations. Class groups and textural subclasses are established according to the the extent of how much different size formations (sand, clay, dust) participate to soil profile formation (indicator 23, SRTS-2003-2012).

Granular composition implies, with different intensities, some physical, hydro-physical and biological features of the soil: total porosity, airflow, total capacity, field capacity, useful water capacity, permeability, compactness, consistency, structure and looseness, micro structure, self-looseness, air, hydrological and thermal regime, biogen activities etc.

This intricate feature of the fertility stage of the soil presents a large variability in space, both in the control section of the soil profile and at the surface, respectively in the concerned layer (Ap) or the upper 20 cm of the soil profile (indicator 23 A)

Thus, in the control section of the profile (table 4), the soils with clay texture (over 46% clay, 0.002 mm) occupy a surface of 49,098 ha, 26.99%, and those with 33-45% clay texture- a surface of 76,942 ha, 42.31%, whereas the soils with a clay-sandy texture occupy 11,937 ha, 6.56 %. These are limiting factors for a surface of 147,007 ha, 80.82% and clay soils cover a surface of 34,883 ha, 19.18% (soils with no limitations).

Table 4

Soil texture in Lipova Hills

Total agrarian Ha %	soils									
	Ap or the upper 20 cm					in the control section				
	UG-UF	SG-SP	LN-LP	TN-TP	AL-AF	UG-UF	SG-SP	LN-LP	TN-TP	AL-AF
181890	**2700**	**19430**	**86058**	**65137**	**8565**	**9030**	**11937**	**34883**	**76942**	**49098**
%	1,48	10,68	47,31	35,81	4,72	4,96	6,56	19,18	42,31	26,99

Referring to the texture in the considered layer (Ap), or the upper 20 cm of the soil profile, the soil with clay texture cover 8565 ha, 4.72%, those with loamy and clay texture cover 65,137 ha, 35.81%, and sand-clay soils – 2700 ha, 1.48%, clay- sandy soils- 19,430 ha, 10.68%, representing limiting factors for a surface of 95,832 ha, 52.69%, whereas clay textured soils cover a surface of 86,058 ha, 47.31% (soils with no limitations).

Knowing and quantifying these characteristics of soil profile allows us to evaluate the reserves of macro and micro elements which can be used by plants in time and also to settle the consequences of many involvement induced through different amenities, essentially changing the soil quality and its vocation for various usages. Related to soil texture there can be found a few elements for energetic consumption and the execution time period for different ways of working the land.

Implementing new agricultural technologies requires knowing the natural conditions of the planned crops, in areas of ecological favorability, considering the limitations that can occur. When evaluating the opportunity of a land lot for certain crops, one needs to consider at least 2 determinant factors: soil texture and the excess of humidity. Researches in soil physics have been maintained at an empirical level, both internationally and nationally, being further looked into only during the last decades, much later than the chemical aspects of soil fertility.

There has been a growth in research into the physic of soil in our country and nowadays it is widely admitted that agricultural systems cannot be promoted without knowing the local specific, including the physical status of the soil.

In total relation with the main eco pedologic parameters, we can state the following:

Fine textured soils and those with humidity excess have reduced opportunity for agricultural practices for conserving systems as the high clay content makes seeding, growing and plants developing difficult, and humidity excess limits going into the field for different works. On a humid and clay soil, when working the land there can appear compacted areas which influence negatively the germination and root development.

When evaluating the excess of humidity, the following factors should be considered: phreatic water depth, hydrological balance, micro landforms, slopes, soil permeability and land floodability. According to the phreatic level, the suitable lands are those where this level is lower than 2 meters, moderately suitable are those with the phreatic level of1-2 meters and unsuitable those with a level higher than 1 meter. When talking about surface humidity, we are interested in the duration of maintaining the excessive water, and the time needed for eliminating the excess through evaporation and infiltration. Thus, the areas where the excess lasts for less than 15 days are suitable, those where it is between 15-30 days are moderately suitable, and the grounds with a longer than 30 days period of excessive humidity are not suitable.

In consonance with those mentioned here, durable management of natural resources and of those anthropical induced, represent a modern form of land management, maintaining and increasing soil fertility and allowing to have high quality produce for long periods of time.

CONCLUSIONS

Knowing the productive and technological characteristics of favorable, restrictive or limiting factors of agricultural production can constitute a precious tool to accomplish the most effective practical measures in production of vegetation for the use of man to improve life standards and those related to a healthy and harmonious environment

This paper offers basic knowledge and methodological elements for the evaluation and characterization of natural resources and of those anthropically modified, hoping that the information provided here will rise the interest of deciding institutions so that the near future, the research and the agricultural practices together with the environment protection will make efforts towards interdisciplinary studies, as one cannot talk about healthy environment without healthy soil.

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