Research Journal of Agricultural Science, 57 (2), 2025; ISSN: 2668-926X

http://doi.org/10.59463/RJAS.2025.2.28

SOIL CHARACTERISTICS FROM BELIU AREA, ARAD COUNTY

Nicoleta Maria VICAR, T. DENUȚ, Corina Maria PELICI, I. GAICA, D. D. DICU, Isidora RADULOV

University of Life Sciences "King Mihai I" from Timisoara, Timișoara, 300645, Romania

Corresponding author:danieldicu@usvt.ro

Abstract. *This paper presents a theoretical analysis of the soils in the Beliu area, located in Arad County, western Romania. The main objective is to evaluate the pedological and agrochemical characteristics of the local soil types, with emphasis on their structure, texture, and capacity to support various agricultural crops. The commune of Beliu, composed of six villages and situated near the Codru-Moma Mountains, occupies a total area of 9,272 hectares, of which 5,570 hectares are designated for agricultural use. The region is characterized by a diverse relief and a wide range of soil-forming factors such as geology, climate, and human activity, which contribute to the complexity of its soil cover. The predominant soil types identified in the area include alluviosols, eutricambosols, preluvosols, luvosols, vertosols, gleysols, and anthrosols. These soils present medium to high fertility, favorable for crops such as cereals, legumes, and fruit trees. However, certain limiting factors, such as poor drainage in gleysols or compaction in vertosols, may require specific soil management practices. The study also highlights the importance of applying appropriate fertilization and irrigation strategies to optimize yields and maintain soil sustainability. Through the synthesis of existing pedological data and literature sources, this research aims to provide a comprehensive understanding of the relationship between soil typology and agricultural productivity. The findings can support more informed decision-making in land use planning and sustainable agricultural development in the region of Beliu.*

Keywords*: soil, agrochemical characteristics, structure, soil texture, land, fertility.*

INTRODUCTION

Soil is a natural body with its own internal organization, resulting from the action of bioclimatic factors on the parent material at the Earth's surface. It may or may not be influenced by human activity and is characterized by a triphasic composition—solid, liquid, and gaseous—a porous and polydisperse structure of the solid phase, vertical horizon differentiation, the presence of living organisms, and a continuous and complex dynamic. These features not only define soil as a historical-natural body, but also assign it the essential role of supporting life, as it serves as the environment where food is produced for all living organisms on Earth, whether terrestrial or aquatic.

Land is defined as a geographically bounded area characterized by a set of specific environmental conditions that determine its suitability for various plants, whether cultivated or spontaneous. These conditions influence the ways in which land is used, managed, and protected for agricultural or forestry purposes.

Soil fertility refers to its capacity to simultaneously and consistently supply plants with nutrients and water in quantities sufficient to meet their physiological and biochemical needs for growth and development. This property is fundamental in assessing soil quality and is influenced by its composition, formation and evolution stages, and the biochemical processes occurring within it.

The agrochemical characteristics, structure, and texture of the soil are key factors in determining the quality and productivity of agricultural land. Agrochemical characteristics

http://doi.org/10.59463/RJAS.2025.2.28

refer to the content of essential nutrients for plants (such as nitrogen, phosphorus, and potassium), the soil pH, which affects nutrient uptake, and the cation exchange capacity, which reflects the soil's ability to retain and supply useful ions to plants. Soil structure involves the arrangement of particles in a way that allows for proper air and water circulation, which supports root system health. Soil texture, defined by the proportions of sand, silt, and clay, determines water retention, permeability, and the mechanical behavior of the soil during agricultural operations. The interaction between these factors directly influences the soil's ability to support plant growth and crop productivity.

MATERIAL AND METHODS

The cadastral territory of Beliu commune, Arad County, covers a total area of 9,272 hectares, of which 5,570 hectares (approximately 60%) represent agricultural land, while the remaining 3,702 hectares (40%) are occupied by forests, water bodies, and other functional categories. Beliu Commune, located in Arad County, Crișana region, Romania, is composed of six villages: Beliu (the administrative center), Benești, Bochia, Secaci, Tăgădău, and Vasile Goldiș. The locality lies at the foothills of the Codru-Moma Mountains, near Pleșu Peak, in a transitional area between the Western Hills and the Pannonian Plain, approximately 77 km from the city of Arad. The locality is located in western Romania, in the northern part of the Sebiș Depression, at the junction between the Criș Plain and the Codru-Moma Mountains, benefiting from varied landforms and a well-developed hydrographic network.

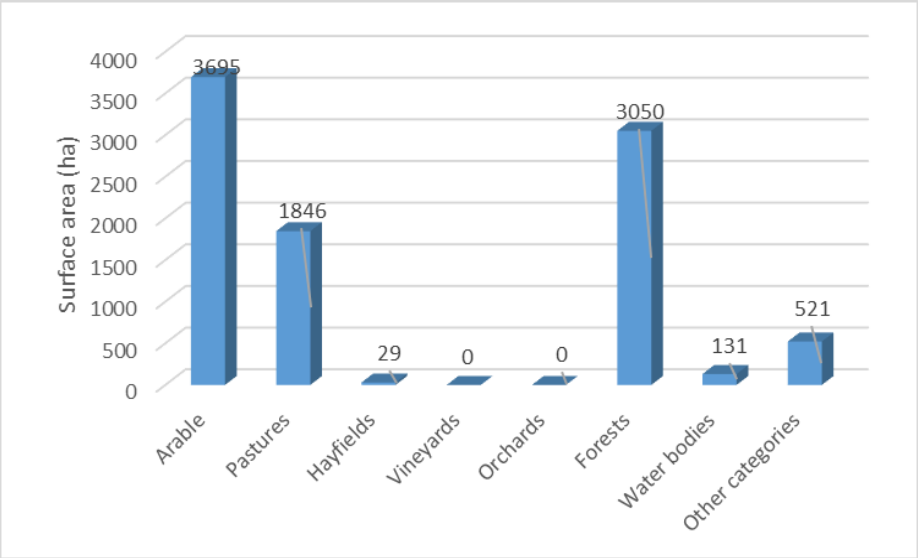

Figure 1. Land categories of use from Beliu (ha)

Soil quality in the pedological context of the Beliu area, Arad County, encompasses the full set of fundamental soil properties and characteristics determined through topographic, geological, geomorphological, pedological, and agrochemical analyses. These defining traits cause any given parcel in this region to differ from others, offering higher or lower agricultural potential depending on soil nature and local factors.

http://doi.org/10.59463/RJAS.2025.2.28

In accordance with FAO terminology, "land quality" is understood as the composite of factors that influence the sustainable use of land for agricultural purposes. The term **"land"** refers to soils, landforms, climate, hydrology, vegetation, and fauna, and also includes land-management practices such as soil improvements and management technologies employed to optimize the area's agricultural potential.

The investigation of ecopedological conditions was carried out in accordance with the Methodology for the Elaboration of Pedological Studies (vols. I–III, ICPA 1987) and the Romanian System of Soil Taxonomy (SRTS 2012, ICPA Bucharest), supplemented by the applicable methodological norms.

RESULTS AND DISCUSSIONS

The northern sector of the Beliu area, Arad County, lies within a geographical region characterized by a diversity of landforms, where plains and depressions alternate with mountain units—typical of the Crișana region. Unlike the Banat relief, which forms a large amphitheater open to the northwest, the terrain in the Beliu area is more fragmented, shaped by both natural factors and long-term human interventions.

To the east, Beliu is dominated by the Codru-Moma Mountains, while to the south it transitions into the plain, linked to the mountains by a series of peripheral hills. Major relief units include the Codru-Moma Mountains and their foothill ridges, intramontane depressions, piedmont plains, and the floodplain of the Crișul Alb River. The landscape is marked by extensive forest cover, lending the region a largely untransformed mountainous character.

Geologically, the Beliu area rests on a Carpathian substrate of crystalline and sedimentary rocks, displaying high petrographic diversity. Paleozoic crystalline schists and granitic rocks are interspersed with younger sedimentary sequences such as sandstones and clays. The region's tectonic framework is complex, featuring uplifted horst blocks and accompanying depressions formed through tectonic fragmentation and erosion.

The hydrographic network is dominated by the Crișul Alb and Mureș rivers—direct tributaries of the Tisza—whose courses organize a series of catchments that play a key role in sculpting the local landscape.

Climatically, Beliu falls within a temperate continental zone with oceanic and sub-Mediterranean influences, characterized by mean annual temperatures between 10 °C and 11 °C and average annual precipitation of 550–600 mm. These climatic conditions, together with the region's geomorphological and geolithological factors, contribute to Beliu's varied landscape and its significant agricultural potential.

The vegetation found within the studied area is typical of the transitional zone between steppe and forest-steppe (particularly on lands affected by hydromorphism).

As a result of its geographical location in the former Mureș River delta, at the intersection between the low plain and the hills, the studied territory presents varied geological and physico-geographical conditions, closely linked to the local base level of the Depression, which has conditioned the formation of a complex soil cover.

Thus, in close correlation with the variety of geomorphological factors that determine the existence of diversified relief units, the geolithological factors that have led to a wide diversity of parent materials, as well as climatic and hydrological conditions and various anthropogenic interventions—starting with the first human activities from the pre-Roman period and continuing with hydro-improvement works initiated more than 250 years ago—the main processes of soil formation and evolution within the researched area have developed at

http://doi.org/10.59463/RJAS.2025.2.28

different intensities. As a result, various genetic soil types (either related or completely different) have formed and continue to evolve.

In close connection with the variety of geomorphological factors that determine the existence of diversified relief units, as well as geolithological factors that have led to a great diversity of parent materials, and climatic or hydrological factors, along with various anthropogenic interventions within the studied area, the current edaphic cover is represented by: alluviosols, eutric cambisols, preluvosols, luvisols, vertisols, gleysoils, and anthrosols (Fig. 2). These soil types reflect, through their geobiochemical and morphological properties, the main defining and determining characteristics for the growth and fruiting of the main cultivated plants. These characteristics are expressed through evaluation scores (bonitation notes), based on which the lands were classified into quality classes from I to V, for an arable area of 3,695 ha and a pasture area of 1,846 ha (Tab. 1).

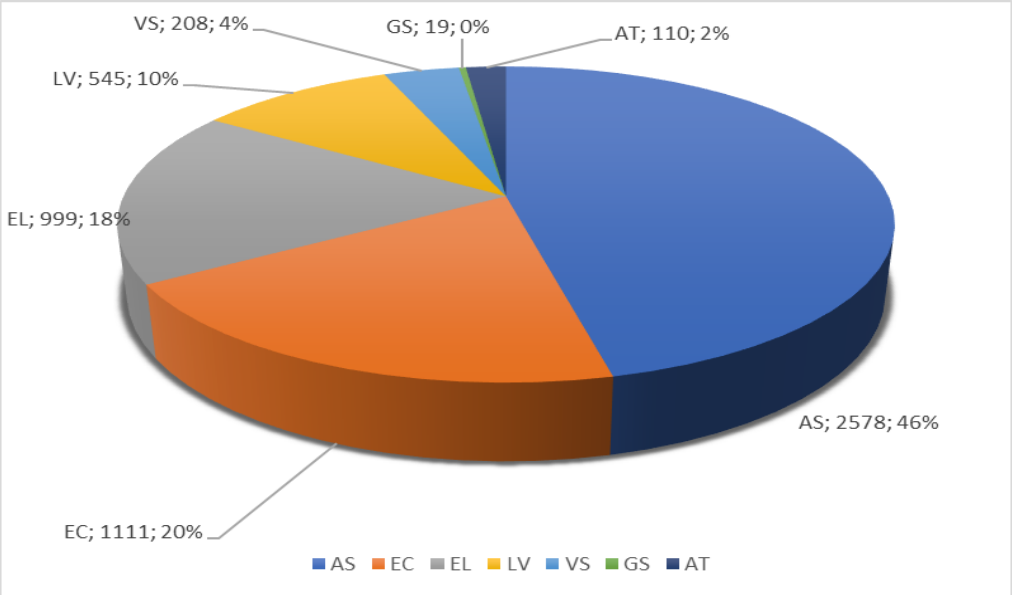

Figure 2. Soil types in Beliu locality, Arad county.(ha)

Alluviosols develop on sediments deposited by flowing water, especially within river floodplains and on their terraces. These soils are characterized by a thick layer of fluvial material (sand, silt, clay) with a loose structure that promotes air and water circulation. Due to the continual input of organic matter and nutrients from the alluvium, they exhibit high natural fertility and are exceptionally well suited to cereal and legume cultivation.

Eutric cambisols are brown earth soils primarily formed on clayey and sandy bedrock, commonly found in hilly and plain regions. They contain moderate to high levels of calcium and other base cations, imparting a near-neutral to slightly alkaline pH and a favorable cation-exchange capacity. These properties, combined with a reasonable humus content, make them ideal for crops such as wheat, barley, and rapeseed.

Preluvosols result from the processes of eluviation and illuviation, where fine materials and migrating colloidal particles accumulate in the lower horizons. The upper layer may be poorer in nutrients and organic matter, while the illuvial horizon (B horizon) becomes

http://doi.org/10.59463/RJAS.2025.2.28

enriched in clay and cations. To maintain their agricultural potential, preluvosols require agronomic measures such as fertilization and soil tillage to improve structure and nutrient reserves.

Luvisols are characterized by a clay illuvial horizon (Bt horizon), which gives the soil a clay-rich texture in depth and an increased water retention capacity. They typically develop under deciduous forests, where the organic matter input and biological activity are high. Luvisols exhibit good fertility and moderate pH levels, making them suitable for crops requiring moderate water retention, such as soybean and sunflower.

Vertisols are distinguished by their high content of expandable clay, which causes the soil to shrink and swell depending on moisture levels. This property creates wide cracks during dry periods, followed by clogging during rainfall, affecting land stability and tillage. Despite the mechanical difficulties in working the soil, vertisols can have high natural fertility and can support grass crops, provided that moisture is properly managed.

Gleysols form under conditions of permanent or periodic excess water (hydromorphism), which inhibits the aerobic decomposition of organic matter. This results in an upper horizon rich in organic matter, with gray and greenish colors due to iron reduction. To be efficiently used in agriculture, gleysols require drainage systems and amendments to prevent root asphyxiation and to restore adequate aeration.

Anthrosols are soils that have been deeply modified by human activities (intensive agriculture, construction, irrigation), which gives them properties that can significantly differ from natural soils. They may include deposits of construction materials, alterations to the soil profile through leveling, and additions of organic or mineral materials. Depending on the degree of transformation, anthrosols can either exhibit enhanced fertility (in cases of manure and compost additions) or problems such as compaction and chemical imbalances that require specific agronomic management.

Table 1

Quality classes for ARABLE and PASTURE use category (ha).

Category of use	Surface	Class I (81-100)	Class a II-a (61-80)	Class a III-a (41-60)	Class a IV-a (21-40)	Class a V-a (0-20)
Arable (ha)	3695	123	703	1865	683	321
Pasture (ha)	1846	845	246	719	36	-

In accordance with the bonitation indicator values corresponding to the main land use categories identified at the time of mapping (PS – pasture, FN – hay meadow, AR – arable land), bonitation scores were calculated and subsequently used to classify the land into quality classes, as stipulated by Order no. 278/2011 of the Ministry of Agriculture and Rural Development (MADR). The classification was performed by grouping bonitation scores in intervals of 20 points, as follows:

- Class I: 81–100 points
- Class II: 61–80 points
- Class III: 41–60 points
- Class IV: 21–40 points
- Class V: 1–20 points

For arable land, the bonitation score was determined as the arithmetic mean of the scores assigned to the eight most widely cultivated crops, namely: wheat (GR), barley (OR),

grain maize (PB), sunflower (FS), potato (CT), sugar beet (SF), soybean (SO), and peas/beans (MF), in accordance with the same legislative act.

Although, geographically, the studied area is situated under relatively similar bioclimatic conditions—due to its location within the former Mureș Delta, at the intersection between the low plain and the hills—the lithological, hydrological conditions and soil formation processes vary from one location to another. This leads to an increased variability of telluric-edaphic factors that contribute to the formation of the environment in which plants grow and produce yield. The long-term influence of natural factors (relief, parent material, climate, hydrology, etc.) as well as human intervention—beginning in the pre-Roman period with the construction of the first earth embankments and continuing with hydro-ameliorative works approximately 250 years ago—has shaped the ecological capacity of the studied area over time.

Despite the presence of a generally favorable natural ecological potential, the actual soil quality is, at first glance, below expectations. This is because most soils are affected by one or more limiting or restrictive factors, even though the area has historically undergone more intense anthropogenic interventions compared to other regions within the reference territory.

The main limiting factors affecting the pedological potential of the analyzed area are primarily related to excess stagnant and phreatic moisture, high soil compaction (settling), and increasing trends of acidification (Table 2). Under these conditions, it is necessary to implement pedo-hydroameliorative measures adapted to local characteristics, such as drainage, water removal, or deep loosening, in order to establish a balanced air-water regime in the soil. Additionally, agrotechnical interventions are required to support the accumulation of nutrients and organic matter, including ameliorative fertilization and the introduction of long-term crop rotations with soil-improving species from the legume and perennial grass families.

Table 2

The limiting factors in Beliu area (ha)

Limiting factors	Low	Moderate	Strong	Very strong, excessive
excess surface moisture	1320	870	99	-
excess phreatic moisture	295	2537	433	19
settlement	1063	2109	-	818
acidified	884	3663	-	399

CONCLUSIONS

Following the pedological and climatic analysis of the Beliu area, Arad County, it can be stated that, although this region is located in a relatively favorable natural ecological area—characterized by a temperate-continental moderate climate and a varied geographical structure—the quality and fertility of the soils do not reach the expected levels. This is mainly due to the presence of limiting factors of edaphic and hydrological nature, which significantly reduce the agricultural productivity of the land.

Among the main limiting factors are excess moisture, both stagnant (at the soil surface) and phreatic (at shallow depths), the high degree of soil compaction (tillage pan), and tendencies toward acidification identified in some soil subtypes. These factors lead to a

weakening of the soil's air-water regime and a reduction in the mobility of nutrients, affecting biological processes in the soil and the development of plant root systems.

To address these problems and make better use of the agricultural potential of the area, the implementation of pedo-hydroameliorative measures adapted to each case is required. These include drainage works to eliminate excess water, deep loosening to improve compacted soil structure, and agrotechnical interventions aimed at increasing the accumulation of organic matter and nutrients in the fertile soil horizons. The introduction of long-term crop rotations, including ameliorative species from the legume and perennial grass families, represents a sustainable strategy for increasing fertility in the medium and long term.

From a climatic point of view, the analysis of the average monthly precipitation regime shows a distribution favorable to agriculture, with maximum values in the summer months (May–July) and minimum values in the winter months. Thus, June and July record the highest precipitation amounts, reaching 80 mm and 75 mm respectively, which coincides with the period of maximum water requirements for plants. However, in the absence of an efficient drainage system, this rainfall can contribute to moisture excess, further emphasizing the need for the hydroameliorative measures previously mentioned.

The total area of the Beliu commune is 9,272 hectares, of which 5,570 hectares are agricultural land. Of this surface, 3,695 hectares are arable land, 1,846 hectares are pastures, and 29 hectares are meadows, indicating a predominant orientation towards field agriculture. Additionally, the presence of pastures offers significant potential for the development of the livestock sector, provided they are properly maintained and managed through a sustainable use of natural resources.

In conclusion, the Beliu area possesses significant agricultural potential, which can be fully harnessed only through a thorough understanding of its pedological and climatic limitations, followed by the implementation of integrated measures for land improvement and sustainable use.

BIBLIOGRAPHY

1.BERTICI RADU, COSMIN ALIN POPESCU, MIHAI VALENTIN HERBEI, DANIEL DICU, FLORIN SALA, 2024, The study of the textural elements variation in relation to the depth on the soil profile, *Conferință AIP*.

2.BERTICI RADU, DANIEL DICU, MIHAI HERBEI, FLORIN SALA, 2022, Model for describing the variation of some agrochemical indices of the soil, Vol. 11 Nr. 1 (2022): Revista Științifică AgroLife

3.DAVID GH., ȚĂRĂU D., ȘANDOR CI, NIȚĂ L, 2018, Soil and climate factors that define land productivity in the lower plain of Banat, Conference Proceedings Volume18, Issue: 3.2, Albena, Bulgaria,

4.DICU D, R BERTICI, M HERBEI, F SALA, 2024, VARIABILITY OF PASTURES BASED ON SOIL QUALITY INDICES., Applied Ecology & Environmental Research, vol 21, no. 6

5.DORNIK A., MARINELA ADRIANA CHEȚAN, DRĂGUȚ L., DICU D., ILIUȚĂ A., 2022, Optimal scaling of predictors for digital mapping of soil properties, Geoderma, Vol. 405, Elsevier

6.DORNIK ANDREI, MARINELA ADRIANA CHEȚAN, LUCIAN DRĂGUȚ, ANDREI ILIUȚĂ, DANIEL DORIN DICU, 2022, Importance of the mapping unit on the land suitability assessment for agriculture, Computers and Electronics in Agriculture, vol. 201, Ed. Elsevier

7.DUMITRU M., ȘTEFĂNESCU SL, 2000, Agri-environmental schemes in the context of rural development, Soil Science no. 2, vol. XXXIV, Ed. Signata, Timisoara,

8.MIHUȚ CASIANA, LUCIAN NIȚĂ, ANIȘOARA DUMA COPCEA, ALEXANDRU RINOVETZ, 2024 - Assessment of the productive capacity of agricultural lands for their sustainable use. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 24, Issue 1, 2024, Print ISSN 2284-7995, E-ISSN 2285-3952, pg. 619

http://doi.org/10.59463/RJAS.2025.2.28

9.MUNTEANU I., 2000, On some aspects regarding the relations between drought, pedogenesis and land degradation (desertification), Soil Science XXXIV, no. 2,
10.POPA MARIA, ALINA LAȚO, MIHAI CORCHEȘ, ISIDORA RADULOV, ADINA BERBECEA, FLORIN CRISTA, LUCIAN NIȚĂ, KAREL IAROSLAV LAȚO, DORIN POPA, 2016, Quality of some soils from the west region of romania, AgroLife Scientific Journal - Volume 5, Number 1.
11.ROGOBETE GH., ȚĂRĂU D, ADIA GROZAV, BUZATU C., COVACI C., DICU DD,2021, Forest soils from Banat and southern Crișana, Ed. Eurobit Timisoara,
12.ROGOBETE GH., ȚĂRĂU, D., 1997 - Soils and their improvement. Banat soil map, Ed. Marineasa, Timisoara,
13.ȚĂRĂU D., ROGOBETE GH., DICU D., 2016, Soils from western Romania, Characterization, Evaluation, Improvement, Ed., Eurobit Timisoara,
14.ȚĂRĂU D., ROGOBETE GH., DICU DD, ADIA GROZAV, NIȚĂ LD, ILIUȚĂ A.Ș., CLARA MAGDA TUDOR, BERTICI R., 2019, Lands and places between the Danube-Gugu-Crișu Negru Peak, Ed. Eurobit Timisoara,
15.TEACI D., 1980, Agricultural land reclamation, Ceres Publishing House, Bucharest,
16.VLAD H., M., 2009, Researches regarding the soils and the possibilities of restoring their fertility in Arad county, Doctoral Thesis, USAMVB, Timisoara.
17.VLAD H., I. BORZA, D.ȚĂRĂU, D. DOLOGA, A. ILIUȚĂ, C. BÂC, DORINA FLOREA, Pedological factors, component of Arad county rural area.
18.*** OSPA Arad archive - Pedological and agrochemical studies,
19.*** SRTS-2012.
20.*** Methodology for elaborating pedological studies, vol. I, II and III, Agricultural Propaganda Editorial Office, Bucharest,