# SOIL RESILIENCE TO CURRENT CLIMATE CHANGE UNDER THE IMPACT OF NEW AGRICULTURAL TECHNOLOGIES

**Amelia ANGHEL[1], Lavinia BURTAN[1], Monica DUMITRAȘCU[1], Mihaela LUNGU[1], MUȘAT Marian[2]**

*[1]National Research and Development Institute for Soil Science, Agrochemistry and Environment - ICPA Bucharest, 61 Mărăști Blvd., District 1, Bucharest, Romania*
*author email: amelutu@yahoo.com; lavinia.burtan@icpa.ro; dumitrascumo@yahoo.com; mihaelalungu.icpa@gmail.com*
*[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd., District 1, Bucharest, Romania, author email: dr_marianmusat@yahoo.com ;*

**Corresponding author email: *lavinia.burtan@icpa.ro***

**Abstract**

*The paper presents the results of physic-chemical and microbiological characteristics of the soil Typical Kastanoziom (SRTS, 2012) in the pedo-climatic conditions of Rîmnicu de Jos, Constanța county (Romania) cultivated using two soil management systems: conventional (classical) and conservative (no-till). Agrophysical profiles were made, from which soil samples were taken (physico-chemical on predetermined depths of 5-10 cm; 25-30 cm and 45-50 cm). The analyses and determinations carried out are in accordance with the standardized methodology commonly used in the ICPA Laboratories and those of the County Offices for Pedological and Agrochemical Studies. No-till is more effective in preserving humus reserves, which is beneficial for long-term soil health and fertility. Bulk density (DAwi g / $cm^3$) in the no-till technology works decreases with depth (the soil is unattached on the first depths – and on the last depth, the soil is very loose), compared to the classical technology where on the depth of 25-30 cm appears a slight compaction. No-till technology improves the chemical characteristics and fertility of the soil, compared to classical (conventional) technology, which can lead to soil alkalization. The implementation of no-till technology seems to greatly increase the resistance of the soil to penetration, which may indicate a better compaction or a more stable structure of the dusty clay soil, which is important for certain crops or for the stability of the land.*

***Key words**: climate change, no-till, soil properties, Kastanoziom tipic*

## INTRODUCTION

Climate change substantially changes the characteristics of different countries or regions, restricting favorable areas for agriculture, imposing radical changes in farm systems, plant cultivation technologies, systems for ensuring ecosanogenesis as a whole (Hera, 2015). Climate change continues at global and european level. Land and sea temperatures are rising (Fussel et al., 2017). As a consequence of climate change, the problems of drought and desertification will exacerbate not only in developing countries, but also in large parts of southern, eastern and Central Europe (JRC, 2011).

From 1901 to the present, Romania has had extremely dry/rainy years every decade, with an increasing number of droughts being identified after 1981. According to the data of the European drought Observatory for Romania, for the period august 11, 2023 - august 19, 2023, showed that, at national level, 96,278 $km^2$ (Combined Drought Index) were affected, with an increasing trend of 1.6%. The soil moisture anomalies were manifested on an area of 32.538 km$^2$ (13.7%), but with a reduction tendency, in proportion of 7.3%; the vegetation affected was 21,249 km$^2$ (8.9%), with a growth trend of 6.3%, and the area affected by heat waves was 20,839 km$^2$.

About 12 million ha of agricultural land, of which about 80% arable land, are affected by one or more limitations, such as: frequent drought (7,100,000 hectares), periodic excess of water (3,781,000 hectares), hydraulic soil erosion (6,300,000 hectares), landslides (702,000 hectares), wind erosion (3780,000 hectares), saline and alkaline soils (614,000 hectares), strong and moderate acidity (3,424,000 hectares), low and very low humus content (7,485,000 hectares), low and very low affordable phosphorus content (6,330,000 hectares), low total nitrogen content (5,110,000 hectares), low accessible potassium content (787,000 hectares), zinc deficiencies (1,500,000 hectares), chemical soil pollution (900,000 hectares), oil and salt water pollution (50,000 hectares), soils degraded by various works (30,000 hectares), solid residue coating (25,000 hectares) (Calciu et al. 2025). When applying UN Sustainable Management soils play an important role in mitigating climate change by storing carbon and decreasing GHG emissions into the atmosphere. Climate change can reduce soil organic carbon (SOC) content, with warming involving more or less c released than in colder conditions, depending on soil water content, which is also a climate-dependent variable (Zhao et al., 2021).

Johnson et al, (2007) highlight that agricultural practices that promote good land management lead to minimizing or reducing the potential for global warming. Such practices include: reducing tillage, which helps prevent soil erosion and has the potential to increase elderberry and may improve $CH_4$ consumption; eliminating grubbing and keeping soil covered with plant debris, cover crops or perennial vegetation, which has the potential to increase SOC. Soils in the EU contain more than 70 billion tonnes of organic carbon, which is equivalent to almost 50 times annual greenhouse gas emissions. However, intensive and continuous arable production can lead to a decline in soil organic matter (Calciu et. al., 2025).

Agriculture around the world will have to face new situations, greater pressure on Natural Resources and climate change. If the temperature rises by more than 2$^0$C, the global food production potential will be sharply reduced and the yields of major agricultural crops such as maize will be reduced globally. The frequency of droughts and floods will increase and produce greater crop losses and land and forest degradation will intensify. In addition, agriculture will need to adjust its production methods to help combat the global impact of climate change (Calciu et al., 2025). Shiva et al. (2008), draws attention to the fact that globalised industrial agriculture also contributes to and is vulnerable to climate change and contributes at least a quarter to current greenhouse gas emissions. Khorramdel et al, (2013) they found that due to the slow release of nutrients in low-input management systems with organic fertilizer application, total soil organic matter (SOM), organic carbon content and stable carbon increased. This can be an indication for the potential for carbon sequestration in low-input management systems and can be viewed as an alternative management system to reduce $CO_2$ production and its release into the atmosphere. Agrotechnical measures must aim at the accumulation of organic carbon in agricultural land, their applicability being different depending on soil type, region and climate regime.

Unger et al. (1988) they showed that with the adoption of the system of conservative agriculture, the infiltration of water into the soil improved and the evaporation of water from the soil was reduced by the presence of the mulch layer. By applying plant debris to the soil surface, Van Doran et al. (1978), led to increased water conservation in the soil and reduction of wind and water erosion. Plant debris plays a role in mitigating surface runoff, leaving time for water to seep into the soil. They also reduce the negative impact of raindrops, keeping soil aggregates intact, which allows better infiltration of water into the soil (Freebairn et al, 1985; McGregor et al. 1990; Dormaar et al. 1996). Romania has in the system of Conservative agriculture 583,800 ha, 6.49% of arable land (FAOSTAT 2018). Healthy soils will increase the EU's resilience and reduce its vulnerability to climate change.

## MATERIALS AND METHODS

Two systems of soil tillage were experimented: conventional (classical) and conservative (no- till) in Rîmnicu de Jos, Constanța county (Romania), latitude: N: 44 3928, longitude: E: 028 2651.

***1) Pedoclimatic characterization of the studied area***

The territory of the commune is located at the meeting of the Casimcea Plateau and the Istria plateau in the depression and Hill area. The specific and predominant landform is that of plain with smooth hills. The climate in this area falls on the temperate climate, characteristic of the Dobrogea area. Winters are milder than in the rest of the country, which is explained by the penetration of warm air masses from the Black Sea. In summer, the same air masses are moist and cool. The average annual temperature is +10° - +11°C. Winters are generally characterized as harsh and dry, and summers as arid. *Vegetation*. The Plateau area is characteristic, being generally represented by xerophyte and mesoxerophyte species, predominant being gramieele and asteraceele, found on natural pastures. Among the grasses are: *Agropirum, Festuca*, and in crops: *Convolvulus sp*. In the studied unit we meet associations of soils: typical Kastanozioms and typical Renzines, calcareous, skeletal.

***2) Soil sampling***

Two main soil profiles have been worked out and characterized from the morphological point of view and that of the physical and chemical characteristics, according to the Working Methodology of ICPA Bucharest (MESP, vol. I-III, 1987) (Figure 1).

Soil samples were collected on the 5-10; 25-30, and 45-50 cm depths. Microbiological samples were collected on the depth of 0-20 cm.

The analyses and determinations carried out are in accordance with the standardized methodology usually used in the ICPA Bucharest laboratories and those of the County Offices for Pedological and Agrochemical Studies.

*Physical analysis*:

Physical determinations: apparent density determined by etuve drying method at 105 oC (DAwi g/cm3); SR EN ISO 11272:2017; determination of water permeability (Ksat mm/h) by constant water gradient method; STAS 7184/15:1991; determination of penetration resistance (RP Kg f/cm2) STAS 7184/-88; methods of physical soil analysis (2009); determination of total porosity (PT wi % v/V) methods of physical soil analysis (2009).

*Chemical analysis*: Determination of pH in aqueous suspension 1:2.5; SR 7184 13:2001; determination of humus content: wet oxidation; STAS 7184/21 82; determination of nitrogen content (Nt): Kjeldahl method; STAS 7184/2-85; determination of phosphorus content ($P_{AL}$): ammonium acetate-lactate extraction; STAS 7184/19-82; determination of potassium content ($K_{AL}$): acetate-lactate extraction ammonium; Stas 7184/18-80;

the humus reserve was determined according to (MESP, 1987, indicator 144).

*Microbiological analysis:*

Microbiological parameters were assessed by plating soil serial dilution on solid agar culture media: Nutrient agar (NA, Difco) for Total Number of BacteriaTNB and potato-dextrose agar (PDA, Merk) for Total Number of Fungi-TNF. Taxonomic composition of microbial communities was identified by morphologic criteria (under a MC5.A optic microscope) and specific manuals for heterotrophic aerobic bacteria (Bergey and Holt, 1994) and for fungi (Baron, 1968; Domsch and Gams, 1970; Watanabe, 2002).

The global physiological activity of microbiota as an indicator expressing the quantity of $CO_2$ released by soil microbial communities was assessed by substrate induced respiration (SIR) method. Species richness or total number of species (S), in microbial communities from soil was determined and microbial diversity assessed by calculating Simpson diversity index (D) (Mohan and Ardelean, 1993).

## RESULTS AND DISCUSSIONS

The comparative analysis of the two technologies applied in the experimental fields was carried out, with harvesting in spring and autumn in 2024, in order to observe how the conservative technologies (no-till) influence the fertility characteristics of the soil within the territorial administrative unit under study, subjected to the aridization process. The comparative analysis was carried out by averaging the values (physico-chemical), of the two sampling stages and then the results of the two applied agricultural technologies were compared.

*Figure 1. U. A.T. Rîmnicu de Jos, (Constanța County).*
*Main profile in no- till technology and agrophysical profile in conventional technology*

*Soil reaction* (pH). In both cases, the soil has a weakly alkaline character with pH values above 7. Higher values at greater depths (above 8) Indicate a tendency towards alkalization, especially at a depth of 45-50 cm. In conventional technology, the pH is weakly alkaline compared to the conservative (no-till) method, which is neutral (*Figure 2*.).

*Humus content* (%) in both applied agricultural technologies is small. (*Fig. 3*).

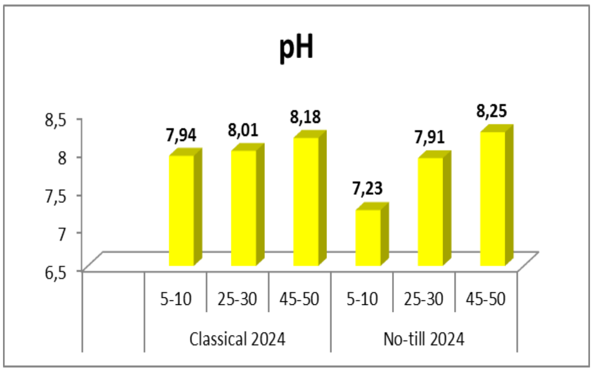


*Figure 2. Influence of soil tillage on pH within Rîmnicu de Jos, (Constanța County)*

The *total nitrogen content* (Nt%), in both technologies, the total nitrogen content decreases with depth, which is typical for agricultural soils. Values for conservative technology are slightly lower than conventional ones. Total nitrogen content are relatively close between the two technologies, but differences can influence fertilization planning for the next season (*Figure 4*).

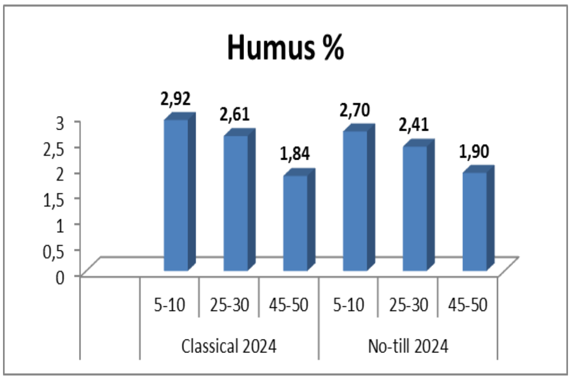


*Figure 3. Influence of soil tillage on humus content within U.A.T. Rîmnicu de Jos, (Constanța County)*

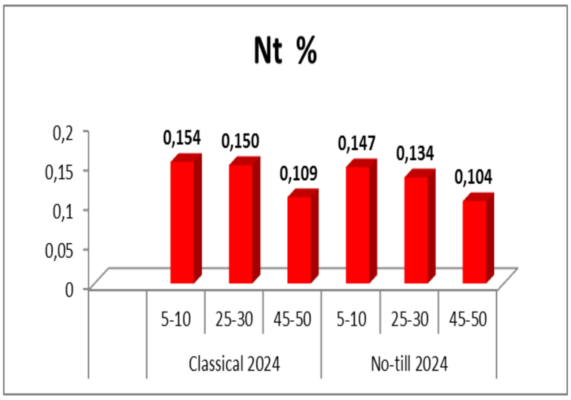


*Figure 4. Influence of soil tillage on the total nitrogen content of U.A.T Rîmnicu de Jos, (Constanța County)*

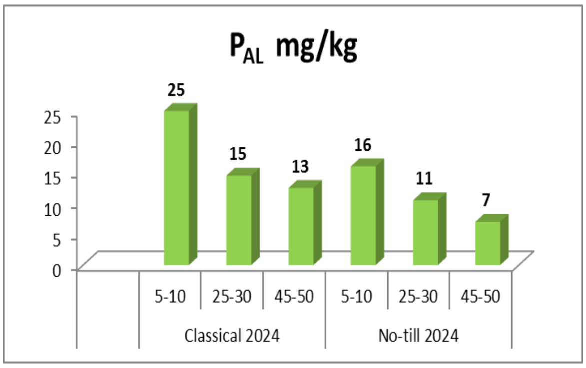


*Figure 5. Influence of soil tillage on the mobile phosphorus content of U.A.T. Rîmnicu de Jos, (Constanța County)*

The content of mobile phosphorus ($P_{AL}$ mg/kg) and mobile potassium ($K_{AL}$ mg/kg). The soil has a relatively high content of potassium and phosphorus in the upper layer, especially in the classical system. In depth, levels decrease for both elements, which may indicate less mobility and availability in deeper layers (*Fig. 5 and 6*.). *Humus reserve* (tonnes/ha), analyzed on the depth of 0-50 cm (*Figure 7*.).

In classical technology the humus reserve decreased slightly from 183 t/ha in may 2024 to 132 t/ha in october 2024, indicating a reduction of approximately 51 t/ha during these months. The humus reserve in no-till technology has increased from 143t/ha to 155 t/ha, (12 t / ha), suggesting that this system helps to keep humus levels more stable. No-till technology is more effective in preserving humus reserves, which is beneficial for long-term soil health and fertility.

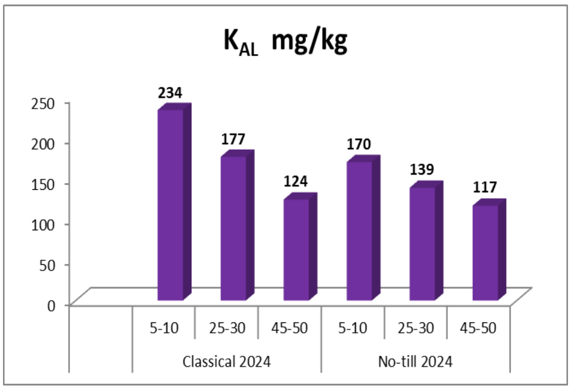


*Figure 6. Influence of soil tillage on the mobile potassium content of U.A.T. Rîmnicu de Jos, (Constanța County)*

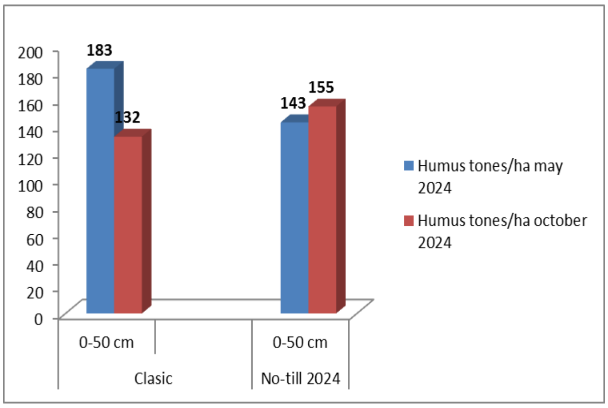


*Figure 7. Influence of soil tillage on humus reserve within U. A.T. Rîmnicu de Jos, (Constanța County)*

*Bulk density* (DAwi g / $cm^3$) as seen in (*Figure 8*), in no-till technology it decreases with depth (the soil is unattached on the first depths – and on the last depth, the soil is very loose), compared to the classical technology where on the depth of 25-30 cm appears a slight compaction.

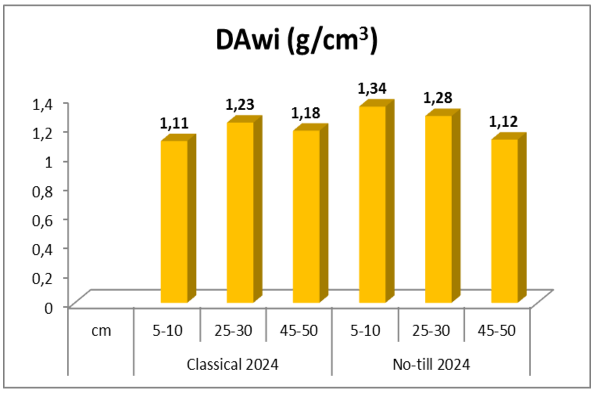


Figure 8. Influence of soil tillage on bulk density within U. A. T. Rîmnicu de Jos, (Constanța County)

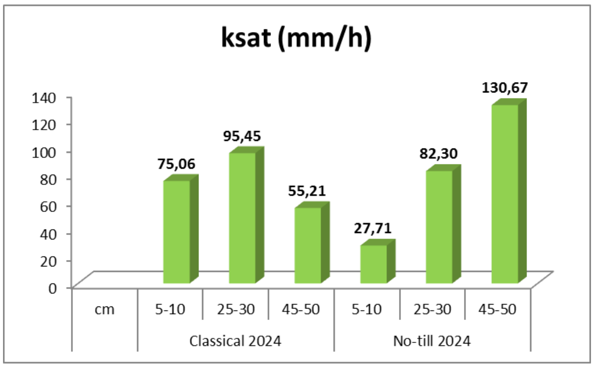


Figure 10. Influence of soil tillage on water permeability within U. A. T. Rîmnicu de Jos, (Constanța County)

*Penetration resistance* RP (Kgf/cm$^2$). Conservative technology gives a much higher resistance to penetration compared to the classical method, especially at shallow depth (5-10 cm).

Resistance decreases with increasing depth, which is normal, but the differences between the two technologies remain significant. The implementation of no-till technology seems to greatly increase the resistance of the soil to penetration, which may indicate a better compaction or a more stable structure of the dusty clay soil, which is important for certain crops or for the stability of the land (*Figure 9*).

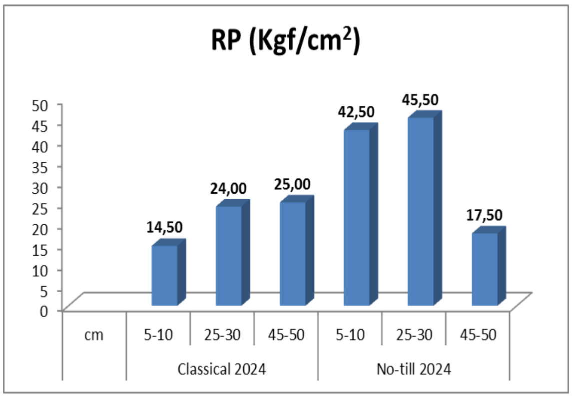


Figure 9. Influence of soil tillage on penetration resistance within U. A. T. Rîmnicu de Jos, (Constanța County)

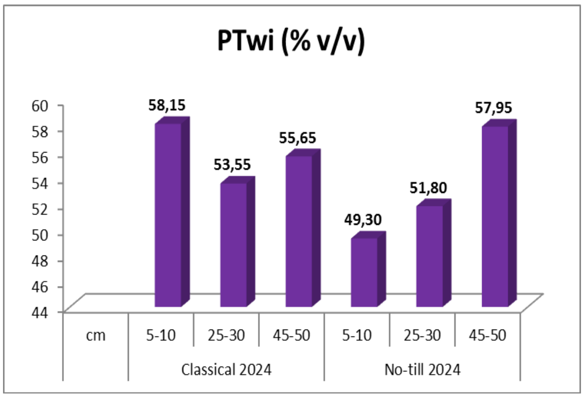


Figure 11. Influence of soil tillage on total porosity within U. A. T. Rîmnicu de Jos, (Constanța County)

*Water permeability* Ksat (mm/h) (Figure 10.), on the depth of 5-10 cm in classical agricultural technology allows faster water seepage compared to no-till technology. At the following depths increases the rate of water infiltration in both technologies.

*Total porosity*, PTwi (% v/v). Soil with a dusty clay texture, tends to be relatively permeable and aerated. For both technologies the values in the range of 50-58% suggest a soil suitable for plant growth, having a good drainage and aeration capacity. (*Figure 11*.).

Cenci et al. (2009) recommends using microbial indicators to assess soil fertility. Microorganisms, more than any other organisms, are highly adaptable to different conditions and respond quickly to changing conditions.

The values of soil respiration (mg $CO_2$/ 100 g soil) in both cultivation systems were of medium level, with more intense metabolic activities in the soil cultivated in classical technology compared to no-till. The bacterial communities (NTB x $10^6$/g dry soil), developed in the conditions of the soil cultivated in classical technology were classified in the category of high values, and those from the soil cultivated in no-till reached medium to high levels. The quantitative determinations of fungi (NTF x $10^3$ / g dry soil), at both soil tillage technologies, presented medium-level herds, but the communities in the classical cultivated soil were more numerous than those in the soil cultivated in the conservative technology (no-till).

## CONCLUSIONS

Soil management and unsustainable agricultural practices can contribute to climate change.

No-till technology improves the chemical characteristics and fertility of the soil, compared to classical (conventional) technology, which can lead to soil alkalization. No-till technology presents a looser soil structure at greater depths, beneficial for the growth and development of plant roots. Conventional technology tends to compact the soil to the surface. The two agricultural technologies of applied soil works, generally have a good porosity, and maintain a balance between drainage and aeration, beneficial to soil health.

Measures to be taken to counteract climate change are to increase SOC, improve soil structure, increase water storage capacity, prevent soil erosion and restore degraded land. All this will lead to ensuring the health of the soil and the multifunctionality of the ecosystems and to increasing the resilience of the soils.

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