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SUSTAINABLE AGRICULTURAL TECHNOLOGIES AND
PRESERVATION OF SOIL FERTILITY IN PEDOCLIMATIC
CONDITIONS IN GĂTAIA, TIMIȘ COUNTY

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Abstract: The study carried out in the locality of Gătaia, Timiș County" highlights the differences between traditional and sustainable agricultural systems applied in western Romania. The research was conducted using field observations and data collected from a local farm in Gătaia, emphasizing the relationships between natural conditions, soil types, and agricultural management practices. Conventional systems rely on intensive soil disturbance, frequent ploughing, and synthetic inputs, while conservation technologies focus on minimal tillage, surface residue preservation, and balanced fertilization. Results show that conservation practices improve soil structure, reduce compaction, and increase water retention capacity. The main soil types identified within the area were Chernozems, Eutric Cambisols, and Vertisols, all influenced by specific geomorphological and climatic conditions. The climatic regime is temperate continental, with mean annual temperatures of 10.9°C and precipitation between 600–700 mm, ensuring favorable conditions for cereals, sunflower, and maize. The research confirms that adopting conservation tillage in the Gătaia area contributes to sustainable land use, better soil fertility, and environmental protection. Furthermore, this system supports long-term productivity and resilience to climate variability. The obtained results can serve as a reference for the implementation of sustainable agricultural technologies in similar agroecosystems in the western part of Romania. In the context of climate change, the application of conservative technologies becomes a viable solution for the sustainability of agroecosystems in the south of Timiș County.

Introduction

Sustainable agriculture is one of the most important development directions of the 21st century, being essential for maintaining the balance between agricultural productivity, conservation of natural resources and adaptation to climate change. According to the Food and Agriculture Organization (FAO, 2021), conservative agricultural practices ensure soil and water protection, reducing erosion, nutrient losses, and physical land degradation. In Europe, these principles are promoted through the Common Agricultural Policy and the Farm to Fork Strategy, which encourage the transition to low-environmental impact farming systems (EUROPEAN COMMISSION, 2023; HAU & JOARIS, 1999).

Material and method

For this work, field data and information provided by a farm located in the Gătaia area, Timiș county, were used.

The purpose of the research is the comparative analysis between conventional and conservative technological systems, in the context of local natural conditions.

The data collected included observations on climate regime, soil types, agricultural land use and technologies applied to wheat, maize, sunflower and rapeseed crops.

The methodology was based on the monographic method, direct observation, comparative analysis and correlation of pedological and climatic parameters. Information from soil maps, documents of the Office of Pedological and Agrochemical Studies Timișoara, as well as climatic data obtained from the Timișoara meteorological station were used.

The parameters analyzed include: average monthly and annual temperature (°C), precipitation (mm), soil types and subtypes (according to SRTS, 2012), soil reaction (pH), humus content, drainage regime and texture.

The comparative assessment of agricultural technologies was carried out by interpreting the physicochemical properties and the degree of soil damage of processes such as compaction, water stagnation and organic matter reduction.

The results were presented tabular and graphic, following the correlation between natural factors and the efficiency of the work systems.



Conventional system



Conservation system

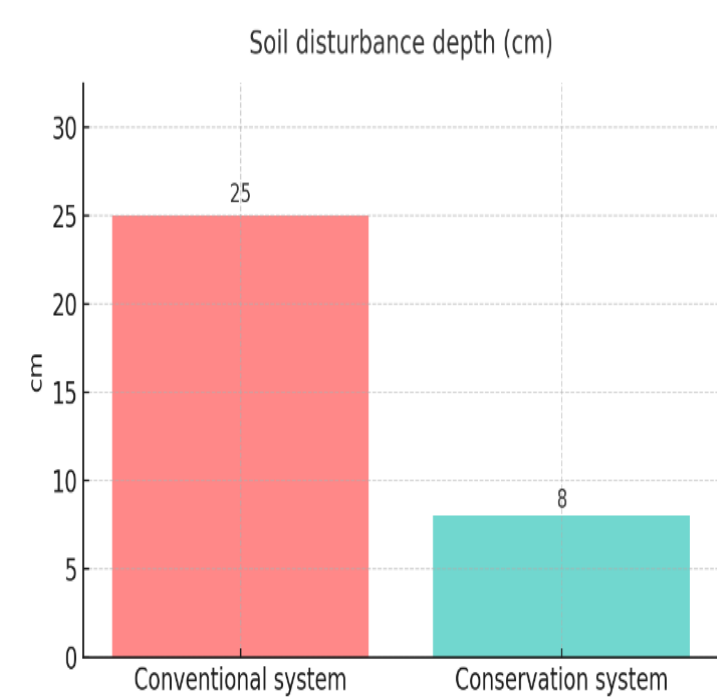


Figure 1. Soil disturbance depth, in cm

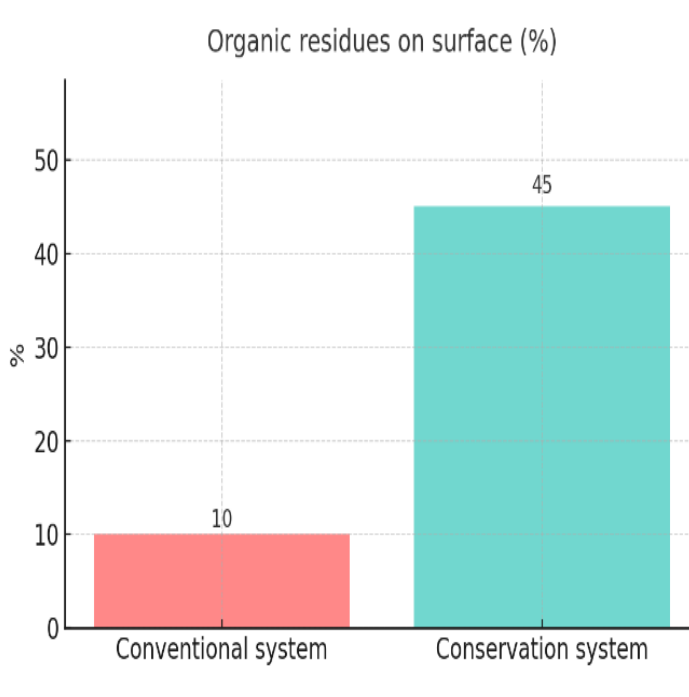


Figure 2. Organic residues on surface, %

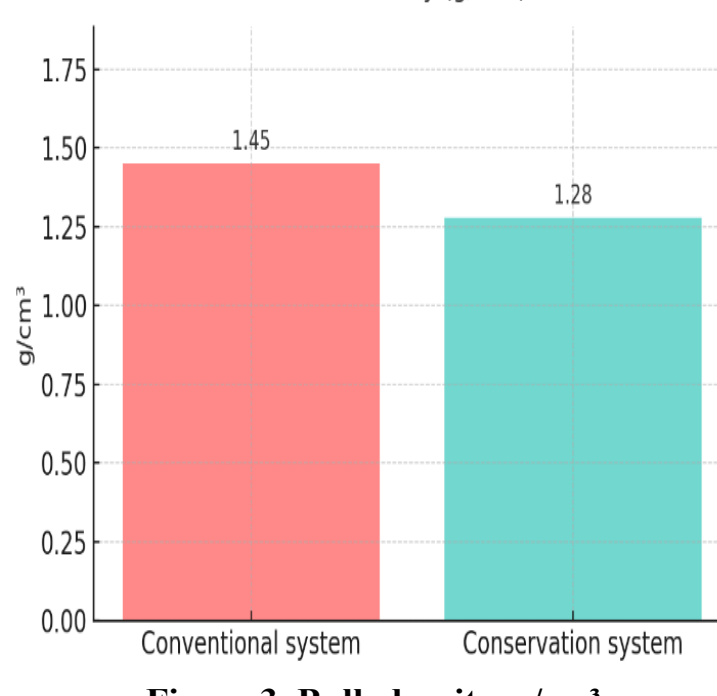


Figure 3. Bulk density, g/cm³

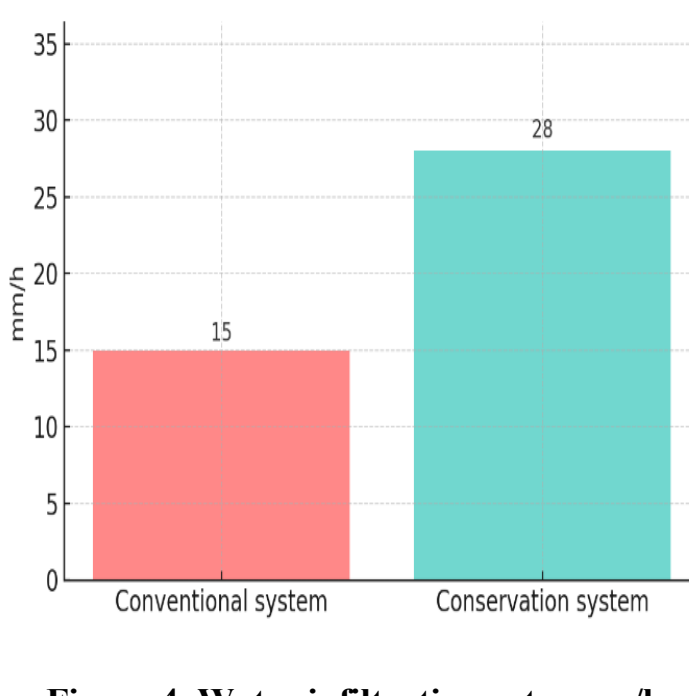
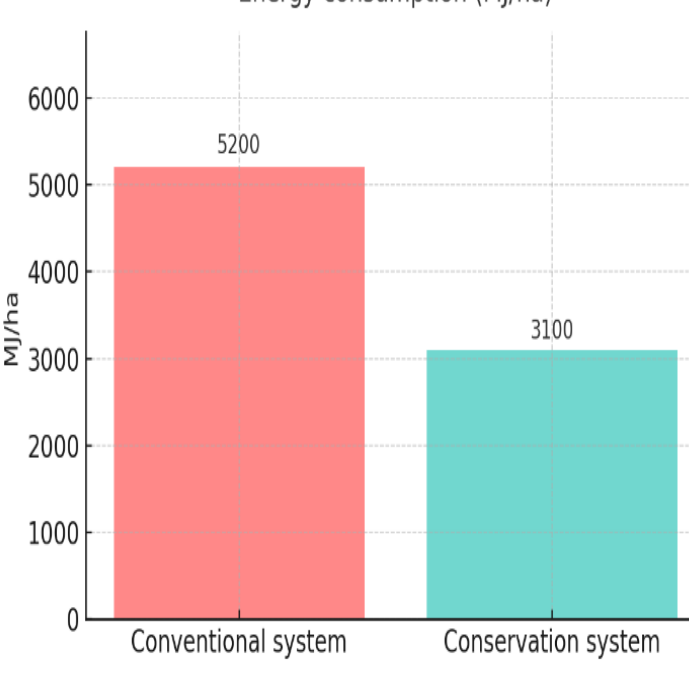
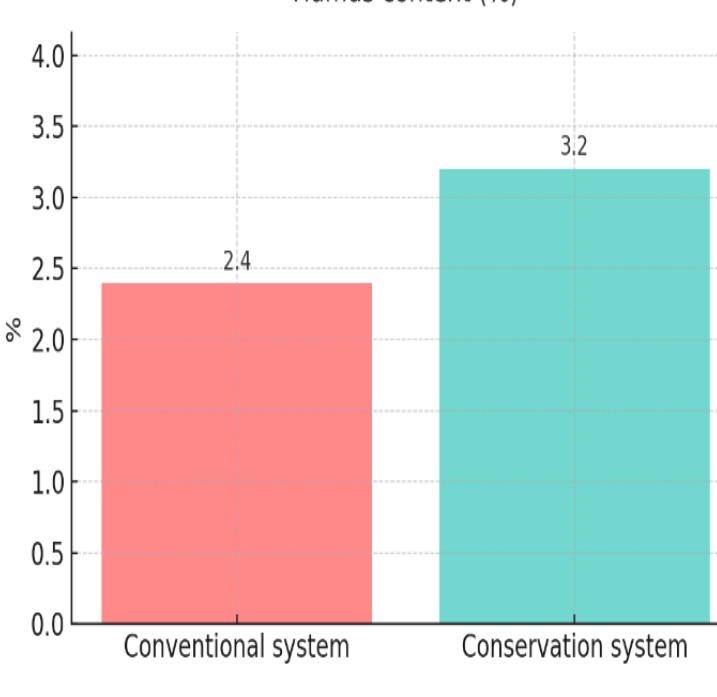


Figure 4. Water infiltration rate, mm/h



Results and discussions

1. Physical-geographical framework

Gătaia is located in the south of Timiș County, in the Timiș Plain, at the contact with the Pogăniș Piedmont, with an average altitude of 108 m. The relief is slightly veiled, specific to the digressive plains of the Bărzava River. The total administrative area is 14,923 ha, of which over 70% is agricultural land (MIRCOV ET AL., 2021).

The geographical positioning favors the practice of mechanized agriculture, but the soils present a significant pedological variability, being influenced by the processes of gelation, stagnation and verticization. These particularities require an adapted use and a correct selection of agricultural technologies.

2. Climatic conditions

The climate is temperate-continental, with Mediterranean influences, characterized by mild winters and hot summers. The average annual temperature is 10.9°C, with average values of 21.6°C in July and -1.2°C in January. Average annual rainfall varies between 600–700 mm, with maximums in May–June.

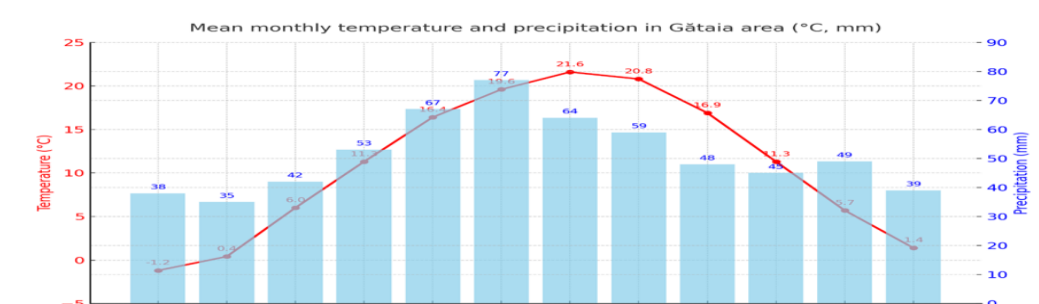


Figure 1. Mean monthly temperature and precipitation in Gătaia area (°C, mm)
(The average temperatures show an annual amplitude of 22.8°C, characteristic of the southern Banat plain areas.)

5.3. Soil characterization

The diversity of soils in the Gătaia area is determined by geological and water peculiarities. According to the SRTS classification (2012), the following soil classes and types predominate on the territory of the locality (table 1.).

Table 1. Main soil types identified in Gătaia area (SRTS, 2012)

Class	Tipul	Subtipul
Protisoluri (PRO)	Aluviosol	gleizat, vertic
Cemisoluri (CER)	Cernozom	carbic, argic
Cambisoluri (CAM)	Eutricambisol	molice, gleic
Luviosoluri (LUV)	Preluviosol	molice, stagnic, vertic
Vertisoluri (VER)	Vertisol	stagnic, gleic

The predominant texture is clayey, with a weak alkaline reaction (pH 7.4–8.0). The humus content varies between 2.5–3.5%, indicating moderate natural fertility. In the depression areas, poor drainage favors the appearance of hydromorphic and gleic soils.

5.4. Comparative technological systems

A number of soil parameters in the two systems were compared, the data are presented in figures 1, 2, 3, 4, 5 and 6.

As for the soil mobilization depth, Figure 1 shows a soil working depth of 25–30 cm in the conventional system, compared to only 8–10 cm in the conservation system. Thus, deep works favor the rapid aeration and mineralization of organic matter, but lead to water losses through evaporation and fragmentation of the soil structure.

On the other hand, the conservative system determines the maintenance of stable aggregates, the reduction of compaction and erosion and energy savings. However, there are also limitations, namely, in the first years, the surface layer may be colder and the seeds may germinate more slowly, especially in cold springs.

In the Gătaia area, where chernozems and preluvosols predominate, reducing the working depth is beneficial because the soils have good structure and natural drainage, and moisture is preserved more efficiently in conditions of frequent drought.

In the Gătaia area, where farms mainly use modern machinery, the adoption of minimum works can lead to considerable energy and financial savings.

The results highlight the advantages of conservative technologies, which provide an improvement in soil structure and a reduction in water losses through evaporation. At the same time, the organic matter content and microbiological activity are higher, especially due to the maintenance of plant debris on the surface.

Conventional agriculture, through deep ploughing and multiple passes with heavy machinery, leads to the compaction of the arable layer and to a decrease in porosity, affecting the aeration and water infiltration processes (DUMITRU ET AL., 1999; FLOREA, 2003). By contrast, the conservative system allows the restoration of the structure of the aggregates and increases their stability over time (GUȘ & TIANU, 1991; DUMITRU ET AL., 2005).

Compared to other agricultural areas in the Banat Plain, such as Banloc or Recea, Gătaia has similar soil and climate conditions, but a higher degree of glaciation and stagnation, which requires careful management of soil tillage. European Studies (HAU & JOARIS, 1999; SZABÓ & PEPÓ, 2005) confirms that minimal tillage reduces soil loss through erosion by 30–40% and improves water retention, an effect also observed in this study.

The results obtained at Gătaia confirm the trends reported in the international literature: soils with clay texture react favorably to conservative systems, due to increased structural stability and reduced compaction. By applying sustainable technologies, an increase in water infiltration capacity and a decrease in losses due to surface runoff are achieved, contributing to the restoration of the soil water balance.

Conclusions

The physical-geographical conditions in the Gătaia area are favorable for the application of conservation systems, due to the flat relief, moderate climate and fertile soil types.

The comparison of the two systems highlights the fact that the soil conservation system is more advantageous in the pedo-climatic conditions of the Gătaia area.

He contributes to:

- conservation of water and organic matter;
- Reduction of erosion and compaction;
- increasing energy and economic efficiency.

Although the transition requires an adaptation of technologies and good management of plant residues, the long-term benefits, increased sustainability of the agroecosystem and resilience to climate change, are obvious.

The conservation system can be successfully implemented in other localities in the Western Plain (for example, Giera, Ciacova, Deta, Banloc, Sânmihailu Român), where the conditions are similar:

- chernozemic or preluvosolic soils,
- moderate annual rainfall (550–600 mm),
- hot and dry summers.

Major benefits include:

- maintaining moisture in the active soil layer;
- reduction of operating costs;
- increasing the stability of agricultural productions;
- protection of the soil against physical and chemical degradation.

Conventional systems cause physical and biological degradation of the soil through intense and repeated tilling.

Conservative agriculture maintains structure, reduces compaction, promotes the accumulation of organic matter and increases water retention capacity.

In the context of climate change, the application of conservation technologies becomes a viable solution for the sustainability of agroecosystems in southern Timiș County.

The results can be used as a basis for scaling up sustainable agriculture systems at regional and national level.