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THE BONITATION METHOD FOR ASSESSING THE FERTILITY OF THE CHERNOZEM

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Abstract

The theme of this paper is to obtain information on soil fertility characteristics of Chernozem soil to determine the general production capacity of the land for different crop plants. The present state of the complex system of soil properties, relief, climatic conditions, geomorphology, the types of agricultural farming practices and land use, are all contributing to loss of soil fertility with all its negative impacts on the environment. For this purpose, the calculation of Bonitation Note (NB) (soil quality index, bonitation score) is determined on the main agricultural crops according to the natural fertility capacity of the soil. The natural bonitation score is calculated based on the soil characteristics, which is assigned to the coefficients from 0 to 1, depending on the preference given by each characteristic. The studied Chernozem, located in the southeast of the Romanian Plain, more precisely in the Baragan Field, is directly investigated with the environmental factors, which together form homogeneous ecological territory units (UT), these UT having specific advantages at various agricultural uses, such as wheat, corn, sunflower, peas and soybean crops. Following a pedological study, Chernozem is in the second quality class, with 72 points, of the maximum of 100 points. Because this assessment of soil is changing under the influence of natural environmental factors and human intervention, the bonitation score must be permanently updated.

Key words**:** *soil, evaluation method, quality index, bonitation, chernozem*

INTRODUCTION

The soils in the Baragan Plain subdivision of the Romanian Plain are fertile varieties, belonging to the Cernisoluri Class, with increased productivity, but suffering from moderate climatic conditions and solid texture, which have a tendency of permanent degradation due to these limiting factors.

It is known that the negative influence of climatic factors, relief, hydrology and edaphic characteristics affects about 80% of Romania's arable land [2].

In our country, the land quality assessment is is determined by calculating the Bonitation Note (BN), thus assigning to each type of soil, a characteristic mark depending on its fertility. By means of this rating, a balance of expenditure per hectare and of the overall income is achieved, with grades 1-3 being preferred, but they are found only in fertile soils [16].

In the case of soils with scores of less than 45 points - as an average calculated for arable - negative economic results are obtained. The average level of a point of qualification is independent of the fertility class, but it varies according to the applied technology from 5.5 lei/point to 7.7 lei/point.

In the case of arable land, which occupies 63.4% of the country's agricultural area, most of the plots are grouped in the II nd quality classe (28.69%), III rd (38.19%), and in I st grade class only 6.7% of the total land, the rest of the classes having different restrictions [5].

Maintaining soil quality in agriculture depends on the use of soil and agricultural practices [6].

The bonitation notes thus obtained highlight aspects related to the quality of the land, the suitability for various uses and the production capacity expressed in kg/ha, and a series of limiting factors that affect the production capacity of agricultural land in within the studied territory, such as drought and fine texture [10].

MATERIALS AND METHODS

The land bonitation of the agricultural land was calculated on the basis of the calculation of the Bonitation Note, according to the quality indicators for the chernozem substrate type, after which the identification of the limiting factors of the agricultural production was made and the corresponding quality class was made [17].

The bonitation for arable land (BN) was calculated for agricultural crops, which are of the highest favorability in the Romanian Plain, based on bonitation indicators, according to "The Methodology of Performing Pedological Studies" [15].

For soil characterization, the Homogeneous Environment Territory (TEO), as defined by Teaci, [15] was followed by morphological, hydrophysical and chemical indicators such as texture, useful edafic volume, bulk density, total porosity, degree of galling, pseudogleization degree, salinity intensity, $CaCO_3$ content, pH, saturation in bases (V%), humus content in Ap and up to 50 cm, respectively, average temperature and precipitation in the area.

The 17 rural and environmental indicators have been included in the agricultural land, which in turn are characterized by a coefficient ranging from 1 to 0. These values vary depending on the intensity of the limiting factor, 1 = very favorable and 0 = unfavorable [18], [13], [14].

For each indicator, for each crop, there are standard tables that include the respective coefficients (both for natural conditions and for potentiated conditions).

The formula for evaluating the land mark for a particular crop is the following (1):

$BN = (X_1 \times X_2 \times X_3 \ldots\ldots \times X_{17}) \times 100$, where: $X_1 \rightarrow X_{17}$ - the value of the coefficient of the eco-pedological index.

For the calculation of the bonitation, I referred to the most important characteristics of the soil, namely: flooding; gleization; average annual precipitations; depth of phreatic water; humus; stagnogleyzation; pollution; salinization; useful edaphic volume; texture in Ap; slope; landslides; total porosity in restrictive horizon; total $CaCO_3$; pH; average annual temperature and stagnant humidity excess [12].

The natural bonitation note is expressed in points, with values from 1 to 100 and is calculated on homogeneous ecological territory units (TEO) for the category of use existing at the time of cartography [11]. The bonitation score has classified the soils in 5 quality classes: Class I between 81 and 100 points; Class II between 61 and 80 points; Class III between 41 and 60 points; Class IV between 21 and 40 points; Class V between 0 and 20 points [9].

For the arable land use category, the natural scoring grade was calculated as the arithmetic average of the 6 - crop - rating marks at the parcel level on an area of 670 ha, these being: FS - sunflower, SO -soybean, MF - peas - beans, PB - corn, OR - barley, GR - wheat, these being the predominant cultures in this area.

RESULTS AND DISCUSSIONS

Starting from the definition of complex soil data by Roman researcher, N. Florea, he defines the soil, as a structured, complex, polyphase, open and polyfunctional system and defines the soil "the product of the transformation of mineral and organic substances from the surface of the earth crust under the influence of environmental factors over a long time, characterized by a certain organization and morphology; it is the environment for the development of superior plants and the basis of living for animals and humans" [4].

On the other hand, the soils are considered natural bodies, consisting of mineral components and organic living organisms, interacting with physical attributes, chemical, biological and morphologically different from those of the parent material from which it formed.

They contain four main constituents, which are in 3 phases of material aggregation: solid, liquid and gaseous [3]:

- the mineral constituents of rocks (from basalt, granite to sandstone, sands or clay),

which constitute 45% of the soil „skeleton" [8] and the organic constituents with a biologic origin (biomass composed of about 50% cellulose, lignin, amino acids, proteins, waxes and pigments) in a proportion of 5%;
- the liquid components (water and solutions) in the proportion of 25%;
- the air (gas and water vapor), which occupies 25% of the soil's mass.

The components of soil liquid and gas are between 15% and 35%, depending on the soil moisture. These solid and liquid constituents are complementary and influence each other, providing the environment necessary for the development of plants and livestock in the soil [15].

The land taken into the study is chernozem on arable and is found in the Baragan Plain. Chernozems are soil specific to the plains, in the surveyed region they occupy 75.9% [1]. Territorial distribution and soil class is conditioned by the main rescue units and climatic conditions, and soil types and subtypes, especially for relief forms, riverine and groundwater or parental rocks [7].

From the climatic point of view, the studied territory is a continental climate specific to the Baragan Plain. The summer is characterized by a dry and warm climate due to the influence of hot and dry continental air, and temperatures reach over 26^0C in July and reach more than 40^0C - 42^0C in August.

The autumn is relatively dry, with very little rains and the winters are cold, with strong blizzards and late spring frosts, which have a destructive effect on the roots of the crop plants.

The chernozem (SRTS-2012), is represented as a continuous east-west stripe strip parallel to the Danube where the processes of leaching and alteration are intense [5].

The soil was developed on parental loess and loessoide deposits and the groundwater was more than 10 m deep. The well-developed grassy vegetation cover leaves a large amount of vegetal remains in the soil, rich in humic acids of the calciferous type.

The soil profile is of the type, (Fig. 1):

Am - Bt_1 - Bt_2 - BC – Cca

Fig. 1. Soil profile, chernozem, Calarasi area.
Source: Own research.

The superficial horizon is of mollic type (Am), has a well developed glomerular structure and structural good condition, the texture is dusty argile clay, firm, plastic, adherent, moderately compact and without iluvial characters.

Horizon B textural (Bt) is at a depth greater than 40 cm, gray-brown to very dark (10YR3/2) in the wet state, polyhedron structure, firm, plastic, is a iluvial the bottom with a high content of clay fine polyhedron structure and less compacted, is up to 100 cm thick.

The horizon Cca, presents texture clay loam dust, dark yellowish brown (10YR4/5) in the wet state and starts at more than 130 cm and containing calcium carbonate ($CaCO_3$).

The texture is undifferentiated on the profile, medium to fine, the glomerular structure, and porosity and aerohydricity are good.

The humus content is higher, reaching 4.5% in Am and high in the calcium mull type.

The degree of saturation with bases (V%) is 92.6 % and pH 7.9.

Physical properties are characterized by medium porosity and permeability, increased microbiological activity and nutrient supply favorable to plant growth.

Table 1. Field Unit Card, Chernozem

Nr. crt.	Soil characteristics	UT	
		Name	Symbol
1.	Soil class	cernisol	-
2.	Soil type	chernozem	CZar
3.	Parent material groups (ind.21)	loess	-
4.	main relief form ind 2	plain	C
5.	Slope, ind.33	3	IP01
6.	Flooding, ind.38	absence	f00
7.	Texture (in horizon A) ind.23	loamy clay	T
8.	Content in skeleton, ind.24	poor skeletal soil	q1
9.	Physiologically useful volume, ind. 133	shallow	d1
10.	Soil reaction (in horizon A) ind.63	7.9	pH071
11.	Humus content (in horizon A) ind.144	4.4	%
12.	Degree of gleization, ind.14	non gleization	G0
13.	Degree of pseudo gleizing, ind.15	poor stagnogleizat	W1
14.	Degree of salinization ind.16	Non-salinization	S0
15.	Degree of alkalinity, ind.17	Non-sodicity	A0
16.	Deep of ground water, ind. 39	small	Q4
17.	Waterlogging, ind.40	absence	I0

Source: Own calculation.

Table 2. Calculation sheet of the natural bonitation notes at TEO level - Chernozem

Nr. crt.	Indicatory and code	Value	TEO1	TEO2	TEO3	TEO4	TEO5	TEO6
			The coefficients for agricultural crops					
			GR	OR	PB	MF	FS	SO
1.	Annual mean of temperature, code 3 C (0^oC)	11.28	1	1	1	1	1	1
2.	Annual mean of precipitations, code 4 c, mm	517	1	1	1	1	1	1
3.	Ggleyzation degree, code 14	Absence gleization	1	1	1	1	1	1
4.	Pseudogleyzation degree W, code 15	poorly stagnated	0.9	0.9	0.9	0.9	0.9	0.9
5.	Salinization and alkalinity S/A, code 16 or 17	no salinized	1	1	1	1	1	1
6.	Texture (horizon A), code 23	clay - argil	1	1	1	1	1	1
7.	Pollution, code 29	Absent pollution	1	1	1	1	1	1
8.	Slope, code 33 (%)	3.2	1	1	1	1	1	1
9.	Landslides, code 38	absent	1	1	1	1	1	1
10.	Deep of ground water, code 39, m	8.3	0.8	0.8	0.8	0.8	0.8	0.8
11.	Flooding, code 40	absent	1	1	1	1	1	1
12.	Total porosity, code 44, %	69	1	1	1	1	1	1
13.	$CaCO_3$ content, code 61, %	10.2	1	1	1	1	1	1
14.	Soil reaction, code 63	7.8	1	1	1	1	1	1
15.	Physiologically useful volume, code 133, %	82	1	1	1	1	1	1
16.	Humus, code 144 %	4.4	1	1	1	1	1	1
17.	Waterlogging , code 181	poor	1	1	1	1	1	1
18.	**NATURAL BONITAGE NOTE**		**72**	**72**	**72**	**72**	**72**	**72**

Source: Own calculation

Gr = Wheat; OR = Barley; PB = Corn; MF = Bean - peas FS = Sunflower; SO = Soybeans.

Land Unit (UT) characterization based on Bonitation Indicators.
The characters of the horizons described above are diagnostic characters for the Bonitation Note and are appreciated as a whole.
They are characterized in terms of soil conditions, topography and drainage as per Table 1.
Indicators used (either directly or indirectly) for natural bonitation and the analysis of restrictive factors are presented in Table 2 and have the following values, which in the case of chernozem substrate are identical for all cultures:

Bonitation indicator calculation:
BN = (1 x 1 x 0.9 x 1 x 1 x 1 x 1 x 1 x 1 x 1 x 1 x 0.8x 1 x 1 x 1 x 1 x) x 100
BN = 72 points,
(identical for all crops)

The average bonitation note for arable grade in the 6 cultures studied on a clay subtype chernozem is 72 points and is calculated from the average of crops: wheat, barley, maize, sunflower, soybeans and bean - peas (this is cultivated more rare on the farm).
The 72 bonitation points, obtained on the type of chernozem subtype soil type, fit these land into Class II quality.
The production limitations on these lands are due to the depth of groundwater, which is at a deep depth, and in dry periods, water can not flow through capillarity to compensate for the water scarcity in the soil, to which the droughts during the year contributes greatly as well.

CONCLUSIONS

The 72 bonitation points, obtained from calculation the Bonitation Note, obtained on chernozem soil type, within these lands in the second grade of quality.Class II lands are of good quality, with soils that are in early stages, poor degradation processes (stagnogenization), lands with a small slope of up to 4%, which can be used for landscaping and drainage excess water, respectively increase of soil fertility.
These lands could be classified as class I, but have the above mentioned limitations or degradations, such as stagnogenization and groundwater depth.
The range of crops on these lands is very wide, ranging from wheat, corn, rapeseed and even sunflower oil that is well suited to this area, but there are limitations due to climatic conditions (dry climate and late spring frosts).

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