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PEDOLOGICAL CHARACTERISTICS AND SOIL FERTILITY CONSTRAINTS FOR WHEAT CULTIVATION IN VLADIMIRESCU COMMUNE, ARAD COUNTY, ROMANIA

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Abstract. *Soil fertility and its limiting factors were evaluated in relation to wheat cultivation in Vladimirescu commune, Arad County, Romania. The study integrated pedological and agrochemical descriptions with land-use information to assess soil properties relevant to crop suitability. Soil texture, bulk density, humus content, cation exchange capacity, nutrient availability, and groundwater conditions were examined comparatively. Derived physical and organic matter indicators were calculated for an illustrative reference chernozem profile using documented reference values and a standardized soil layer. The estimated total porosity was 48.3%, indicating a substantial pore volume, although soil aeration also depends on pore size distribution and moisture conditions. The calculated humus stock reached 68.5 tonnes per hectare, while a cation exchange capacity of 31.0 cmol(+)/kg indicated nutrient retention potential. The comparative analysis revealed differences in phosphorus availability between chernozem types, whereas potassium supply was generally moderate to good. Soil compaction, restricted drainage, and shallow groundwater emerged as relevant constraints that may hinder root development and nutrient uptake. These findings indicate that soil fertility management for wheat requires integrated consideration of physical, chemical, and hydrological properties. Appropriate practices include maintaining soil organic matter, preventing compaction, improving drainage where necessary, and adjusting mineral fertilization to soil characteristics and crop requirements.*

Keywords*: soil fertility; wheat; chernozem; soil porosity; nutrient availability*

INTRODUCTION

Soil fertility is a functional expression of the interactions among soil structure, water dynamics, organic matter, nutrient availability and biological activity. For common wheat (*Triticum aestivum* L.), adequate nutrient reserves do not necessarily ensure optimal crop performance when root penetration, oxygen supply or water movement are restricted. Experimental work has demonstrated the sensitivity of wheat root development to mechanical impedance (COLOMBI and WALTER, 2017), while broader syntheses have linked agricultural traffic to deterioration of soil structural functions (MILEUSNIĆ et al., 2022; BELLO-BELLO et al., 2022).

Soil organic matter contributes to aggregate stability and nutrient cycling, although its agronomic effects depend on texture, weather and management (PAGE et al., 2020; BOLINDER et al., 2020; HAO et al., 2023). The availability of phosphorus, in particular, depends not only on total soil reserves but also on sorption and precipitation reactions and the capacity of the root system to acquire soluble forms (HAN et al., 2022; JAMAL et al., 2023). These interactions justify evaluating physical, chemical and hydrological indicators jointly rather than classifying agricultural suitability from a single soil property.

Vladimirescu commune is situated in the Arad Plain, within the lower Mureș landscape. Its agricultural land occurs across loess-like deposits, fine-textured materials and alluvial settings characterized by variable groundwater influence. The General Urban Plan describes several contrasting soil groups, including typical and cambic chernozems, hydromorphic soils and alluvial soils (VLADIMIRESCU LOCAL AUTHORITY, GENERAL URBAN

PLAN). These descriptions provide a relevant territorial basis for considering soil fertility limitations affecting wheat cultivation. Recent research conducted in the north-western sector of the Arad Plain has also highlighted the diversity of soil types and the importance of adapting agricultural management practices to local pedological and hydrological conditions (NIȚĂ et al., 2026).

The objective of this study was to synthesize documentary pedological information for Vladimirescu commune, calculate transparently defined reference indicators for typical chernozem, and interpret the principal constraints on effective soil fertility for wheat. The contribution consists of an integrated, locally focused assessment; it does not represent a new experimental survey or a quantitative yield prediction.

MATERIAL AND METHODS

The study area comprises the administrative territory of Vladimirescu commune, Arad County, including the settlements of Vladimirescu, Horia, Cicir and Mândruloc. The assessment was documentary and analytical in nature and relied on the General Report of the commune's General Urban Plan, approved in 2015, and the Local Development Strategy 2021–2027. Land-use structure was derived from 2014 records reproduced in the local strategy, which cites the INS TempoOnline database (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015; 2021).

Information was extracted from local pedological descriptions on soil units, parent materials, texture, compaction, porosity, humus content, soil reaction, carbonates, cation exchange capacity, base saturation, nitrogen, phosphorus and potassium supply, and moisture conditions. Comparisons were made between soil types and, where supported by the documentation, between genetic horizons. Traditional soil-unit names (humic gley soils - "lăcoviști" according to the Romanian soil classification) were retained for consistency with the local source, without implying automatic equivalence with current taxonomic classes.

The share of each land-use category was calculated as the category area (S_i, ha) divided by the reference area (S_t, ha): $P_i = (S_i / S_t) \times 100$. Percentages were rounded to two decimal places. The area of non-agricultural land was obtained by summing its individual categories because the source document contains a discrepancy between the printed subtotal and the sum of its components.

For typical chernozems, the total porosity range was estimated from the bulk density range reported in the General Urban Plan using $P_t = [1 - (\rho_\beta / \rho_s)] \times 100$, where ρ_β denotes soil bulk density and ρ_s particle density. A conventional particle density of 2.65 g/cm³ was adopted. This calculation is a mathematical transformation of a documentary range, not a laboratory determination. The bulk density unit is incorrectly printed in the General Urban Plan ("gr./mc."); interpreting the reported numerical range as g/cm³ is consistent with the expected magnitude of bulk density in mineral soils and is explicitly identified here as a data-processing decision.

Soil reaction classes and nutrient supply categories were reported qualitatively, as stated in the local documentation. No pH values, nutrient concentrations, crop yields or fertilisation treatments were generated. Published findings on soil structure and nutrient use were employed solely to interpret pedological and agronomic mechanisms, without numerically transferring those results to Vladimirescu commune (HAN, WHITE and CHENG, 2022; YANG et al., 2022; FRENE, PANDEY and CASTRILLO, 2024).

RESULTS AND DISCUSSIONS

Land use and distribution of the main soil units

According to the 2014 land-use records, Vladimirescu commune covers 12,230 ha, of which 8,700 ha are agricultural land and 8,519 ha are arable land. Thus, arable land accounts for 69.66% of the administrative area and 97.92% of the agricultural land. The predominance of arable use warrants an analysis of edaphic constraints relevant to wheat; however, these proportions describe the structure of land use, not the area actually cultivated with wheat (PRIMĂRIA COMUNEI VLADIMIRESCu, 2021).

Table 1

Land-use structure of Vladimirescu commune in 2014

Land-use category	Area (ha)	Share of total (%)
Arable land	8,519	69,66
Other agricultural land	181	1,48
Total agricultural land	8,700	71,14
Non-agricultural land	3,530	28,86
Total administrative area	12,230	100,00

Note: *Data adapted from Primăria Comunei Vladimirescu (2021), Table 13. "Other agricultural land" comprises pastures (153 ha), hayfields (9 ha), orchards (13 ha) and vineyards (6 ha). The original source prints the non-agricultural subtotal as 3,500 ha, although the sum of its components is 3,530 ha; the latter is used here.*

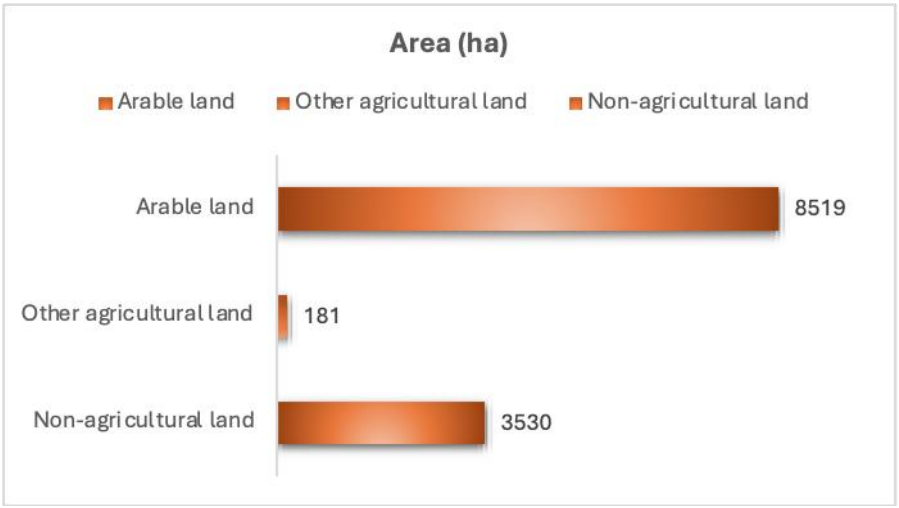


Figure 1. Distribution of the administrative area by land-use category; 2014 data adapted from Primăria Comunei Vladimirescu (2021)

The pedological cover described in the General Urban Plan includes typical and cambic chernozems, humic gley soils, gleyic soils and alluvial soils. Chernozems occupy extensive areas and constitute an important agricultural resource. Soils with stronger groundwater influence occur in low-lying and depressional sectors, whereas alluvial deposits are associated with the Mureș floodplain. This distribution reflects different soil-forming

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environments, with consequences for soil physical and chemical properties (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

Physical characteristics, humus content and structural condition

Typical chernozems developed on loess-like deposits, loams and clays, and have predominantly loamy to clay-loamy textures, becoming lighter at depth. The local documentation describes them as relatively weakly compacted, with good porosity and good to moderate permeability. Humus content of 2.0–3.0% is reported for the Am horizon, decreasing with depth (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

The reported numerical bulk density range of 1.33–1.41, interpreted as g/cm³ in accordance with the methodological note, corresponds to a calculated total porosity of 46.8–49.8% when the conventional particle density of 2.65 g/cm³ is used. The minimum porosity corresponds to the maximum bulk density, and vice versa. This range describes only the total volumetric proportion of pores; it does not quantify micropores, macropores or plant-available water.

Cambic chernozems exhibit more variable textures, from sandy loam to clay, and are described as having more pronounced compaction, higher bulk density and lower porosity. Humus content is below 3% in the Am horizon and approximately 1.5% in the Bv horizon. This vertical differentiation highlights the importance of the surface horizon for biological functioning and structural stability. Nevertheless, the local source ranks cambic chernozems among the most fertile soils in the area; compaction should therefore be interpreted as a specific potential constraint rather than evidence of generally low fertility (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

Table 2

Summary of documented soil properties in Vladimirescu commune

Soil unit	Physical and organic properties	Relevant characteristic
Typical chernozem	Loamy to clay-loamy texture; humus in Am horizon 2–3%; porosity described as good	Good to moderate permeability; arable use
Cambic chernozem	Sandy loam to clay texture; humus in Am below 3%, in Bv ≈1.5%; pronounced compaction	Low to very low porosity; variation with depth
Humic gley soils (Lăcoviști)	Variable texture; humus 3–8%; groundwater influence	Unfavourable water–air regime under wet conditions
Gleyic soil	Medium to very fine texture; humus 1–3%	Excess moisture and reduction processes
Alluvial soil	Texture and humus vary according to deposits	Suitability depends on drainage and parent material

Note: Summary adapted from the General Urban Plan report (Primăria Comunei Vladimirescu, 2015). The categories do not represent measured averages for the entire commune.

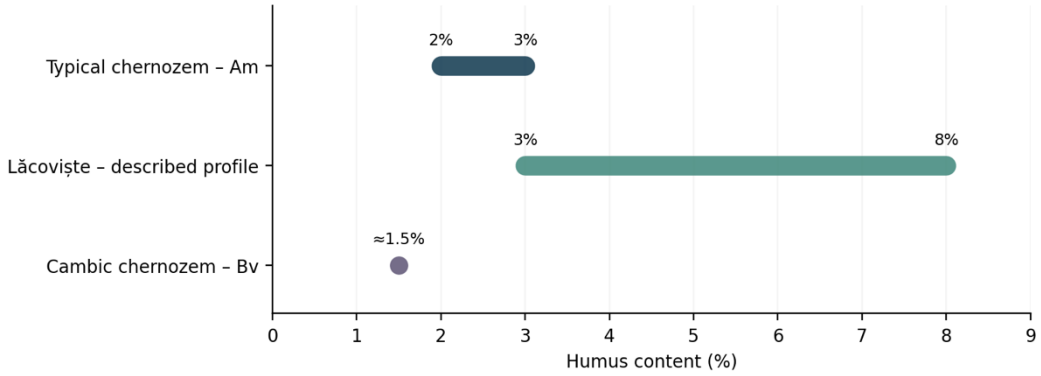


Figure 2. Humus content ranges reported in the General Urban Plan; the symbol for the Bv horizon denotes an approximate value

The agronomic relevance of humus extends beyond its percentage concentration. Organic matter supports particle aggregation, water retention and nutrient dynamics. Published reviews highlight the roles of crop-residue management, organic fertilisation and conservation practices in soil organic carbon dynamics, with responses depending on initial conditions and cropping systems (ABBAS et al., 2020; BOLINDER et al., 2020; PAGE, DANG and DALAL, 2020; JIN et al., 2020; HAO et al., 2023). These findings support a functional interpretation of local values, without implying that quantitative effects reported in experiments elsewhere have also been observed in Vladimirescu.

Table 3

Derived physical indicator for typical chernozem

Interpreted bulk density (g/cm³)	Estimated total porosity (%)	Status of value
1.33	49.8	Calculated upper limit of range
1.41	46.8	Calculated lower limit of range

The bulk density numerical range is taken from the General Urban Plan (2015), where the original unit is printed inconsistently. Porosity was calculated as $P_t = [1 - (\rho_\beta/2.65)] \times 100$; the values are not original analytical measurements.

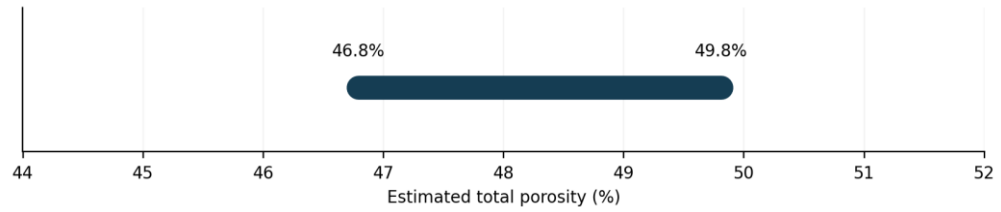


Figure 3. Total porosity range estimated from the bulk density limits reported in the General Urban Plan, assuming that these are expressed in g/cm³ and using $\rho_s = 2.65$ g/cm³

Compaction cannot be characterized by a single soil property: its effects on root penetration also depend on texture, moisture content and mechanical resistance to penetration.

Recent literature indicates that wheat root responses to soil densification depend on these conditions, while within-field variation in bulk density limits spatial extrapolation (MILEUSNIĆ et al., 2022; YANG et al., 2022; YU et al., 2024; FRENE, PANDEY and CASTRILLO, 2024; PERALTA OGOREK et al., 2025; BELLO-BELLO et al., 2022). Consequently, low porosity described for a soil unit indicates a functional risk rather than demonstrating uniformly compacted conditions across all associated fields.

Soil reaction, the exchange complex and nutrient supply

For cambic chernozems, the General Urban Plan reports slightly acidic to neutral conditions in the Am and Bv horizons and slightly to strongly alkaline conditions in the C horizon. Carbonates are leached from the upper part of the profile and accumulate in the C horizon, where $CaCO_3$ content is reported at 4–16%. In some profiles influenced by groundwater, pronounced alkalinity may occur in the lower horizon. These characteristics document vertical chemical differentiation without allowing a single pH value to be assigned to the entire soil unit (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

In typical chernozems, the cation exchange capacity of the Am horizon is 30–32 meq/100 g soil, numerically equivalent to 30–32 cmol(+)/kg. In cambic chernozems, base saturation is approximately 90% in the Am horizon and 95% in the Bv horizon. These indicators describe the exchange complex and its capacity to retain cations, but they do not directly measure the amount of potassium or nitrogen available to wheat (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

Plant-available phosphorus is described as moderately supplied in typical chernozems and poorly to moderately supplied in cambic chernozems; exchangeable potassium is assessed as moderate to good and good, respectively. Typical chernozems are also reported to have a moderate total nitrogen content in the Ap horizon. These categories originate from the local documentation and are not converted into P-AL or K-AL concentrations, because the analytical method and individual values are not specified in the material examined (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

Phosphorus availability depends on soil reaction, adsorption surfaces, chemical speciation and adsorption–desorption and precipitation–dissolution equilibria. Accordingly, the presence of carbonates and alkaline reaction in the C horizon may influence phosphate dynamics but do not, by themselves, demonstrate phosphorus deficiency in the arable layer. The relevance of these processes and of phosphorus management in wheat is supported by studies of soils with contrasting reactions and fertilization in calcareous soils (HAN, WHITE and CHENG, 2022; BOUBEKRI et al., 2023; JAMAL et al., 2023).

Distinguishing between total nutrient forms, extractable fractions and nutrients actually taken up by plants is also important for nitrogen. Reviews of nitrogen fertilisation efficiency in wheat show that crop response depends on soil properties, application rate and timing, supporting the need for field-specific agrochemical assessment (YOKAMO et al., 2023).

Soil water–air regime, affected soil types and constraints for wheat

Humic gley soils (locally referred to as “lăcoviști” in the Romanian soil classification) are described in depressions and abandoned valleys, where groundwater frequently occurs at 1.0–1.5 m depth and sometimes closer to the surface. Humus content of 3–8% and nutrient supply classified as good or very good coexist with an unfavourable soil water–air regime. This contrast illustrates that the chemical fertility potential of a soil does not guarantee agricultural suitability when excess water restricts gas exchange and root functioning (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

Gleyic soils are likewise affected by excess moisture and reduction processes; they exhibit a more acidic reaction and a humus content of 1–3%. Base saturation is described as lower, at approximately 55–80%. In contrast, alluvial soils vary according to the nature of their deposits, exhibit neutral to slightly alkaline reaction, and may offer favourable agricultural conditions where the water regime supports crop growth (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015).

These characteristics need to be interpreted jointly for wheat cultivation. In cambic chernozems, compaction and reduced porosity may restrict root exploration under certain moisture conditions; in areas influenced by groundwater, insufficient aeration may impair water and nutrient uptake. In typical chernozems, moderate plant-available phosphorus supply warrants agrochemical testing before fertilisation is prescribed but does not demonstrate a widespread nutrient deficiency (PRIMĂRIA COMUNEI VLADIMIRESCU, 2015; YU et al., 2024; PERALTA OGOREK et al., 2025).

Table 4

Main limiting factors identified in local pedological documentation

Soil unit	Documented characteristic	Agronomic implications for wheat
Typical chernozem	Humus 2–3%; available phosphorus: moderate	Organic matter conservation; fertilisation based on soil testing
Cambic chernozem	More pronounced compaction; low porosity; available P: poor to moderate	Assessment of compaction and nutrient availability
Humic gley soil	Groundwater at 1.0–1.5 m; unfavourable water–air regime	Constraints due to excess water during wet periods
Gleyic soil	Excess moisture; more acidic reaction; humus 1–3%	Specific hydrological and chemical constraints
Alluvial soil	Properties depend on deposits and drainage	Site-specific suitability assessment

Note: Interpretative synthesis based on the Vladimirescu General Urban Plan (2015). The agronomic relationships indicate plausible implications of the documented characteristics, not effects quantified experimentally in this study.

The results confirm that pedological constraints are not uniform across the commune: where chemical properties are relatively favourable, groundwater conditions and soil physical status may limit effective fertility. Farm-level decisions should therefore complement territorial descriptions with the location of the relevant soil unit, up-to-date agrochemical analyses and an assessment of drainage conditions. These requirements do not diminish the usefulness of the regional characterisation; they define the appropriate scale for applying its conclusions.

CONCLUSIONS

In Vladimirescu commune, arable land occupied 8,519 ha, corresponding to 69.66% of the administrative area, according to 2014 land-use records. This share highlights the importance of pedological characterization for agricultural land use without indicating the area devoted specifically to wheat.

Typical chernozems are characterized by predominantly loamy to clay-loamy texture, 2–3% humus in the Am horizon, porosity described as good, and a cation exchange capacity of 30–32 cmol(+)/kg. Based on the reported bulk density range and an assumed particle density of 2.65 g/cm³, total porosity was estimated at 46.8–49.8%, subject to the interpretation of the original unit in the General Urban Plan.

Cambic chernozems exhibit a soil reaction gradient from slightly acidic to neutral in the Am and Bv horizons to alkaline in the C horizon, where $CaCO_3$ content reaches 4–16%. More pronounced compaction and poor to moderate plant-available phosphorus supply warrant attention in wheat management, without negating the high agricultural potential attributed to these soils by the local documentation.

In soil units affected by excess moisture, especially and gleyic soils, constraints related to soil water and aeration may outweigh the advantages of higher organic matter content. Land suitability for wheat should therefore be assessed by jointly considering physical, chemical and hydrological properties and basing agricultural management decisions on the characteristics of individual fields.

BIBLIOGRAPHY

ABBAS, F., HAMMAD, H. M., ISHAQ, W., FAROOQUE, A. A., BAKHAT, H. F., ZIA, Z., FAHAD, S., FARHAD, W., CERDÀ, A. (2020). A review of soil carbon dynamics resulting from agricultural practices. Journal of Environmental Management, 268, 110319. https://doi.org/10.1016/j.jenvman.2020.110319

AIOANEI, DENISA MARIA, MANEA, D. N., IENCIU, ANIȘOARA AURELIA (2022). Current measures to combat segetal species in the autumn wheat crop. Research Journal of Agricultural Science, 54(3), 3–11.

BELLO-BELLO, E., LÓPEZ-ARREDONDO, D., RICO-CHAMBRÓN, T. Y., HERRERA-ESTRELLA, L. (2022). Conquering compacted soils: uncovering the molecular components of root soil penetration. Trends in Plant Science, 27(8), 814–827. https://doi.org/10.1016/j.tplants.2022.04.001

Bolinder, M. A., Crotty, F., Elsen, A., Frąc, M., Kismányoky, T., Lipiec, J., Tits, M., Tóth, Z., Kätterer, T. (2020). The effect of crop residues, cover crops, manures and nitrogen fertilization on soil organic carbon changes in agroecosystems: a synthesis of reviews. Mitigation and Adaptation Strategies for Global Change, 25, 929–952. https://doi.org/10.1007/s11027-020-09916-3

BOUBEKRI, K., SOUMARE, A., LYAMLOULI, K., OUHDOUCH, Y., HAFIDI, M., KOUISNI, L. (2023). Improving the efficiency of phosphate rocks combined with phosphate solubilizing *Actinomycetota* to increase wheat growth under alkaline and acidic soils. Frontiers in Plant Science, 14, 1154372. https://doi.org/10.3389/fpls.2023.1154372

COLOMBI, T., WALTER, A. (2017). Genetic diversity under soil compaction in wheat: Root number as a promising trait for early plant vigor. Frontiers in Plant Science, 8, 420. https://doi.org/10.3389/fpls.2017.00420

FRENE, J. P., PANDEY, B. K., CASTRILLO, G. (2024). Under pressure: elucidating soil compaction and its effect on soil functions. Plant and Soil, 502, 267–278. https://doi.org/10.1007/s11104-024-06573-2

HAN, Y., WHITE, P. J., CHENG, L. (2022). Mechanisms for improving phosphorus utilization efficiency in plants. Annals of Botany, 129(3), 247–258. https://doi.org/10.1093/aob/mcab145

HAO, X., ABOU NAJM, M., STEENWERTH, K. L., NOCCO, M. A., BASSET, C., DACCACHE, A. (2023). Are there universal soil responses to cover cropping? A systematic review. Science of the Total Environment, 861, 160600. https://doi.org/10.1016/j.scitotenv.2022.160600

JAMAL, A., SAEED, M. F., MIHOUB, A., HOPKINS, B. G., AHMAD, I., NAEEM, A. (2023). Integrated use of phosphorus fertilizer and farmyard manure improves wheat productivity by improving soil quality and P availability in calcareous soil under subhumid conditions. Frontiers in Plant Science, 14, 1034421. https://doi.org/10.3389/fpls.2023.1034421

JIN, Z., SHAH, T., ZHANG, L., LIU, H., PENG, S., NIE, L. (2020). Effect of straw returning on soil organic carbon in rice–wheat rotation system: a review. Food and Energy Security, 9(2), e200. https://doi.org/10.1002/fes3.200

NIȚĂ, L, LAȚO, I. K., CRISTA, F., RADULOV, ISIDORA, BERBECEA, ADINA, LAȚO, ALINA, CRISTA, LAURA, NIȚĂ, SIMONA (2026). Sustainable management of soil resources in the north-western area of the Arad Plain. Research Journal of Agricultural Science, 58(2), 337–346.https://doi.org/10.59463/RJAS.2026.2.41

MILEUSNIĆ, Z. I., SALJNIKOV, E., RADOJEVIĆ, R. L., PETROVIĆ, D. V. (2022). Soil compaction due to agricultural machinery impact. Journal of Terramechanics, 100, 51–60. https://doi.org/10.1016/j.jterra.2021.12.002

PAGE, K. L., DANG, Y. P., DALAL, R. C. (2020). The ability of conservation agriculture to conserve soil organic carbon and the subsequent impact on soil physical, chemical, and biological properties and yield. Frontiers in Sustainable Food Systems, 4, 31. https://doi.org/10.3389/fsufs.2020.00031

PERALTA OGOREK, L. L., GAO, Y., FARRAR, E., PANDEY, B. K. (2025). Soil compaction sensing mechanisms and root responses. Trends in Plant Science, 30(5), 565–575. https://doi.org/10.1016/j.tplants.2024.10.014

YANG, P., REIJNEVELD, A., LERINK, P., QIN, W., OENEMA, O. (2022). Within-field spatial variations in subsoil bulk density related to crop yield and potential CO_2 and N_2O emissions. CATENA, 213, 106156. https://doi.org/10.1016/j.catena.2022.106156

YOKAMO, S., IRFAN, M., HUAN, W., WANG, B., WANG, Y., ISHFAQ, M., LU, D., CHEN, X., CAI, Q., WANG, H. (2023). Global evaluation of key factors influencing nitrogen fertilization efficiency in wheat: a recent meta-analysis (2000–2022). Frontiers in Plant Science, 14, 1272098. https://doi.org/10.3389/fpls.2023.1272098

YU, C., MAWODZA, T., ATKINSON, B. S., ATKINSON, J. A., STURROCK, C. J., WHALLEY, R., HAWKESFORD, M. J., COOPER, H., ZHANG, X., ZHOU, H., MOONEY, S. J. (2024). The effects of soil compaction on wheat seedling root growth are specific to soil texture and soil moisture status. Rhizosphere, 29, 100838. https://doi.org/10.1016/j.rhisph.2023.100838

*** PRIMĂRIA COMUNEI VLADIMIRESCU (2015). Planul Urbanistic General al comunei Vladimirescu. Memoriu general. https://www.primariavladimirescu.ro/wp-content/uploads/2020/04/02_Memoriu-General-PUG-Comuna-Vladimirescu.pdf

*** PRIMĂRIA COMUNEI VLADIMIRESCU (2021). Strategia de dezvoltare locală a comunei Vladimirescu 2021–2027. https://www.primariavladimirescu.ro/wp-content/uploads/2021/02/STRATEGIA-DE-DEZVOLTARE-LOCALA-2021-2027_Vladimirescu.pdf