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Mitigation of Aridization through Irrigation Strategies in Western Romania

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Abstract: *Aridization is becoming a major challenge for agricultural sustainability in Western Romania due to climate variability, rising temperatures, and irregular precipitation. In recent years, the region has experienced longer summer periods with high temperatures and extended droughts, leading to reduced soil moisture and increased crop vulnerability to water stress. In some areas, prolonged drought has also caused groundwater depletion, affecting shallow wells and local water availability. This study examines irrigation as an important adaptation measure for maintaining agricultural productivity under these conditions. Special attention is given to modern irrigation technologies, such as precision irrigation systems and IoT-based monitoring tools, which improve water use efficiency and support real-time soil moisture management. The research analyzes climatic trends, soil properties, and crop water requirements in Western Romania, focusing on sensitive crops such as potato (Solanum tuberosum). It also evaluates the effects of irrigation scheduling, water quality, and soil management practices on reducing land degradation and preserving soil structure. Experimental observations and literature data underline the importance of adapting irrigation practices to local pedoclimatic conditions, especially during frequent drought periods. The results show that efficient irrigation systems, combined with sustainable water resource management, can reduce the negative effects of aridization, improve yield stability, and increase resilience to climate change. The study highlights the importance of integrating technological innovation with agronomic practices to support long-term agricultural sustainability in Western Romania.*
Keywords: aridization, irrigation systems, drought, groundwater depletion, water use efficiency, soil moisture, climate change adaptation, sustainable agriculture, Western Romania

Introduction

- Aridization is becoming a major problem for agriculture in Western Romania due to higher temperatures, irregular rainfall, and prolonged drought periods. These conditions reduce soil moisture, lower groundwater reserves, and negatively affect crops such as potato, maize, wheat, and sunflower. In some areas, shallow wells have partially dried out because of extended drought.
- Modern irrigation systems are essential for maintaining crop productivity and improving water use efficiency. In addition, precision agriculture technologies such as soil moisture sensors, IoT systems, and AI-assisted irrigation management can optimize water consumption and support sustainable agriculture under climate change conditions.

Material and method

- The study area is located on the outskirts of Timișoara, within the Banat Plain, an important agricultural region characterized by fertile chernozem and alluvial soils with good water retention capacity and high agricultural productivity. The flat terrain and favorable pedoclimatic conditions make the area suitable for irrigation system implementation.
- Western Romania has a temperate-continental climate with increasing climatic instability in recent years, including higher summer temperatures, longer drought periods, and irregular rainfall distribution. Meteorological data from the last three years indicate frequent heatwaves and extended periods without rainfall during critical crop development stages. Although the average annual precipitation is approximately 600–650 mm, water deficits during summer increasingly affect agricultural production.

- A smart irrigation system is proposed for a vegetable cultivation area located on the outskirts of Timișoara, designed to improve water efficiency and reduce the effects of aridization under increasingly unstable climatic conditions. The irrigation layout includes multiple vegetable crops with different water requirements, such as potato, cabbage, pepper, and root vegetables, supplied through a combined drip and micro-sprinkler irrigation network. The proposed system uses drip irrigation lines for crops requiring localized water application, including potato, cabbage, and pepper. The drip tape configuration is designed with emitters spaced at 20 cm intervals and a discharge rate of approximately 1.3 L/h, ensuring uniform soil moisture distribution and reduced evaporation losses. For root vegetables, a micro-sprinkler irrigation sector is proposed using GyroNet Turbo sprinklers arranged in a 5 × 6 m scheme, providing controlled precipitation and improved surface coverage.
- The system is supplied by a groundwater source with an available operating pressure of approximately 2.5 bar and a maximum pump flow rate of 300 L/min.
- To increase irrigation efficiency, the proposed setup integrates IoT monitoring technologies and AI-assisted irrigation management. Soil moisture sensors, temperature sensors, and weather data acquisition systems continuously monitor field conditions in real time. The collected data are transmitted through ESP32/ESP8266 communication modules and processed using AI-supported algorithms capable of optimizing irrigation scheduling according to crop water demand, climatic conditions, and soil moisture dynamics.

Results and discussions

Climatic Conditions and Water Deficit

- The precipitation map for April 2026 highlights a significant rainfall deficit in the Banat region, where precipitation values were recorded at ≤10 mm, representing some of the lowest amounts in Romania. Such low precipitation levels during early spring represent a major concern for agriculture, particularly because March and April coincide with the beginning of the vegetation period and crop establishment phase.

Month	Multiannual Average (mm)	2025 Recorded Precipitation (mm)	Water Deficit
March	42	23	-19
April	51	9	-42
May	70	32	-38
June	84	3	-81
July	65	12	-53
August	55	8	-47

Figure 2 - Monthly Precipitation During Vegetation Period

Figure 3 - Severe agricultural drought affecting a cultivated field

- During early crop development, soil moisture is essential for germination, root formation, and plant growth. Low rainfall can reduce crop development and productivity, especially for maize, sunflower, potato, and wheat. Under these conditions, irrigation becomes necessary to maintain adequate soil moisture and reduce the effects of drought in Western Romania.

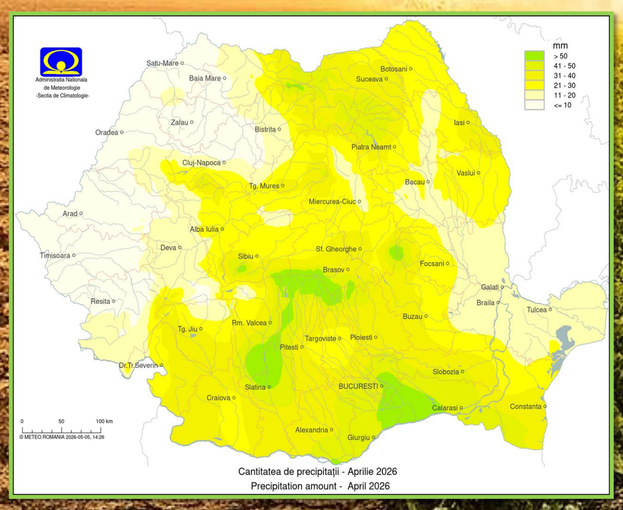
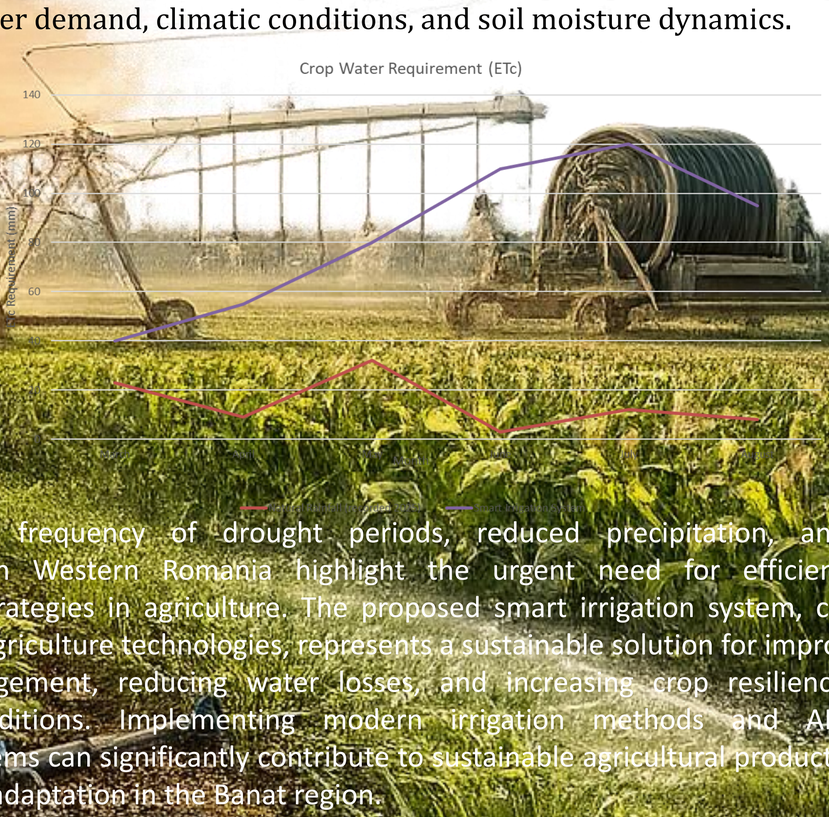


Figure 1 – Precipitation amount in Romania April 2026



Conclusions

- The increasing frequency of drought periods, reduced precipitation, and rising temperatures in Western Romania highlight the urgent need for efficient water management strategies in agriculture. The proposed smart irrigation system, combined with precision agriculture technologies, represents a sustainable solution for improving soil moisture management, reducing water losses, and increasing crop resilience under aridization conditions. Implementing modern irrigation methods and AI-assisted monitoring systems can significantly contribute to sustainable agricultural productivity and climate change adaptation in the Banat region.