Research Journal of Agricultural Science, 58 (2), 2026; ISSN: 2668-926X;

http://doi.org/10.59463/RJAS.2026.2.11

THE INFLUENCE OF AGRICULTURAL PRACTICES AND ENVIRONMENTAL FACTORS ON SOIL QUALITY FROM TORMAC, TIMIS COUNTY

Daniel Dorin DICU (ORCID: 0000-0003-0948-9159)[1], Iasmina-Amalia OPREAN[1], Radu BERTICI[1] (ORCID: 0009-0007-1322-0773), Mihai Valentin HERBEI[1] (ORCID: 0000-0002-3884-3658), Attila BLENESI-DIMA[1] (ORCID: 0009-0001-0495-1132)

[1] ***University of Life Sciences "King Mihai I" from Timisoara, 300645, 119, Calea Aradului, Timisoara, Romania***

Corresponding author: oprean.iasmina-amalia.fa@usvt.ro

Abstract. *The soil represents the loose layer at the Earth's surface which, over time, has acquired its main characteristic—fertility—through the simultaneous and long-term action of natural pedogenetic factors. Originally, the Earth's crust was compact and unsuitable for plant development, consisting solely of rocks and minerals. Continuous interaction with the atmosphere, hydrosphere, and later the biosphere led to the disintegration and alteration of rocks, transforming the hard and compact mass into a loosened material capable of supporting plant life. This transformation marks the beginning of soil formation, during which processes such as the accumulation of organic matter, eluviation, and illuviation gradually shape the structure and properties of the soil. The importance of soil is fundamental for all life on Earth, considering that over 90% of human and animal food originates directly or indirectly from it. The continuous reduction of arable land per capita—estimated to decrease to only 0.10 ha by the year 2150—highlights the need for innovative and sustainable technologies that can prevent soil degradation and maintain its productive capacity. Soil is regarded as the essential natural resource of efficient and sustainable agricultural systems and as the "heart" of terrestrial ecosystems due to its role as a reservoir of energy, water, and nutrients, as well as its direct influence on the process of photosynthesis. Humanity's relationship with soil dates back to ancient times, representing the foundation of the first agricultural revolution and the development of early agriculture, emphasizing the decisive role of soil in the evolution of human society.*

Keywords: *Fertility, Soil, Sustainability, Soil structure, Mineralization processes.*

INTRODUCTION

Soil represents one of the most important natural resources on the planet, playing a crucial role in maintaining life on Earth and in the functioning of ecosystems. Through its physical, chemical, and biological properties, soil provides the necessary support for plant growth and development, thus forming the basis of food chains and serving as the primary source of food for humans and animals (Brady & Weil, 2008). It supplies the nutrients required by vegetation, and through their transfer into the vegetative organs of crops, it indirectly affects the quality of food consumed by humans and animals.

From an economic perspective, soil fulfills both an active role, as the primary means of production in agriculture and partially in forestry, and a passive role, as space for the development of infrastructure and social and cultural activities (Lal, 1992). In agriculture, attention focuses on arable, orchard, and vineyard soils, as well as pastures and hayfields, which are subjected to high intensities of anthropogenic influence. This usage often leads to modifications of the natural soil formation processes, resulting in physical, chemical, and biological degradation, with negative effects on fertility and productive capacity (Njios).

Soil fertility represents its defining characteristic, distinguishing it from any other terrestrial material. It reflects the soil's ability to provide optimal conditions for the production

of plant biomass through the availability of water, air, and nutrients, in a context that also includes other ecological factors such as light and temperature (Chiriță, 1977). Soil functions are in constant interaction, and its long-term use must consider the balance between agricultural and non-agricultural functions to prevent environmental degradation (FAO, 2015).

In this context, the assessment of the natural environment and soil degradation processes in Tormac Commune becomes essential for identifying trends in environmental transformation, as well as for proposing strategies for the sustainable management of this vital resource. The present study aims to analyze how anthropogenic activities and natural factors influence soil conditions, emphasizing the conservation of fertility and productive capacity within a constantly changing environment.

MATERIAL AND METHODS

The study was conducted in Tormac Commune, a hilly area characterized by small farms typical of subsistence agriculture. Representative plots were selected for the main agricultural uses: arable land and hayfields.

The study was conducted in Tormac Commune on representative plots of arable land and hayfields, characteristic of subsistence agriculture in the hilly area. Soil samples were collected at depths of 0–20 cm, 20–40 cm, and 40–60 cm, each sample consisting of several randomly collected sub-samples, mixed according to standard methodological procedures. Physical soil properties were assessed by determining the structure and stability of aggregates (sieving method), porosity and bulk density (constant-volume cylinder method), and compaction (manual penetrometer).

Chemical analyses included pH in water (1:2.5 soil-to-water ratio), humus and organic carbon content (Walkley-Black method), total and mineralized nitrogen (Kjeldahl method and determination of nitrate/ammonium N), and available phosphorus (Olsen method).

Biological characteristics were evaluated by measuring microbial activity (soil respiration, microbial biomass) and stable organic matter.

Data were collected by sampling soil at various depths, following standard methodological protocols for soil fertility and degradation studies. The results were statistically analyzed to identify trends in the studied parameters and to highlight the factors that most influence soil fertility and its productive potential.

RESULTS AND DISCUSSIONS

Agricultural policies adopted at the international level, particularly during the 1960s–1970s, encouraged the expansion of areas cultivated with cereals and root crops, as well as the intensification of conventional technological systems. This intensification of soil tillage generated an increased risk of erosion, a phenomenon particularly pronounced on sloped lands and exacerbated by the improper application of crop cultivation technologies (Lal, 1992).

Other factors contributing to erosion include leaving the soil bare during critical periods, burning or removing crop residues, and excessive soil tillage under unsuitable moisture conditions.

Regarding land use structure, Tormac Commune covers a total area of 13,406 ha, of which approximately 94.95% (12,732 ha) are agricultural lands, while forests occupy only 0.75% of the territory, highlighting the predominantly agrarian character of the commune and the economic importance of agriculture.

http://doi.org/10.59463/RJAS.2026.2.11

Geomorphologically, the commune is located in the Tormac Plain, a component of the Banat Hilly Plain, with predominantly flat terrain and slight undulations, favorable for intensive agriculture and rural arrangements.

The geological substrate consists of crystalline materials overlain by tertiary and quaternary alluvio-colluvial deposits, which have contributed to the formation of fertile and diverse soils, directly influencing the agricultural potential of the territory. This geological and sedimentary structure also determines hydrological characteristics and land stability, representing an essential factor in the sustainable planning of natural resource use.

On uncultivated lands, erosion is a slow natural process important for soil profile formation. On agricultural lands, however, erosion reduces rooting depth, decreases available water and nutrient reserves for plants, and fragments the terrain through gully formation. Soil sediments transported down slopes affect access routes, surface waters, and irrigation and drainage channels, generating negative impacts on aquatic ecosystems (FAO, 2015). The intensification of conventional agriculture through mechanization and frequent plowing has significantly contributed to increased erosion in recent decades. The use of fertilizers and pesticides partially offsets the negative effects on crop yield, but it also has polluting effects on the environment, increases energy consumption, and leads to an unsustainable agricultural system.

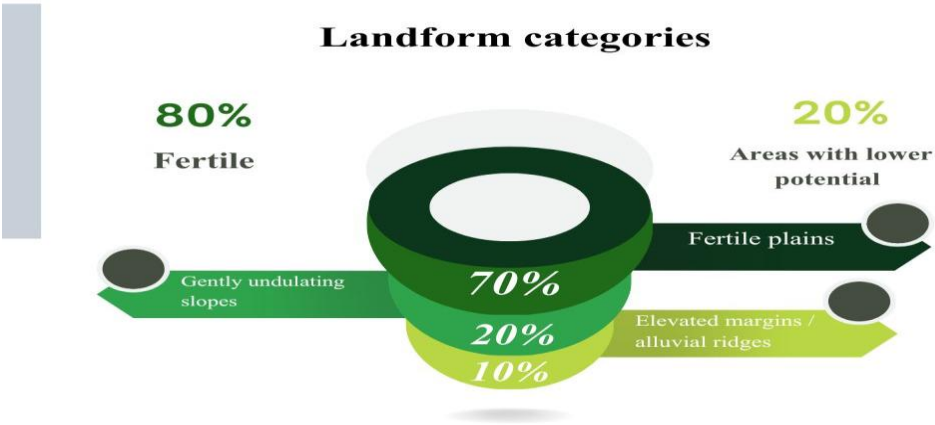


Figure 1 Landform categories

Soil represents one of the most important components of the natural environment, playing a fundamental role in supporting terrestrial ecosystems and agricultural production. In Tormac Commune, the predominantly agricultural character of land use makes the maintenance, enhancement, and restoration of soil quality a major priority in the context of current environmental transformation trends.

Understanding the influence of soil fertility on plant growth and development, as well as the dynamic changes in soil properties caused by agricultural practices, is essential for assessing the sustainability of land use in this area.

The following table summarizes the main soil degradation processes identified in Tormac Commune, along with their primary causes, affected soil properties, and the resulting impacts on soil quality and agricultural productivity. This synthesis highlights the most critical

http://doi.org/10.59463/RJAS.2026.2.11

factors influencing soil sustainability under current land-use practices, providing a clear overview of areas that require targeted conservation measures.

Soils, like most natural resources, exist in a dynamic equilibrium, with most changes occurring slowly and being barely perceptible at the scale of a human generation. However, in Tormac Commune, certain degradation processes can become evident over relatively short periods, especially under intensive agricultural management. Processes such as soil compaction, structural degradation, loss of organic matter, and the intensification of erosion can be accelerated by repeated mechanical operations, monoculture practices, and excessive use of chemical inputs.

Figure 2. Main soil degradation processes in Tormac, causes and effects

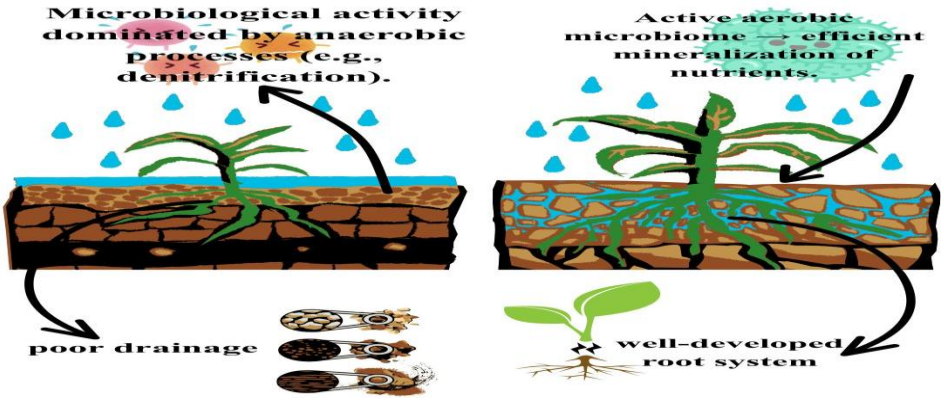


Figure 3. The impact of compaction on plant growth

Research Journal of Agricultural Science, 58 (2), 2026; ISSN: 2668-926X;
http://doi.org/10.59463/RJAS.2026.2.11

Changes occurring in soil structure and composition are commonly referred to as structural modifications and are directly or indirectly measurable, being closely related to land use patterns. In recent decades, increasing pressure from intensive land use has led, including in Tormac Commune, to severe soil and land degradation.

Conventional agriculture, practiced extensively over long periods, has generated both positive effects on crop production and significant negative impacts on soil quality.

In this context, the adoption of a sustainable soil management approach becomes necessary in order to integrate ecological and socio-economic principles into land-use practices. According to Eswaran (1994), sustainable soil management represents a complex system of agricultural technologies aimed at conserving soil resources, maintaining fertility, and reducing environmental impacts. The application of such systems in Tormac Commune could significantly contribute to limiting soil degradation and improving soil structure.

Agricultural systems that promote the improvement and conservation of soil structure generally lead to increased organic matter content, enhanced biological activity, and greater diversity of macrofauna and mesofauna. In Tormac Commune, the promotion of environmentally friendly agricultural practices represents a viable solution for ensuring the long-term productivity and sustainable use of agricultural soils.

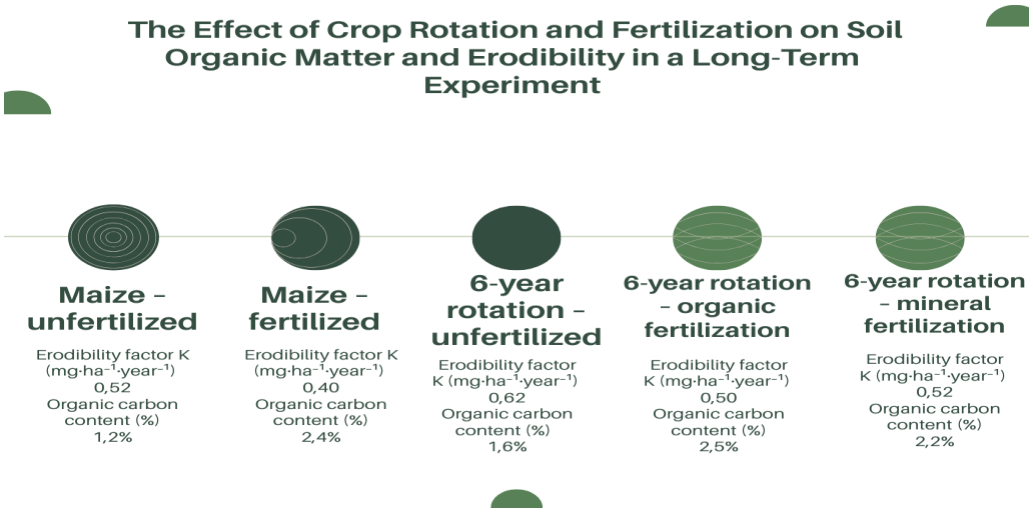


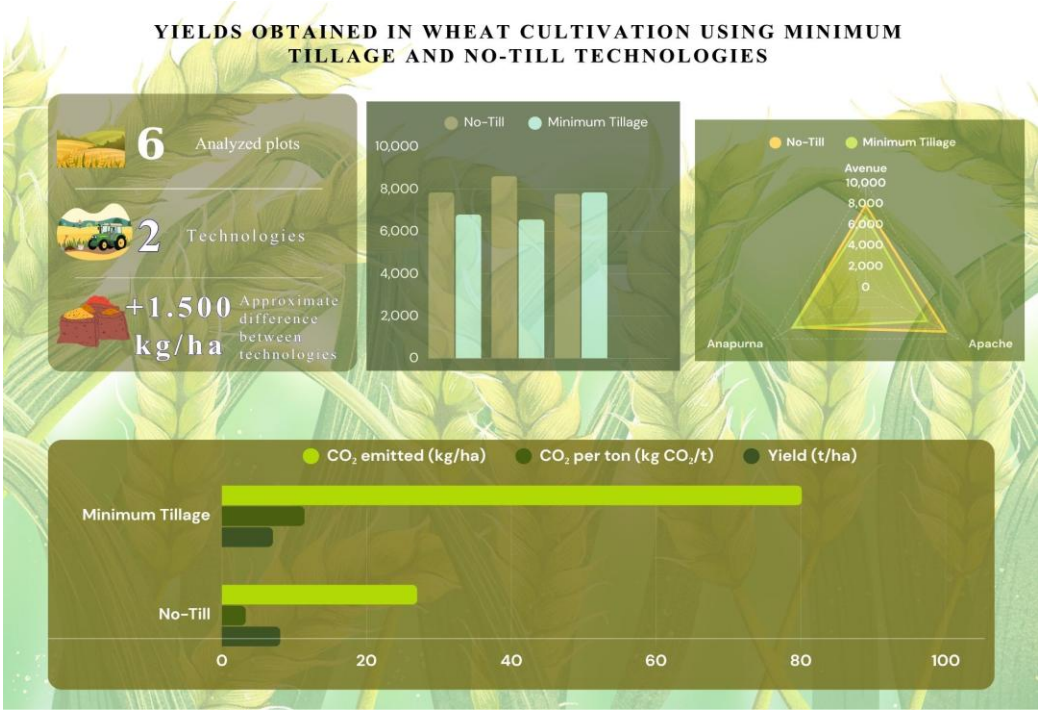
Figure 4. The Effect of Crop Rotation and Fertilization on Soil Organic Matter and Erodibility in a Long-Term Experiment

The assessment of soil fertility in Tormac Commune revealed significant changes in the physical, chemical, and biological properties of the soil, depending on the duration of application of the conservation tillage system (no-till). The analysis was carried out on the cultivated soil profile, under subsistence farming conditions specific to the hilly area, characterized by small land holdings, limited mechanization, and the use of animal traction.

Research Journal of Agricultural Science, 58 (2), 2026; ISSN: 2668-926X;

http://doi.org/10.59463/RJAS.2026.2.11

During the initial phase of no-till implementation, a tendency toward increased soil compaction was observed, associated with a high content of mineralized nitrogen and an incipient accumulation of plant residues on the soil surface. The soil structure exhibited a relatively high content of structural carbon; however, aggregates were still unstable and biological activity remained low.



In the transition phase (1–5 years), the results indicate the onset of organic matter and phosphorus accumulation processes, accompanied by a higher rate of nitrogen immobilization compared to nitrogen mineralization. The continuous input of plant residues favored the gradual recovery of soil structure and the initiation of stable aggregate reconstruction.

The consolidation phase (5–10 years) was characterized by a significant accumulation of plant residues and a marked increase in organic carbon content. Soil water retention capacity increased above the reference level, while microbial biomass began to recover, indicating the resumption of biological activity.

At this stage, the organic matter cycle became slower, and total soil nitrogen was lower than the amount of nitrogen mineralized annually. In the conservation phase (beyond 10–20 years), soils in Tormac Commune exhibited the most favorable characteristics, including high organic carbon content, a stable soil structure, a longer nutrient cycling process, and improved water retention capacity. Biological activity was rebalanced, and although nitrogen and phosphorus availability was lower compared to the initial phases, it was better synchronized with plant requirements due to a more efficient nutrient cycle.

Research Journal of Agricultural Science, 58 (2), 2026; ISSN: 2668-926X;
http://doi.org/10.59463/RJAS.2026.2.11

The results obtained for Tormac Commune highlight the decisive role of the no-till system in the gradual improvement of soil quality, particularly in the context of subsistence agriculture.

Compared to conventional technological systems, characterized by repeated soil tillage and frequent periods without vegetation cover, the no-till system contributes to the reduction of physical degradation processes such as structural breakdown, surface crusting, and secondary compaction.

In the early stages, the positive effects of the system are limited and may even be masked by increased compaction and temporary nitrogen imbalances, which explains farmers' reluctance to adopt this practice. However, the continuous maintenance of conservation practices leads, in the medium and long term, to the restoration of soil structure and aggregate stabilization, thereby reducing the risk of erosion, siltation, and surface runoff.

The progressive accumulation of organic matter plays a key role in improving soil hydrophysical properties by enhancing infiltration and water retention capacity—an aspect of particular importance for the hilly area of Tormac Commune, where rainfall distribution is often uneven. Furthermore, the recovery of biological activity contributes to a more balanced nutrient cycle, reducing dependence on external fertilizer inputs.

In conclusion, the data obtained confirm that the no-till system, when applied consistently and adapted to local conditions, represents a viable solution for the conservation and enhancement of soil fertility in Tormac Commune.

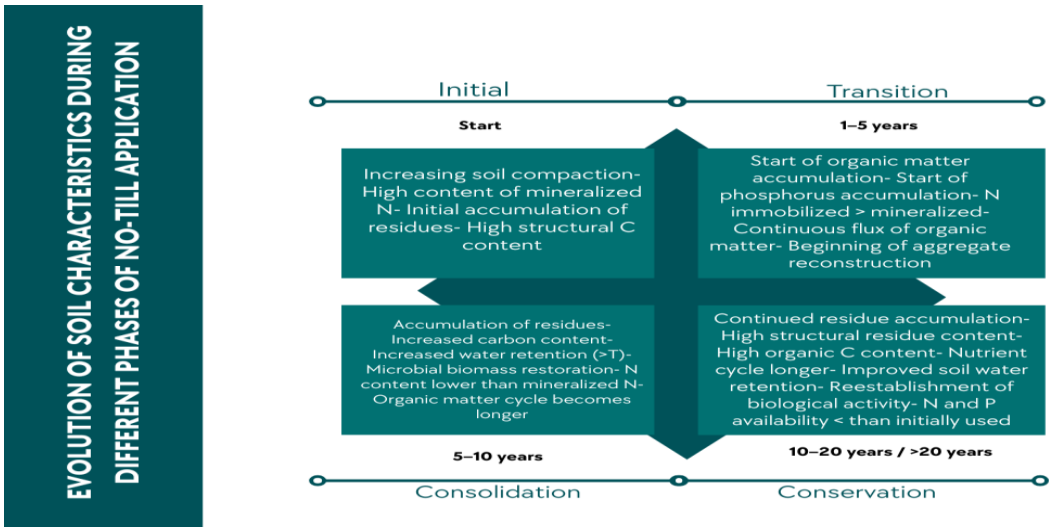


Figure 6. Evolution of soil characteristics during different phases of no-till application

CONCLUSIONS

This study highlights the essential role of soil as a fundamental natural resource for sustaining life, supporting terrestrial ecosystems, and maintaining agricultural production. Soil formation, resulting from the long-term action of natural pedogenetic factors, confers fertility as the defining characteristic that enables soil to supply water, air, and nutrients necessary for

plant growth. In the context of the continuous reduction of arable land per capita, the protection and sustainable use of soil resources have become a major priority.

The analysis of the natural and geomorphological framework of Tormac Commune shows its predominantly agricultural character, with a very high proportion of agricultural land and a limited forested area.

Although geomorphological and pedological conditions are generally favorable for agriculture, intensive land use associated with repeated mechanical operations and frequent periods without vegetation cover promotes soil degradation processes, particularly erosion, compaction, and structural deterioration.

The assessment of soil degradation processes in Tormac Commune revealed the significant impact of conventional agricultural practices on soil quality. Intensive tillage, monoculture systems, and improper use of chemical inputs have led to losses of organic matter, reduced aggregate stability, and an increased risk of erosion. These processes directly affect soil fertility and its long-term productive capacity.

The applied methodology, based on the analysis of physical, chemical, and biological soil properties at different depths, enabled a comprehensive and reliable evaluation of soil conditions in Tormac Commune. Laboratory determinations and statistical analysis highlighted the close relationships between agricultural practices, soil structure, organic matter content, and nutrient dynamics.

The results demonstrate that the application of conservation tillage (no-till) positively influences soil property evolution, although beneficial effects become evident only over time. In the initial stages, temporary negative effects such as increased compaction or nitrogen imbalances may occur; however, consistent long-term application leads to improvements in soil structure, increased organic carbon content, enhanced water regime, and the recovery of biological activity during the transition, consolidation, and conservation phases.

Overall, this study confirms that the adoption of sustainable agricultural practices adapted to local conditions in Tormac Commune is essential for conserving soil fertility and limiting degradation processes.

BIBLIOGRAPHY

AKINBODE, S.O., FOLORUNSO, O., OLUTOBERU, T.S., OLOWOKERE, F.A., ADEBAYO, M., AZEEZ, S.O., HAMMED, S.G., BUSARI, M.A., 2024 – Farmers' Perception and Practice of Soil Fertility Management and Conservation in the Era of Digital Soil Information Systems in Southwest Nigeria. *Agriculture*,

BRADY, N.C., WEIL, R.R., 2008 – *The Nature and Properties of Soils*. 14th Edition, Pearson Prentice Hall, New Jersey, USA.

FLANDERS, J., 2015 – *Status of the World's Soil Resources*. Food and Agriculture Organization of the United Nations, Rome, Italy.

IANOȘ, GH., PUȘCĂ, I., GOIAN, M., 1997 – *Solurile Banatului*. USAMVB Timișoara, Romania (cit. in literatura de profil).

LAL, R., 1992 – *Soil Erosion and Land Degradation: Implications for Agricultural Sustainability*. *Advances in Soil Science*, Volume 19, Springer, New York, USA.

LAL, R., 2019 – *Restoring Soil Quality to Mitigate Soil Degradation*. *Springer Nature*, 2019 (referință generală).

NJOKENG, J.N., NKENGAFAC, N.J., MUBETENEH, T.C., DEH NJI, H., FORGHAB, N.E., 2021 – Soil Fertility Management Practices by Smallholder Farmers in the Bamboutos Mountain Ecosystem. *World Journal of Agricultural Research*, 9(2):58–64. https://doi.org/10.12691/wjar-9-2-3

POPESCU, E., NENCIU, F., VLADUȚ, V., 2022 – A New Strategic Approach Used for the Regeneration of Soil Fertility, in Order to Improve the Productivity in Ecological Systems. *Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering*, Vol.

RANKOANA, S.A., 2023 – Farmers Knowledge on Indigenous Soil Types: A Review. *EHASS Journal*, Vol.4, No.13:1561–1566.

SCHILLACI, C., 2025 – Book Review: *Impact of Agriculture on Soil Degradation II: A European Perspective*. *The Handbook of Environmental Chemistry*, Springer Cham.

SIDLAUSSKAS, G., BERNOTAS, S., 2003 – Some Factors Affecting Seed Yield of Spring Oilseed Rape (Brassica napus L.). *Agronomy Research*, 1(2):229–243, Lithuania.

TITIANU, M., AOSTĂCIOAEI, T.G., MIHU, G.D., CAKPO, S., ȚOPA, D., JITĂREANU, G., 2025 – Assessing the Impact of the No-Tillage System on Soil Physical Parameters and Water Conservation in Corn Crops. *Journal of Applied Life Sciences and Environment*, 58(2):169–188. https://doi.org/10.46909/alse-582171