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AGROPRODUCTIVE DIFFERENCES BETWEEN TWO LUVOSOL UNITS AT THE PREAJBA GORJ EXPERIMENTAL CENTER, ROMANIA

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Abstract

This paper presents the agroproductive differences between two luvisol units at the Preajba Experimental Center, Gorj, Romania, under the influence of surface erosion. Thus, two soil profiles were comparatively executed, one on the plateau on a slope of 2-5%, on a typical luvisol characterized by an Aţel, Ao, AE, El, Bt1, BC, C profile, and another in the lower third of the slope on a 10-15% where a stagnic eroded luvisol was identified. The latter had gradually removed its upper horizons due to slow surface geological erosion, exhibiting a shorter profile with the AoEl, El, Bt1w, Bt2w sequence. By washing the fertile topsoil year after year, the physical and chemical properties of the soil worsened. In this regard, the bonitation sheets were drawn up, the potential yields achieved under natural conditions were determined, and following the application of specific hydro-ameliorative measures and the execution of enhanced bonitation based on them, it was observed that the bonitation scores increased, the favourability classes decreased, and the yields increased directly proportional to the value of the enhanced bonitation score.

Key words*: *chemical properties, agroproductive, differences, potential yields, bonitation score

INTRODUCTION

The increase in the world's population, resulting in the intensive development of agriculture, requires the rational use of soil, highly productive varieties and hybrids, improved cultivation technologies to avoid the degradation of cultivated land.

Past and present human intervention in the environment has unexpected consequences. Chaotic deforestation and soil degradation with immediate consequences in decreased productivity are recognized as major problems worldwide. Soils are washed, destroyed or contaminated with various toxic substances to an extent too great to keep up with protection and control measures. In order to be able to feed the world's future population which is expected to reach about 8 billion by the beginning of the third millennium, vigorous action is needed to conserve soil resources, increase the area under cultivation and, in particular, increase agricultural productivity [1].

In the Gorj County, agriculture is of great importance as an economic branch, primarily for the support of the local population's standard of living. For this reason, it is necessary to know as much as possible about the soil, its fertility status which influences its productive capacity, but also to identify sustainable, diversified and balanced agricultural technologies that ensure the conservation of both the soil and the surrounding environment, in order to provide high, stable and high nutritional quality productions [8, 11]. The Gorj County has a geographical diversity that influences the types of grown crops. In general, agriculture in the Gorj County is varied, covering cereal crops, vegetables, fruit, viticulture and animal growth. Gorj's climate and soils can influence the types of predominant crops that are widely grown and essential for the food and feed industry. Thus, in 2022, the most cultivated crops in the county were maize (52,947 ha), wheat (11,326 ha), grasslands (3,676 ha) alfalfa (2,776 ha), sunflower (251 ha), potato

(188 ha), peas (142 ha) and beans (91 ha) [10].

Declining soil fertility should be a wake-up call to limit soil degradation and rehabilitate soils by changing production technologies to improve their physical, chemical and biological properties [16]. Current agricultural technologies have become a very pressing problem because they can influence the productive capacity of soils, with various changes occurring such as: appearance and formation of crusts, mineralisation of organic matter, compaction, reduction of mesofauna, which leads to the appearance of negative phenomena such as accelerated erosion, reduction of humus content and fertilizing elements [2]. Thus the identification of temporal and spatial changes in the soil is of great importance for the development and implementation of sustainable agricultural technologies [3, 4, 12, 13, 15] which would ensure that the soil can continue to provide goods and services [5, 14, 6, 7].

This paper comparatively examines the physico-chemical characteristics of typical luvisol and eroded stagnant luvisol, as well as the agroproductive differences between these soil units under natural and enhanced conditions. Thus it was observed that when applying some technological systems, the physico-chemical properties of the soil should be taken into account, as soils respond differently to their application, this response being directly influenced by humus content, soil texture, soil structure, fertilizer content, pH, etc. [16]. Adopting sustainable agricultural technologies in soil management is a very important element in providing food, clean water, quality feed, a healthy environment, as well as various ecosystem and biodiversity services [16].

MATERIALS AND METHODS

In order to determine the agroproductive differences between the two soil units, soil profiles were carried out on the typical luvisol found in the Preajba Experimental Field, the Gorj County.

In this session, main profiles and secondary profiles were executed according to the working methodology as follows:

- the main profiles were made to a depth of 1.5 m, a length of 1.5 m and a width of 0.6 m;
- the secondary or control profiles were made to a depth of 0.8 m, a length of 1 m and a width of 0.4 m.

After fixing the main profiles on the plan, the control profiles were executed according to the same methodology in order to establish the soil limits. The work plan included planimetry and levelling data, ground boundaries were drawn according to the characteristics of the terrain expressed on the work plan.

Soil samples were collected following the same field methodology developed by Bucharest ICPA [9]. Soil samples were collected from each soil profile by horizon, with two types of samples being collected:

–pedologic samples: in disturbed or modified structure (were harvested in bags), in undyed structure or in natural size (they were collected in metal cylinders);

–agrochemical samples that were collected according to the agrochemical sampling methodology. Following laboratory analyses, the physical and chemical properties of the soils studied were determined.

Soil samples were dried at room temperature; soil subsamples were homogenised, ground and passed through a 250 μm sieve. The following analytical methods were used to determine the chemical properties according to the ICPA Bucharest methodology [9]:

− pH (potentiometric method in aqueous suspension at soil/water ratio of 1/2.5 – SR 7184 /13-2001);

− base saturation degree, V% (Kappen Schoffield method).

− organic matter (humus): volumetric determination, (Walkley-Black humidification method, STAS 7184/21-82);

− mobile phosphorus content (Egner-Riehm-Domingo method and colorimetric molybdenum blue, Murphy-Riley method ascorbic acid reduction);

− mobile potassium content (Egner-Riehm-Domingo extraction and flame photometry);

− sum of exchangeable bases (SB): Kappen method by extraction with HCl solution 0.05 n;
− exchangeable aluminium (Al): Kappen method by extraction with KCl solution;
− hydrolytic acidity, extraction with sodium acetate at pH 8.2;
− degree of saturation in bases (V%): by calculation with the relation V%= SB/Tx100; T= Ah+ SB;
The physical characteristics were determined as follows: determination of particle size fractions: pipette method for fractions ≤ 0.002 mm; wet grinding method for fractions of 0.002-0.2 mm and dry grinding method for the fractions > 0.2 mm (Kacinski scale). Fractions > 2 mm in diameter were separated by dry sieving as a percentage of the quantity of the collected sample. The texture of the soil has been refined using the texture triangle.

RESULTS AND DISCUSSIONS

Comparative studies were carried out in the experimental field of Preajba in the Gorj County, two soil units, formed and evolved in conditions of climate and specific relief, namely the typical luvisol and the stagnant eroded luvisol. Typical Luvisol was encountered and studied in the reference area on a 2-5% sloping plateau formed on parent material represented by fluvial terrace deposits (sandy clays), with groundwater depth between 5 - 10 m under natural vegetation represented by grassland with acidophilous species.
The soil is characterised by a profile such as *Aţel*– Ao – AE – Els – Bt– BC – C. The soil profile was carried out on grassland with acidophilous species showing the following morphological properties:
–*Aţel horizon* (0 – 5 cm), slightly dark brown colour, with a loamy texture, well-developed small polyhedral, coloured structure, it is a moist, porous, compact medium, contains very dense roots, with a gradual transition to the next horizon;
–*Ao Horizon* (5 – 17 cm), slightly light brown colour, with well-developed small polyhedral, coloured structure, loamy texture, contains very dense roots; it is a moist, porous, compact medium, with gradual transition to the next horizon;
–*AE Horizon* (17 – 23 cm), is slightly greyish brown, well-developed medium, coloured polyhedral structure, sandy-loamy texture, rarely contains small and medium skeletal material, Fe oxide spots, dense roots; it is a wet, porous, compact medium, with clear transition to the next horizon;
–*Els Horizon* (23 – 45 cm); it is greyish brown, with moderately developed medium, coloured polyhedral structure, sandy-loamy texture, often contains medium rolled material with Fe stains and oxides, rare roots; it is a wet, porous, compact medium;
–*BtHorizon* (45 – 62 cm), is reddish brown, moderately developed polyhedral medium coloured structure, sandy-loamy texture, frequently contains rolled, finely porous, compact material;
–*BCHorizon* (62 – 75 cm), it is rusty brown with yellowish spots, with a sandy-loamy-clayey texture, frequently contains small and medium rolled material; it is a porous and compact medium;
–*CHorizon* (75 – 100 cm); it is rusty brown, unstructured, with a sandy-loamy texture, with frequently-very often skeletal material.
Stagnant eroded luvisol was studied on a sloping terrain, with a 10-15% slope through a profile executed in the middle of the slope. The natural conditions in which the soil was formed and evolved are those specific to the area and similar to those presented in typical luvisol.
The soil profile is represented by the AoE – Els – Bt_1w – Bt_2w horizons and was executed on natural grassland with acidophilous species. The morphological description is given below:
–*AoE Horizon* (0 – 15 cm), light brown colour, small polyhedral angular structure, sandy-loamy texture, rarely contains small to medium rolled material throughout the profile, very dense roots; it is a moist, porous, compact medium, with gradual transition to the next horizon;
–*Els Horizon* (15 – 41 cm) is slightly greyish brown, moderately developed medium coloured polyhedral structure, sandy-loamy-powdery texture, contains rare

ferromanganese nodules, dense roots; it is a wet, porous, compact medium;

–*Bt_1wHorizon* (41 – 67 cm) is yellowish brown with 30% rusty and 30% vinegary spots, well-developed medium coloured polyhedral structure, sandy-loamy texture, contains frequent ferromanganese nodules, rare roots; it is finely porous, a wet, compact medium, with gradual transition to the next horizon;

–*Bt_2wHorizon* (67 – 90 cm) is yellowish-brown with rusty spots 30% and vinegary 40%, medium, polyhedral, medium coloured, poorly defined structure, contains many ferromanganese nodules, very dense roots, it is fine, porous, and wet.

As a result of the configuration of the land, i.e. slope with a gradient of 10-15%, over time, the soil has undergone surface erosion processes, which has also been amplified by the large amounts of rainfall in the area. By the gradual and permanent removal of the solidified material from the surface, it was found that the accumulation horizon was almost removed and therefore it can be observed the presence of an AoE crossing horizon, also 10-15 cm thick. The 10-15% slope of the slope has, over time, led to slow geological erosion processes that have gradually but permanently removed the humified surface horizons so that the soil is characterised by a shorter profile compared to the previously presented soil on flat ground, with the following pattern: AoEl, Els, Bt_1w, Bt_2w.

A comparative study of the two soil units reveals the following aspects:

(a)In terms of morphological properties. It can be seen that the soil on the plateau is better developed on a thickness of 75-100 cm, and all the genetic horizons formed and evolved over time are present, while the soil on the slope profile is shorter 67-90 cm and incomplete, in the sense that the horizon at the surface Ao has been almost completely removed by slow geological erosion of the surface. In addition to the development of the profile, between the two soil units there is also a difference in the colour of the surface horizon.

Thus, while the horizon from the surface to the ground on the plateau is dark brown (10YR3/3), the colour of the soil on the slope is light brown (10YR5/2), this can be explained by the presence of colloidal silica which powders the structural aggregates of the surface horizon.

Another aspect or explanation for the darker colour in the horizon from the surface to the soil on the plateau is the presence of a higher percentage of humus, compared to the soil on the slope, where through slow geological erosion, along with the mineral material, organic matter has been removed.

The sequence of horizons is also differentiated between the two soil units, in the sense that in the typical luvisol on the plateau, no stagnation processes are obvious which proves that the soil has a good overall drainage, while in the luvisol on the inclined ground, w horizon appears on the soil profile starting at a depth of 40 cm, in B horizon, as result of a higher clay content.

(b) In terms of physical properties (Table 1 and 2) it is found that the typical luvisol in terms of granulometric composition has coarse sand in its composition which is maintained at over 20% throughout the profile depth except for the BC and C horizon where the percentage is 17.4% respectively 16.3%, fine sand also decreases on the soil profile from 31.2% in the Ațel surface horizon to 13.7% in the parent material, and the fine fraction, dust, is 30.5% in the surface horizon and decreases to 8.5% in the C horizon.

The fine clay fraction is found in the analysed soil in small percentage under 15% which determines a loamy texture.

The fractions with a diameter of more than 2 mm that make up the soil skeleton are found in the analysed profile starting with the AE horizon where they register a value of 11.8% and increase over the depth of the profile with a value of 41.2% in the BC horizon and 52.1% in the C horizon, which shows that the soil has a small edaphic volume.

Table 1. Main physical and chemical properties of typical upland luvisol (2-5% slope)

Item No.	Horizon	Depth	pH	V %	H %	P mobile (ppm)	K mobile (ppm)	Al	SB	SH	Gravel %	Granulometry %					U %
								me/100 g soil				Coarse sand	Fine sand	Dust	Clay	Texture	
1	Aţel	0-5	5.3	46.2	5.04	16	174	0.48	7.4	8.6		24.9	31.2	30.5	13.4	LN	1.2
2	Ao	5-17	5.4	45.8	2.68	12	144	0.46	6.0	7.1		27.9	29.4	28.4	14.3	LN	0.9
3	AE	17-23	5.3	40.6	1.76	9	76	0.48	4.8	7.0	11.8	24.5	25.1	25.8	12.8	L	0.8
4	Els	23-45	5.1	38.3	0.80	6	46	0.70	4.3	6.9	12.5	24.2	24.8	25.3	13.2	L	0.7
5	Bt_l	45-62	5.1	42.0	0.40	3	34	0.72	4.5	6.2	18.0	21.2	24.5	22.2	14.1	L	0.7
6	BC	62-75	5.1	60.1	0.32	2	38	0.68	10.1	6.7	41.2	17.4	16.2	13.1	12.1	LP	1.3
7	C	75-100	5.3	62.1	0.08	2	38	0.48	11.5	7.0	52.1	16.3	13.7	8.5	9.4	LP	1.6

Source: Own results.

In the soil of the slope, the stagnant luvisol, the particle size composition shows that sand and dust predominate in its composition, with values above 25% in all horizons, while the fine fraction, clay, records low values of 10.1% in the surface horizon and higher values of 24.2% in the Bt_2w horizon.

Table 2. Main physical and chemical properties of stagnant luvisol on the plateau (10-15% slope)

Item No.	Horizon	Depth	pH	V %	H %	P mobile (ppm)	K mobile (ppm)	Al	SB	SH	Granulometry %					U %
								me/100 g soil			Coarse sand	Fine sand	Dust	Clay	Texture	
1	AoE	0-15	5.6	49.6	3.40	6	50	0.40	6.4	6.5	24.7	33.1	32.1	10.1	LN	1.0
2	El	15-41	5.6	46.8	1.48	4	46	0.42	5.2	5.9	26.5	34.7	26.2	12.6	LN	0.8
3	Bt_lw	41-67	5.7	60.6	0.44	2	38	0.40	7.4	4.8	31.2	28.3	23.7	16.8	LN	1.1
4	Bt_2w	67-90	5.5	62.5	0.36	1	38	0.46	9.7	5.8	28.1	24.6	23.1	24.2	LN-L	1.5

Source: Own results.

In conclusion, it can be estimated that there are differences between the two soils in terms of soil texture which is of the loamy-powdery type in the soil on the slope and coarser (loamy-sandy) in the soil on the plateau. Another difference is the useful edaphic volume which is smaller in the soil on the plateau where the soil skeleton is present from a depth of 17 cm in the AE crossing horizon while in the soil on the slope no material with a diameter of more than 2 mm has been identified and although the soil profile is shorter, it has a larger soil volume (67%).

3. From a chemical point of view (Table 1 and 2), there is a clear difference in the content of organic matter, which in the plateau soil has a value of 5.04% in the Ao horizon and decreases on the soil profile to 0.32% in the BC horizon due to the lower amount of organic debris undergoing decomposition. In the Aţel surface horizon where more organic debris accumulates in various stages of decomposition, the percentage of organic matter is 5.04%. In stagnant luvisol on the slope, the humus content is much lower, with a difference of almost 2% in the surface horizon and decreases on the soil profile down to 0.36% in Bt_2w. Although the soil is occupied by grassland, and organic material must have accumulated in various stages of decomposition, slow geological erosion has removed much of the decomposed organic material. The difference between the two studied soils is also observed in terms of soil reaction (pH value). Although the natural conditions of the area favour the presence of an acid reaction, it is noted that the pH value of the soil on the plateau is lower (5.3) compared to the pH value of the soil on the slope (5.6). As far as the soil colloidal complex is concerned, there are no obvious differences between the two soils, the degree of saturation in bases (V%) remaining in the oligo-mesotrophic range, in the surface

horizons and mesotrophic in the deep horizons, correlating very well with pH value.

The soil reaction is strongly acidic, the pH being maintained throughout the depth of the profile at a value between 5.1 and 5.4.

In terms of chemical emissions, here too there are differences between the two types of soil, i.e. phosphorus and mobile potassium content, from non-eroded soil which has high values, i.e. 16 ppm P_2O_5 and 174 ppm K_2O in the surface horizon, while in the eroded soil the values are about 3 times lower, i.e. 6 ppm P_2O_5 and 50 ppm K_2O, explained by the fact that with the material eroded and transported from the surface horizon, the respective chemical elements were also removed.

In conclusion, it can be stated that the erosion manifested on the land with a slope of 10 - 15% has mainly caused the removal of the Aţel and Ao horizons from the surface, the AE transition horizon appearing in the light and during this time the fertility of the soil considerably decreased, as demonstrated by the decrease in chemical elements, humus and organic matter in the surface horizons.

By correlating the natural factors that contributed to the formation and evolution of the two soil types and their properties, the credit ratings and favourability classes of the plants predominantly used in the area (maize, wheat, grassland and alfalfa on a large scale and, to a lesser extent, sunflowers, potatoes, peas and beans) were established. On the basis of the credit ratings, the productive potential of these soils was assessed; the results are presented in the Tables 3 and 4.

Table 3. Sheet for the calculation of the rating score on the typical luvisol on a 2 - 5% slope

Ecoped. Indicator	Wheat	Maize	Sunflower	Potato	Pea/Bean	Grassland	Alfalfa
Tm	1	1	1	0,9	1	1	1
Pm	1	1	1	1	1	1	1
Gz	1	1	1	1	1	1	1
St	1	1	1	1	1	1	1
Sa	1	1	1	1	1	1	1
Tex	1	1	1	1	1	1	1
Pol	1	1	1	1	1	1	1
I%	1	1	1	1	1	1	1
Hazel	1	1	1	1	1	1	1
Groundwater	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Flood	1	1	1	1	1	1	1
Porosity	0.9	0.9	0.9	0.8	0.9	1	0.9
$CaCO_3$	1	1	1	1	1	1	1
pH	0.9	0.8	0.8	0.8	0.8	0.9	0.9
Ed Vol.	0.9	0.8	0.8	0.8	0.9	0.9	0.9
Rez.	0.9	0.9	0.9	0.9	0.9	1	1
Exc.	1	1	1	1	1	1	1
Bonitation grade	52	42	42	37	47	65	58
Favourability class	V	VI	VI	VII	VI	IV	V
Average bonitation grade = 31 points							
FAVOURABILITY CLASS – VIIth							

Source: Own results.

Thus, yields are expressed on the basis of the yield points and kilograms per yield point for the following crops: wheat, maize, sunflower, potato, peas/beans, grass and alfalfa.

The bonitation grades for each crop are multiplied by the kilograms/point of the credit note which is different for each crop, i.e.: wheat – 60 kg/point, maize – 80 kg/point, sunflower – 30 kg/point, potato – 450 kg/point, pea – 28 kg/point and bean – 15 kg/point, grassland – 200 kg/point, and alfalfa – 80 kg/point.

Calculating in this way, the following potential productions were highlighted which could be achieved under normal conditions by applying appropriate technologies.

For a typical luvisol on a 2-5% slope, according to the yield grades (Table 3) and the kilograms/point of the yield grade, the following yields are possible:

- Wheat – 52 points x 60kg/point = 3,120 kg/ha;
- Maize – 42 points x 80 kg/point = 3,360 kg/ha;
- Sunflower – 42 points x 30 kg/point = 1,260 kg/ha;
- Potato – 37 points x 450 kg/point = 1,6650 kg/ha;
- Pea – 47 points x 28 kg/point = 1,316 kg/ha;
- Bean – 47 points x 15 kg/point = 705 kg/ha;
- Grassland – 65 points x 200 kg/point = 13,000 kg/ha;
- Alfalfa – 58 points x 80 kg/point = 4,640 kg/ha.

In the case of stagnant luvisol on a 10-15% slope, according to the bonitation grades in Table 4, the following potential yields can be obtained:

- Wheat – 27 points x 60 kg/point = 1,620 kg/ha;
- Maize – 24 points x 80 kg/point = 1,920 kg/ha;
- Sunflower – 24 points x 30 kg/point = 720 kg/ha;
- Potato – 19 points x 450 kg/point = 8,550 kg/ha;
- Pea – 30 points x 28 kg/point = 840 kg/ha;
- Bean – 30 points x 15 kg/point = 450 kg/ha;
- Grassland – 41 points x 200 kg/point = 8,200 kg/ha;
- Alfalfa – 23 points x 80 kg/point = 1,840 kg/ha.

Thus, one can see the negative influence that slope has on soils and implicitly on yields. From Table 5 and Figure 1, it can be noted that on soil with no risk of erosion, with a slope of 2-5%, yields are 48.08% higher for wheat, 42.86% higher for maize and sunflower, with 48.65% for potatoes and 36.17% for peas and beans, 36.92% for grassland and 60.34% for alfalfa, compared with soil at high risk of erosion on a 10-15% slope.

Table 4. Sheet for the calculation of the rating score on stagnant luvisol on a 10-15% slope

Ecoped. Indicator	Wheat	Maize	Sunflower	Potato	Pea/Bean	Grassland	Alfalfa
Tm	1	1	1	0,9	1	1	1
Pm	1	1	1	1	1	1	1
Gz	1	1	1	1	1	1	1
St	0.9	0.9	0.9	0.8	0.9	1	0.8
Sa	1	1	1	1	1	1	1
Tex	0.9	1	1	1	0.9	0.9	1
Pol	1	1	1	1	1	1	1
I%	0.9	0.8	0.8	0.7	0.9	1	0.9
Hazel	1	1	1	1	1	1	1
Groundwater	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Flood	1	1	1	1	1	1	1
Porosity	0.9	0.9	0.9	0.9	0.9	0.9	0.9
$CaCO_3$	1	1	1	1	1	1	1
pH	0.9	0.9	0.9	0.9	1	0.9	0.8
Ed Vol.	0.8	0.7	0.7	0.9	0.8	0.7	0.7
Rez.	0.9	0.9	0.9	0.9	0.9	1	1
Exc.	0.8	0.8	0.8	0.7	0.8	1	0,8
Bonitation grade	27	24	24	19	30	41	23
Favourability class	VIII	VIII	VIII	IX	VIII	VI	VIII
Average bonitation grade = 30 points							
FAVOURABILITY CLASS – VIIIth							

Source: Own results.

Analysing the physico-chemical properties of the typical luvisol located on the land with a slope of 2-5% in the Experimental Field of Preajba in the Gorj County, and following the execution of the work of bonitation in natural conditions, it is found that this soil requires as improvement measures the following works: appropriate organic-mineral fertilization in order to increase the content of organic matter, but also the application of amendments based on calcium carbonate ($CaCO_3$), to correct the soil reaction (pH value).

Table 5. Potential yields of different crops on typical uneroded and eroded luvisol under natural conditions (kg/ha and %)

Crop	2-5% Kg/ha	10-15%	
		Kg/ha	% - as compared to 2-5%
Wheat	3,120	1,620	51.92
Maize	3,360	1,920	57.14
Sunflower	1,260	720	57.14
Potato	16,650	8,550	51.35
Pea	1,316	840	63.83
Bean	705	450	63.83
Grassland	13,000	8,200	63.08
Alfalfa	4,640	1,840	39.66

Source: Own results.

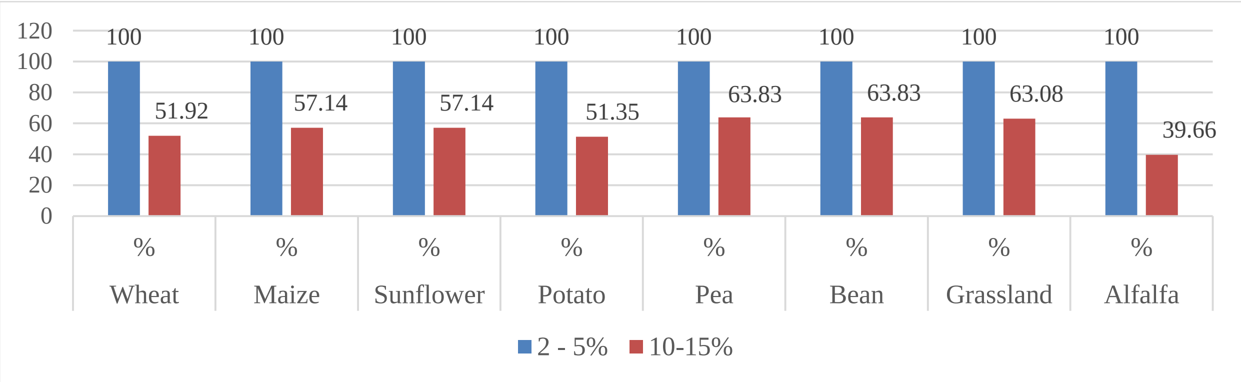

Fig. 1 Potential yields of different crops on non-eroded and eroded stagnant luvisol under natural conditions
Source: Own calculation and graphic.

According to the two improvement works, the improvement work was carried out under improved conditions, following which the crop plants predominantly used in the studied area obtained the following bonitation grades and favourability classes (Table 6).

Table 6. Calculation of the bonitation score for different crops on typical luvisol under potent conditions

Specification	Wheat	Maize	Sunflower	Potato	Pea/Bean	Grassland	Alfalfa
Natural bonitation grade	52	42	42	37	47	65	58
Coeficienti de potentare pentru fertilizarea organo-minerala	1,1	1,1	1,1	1,1	1,1	1	1
Potency coefficients for organo-mineral fertilisation	1,4	1,4	1,4	1,1	1,4	1,2	1,6
Potency coefficients for acidity correction	80	65	65	45	72	78	93
Potency bonitation grade	III	IV	IV	VI	III	III	II

Source: Own results.

On stagnant luvisol located on land with a slope of 10-15%, the following measures are required as water improvement works: removal of excess stagnant water (by deep draining works), improvement of soil aerohydric regime, humus reserve and soil reaction (by complex organo-mineral fertilization and limestone amendment), prevention and control of surface erosion (through special agrotechnical and hydrotechnical works).

The rating grades obtained after the application of these works, and the favourability classes, are shown in Table 7.

In the case of typical luvisol on a 2-5% slope, according to the bonitation grades in table 6, the following potential yields can be obtained:

- Wheat – 80 points x 60 kg/point = 4,800 kg/ha;
- Maize – 65 points x 80 kg/point = 5,200 kg/ha;
- Sunflower – 65 points x 30 kg/point = 1,950 kg/ha;
- Potato – 45 points x 450 kg/point = 20,250 kg/ha;
- Pea – 72 points x 28 kg/point = 2,016 kg/ha;
- Bean – 72 points x 15 kg/point = 1,080 kg/ha;
- Grassland – 78 points x 200 kg/point = 15,600 kg/ha;
- Alfalfa – 93 points x 80 kg/point = 7,440 kg/ha.

In the case of stagnant luvisol on a 10-15% slope, the following potential yields can be obtained according to the bonitation grades in Table 7.

Table 7. Calculation of the bonitation score of different crops on stagnant luvisol eroded under potent conditions

Specification	Wheat	Maize	Sunflower	Potato	Pea/Bean	Grassland	Alfalfa
Natural bonitation grade	27	24	24	19	30	41	23
Potency coefficients for erosion	1.2	1.3	1.3	1.3	1.1	1.1	1.2
Potency coefficients for stagnogleying	1.2	1.2	1.1	1.4	1.2	1.1	1.5
Potency coefficients for organo-mineral fertilisation	1.1	1.1	1.1	1.1	1.1	1	1
Potency coefficients for acidity correction	1.1	1.1	1.1	1.1	1.2	1.1	1.2
Potency bonitation grade	47	45	42	42	52	55	50
Favourability class after potency	**VI**	**V**	**VI**	**VI**	**V**	**V**	**VI**

Source: Own results.

- Wheat – 47 points x 60 kg/point = 2,820 kg/ha;
- Maize – 45 points x 80 kg/point = 3,600 kg/ha;
- Sunflower – 42 points x 30 kg/point = 1,260 kg/ha;
- Potato – 42 points x 450 kg/point = 18,900 kg/ha;
- Pea – 52 points x 28 kg/point = 1,456 kg/ha;
- Bean – 52 points x 15 kg/point = 780 kg/ha;
- Grassland – 55 points x 200 kg/point = 11,000 kg/ha
- Alfalfa – 50 points x 80 kg/point = 4000 kg/ha.

And after the application of specific improvement works according to the physico-chemical properties of the two studied soils, it can be seen from Table 8 and figure 2 that the influence of the slow geological erosion process is maintained in terms of the level of potential yields obtained by the plants used in the area.

Table 8. Potential yields of different crops on typical uneroded and eroded luvisol under potency conditions (kg/ha and %)

Crop	2-5% Kg/ha	10-15%	
		Kg/ha	% - as compared to 2-5%
Wheat	4,800	2,820	58.75
Maize	5,200	3,600	69.23
Sunflower	1,950	1,260	64.62
Potato	20,250	18,900	93.33
Pea	2,016	1,456	72.22
Bean	1,080	780	72.22
Grassland	15,600	11,000	70.51
Alfalfa	7,440	4,000	53.76

Source: Own results.

Thus, yields are 41.25% higher for wheat, 30.77% higher for maize, 35.38% higher for sunflowers, 6.67% higher for potatoes, 27.88% higher for peas and beans, 29.49% higher for grass and 46.24% higher for alfalfa.

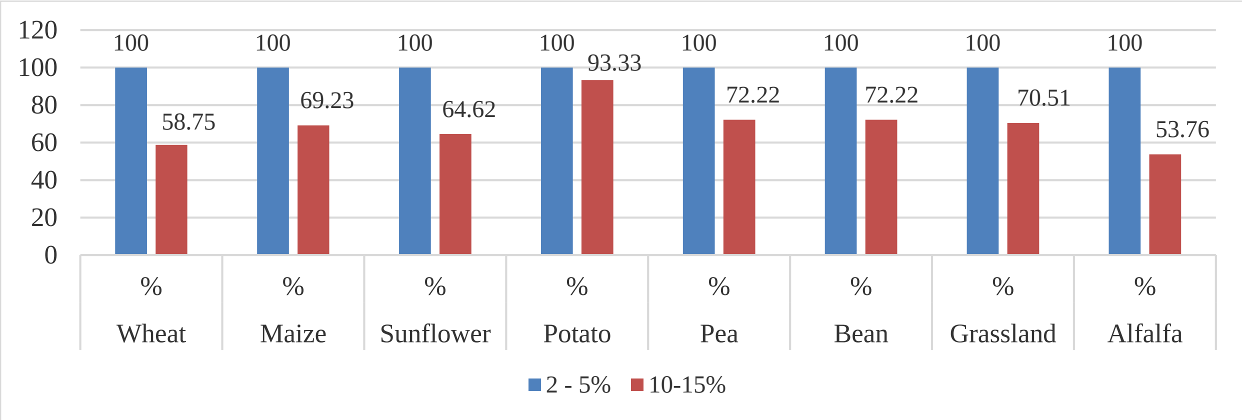

Fig. 2. Potential yields of different crops on non-eroded and eroded stagnant luvisol under potency conditions
Source: Own calculation and graphic.

CONCLUSIONS

Through the analysis of the main physical and chemical properties of the soil samples collected from the two studied soil profiles, it was revealed that the loss of the surface soil layer, by washing away the fertile soil layer year after year, gradually leads to the worsening of the chemical, morphological and physical properties of the soil.

By drawing up the bonitation chart, based on the voucher scores, it was revealed that on typical luvisol, without risk of erosion, the potential yields that can be obtained under normal conditions, by applying appropriate technologies, are 48.08% higher for wheat, with 42. 86% for maize and sunflower, 48.65% for potatoes and 36.17% for peas and beans, 36.92% for grassland and 60.34% for alfalfa, compared to soil with a high risk of erosion, showing the negative influence of slope on soils and therefore on yields.

After the application of specific improvement works, according to the physico-chemical properties of the two soils studied, it was found that the potential yields were 46% higher under these conditions, 24% for alfalfa, 41.25% for wheat, 35.38% for sunflower, 30.77% for maize, 29.49% for grassland, 27.88% for peas and beans and 9.89% for potatoes on soil without erosion risk compared to soil with erosion risk.

In the case of typical luvisol on the plateau, without risk of erosion, by applying the potency works, it was found that yields increased in most crops by more than 50% (maximum 63.34% for alfalfa and minimum 20% in the case of grasslands).

In the case of stagnant luvisol on a 10-15% slope, subject to the process of geological surface erosion, through the application of specific improvement works, compared to that exploited under normal conditions, very large differences in production have been recorded, i.e.: 121.05% for potatoes, 117.39% for alfalfa, 87.50% for maize, 75% for sunflowers, 74.07% for wheat, 73.33% for peas and beans and 3414% for grassland.

Knowing the consequences of surface erosion, human activity is very important for soil protection, in terms of systematization of crops on arable land, choice of land use category, use of technological system of plant cultivation, exploitation of forest resources, rational grazing and sustainable development management in the Gorj County.

It is therefore necessary to identify the areas at risk of erosion as accurately as possible, in order to intervene with consolidation, stabilisation, levelling, land modelling and other hydro-improvement works.

REFERENCES

[1]Bălan M, 2017, Researches on the evolution of soil main chemical indicators under the influence of

different crops, soil water erosion and fertilization on typical luvosoil from Experimental field Preajba, Gorj County, Annals of the University of Craiova, Agriculture - Montanology - Cadastre series Vol.XLVII(1), 260-267.

[2]Bălan, M., 2021, Study on the soils of Gorj County and their quality. Annals of the University of Craiova, Agriculture - Montanology - Cadastre series, Vol.LI (1), 199-206.

[3]Bouma, J., Van Ittersum, M. K., Stoorvogel, J. J., Batjes, N. H., Droogers, P., Pulleman, M. M., 2017, Soil capability: exploring the functional potentials of soils. In: Field, D.J.e.a. (Ed.), Global Soil Security. Springer International Publishing, Switzerland, 27-44.

[4]Davidson, D. A., 2000, Soil quality assessment: recent advances and controversies. Progress in Environmental Science, 2. 342–350.

[5]Doran, J. W., Zeiss, M. R., 2000, Soil health and sustainability: managing the biotic component of soil quality. Appl. Soil Ecol., 15. 3–11.

[6]European Union, European Commission, 2006, Thematic Strategy for Soil Protection. Commission of the European Communities. https://eur-lex.europa.eu/EN/legal-content/summary/thematic-strategy-for-soil-protection.html, Accessed on January 25, 2024.

[7]European Commission Law, 2021, Healthy soils – new EU soil strategy. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12634-Healthy-soils-new-EU-soil-strategy_en, Accessed on January 25, 2024.

[8]Hansen, L., Noe, E., Højring, K., 2006, Nature and Nature Values in Organic Agriculture. An Analysis of Contested Concepts and Values Among Different Actors in Organic Farming. Journal of Agricultural and Environmental Ethics, 19. 147–168.

[9]Institute of Research for Pedology and Agrochemistry, ICPA, 1987, Methodology for elaborating pedological studies. Vol. I, II and III.

[10]National Institute of Statistics, NIS, http://statistici.insse.ro:8077/tempo-Online/#/pages/tables/insse-table, Accessed on January 25, 2024.

[11]Patzel, N., Sticher, H., Karlen, D. L., 2000, Soil fertility - phenomenon and concept. Journal of Plant Nutrition and Soil Science, 163(2), 129–142.

[12]Rhodes, C. J., 2017, The imperative for regenerative agriculture. Science Progress 100. 80–129.

[13]Smith, P., 2012, Soils and climate change. Current Opinion in Environmental Sustainability 4(5), 539–544.

[14]Toth, G., Hermann, T., Da Silva, M.R., Montanarella, L., 2016, Heavy metals in agricultural soils of the European Union with implications for food safety. Environment international 88, 299-309.

[15]Várallyay, G., 2010, Role of Soil Multifunctionality in Sustainable Development. Soil & Water Res.,Vol. 5(3), 102–107.

[16]Zafiu, C., Mihalache, M., 2021, Research on the Influence of Technological Systems on Maize Cultivation in the South of the Dolj County, Romania, Scientific Papers. Series A. Agronomy, Vol. LXIV(1), 180-185.