Scientific Papers. Series A. Agronomy, Vol. LXVI, No. 2, 2023
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH ON THE EVOLUTION OF THE MORPHOLOGICAL, PHYSICAL, HYDRO-PHYSICAL PROPERTIES OF CHROMIC LUVISOIL FROM DOLJ COUNTY, IN THE PERIOD 1995-2021

Jenica CĂLINA, Aurel CĂLINA, Alin CROITORU

University of Craiova, Faculty of Agronomy, 19 Libertatii Street, Craiova, Romania

Corresponding author email: croitorualinc@yahoo.com

Abstract

The paper presents an original and multidisciplinary theme regarding the evolution of the main agro-productive properties given by the morphological, physical and hydro-physical properties of the chromic luvisols from Dolj County, exploited in the specific cultivation conditions of agritourism households. The novelty elements of this theme consist primarily in the tracking of all these properties over a long period of more than 25 years, using as a comparison term the chromic luvisol evolved under natural conditions, under forest vegetation. In order to be able to compare and observe the evolution of these properties over time, soil profiles were also carried out on the soils taken in cultivation, both in 1995 and in 2021, tracking their impact on the quality and quantity of agricultural productions, by significantly decreasing natural fertility and worsening these properties. Based on the significant and relevant results obtained, over a quarter of a century of research, it was concluded that this type of soil has undergone obvious changes in the sense of worsening some agro-productive properties, especially on cultivated soils.

Key words*: morphological, physical, hydro-physical properties, soil profile, soil pollution.*

INTRODUCTION

Soil is the most important resource of our planet, forming the base of our existence on Earth. Soil faithfully mirrors the influence of the anthropogenic activities (Zajícová & Chuman, 2019), climate, flora and fauna in variable periods of time (Hole, 1981).

Soil fertility, which offers continually and simultaneously the nutritive elements and water necessary for the growth and development of plant life, represents the guarantee of ensuring abundant, stable and healthy products (Patzel et al., 2000; Hansen et al., 2006), necessary to the generations of today and to those of tomorrow (O'Sullivan et al., 2017).

Identifying and understanding the temporal and spatial changes in the state of soil are essential for elaborating and implementing policies for the sustainable use of soil (Davidson, 2000; Várallyay, 2010; Smith, 2012; Bouma et al., 2017; Rhodes, 2017; Rahman & Singh, 2019), and also to have the certainty that the soil can ensure the continuity of goods and services (Doran & Zeiss, 2000; European Commission, 2006; Toth et al., 2016).

There is no doubt that there are strong connections between soil and human health, as recent studies explore our knowledge in this area (Brevik, 2013; Pepper, 2013; Rodrigues & Römkens, 2018; Zhou et al., 2019) and offer significant opinions regarding future research for soil and human health (Heckman, 2013; Bünemann et al., 2018; Brevik et al., 2020).

This article systematically examines the qualitative and quantitative characteristics chromic luvisols from the South-West region of Romania, utilized in the specific cultures of agritouristic farms and households. In Romania, agritourist households appeared after the fall of communism, as agritourism became a viable economic activity for small owners from the countryside. The seamless implementation of security for the offered services and traceability of the agri-food products in the agritourism activity represents a yet unreached milestone for Romanian owners of the small family farms, as it necessitates technical, preventative and self-controlled analyses (Mihalache et al., 2014; Tudor, 2019).

We considered how the data regarding the evolution of soil can contribute to establish preventative measures for negative phenomena. The specific contribution of this paper is to consider this type of soil in relation to human health and how soil can be evaluated in the context of food security, namely agri-food quality and traceability.

In this work, only the evolution of the main morpho-physical-hydric properties of this type of soil is presented, because due to the duration of more than 25 years, during which the research was carried out, a lot of data and results were accumulated and we considered that the aspects related to the main chemical properties and soil contamination with heavy metals, to be presented in another paper, which will be published later.

MATERIALS AND METHODS

In order to achieve the stated objectives, field research was necessary, during which several soil profiles were morphologically analysed, and samples were collected from the most representative soils for laboratory analysis (Călina & Călina, 2019; Călina et al., 2022). Field maps and mapping works from the Dolj County Offices of Pedological and Agri-chemistry Studies were utilized. The soil profiles were taken from a depth of about 200 cm. Each profile was morphologically characterized, with the following properties being established: thickness of the horizons, color, texture, structure, porosity, compactness, adhesion, neoformation, moisture, and parent rock. Soil samples were collected from every layer of the profiles distributed by soil genesis, replicated 3 times, in its undisturbed and disturbed structure, using cylinders (5 x 5 cm).

Soil profiles have the following particularities:

Profile under forest vegetation: location - 4 km North-West from Șimnic in Tufarul Viilor forest; altitude - 170 m average height; relief - piedmont plateau Leu-Rotunda, flat terrain; vegetation - Querce forest formed by: *Quercus freinetto, Quercus cerris, Quercus pubescents, Acer campestre, Crataegus monogina, Ulmus* sp.; parent material - clay deposits combined with loess deposits; natural drainage - good; groundwater depth - more than 15 m.

Profiles under agricultural corps: location - 3 km North-Est from Șimnic; altitude - 168 m average height; relief - piedmont plateau Leu-Rotunda, parent material - marly deposits and clayey marls, natural drainage - not good; groundwater depth - more than 16 m.

Soil profiles were taken in approximately the same place, 25 years apart, in the same climatic, relief, fauna, and anthropic conditions, thus the same paedogenetic conditions.

a) ***Determination of physical and mechanical properties***

In order to determine the physical properties of soils, the samples collected in their undisturbed structure (in metal cylinders) were analysed as follows: *particle size distribution* - Kachinsky method; the texture - by the Chiriţă-Burt triangle; *soil density* (D, g/cm^3) - pycnometer method; *bulk density* (BD, g/cm^3) - the National Research and Development Institute for Soil Science, Agri-chemistry and Environment method, by reference to the dry soil mass in the oven at the volume of the cylinder in which the soil sample was taken; *resistance to penetration* (RP, kgf/cm^2) - method of resistance to dynamic penetration, on samples taken in metal cylinders, the soil being brought to a moisture equal to 50% of its capillary water capacity (Canarache, 1990; Dumitru et al., 2011; Stătescu et al., 2013).

total porosity (Pt, %) - calculated with Eq. (1): $Pt\ (\%) = 100 \cdot (1 - \frac{Da}{D})$ (1)

air porosity (Pa, %) - calculated with Eq. (2): $Pa = Pt - Fc \cdot BD$ (2)

b) ***Determination of hydro-physical properties:***

- *water permeability* - the National Research and Development Institute for Soil Science, Agri-chemistry and Environment method; hygroscopicity coefficient (HC, %) - Mitscherlich method; wilting coefficient (WC, %) - through calculation using Eq. (3): $WC = HC \cdot 1.5$ (3);
- *the moisture equivalent* (ME, %) - by centrifugation of soil samples with a force greater than 1,000 times the gravitational acceleration;
- *field capacity* (FC, %) - calculated using Eq. (4): $FC = ME \cdot 0.84 + 2.64$ (4);
- *available water capacity* (AWC, %)-through calculation, using the formula Eq. (5):

$$AWC = FC - WC \quad (5);$$

- *hydraulic conductivity/permeability* (K, mm/h) - under laboratory conditions by infiltration under constant degree - National Research and Development Institute for Soil Science, Agri-chemistry and Environment (ICPA) Bucharest.

RESULTS AND DISCUSIONS

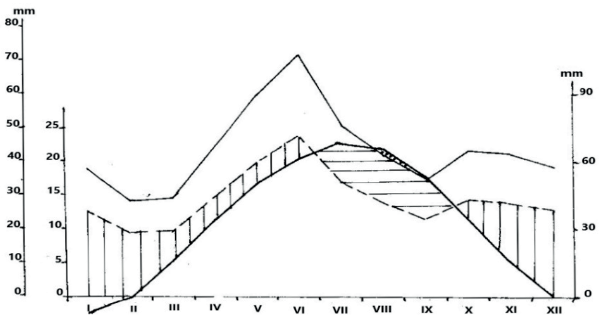
Characterization of the researched area

The chromic luvisols in Oltenia it occupies a strip defined by the North by Turnu-Severin, Bistrita, Terpezita, Ghercești, Bals, Piatra-Olt, and in the South by Burila Mare, Braniște, Mărăcinele, Segarcea, Tâmburești, Deveselu and Caracal. *Chromic luvisols* are defined by the presence of the El and Bt horizons and formed in the wetter part, north of the researched area. These soils are found in a complex with other chromic luvisols, occupying in the researched area approximately 10,283.28 ha, 7.4% respectively of the total *chromic luvisols* soils in this area (Florea et al., 1987; Stănilă, 2016).

The relief is represented by flat surfaces and depressions, such as the Getic Piedmont, the high Leu-Rotunda field and the high terraces of the Jiu, where rainwater accumulates due to the impermeable soil layer, leading to the phenomenon of podzolization. The average altitude of the relief is about 170 m. From a geological point of view, the area with chromic luvisols falls in the Upper Pleistocene (Coteț, 1973).

The parent material on which it was formed is generally composed less often of loess deposits, with the predominance of marly deposits and marly clays which hinder the internal drainage capabilities of the soil (Șorop & Vasile, 1990).

The climate of this area according to Kopper falls mostly under Cfax type and to a lesser extent under Cfbx. The climatic conditions in the area of *chromic luvisols* soils in Oltenia contributed greatly to the formation of these types of soils, which have different properties from other types existing in our country. Characterized on the basis of meteorological data from Craiova station, it falls within the continental type with a weak Mediterranean influence and has the following Cfax formula, according to Köper (Șorop & Vasile, 1990; Mihalache, 2006).



average monthly temperature; 1/2 scale precipitation; 1/3 scale precipitation; wet period; drought period; dry period; excessively wet period; P- the average amount of annual rainfall; Pv- the average amount of rainfall in the growing season; T- multiannual average temperature.

Figure 1. Climateogram type Walter H. - Lieht H., by the Craiova meteorological station, multiannual average (1970-2021)

The average annual temperature according to Craiova Meteorological Station is 10.8°C, and the number of days without frost is 102. The average number of days with frost is about 36 days. The duration of the frost-free interval is 203 days, which influences the duration of the vegetation period and agricultural crops. The average number of frost days in Craiova is 102 days (Păunescu, 1975). The average amount of annual precipitation is about 500-550 mm, and evapotranspiration is about 685 mm (Figure 1). The annual sum of temperatures higher than 0°C amounts to 4200°C, which determines good conditions for the growth and development of many crops.

Hydrography and hydrogeology have a special importance in the soil formation process. Of greater importance for the paedogenetic process are the surface waters (rivers) that can sometimes overflow, the groundwater in terms of depth, degree and type of mineralization, coastal springs, stagnant surface waters (from precipitation) that condition the pseudo-gleization process (Păunescu, 1975).

From a hydrographic point of view, the area of *chromic luvisols* in the researched area is drained by two large rivers, the Jiu which borders the western area and the Olt which represents the eastern border. The Jiu is characterized by a valley 120 m deep in Craiova, and 80 m in Rojiște, compared to the level of the fields that border it. The Olt is the second basic component of the hydrographic network in this area. On its left side its most important tributaries are: Dârjov and Iminog. On the right side the tributary valleys are formed by: Olteț, Teslui, and Caracal valleys, and on the western side, the Buca and Arțăroasa tributaries, whose valleys have parallel confluences (Coteț, 1973).

Vegetation. The monotony of the landscape and the low altitudes determine a relative uniformity of the vegetation. In most parts of the territory, natural vegetation has been replaced by agricultural crops. The natural vegetation encountered on smaller areas in the valleys comes in the form of clusters of forests (e. g. Tufarul Viilor), small areas of grassland and poor-quality meadows or as weeds in agricultural crops. The species of wood plants are *Quercus pubescens*, *Quercus pedunculiflora, Fraxinus excelsior*, and the brushwood is represented by the wild privet, the blackthorn, the hawthorn and the rose (Răduțoiu et al., 2018).

Among the most common grassy species we can find meadow fescue, bluegrass, rape field, couch grass, thick knot grass, amaranth, bindweed, foxtail, thistle, chicory, red poppy, plantain and thistle. The depression areas where the precipitation water stagnates on the surface, herbaceous vegetation replaces the forest and is represented by: *Gratiola officinalis, Grafolium uliginosum, Phragnites australis, Scirpus lacustris, Typha latifolia* and *Trifolium arvense* (Răduțoiu et al., 2018).

Agri-pedological characterization of chromic luvisols

a) ***Morphological characteristics***

The comparative analysis of the morphological characteristics (Table 1) highlights a profile with clearly defined horizons, in the case of the chromic luvisol that evolved under the influence of forest vegetation and the intervention of the anthropic factor through agriculture, constantly present on the surface horizons of the soils that evolved on the lands used for cultivating crops in the agritourist farms (horizon Ao 29 cm in 1995 and 33 cm in 2021).

Table 1. Morphological characteristics of soil profiles of the chromic luvisol

Profile layer / Depth (cm)	***Morphological characteristics***
Year - 1995 - Forest vegetation	
Ao horizon: 0-22 cm	Dark brown-gray color (10YR 5/3) in wet state and (10YR 5/4) in dry state; clay texture; medium and small glomerular structure, well developed; crumbly when wet and hard when dry; weak plastic; weak adhesive; moderately compact; frequent earthworm channels containing coprogen agglomerations; frequent grassy roots and rare small woody roots; gradual transition.
AB horizon: 22-33 cm	Dark brown-gray (10YR 4/2) in wet state and light gray-brown (10YR 6/2) in dry state; clay texture; medium and small polyhedral subangular structure, moderately developed; friable in wet state and harder in dry; weak plastic; weak adhesive; moderately compact; rare earthworm channels containing coprogen agglomerates; large and sparse grassy roots and a thick woody root at the base; gradual transition.
BE horizon: 33-45 cm	Dark brown-gray color (7.5YR 4/2) in wet state and (7.5YR 5/3) in dry state; clay texture; polyhedric subangular and medium and large angular structure, poorly developed; crumbly when wet and harder when dry; quartz powder on the surface of structural aggregates and quartz accumulations in the form of whitish spots; non-plastic; non-adhesive; weak compact; a large woody root at the top and several small, sparse grassy roots; very rare earthworm channels containing coprogen agglomerates; gradual transition.
Bt_1 horizon: 45-96 cm	Reddish-brown-gray (7.5YR 4/3) when wet and (7.5YR 5/3) when dry; clay loam texture; medium and large prismatic structure, well developed; firmly moist and hard dry; almost continuous clay film on horizontal and vertical structural faces; plastic; adhesive; compact; ferro-manganous punctate separations and small and rare grains; frequent medium and thin woody roots especially in the upper part of the horizon; root channels; gradual transition.
Bt_2 horizon: 96-149 cm	Dark reddish brown (7.5YR 4/4) when wet and (7.5YR 5/4) when dry; clay loam texture; medium and large prismatic structure, well developed; firmly when moist and hard when dry; plastic; adhesive; compact; discontinuous film of clay on vertical and horizontal structural faces; relatively frequent small ferro-manganous and grain repairs; very rare thin and medium roots; root channels; gradual transition.

Bt_3 horizon: 149-200 cm	Yellowish-reddish brown (7.5YR 5/4) when wet and (7.5YR 6/4) when dry; clay loam texture; prismatic structure, poorly developed; plastic; adhesive; compact; clay film in the form of spots and vines; fine pores; weak manganese grains.
Year - 1995 - Agriculture crop	
Ao horizon: 0-29 cm	Brown-gray color (7.5YR 4/3) in wet state; very poorly developed prismatic structure; clay texture; frequent roots; loose; weak compact; damp; gradual transition.
AE horizon: 29-44 cm	Slightly yellowish brown-gray color (7.5YR 3/2); colloidal silica powder; clay texture; poorly developed prismatic structure; compact; rare thin roots; gradual transition.
Bt_1 horizon: 44-73 cm	Brown color with reddish tinge (10YR 5/3); clay loam texture; medium and poorly developed subangular polyhedral structure; damp; common manganese grains; gradual transition.
Bt_2 horizon: 73-108 cm	Dark brown with reddish tinge (10YR 4/3); clay loam texture; large polyhedral structure; compact; damp; fine pores; common manganese grains; contains traces of roots; gradual and linear transition.
Bt_3 horizon: 108-141 cm	Brown color with reddish tinge (10YR 5/4); clay loam texture; large and poorly developed subangular polyhedral structure; dense manganese spikes; compact; damp; weak traces of roots are noticed; gradual transition.
BC horizon: 141-200 cm	Reddish-yellowish brown (10YR 4/3); clay loam texture; large subangular polyhedral structure; very compact; without roots; damp; very low concentrations of calcium carbonate at the base.
Year - 2021 - Agriculture crop	
Ao horizon: 0-33 cm	Dark brown-gray color (10YR 3/2) in wet state and (10YR 4/3) in dry state; clay loam texture; large, well-developed granular and grainy structure; plastic; adhesive; weak compact; fine and frequent pores; gradual transition.
EB horizon: 33-71 cm	Dark reddish brown-gray color (7.5YR 3/2) in wet state and (7.5YR 4/2) in dry state; clay loam texture; subangular and angular polyhedral structure; weak adhesive; moderately compact; common manganese grain; weak powdering of quartz on the surface of aggregates and weak accumulations of quartz in the form of whitish spots; gradual transition.
Bt_1 horizon: 71-102 cm	Dark reddish-brown color (7.5YR 3/2) in wet state and (7.5YR 4/3) in dry state; clay loam texture; large and medium prismatic structure; plastic; adhesive; moderately compact; almost continuous clay films on the surface of structural aggregates; frequent small grains; gradual transition.
Bt_2 horizon: 102-140 cm	Slightly dark yellowish-reddish brown (7.5YR 4/3) in wet state and (7.5YR 4/4) in dry state; clay loam texture; medium and large prismatic structure; plastic; compact; continuous clay film on the surfaces of structural aggregates; frequent and medium-sized small grains; leaks of darker material from the upper horizons; gradual transition.
Bt_3 horizon: 140-171 cm	Dark yellow-reddish brown (7.5YR 4/3.5) in wet state and (7.5YR 5/4) in dry state; clay loam texture; small, moderately developed angular and prismatic polyhedral structure; plastic; adhesive; compact; clay film in the form of stains; frequent small grains; gradual transition.
BC horizon: 171-200 cm	Dark reddish brown-yellowish color (7.5YR 4/4) in wet state and (7.5YR 6/5) in dry state; very poorly developed prismatic structure; small and frequent manganese grains; clay film in the form of stains; small and very rare veins, spots and concretions of $CaCO_3$.

Source: own results

From a morphological stand point, significant modification can be observed in the thickness of the Ao and EB horizons, for the soils utilized for agriculture, this change being more evident in the year 2021. Also, in the year 2021 the leaching process manifests up to a depth of 71 cm (Figure 2, Table 1).

b) ***Granulometric composition***

The chromic luvisol soil developed under woody vegetation has a coarse sand content of around 10%, with slight decreases in the B horizons, up to 7.5%.

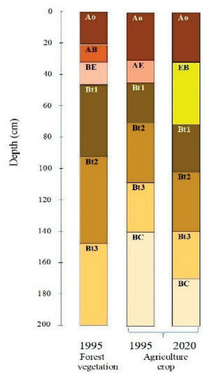


Figure 2. Soil profiles by vegetation types and over time

The percentage of fine sand is higher than the course one, registering a slight decrease in profile from 37.9%, in the Ao horizon, to 25.1% in the Bt_2 horizon.

The dust fraction has values around 20%, with slight increases and decreases from one horizon to another. The clay registers average values with increases per profile from 30.4% at the surface, to 42.7% in the Bt_2 horizon. This particle size composition imprints a loamy texture on the soil in the first horizons and clay-loamy and loam-clay in the following horizons (Table 2).

The cultivated chromic soil luvisol has, from a granulometric point of view, a coarse sand content higher than 8.5%, in the first horizons, which decreases slightly in the deep horizons, up to 6.3%, in Bt_4. Fine sand registers a percentage of 37.5% in the Ao horizon and decreases to 26.2% in Bt_1. Adding these two fractions of sand, it was remarked that they approach 50% in the first 3 horizons and fall below 40% in the next 4 horizons. The fine fraction, clay registers a lower percentage in the horizon Ao (29.2%) and increases strongly at the level of B horizons, reaching 47.8% in Bt_1 (Table 2). This granulometric composition imprints the soil a loamy texture in the first 2 horizons, clay-loamy in Bt_1 and Bt_2 and loam-clayey in the last 2 horizons.

Table 2. Particle size distribution of the chromic luvisol

Horizon	***Horizon depth (cm)***	***Sampling depth (cm)***	***Particle size distribution (%)***				***Textural class***
			Coarse sand 2-0.2 mm	***Fine sand 0.2-0.02 mm***	***Silt 0.02-0.002 mm***	***Clay <0.002 mm***	
Year - 1995 - Forest vegetation							
Ao	0-22	5 - 15	10.4	37.9	21.3	30.4	Loam
AB	22-33	22 - 32	9.6	36.1	22.7	31.6	Loam
BE	33-45	35 - 45	8.8	35.8	24.9	30.5	Loam
Bt_1	45-96	70 - 80	7.5	34.9	19.1	38.5	Loam clay
Bt_2	96-149	120 - 130	10.9	25.1	21.3	42.7	Loam clay
Bt_3	149-200	175 - 185	10.2	28.4	24.1	37.3	Loam clay
Year - 1995 - Agricultural crop							
Ao	0-29	10 - 20	10.31	27.87	30.69	31.13	Loam
AE	29-44	30 - 40	10.74	27.41	27.91	33.94	Loam clay
Bt_1	44-73	50 - 60	8.76	25.44	27.98	37.82	Loam clay
Bt_2	73-108	85 - 95	7.41	22.08	24.27	46.24	Clay loam
Bt_3	108-141	120 - 130	8.19	26.83	27.85	37.13	Loam clay
BC	141-200	175 - 185	14.21	23.48	28.76	33.55	Loam clay
Year - 2021 - Agricultural crop							
Ao	0-33	10-20	8.5	37.5	24.8	29.2	Loam
EB	33-71	50-60	8.5	35.8	25.3	30.4	Loam
Bt_1	71-102	85-95	5.6	26.2	20.4	47.8	Clay loam
Bt_2	102-140	115-125	6.9	28.7	19.3	45.1	Clay loam
Bt_3	140-171	150-160	6.3	31.3	19.9	42.5	Loam clay
BC	171-200	180-190	6.3	32.1	19.4	42.2	Loam clay

Source: own results

c) ***The main physical properties***

Regarding the main physical properties, the chromic soil luvisol developed under woody vegetation is looser at the surface, compared to the cultivated soils, thus, the apparent density (AD) has the value of 1.24 g/cm^3 in the horizon Ao and 1.46 g/cm^3 in the transition horizon BE. The total porosity (Pt) has a value of 51.4%, in Ao and 43.56% in the BE horizon, and the aeration porosity (Pa) is 19.8%, in the first horizon and 12.24% in the second. In the deep horizons the values of the physical properties of the soil increase or decrease, approaching those of the cultivated soils, which demonstrates that the influence of the anthropogenic factor is felt only in the first half of the soil profile (Table 3)

Comparatively, in the chromic soil luvisol evolved under crop culture, there is a strong compaction, the apparent density (DA) increasing from 1.37 g/cm^3 (Ao) to 1.58 g/cm^3 (Bt_3). The compaction is also highlighted by the total porosity which decreases in profile from 47.5% to 42.3% with depth. Also, the resistance to penetration (RP) has high values in the Bt_2 horizon 119 kgf/cm^2 (Table 3).

Table 3. Main physical properties of the chromic luvisol

Horizon	*Horizon depth (cm)*	*Sampling depth (cm)*	*BD (g/cm^3)*	*D (g/cm^3)*	*Pt (%)*	*Pa (%)*	*RP (kg f/cm^2)*
Year - 1995 - Forest vegetation							
Ao	0-22	5 - 15	1.24	2.55	51.40	19.80	50
AB	22-33	22 - 32	1.36	2.60	47.70	12.24	52
BE	33-45	35 - 45	1.49	2.64	43.56	1.17	68
Bt_1	45-96	70 - 80	1.50	2.67	43.82	-	89
Bt_2	96-149	120 - 130	1.54	2.69	42.75	-	92
Bt_3	149-200	175 - 185	1.53	2.70	43.35	-	99
Year - 1995 - Agricultural crop							
Ao	0-29	10 - 20	1.21	2.58	53.10	27.80	45
AE	29-44	30 - 40	1.33	2.62	49.20	18.10	59
Bt_1	44-73	50 - 60	1.47	2.65	44.50	9.20	67
Bt_2	73-108	85 - 95	1.54	2.68	42.53	1.31	92
Bt_3	108-141	120 - 130	1.57	2.67	41.19	9.13	73
BC	141-200	175 - 185	1.60	2.67	40.07	8.29	69
Year - 2021 - Agricultural crop							
Ao	0-33	10-20	1.37	2.61	47.50	14.42	62
EB	33-71	50-60	1.46	2.66	45.11	12.27	71
Bt_1	71-102	85-95	1.48	2.69	45.00	4.50	114
Bt_2	102-140	115-125	1.54	2.71	43.20	3.28	119
Bt_3	140-171	150-160	1.58	2.73	42.10	1.87	86
BC	171-200	180-190	1.58	2.74	42.30	2.65	91

BD - Bulk density; D - Soil density; Pt - Total porosity; Pa - Air porosity; RP - Resistance to penetration; Source: own results

d) ***The main hydro-physical properties***

From table 4, we notice that in the soil under woody vegetation, the hydro-physical indices have values that correlate well with the granulometric composition, increasing from the surface to the B horizons, where the largest number of fine fractions accumulate. The high values of the main hydro-physical indices for this type of soil in the upper horizon, compared to those recorded in the soil utilized for cultivation of crops, are mainly due to the high content of organic matter.

Furthermore, from this table it can be noted that the hydro-physical indices from the chromic luvisol used for agriculture correlate well with the clay content of the soil, increasing at the level of the B horizons, where the accumulation of clay has the highest percentage. Thus, at the level of the Bt1 horizon, the wilting coefficient (WC) has the value of 16.45%, the field capacity (FC) 27.36%, and the water permeability 0.54 mm/h (Table 4).

Commenting on the data presented in Tables 1 to 4 regarding the values of the indices obtained for the soil profiles under woody vegetation and cultivated crops, we found that the apparent density (AD) for soil under woody vegetation is lower than for cultivated soil. The differentiation is significant, especially in the first horizons. The same changes in terms of use are observed in the porosity. Thus, in the chromic soil luvisol evolved under natural conditions of formation, under woody vegetation, the total porosity (Pt) and the aeration porosity (Pa) have high values in the first horizon, around 50% and around 20%, respectively. In the cultivated soil, the total porosity (Pt) decreases in the surface horizon to 47.50%, and the aeration porosity (Pa) decreases to 14.42%. Also, the resistance to penetration (RP) is less than 50 kgf/cm^2, in the Ao horizon, for the chromic soil luvisol under the forest and 62 kgf/cm^2, for the cultivated soil. Water permeability is better for the chromic soil luvisol under the forest, being 5.4 mm/h, compared to 3.0 mm/h for the cultivated soil. In the cultivated soil, this decreases a lot except for the surface horizon from 1995, when it is lower, due to the loosening of the soil through special agri-technical works.

Table 4. Main hydro-physical values of the chromic luvisol

Horizon	*Horizon depth (cm)*	*Sampling depth (cm)*	*HC (%)*	*WC (%)*	*ME (%)*	*FC (%)*	*AHR (%)*	*Permeability (mm/h)*
Year - 1995 - Forest vegetation								
Ao	0-22	5 - 15	7.26	10.89	26.48	25.52	14.63	5.48
AB	22-33	22 - 32	8.64	12.96	27.11	26.07	13.11	5.21
BE	33-45	35 - 45	9.27	13.90	29.84	28.43	14.52	2.56
Bt_1	45-96	70 - 80	11.49	17.23	33.67	31.68	14.44	0.98
Bt_2	96-149	120 - 130	12.60	18.90	34.35	32.33	13.43	0.52
Bt_3	149-200	175 - 185	8.24	12.11	28.81	24.92	12.81	0.62
	Year - 1995 - Agricultural crop							
Ao	0-29	10 - 20	5.47	8.20	21.18	20.94	12.73	6.21
AE	29-44	30 - 40	6.31	9.46	23.97	23.35	13.88	3.40
Bt_1	44-73	50 - 60	8.26	12.39	24.76	24.03	11.64	2.58
Bt_2	73-108	85 - 95	10.19	15.28	27.91	26.76	11.47	2.16
Bt_3	108-141	120 - 130	7.42	11.18	20.58	20.42	9.24	3.96
BC	141-200	175 - 185	6.04	9.06	19.94	19.86	10.80	4.78
	Year - 2021 - Agricultural crop							
Ao	0-33	10-20	7.30	10.95	23.76	23.17	12.22	3.01
EB	33-71	50-60	7.30	10.95	22.98	22.49	11.53	2.48
Bt_1	71-102	85-95	10.97	16.45	28.61	27.36	10.90	0.54
Bt_2	102-140	115-125	10.44	15.66	26.94	25.92	10.26	0.37
Bt_3	140-171	150-160	9.86	14.79	26.41	25.46	10.67	0.64
BC	171-200	180-190	9.83	14.74	25.98	25.09	10.34	0.21

HC - Coefficient of hygroscopicity; WC - Wilting coefficient; ME - Moisture equivalent; FC - Field capacity; AHR - Active humidity range; Source: own results

How it is used is also very significantly negative for some chemical properties, especially in terms of organic matter content. Thus, in the soils under woody vegetation the percentage of organic matter is high, 4.02%, and in the cultivated ones, the soil content in organic matter decreased almost by half, being in the first horizon of 2.35%.

Thus, we can state that by cultivating crops on the chromic soil luvisols in the researched area, they undergo more or less accentuated changes. Among these changes we mention a stronger settlement, a worsening of the porosity, a decrease of the permeability and the content of organic matter. Given these trends, measures must be taken to counteract them, such as a deep loosening and organic fertilization to increase porosity, improve the structure and increase the humus reserve in the soil.

CONCLUSIONS

Research on this type of soil on the main agri-productive properties has found that in terms of morphological characteristics, i.e., the succession and thickness of the horizons, there were no significant changes, both on the soil under woody vegetation and on soils used for cultivating, during the 25 years of observations. Regarding the granulometric composition, there is a decrease in the clay content in the cultivated soils, an increase of the clay content and an increase of the coarse fractions (sand), due to the washing phenomenon, the cultivated plants having a lower retention capacity of fine clay particles. This phenomenon is also present in depth where the amount of clay removed from the soil surface is deposited in the Bt horizons.

From the point of view of physical properties, there is a considerable decrease in the total porosity and aeration of the soil use for crop cultivation, compared to the soil developed under woody vegetation, especially in 2021, where aeration porosity reaches only 14.42%. Along with their decrease, there is a worsening of the soil aeration regime and a substantial increase in penetration resistance, by approximately 12 kgf/cm^2, in 2021, compared to that of the soil under woody vegetation.

At the hydro-physical level indices the cultivated soils, compared to the one under woody vegetation presents a decreased FC - field capacity and AHR - active humidity range, an aspect which is due mainly to the washing phenomenon that led to the elution of clay particles and organic matter from the surface layer, their retention at the soil surface being more effective on soils with permanent vegetation, such as forests. And permeability to water decreased by about two units, due primarily to subsidence of the soil surface layer as a result of repeated passages with heavy soil tillage equipment.

To sum up, it can be stated that from following the research, the main agri-productive properties of chromic luvisol have changed very significantly, natural fertility decreasing greatly on cultivated soils, compared to those developed in a natural state, under woody vegetation. It has also been highlighted that due to the cultivation technologies applied in agritourism farms, with a lower number of processing works and inputs of pesticides, fungicides and insecticides, the main agri-productive properties of the soil have been preserved even after an operating period of more than 25 years.

Following these conclusions, it is recommended that, for the total protection of the soils, crops and tourists, the agritourist farms in Romania must practice an organic agriculture that involves the application of agricultural technologies that are sustainable, diversified and balanced to ensure the preservation of the environment and a certain nutritional and traceable quality of the food served.

REFERENCES

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.

Brevik, E. C. (2013). Soils and human health - an overview. In: *Soils and human health*, edited by: Brevik, E. C. and Burgess, L. C., Boca Raton, FL, USA, CRC Press, 29-56.

Brevik, E. C., Slaughter, L., Singh, B. M., Steffan, J. J., Collier, D., Barnhart, P., Pereira, P. (2020). Soil and Human Health: Current Status and Future Need, Air. *Soil and Water Research, 13*. 1–23.

Bünemann, E. K., Bongiorno, G., Bai, Z., Creamer, R. E., Deyn, G., Goede, R., Fleskens, L., Geissen, V., Kuype,r T. W., Mäder, P., Pulleman, M., Sukkel, W., Groeningen, J. W., Brussaard, L. (2018). Soil quality- A critical review. *Soil Biology and Biochemistry, 120.* 105–125.

Canarache, A. (1990). *Physics of agricultural soils*. Ceres Publishing, Bucharest, 73-81.

Călina, A., Călina, J. (2019). Research regardig the agriproductive properties of the typical reddish preluvosol between Jiu and Olt rivers and its evolution from 1997-2017 in farms and agritouristic households. *Romanian Agricultural Research, 36*. 251–261.

Călina, J., Călina, A., Iancu, T., Miluț, M. and Croitoru, A. C. (2022). Research on the Influence of Fertilization System on the Production and Sustainability of Temporary Grasslands from Romania. *Agronomy, 12*(12), 2979.

Cernescu, D. (1964). Soil Research Methods (in Romanian). *Romanian Academy Publishing House*, Bucharest, 65-92.

Chiriță, C. D., Păunescu, C., Teaci, D. (1967). *Romania's Soils* (in Romanian). Agrosilivică Publishing, Bucharest, 72-95.

Coteț, P. (1973). *Romania's Geomorphology* (in Romanian). Technic Publishing, Bucharest, 97-165.

Davidson, D. A. (2000). Soil quality assessment: recent advances and controversies. *Progress in Environmental Science, 2*. 342–350.

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

Dumitru, M., Manea, A., Ciobanu, C., Dumitru, S., Vrînceanu, N., Rîşnoveanu, I., Calciu, I., Tănase, V., Preda, M. (2011). *Soil quality monitoring in Romania.* Sitech Publishing, Craiova, Romania, 50-52.

Florea, N., Bălăceanu, V., Răuță, C., Canarache, A. (1987). *Soil survey methodology (in Romanian)-Part I, II, III*. National Research and Development Institute for Soil Science, Agrochemistry and Environment, Ministry of Agriculture, Methods Reports Guidance, No. 20, Bucharest: 190-225.

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.

Heckman, J. R. (2013). Human contact with plants and soils for health and well-being, in: Soils and human health. Edited by: Brevik, E. C. and Burgess, L. C., Boca Raton, FL, USA, CRC Press, 227-240.

Liu, H., LI, B., Ren, T. (2015). Soil profile characteristics of high-productivity alluvial cambisols in the North China Plain, *Journal of Integrative Agriculture*, *14.* 765–773.

Mihalache, M., (2006). *Pedology: genesis, properties and taxonomy of soils*. Ceres Publishing, Bucharest, 35-89.

Mihalache, M., Ilie, L. Madjar, R. (2014). Translocation of heavy metals from sewage sludge amended soil to plant. *Revue Roumaine de Chimie, 59*. 81–89.

O'Sullivan, L., Bampa, F., Knights, K., Creamer, R. E. (2017). Soil protection for a sustainable future: options for a soil monitoring network for Ireland. *Soil Use & Management, 33*. 346–363.

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

Păunescu, C. (1975). *Forest Soils* (in Romanian). Romanian Academy Publishing House, Bucharest, 8-22.

Pepper, I. L. (2013). The soil health: human health nexus. *Crit Rev Env Sci Tec., 43*(24), 2617–2652.

Răduțoiu, D., Simeanu, C. G., Stan, I. (2018). Contributions to halophilic flora and vegetation in Oltenia (Romania). *Scientific Papers-Series B. Horticulture, 62*. 655–660.

Rodrigues, S. M., Römkens, P. F. A. M. (2018). Human health risks and soil pollution. In: Duarte A., Cachada A., Rocha-Santos T., eds. *Soil Pollution*. London: Academic Press, 217-250.

Rhodes, C. J. (2017). The imperative for regenerative agriculture. *Science Progress 100*. 80–129.

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

Stănilă, A. L. (2016). With Regard to the Chromic Luvisols in Romania. *Journal of Agricultural Studies, 4*. 2–8.

Stătescu, F., Zaucă, C. D., Pavel, V. P. (2013). Soil structure and water-stable aggregates. *Environmental Engineering and Management Journal*, *12*, 741-746.

Șorop, G., Vasile, D. (1990). *Pedology*. University of Craiova Publishing, 78-91.

Tudor, V. C., Mocuta, D. N., Teodorescu, R. F. and Smedescu, D. I. (2019). The issue of plastic and microplastic pollution in soil. *Materiale Plastice*, *56*(3).

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

Zajícová, K., Chuman, T. (2019). Effect of land use on soil chemical properties after 190 years of forest to agricultural land conversion. *Soil & Water Res*., *14*, 121–131.

***EM, Environment Ministry (1997). Order 756/ for the approval of the Regulation on the assessment of the environmental pollution. Official Gazette, No. 303 bis.

***EU, European Commission (2006). Thematic Strategy for Soil Protection. Commission of the European Communities, 12.