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REDUCING AGRICULTURAL WATER CONSUMPTION IN WESTERN ROMANIA: CHALLENGES AND SUSTAINABLE SOLUTIONS

Laura ȘMULEAC [1] (ORCID: 0000-0003-3901-5691); Adrian ȘMULEAC [1] (ORCID: 0000-0002-4351-826X); Raul PAȘCALĂU [1] (ORCID: 0000-0001-9335-0939), Răzvan GUI-BACHNER [1], Mahfoud BAKLI [2] (ORCID: 0000-0002-1427-2985); Rauf JURAKHON [3]

[1]University of Life Sciences "King Mihai I" from Timisoara, Romania

[2]Université de Ghardaia, Algeria

[3]Tajik Technical University named after M.S. Osimi

Corresponding author: raul.pascalau@usvt.ro

Abstract. *Western Romania faces increasing pressure on agricultural water resources due to recurrent droughts, rising temperatures, uneven rainfall, and inefficient irrigation practices. The region includes productive plains and mixed farming systems where maize, wheat, sunflower, vineyards, and vegetable crops depend on reliable seasonal moisture. This abstract examines the main drivers of excessive agricultural water consumption and proposes sustainable solutions suited to local environmental and socioeconomic conditions. Key challenges include aging canal networks, conveyance losses, low adoption of precision irrigation, fragmented land ownership, limited farm capital, weak monitoring of groundwater extraction, and declining soil organic matter that reduces water retention. Climate variability further intensifies demand during summer heatwaves while competition with households, industry, and ecosystems is growing. Effective responses begin with modernization of irrigation infrastructure through lined channels, pressurized systems, drip technologies, and smart scheduling based on soil moisture sensors and weather forecasts. Conservation practices such as minimum tillage, mulching, cover crops, residue management, and compost application improve infiltration and reduce evaporation losses. Crop diversification toward drought tolerant varieties and adjusted planting calendars can lower peak water demand while maintaining farm income. Rainwater harvesting, farm ponds, treated wastewater reuse, and managed aquifer recharge offer supplementary supplies in dry years. Institutional measures are equally important including farmer training, cooperative water user associations, volumetric pricing incentives, easier access to green finance, and digital advisory services. Strong data collection on withdrawals, salinity, yields, and efficiency enables adaptive governance. Overall, an integrated strategy combining technology, soil restoration, policy reform, and community participation can substantially reduce water consumption, strengthen resilience, and support sustainable agriculture in Western Romania for future generations and regional prosperity through innovation, collaboration, education, research, partnerships, local leadership, stronger markets, better maintenance, transparent institutions, resilient landscapes, healthier rivers, secure livelihoods, and balanced development goals ahead together for all communities there now today onward sustainably.*

Keywords*: Western Romania, agricultural water use, sustainable irrigation, climate resilience, water efficiency*

INTRODUCTION

Agricultural water management has become an increasingly important issue in Western Romania as climate variability, recurrent drought, rising temperatures, and changes in precipitation patterns place additional pressure on available water resources. The western part of the country includes some of Romania's most productive agricultural areas, particularly the lowlands associated with the Western Plain and the Banat region. Fertile soils, relatively favourable topography, and an important tradition of cereal and industrial crop production give agriculture a major economic role in this area. Nevertheless, agricultural productivity remains strongly dependent on the availability of water during critical periods of crop development (PRĂVĂLIE et al., 2020; ȘMULEAC et al., 2025).

The climate of Western Romania is influenced by both continental and oceanic air masses, resulting in considerable spatial and temporal variability in precipitation. Although annual precipitation can support rainfed agriculture in many years, its distribution during the growing season is not always synchronized with crop water requirements. Long intervals without significant rainfall can occur during late spring and summer, while high temperatures accelerate soil moisture depletion through evaporation and crop transpiration. Consequently, crops may experience severe water stress during flowering, grain formation, and other sensitive phenological stages.

Recent climatic tendencies have increased concern regarding the future reliability of rainfall-based agricultural production. Higher temperatures increase atmospheric evaporative demand, while more frequent heatwaves can significantly increase irrigation requirements. At the same time, intense precipitation events may produce large quantities of runoff over short periods without effectively replenishing soil moisture. This combination of drought periods and intense rainfall creates a complex water-management challenge: agriculture needs to conserve water during periods of abundance and use it more efficiently during periods of scarcity.

The agricultural structure of Western Romania further influences water demand. Important crops include wheat, maize, sunflower, rapeseed, vegetables, orchards, vineyards, and forage crops. Their water requirements differ according to species, variety, soil characteristics, planting date, and climatic conditions. Maize, for example, can be particularly vulnerable to water deficit during flowering and grain formation. Vegetable production generally requires more reliable and precisely controlled water supplies because short periods of water stress can affect both yield and commercial quality (ȘMULEAC et al., 2025).

Despite the agricultural potential of the region, water-use efficiency is constrained by several technical and socioeconomic factors. Some irrigation infrastructure was designed several decades ago and requires rehabilitation or modernization. Water losses can occur during conveyance and distribution, particularly where canals and associated infrastructure have deteriorated. At farm level, irrigation may still be scheduled according to fixed intervals or farmer experience rather than actual measurements of soil moisture and crop water requirements (PELEA et al., 2016; LUP et al., 2017).

Farm fragmentation represents an additional challenge. The coexistence of large commercial farms and numerous small and medium-sized holdings creates significant differences in access to capital, irrigation equipment, technical knowledge, and digital technologies. While larger farms may have the capacity to invest in precision irrigation, weather stations, soil sensors, and automated systems, smaller farms can face financial barriers to adopting such technologies (VIJULIE et al., 2012).

Soil degradation can further increase agricultural water consumption. Declining organic matter, soil compaction, erosion, and inappropriate tillage reduce infiltration and water-holding capacity. Under these conditions, rainfall is less effectively stored in the soil profile, increasing crop dependence on subsequent precipitation or irrigation. Improving soil quality should therefore be considered an integral component of water conservation rather than a separate agricultural objective (KADER et al., 2019; RAMOS et al., 2024).

Reducing agricultural water consumption does not mean simply restricting irrigation. The objective should be to reduce unnecessary withdrawals and non-productive losses while maintaining economically viable crop production. This requires increasing crop water productivity, defined as the agricultural output obtained per unit of water consumed. Sustainable water management should therefore combine efficient irrigation, improved soil management,

suitable crop selection, alternative water sources, digital decision-support tools, and appropriate institutional mechanisms.

MATERIAL AND METHODS

The study was developed using an integrated qualitative assessment of agricultural water management conditions in Western Romania. The analysis focused primarily on the agricultural landscapes of the Western Plain and Banat, where crop production, climatic variability, soil properties, irrigation infrastructure, and water availability interact to determine agricultural water demand.

The methodological framework was structured around three main components: identification of factors increasing agricultural water consumption, evaluation of potential water-saving measures, and assessment of their suitability under the environmental and socioeconomic conditions characteristic of Western Romania.

The principal factors considered were increasing temperature and evapotranspiration, seasonal rainfall deficits, soil moisture depletion, irrigation efficiency, conveyance losses, soil degradation, crop structure, groundwater use, farm fragmentation, and financial or technical barriers to modernization.

Potential solutions were grouped into five categories: irrigation and infrastructure modernization; precision and digital water management; soil and crop management; development of supplementary water sources; and institutional, economic, and educational measures. This approach allows water conservation to be considered as a combination of technological, agronomic, environmental, and governance interventions.

Water-use performance was evaluated conceptually through crop water productivity, expressed as the ratio between agricultural production and the quantity of water consumed. Increasing crop water productivity is considered a more appropriate objective than simply reducing irrigation volume because insufficient irrigation can reduce yields without necessarily improving overall resource sustainability.

The evaluation also considered several indicators relevant to sustainable agricultural water management: irrigation application efficiency, soil moisture, groundwater levels, soil organic matter, water quality, salinity, crop yield, crop water productivity, and the stability of production during drought years.

Solutions were assessed according to their potential to reduce evaporation and conveyance losses, improve soil water storage, optimize irrigation scheduling, reduce peak crop water demand, diversify available water sources, and improve farmers' capacity to respond to drought. Particular consideration was given to the feasibility of combining measures because individual technologies are unlikely to provide sufficient adaptation under increasing climatic variability.

RESULTS AND DISCUSSIONS

The analysis indicates that agricultural water consumption in Western Romania is determined by the interaction between climatic conditions, crop water requirements, soil characteristics, irrigation infrastructure, and farm management. Climate change acts as an important multiplier of existing pressures by increasing evapotranspiration and reducing the reliability of rainfall during critical crop development periods.

One of the main challenges is the seasonal imbalance between water availability and agricultural demand. Rainfall during autumn, winter, or early spring cannot fully compensate for prolonged water deficits during summer if soils and landscapes have limited capacity to store

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water. High temperatures during June, July, and August accelerate evaporation and transpiration, creating conditions in which soil water reserves can decline rapidly. Therefore, agricultural water conservation should begin with increasing the capacity to capture and retain precipitation before considering additional irrigation withdrawals.

The comparative assessment showed that the factors influencing agricultural water consumption do not have the same importance or require the same type of intervention. Climatic pressures and seasonal rainfall deficits cannot be directly controlled at farm level, whereas irrigation losses, inappropriate scheduling, reduced soil-water retention, and crop management can be addressed through technical and agronomic measures. This distinction is particularly relevant for Western Romania, where water-saving strategies should focus not only on increasing water supply but also on reducing avoidable demand and improving the capacity of agricultural soils and infrastructure to retain and distribute available water.

Table 1

Main drivers of agricultural water consumption in Western Romania and potential management responses

Driver	**Effect on agricultural water use**	**Possibility of intervention**	**Priority response**
High summer temperatures	Increased evapotranspiration and crop water demand	Limited direct control	Improved irrigation timing and crop adaptation
Seasonal rainfall deficits	Reduced soil-water availability	Limited direct control	Storage and supplementary irrigation
Conveyance losses	Increased water withdrawals	High	Infrastructure rehabilitation
Inefficient irrigation scheduling	Excessive or poorly timed application	High	Soil moisture monitoring and weather-based scheduling
Low soil-water retention	Increased irrigation frequency	Moderate–high	Organic matter, residues, mulching and reduced tillage
Water-demanding crop structure	High seasonal water demand	Moderate	Crop diversification and adapted varieties
Groundwater overuse	Declining strategic reserves	High through regulation	Monitoring, abstraction control and recharge
Farm fragmentation	Unequal access to efficient technologies	Moderate	Cooperation, shared infrastructure and financial support

Source: Authors' assessment.

Modernization of irrigation infrastructure offers significant opportunities for reducing water losses. Open canals can lose water through seepage, evaporation, vegetation growth, and infrastructure deterioration. Rehabilitation of critical sections, improved maintenance, appropriate lining where technically and environmentally justified, and conversion to pressurized distribution systems can increase delivery efficiency. However, infrastructure modernization requires substantial investment and coordinated management because irrigation networks generally serve multiple users.

At farm level, drip irrigation is particularly suitable for vegetables, orchards, vineyards, and other high-value crops. By applying water directly or close to the root zone, drip systems can reduce surface evaporation and improve control over irrigation volumes. Fertigation can also be integrated into these systems, allowing water and nutrients to be applied according to crop requirements.

For large-scale field crops, appropriately managed sprinkler or mobile irrigation systems may provide greater operational flexibility. Their performance, however, depends strongly on weather conditions. Irrigating during periods of high temperature and strong wind

can increase evaporation and reduce distribution uniformity. Irrigation during cooler periods of the day, combined with appropriate application rates, can improve efficiency.

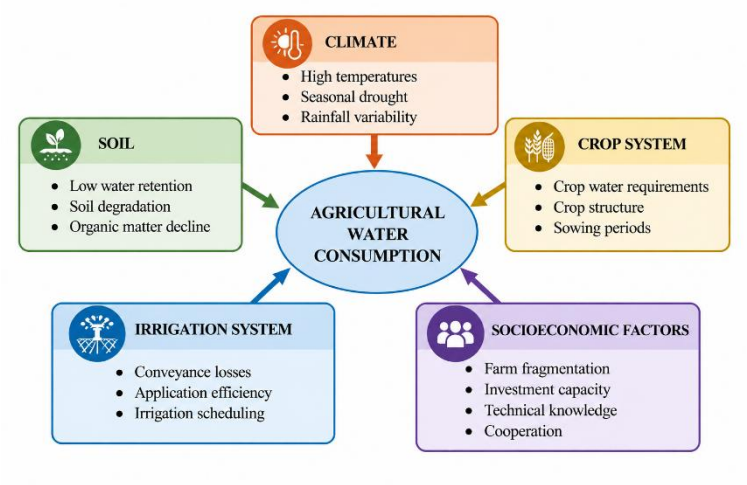


Figure 1. Main drivers of agricultural water consumption in Western Romania

A particularly important opportunity for Western Romanian agriculture is the expansion of soil moisture monitoring. Sensors installed at different depths within the root zone can provide information on available soil water and indicate when irrigation is actually required. When these measurements are combined with local meteorological data, crop development stages, and evapotranspiration estimates, irrigation can be scheduled according to actual crop requirements.

Precision agriculture can further improve this process. Agricultural fields are rarely homogeneous. Differences in soil texture, organic matter, topography, and rooting conditions create spatial differences in water availability. Applying an identical quantity of irrigation water across an entire field may therefore lead to over-irrigation in some areas and insufficient irrigation in others. Variable-rate technologies and spatial soil information can potentially address these differences and improve water productivity.

Remote sensing provides another valuable tool for identifying crop water stress. Satellite and drone observations can provide information on vegetation development, canopy temperature, and spatial variability within fields. These data can help farmers identify areas affected by water stress before visible symptoms become severe. Nevertheless, digital technologies should complement rather than replace field observations and agronomic knowledge.

From a regional applicability perspective, soil moisture monitoring and weather-based scheduling may represent more immediately accessible solutions than fully automated variable-rate irrigation. The latter can provide greater spatial control but requires higher investment, detailed field information, compatible equipment, and technical expertise. Consequently, the appropriate level of digitalization should be adapted to farm size, crop value, existing machinery, and investment capacity.

Improving soil water retention represents one of the most cost-effective long-term strategies for reducing irrigation dependence. Western Romania includes extensive agricultural soils with high productive potential, but intensive cultivation can lead to declining organic matter

and soil structural degradation. Maintaining crop residues, reducing unnecessary tillage, applying organic amendments, and using appropriate cover crops can improve soil aggregation and infiltration.

Mulching can reduce direct evaporation from the soil surface, particularly in horticultural crops and vineyards. Organic or other suitable mulch materials can simultaneously suppress weeds, moderate soil temperature, and protect the soil against the impact of intense rainfall. Crop residues can provide similar functions in conservation agriculture systems.

Minimum tillage and reduced tillage may contribute to soil-water conservation by limiting soil disturbance and maintaining surface residues. However, these practices should be adapted to soil type, crop rotation, compaction risk, and local climatic conditions. No single tillage system is universally optimal, and long-term soil monitoring is necessary to evaluate changes in structure, infiltration, and water availability.

These measures generally require less specialized infrastructure than irrigation modernization and can therefore be relevant to a wider range of farm sizes. Their effects are gradual rather than immediate, but improvements in soil structure and water retention can reduce irrigation dependence and increase resilience during short rainfall deficits.

Crop diversification can reduce both water consumption and economic vulnerability (PRĂVĂLIE et al., 2020; ȘMULEAC et al., 2025). Production systems dominated by crops with high summer water requirements can experience significant pressure during drought. Introducing crops and cultivars with different rooting characteristics, growing periods, and water requirements can distribute demand more evenly throughout the agricultural season.

Compared with infrastructure-based measures, crop adaptation can often be implemented with lower capital requirements, although its effectiveness depends strongly on crop markets, farm specialization, soil conditions, and the availability of suitable varieties. For this reason, crop adaptation should complement rather than replace improvements in irrigation and soil-water management.

Drought-tolerant varieties provide another important adaptation measure. Plant breeding and improved seed selection can increase tolerance to heat and temporary water deficit. Nevertheless, drought tolerance should not be interpreted as complete independence from water availability. Even tolerant varieties require adequate moisture during critical development stages.

Rainwater harvesting and on-farm storage could supplement irrigation supplies. Farm ponds and small reservoirs can capture runoff or other suitable water during wet periods for use during short dry periods. Such systems are particularly useful when storage can be integrated into local drainage and water-management infrastructure. Their design should consider evaporation, water quality, ecological impacts, land availability, and economic feasibility.

Treated wastewater represents another potential supplementary source, particularly in areas located near sufficiently large settlements and treatment facilities. Reusing appropriately treated wastewater for agriculture could reduce pressure on freshwater resources while providing a more predictable supply during drought. However, implementation requires rigorous standards for water quality and monitoring of pathogens, salinity, nutrients, and other contaminants. Groundwater should be managed particularly carefully. It provides an important reserve during dry years, but unrestricted pumping can transform a short-term adaptation measure into a long-term sustainability problem. Monitoring abstraction volumes and groundwater levels is therefore necessary. Where hydrogeological conditions permit, managed aquifer recharge could help replenish reserves using excess water available during wetter periods ((PRĂVĂLIE et al., 2020; ȘMULEAC et al., 2025).

Another major finding is that technological measures alone cannot guarantee lower regional water consumption. Improvements in irrigation efficiency can sometimes reduce the quantity of water required per hectare while simultaneously making irrigation economically attractive over a larger cultivated area. Consequently, total withdrawals may remain unchanged or even increase. Water-saving programmes should therefore monitor actual withdrawals and consumptive use rather than relying exclusively on technical irrigation-efficiency indicators.

Based on the comparative criteria defined in the methodological framework, the principal water-saving measures were assessed according to their expected water-saving potential, investment requirements, technical complexity, suitable farm scale, and regional applicability (Table 2).

Table 2

Comparative applicability of water-saving measures in Western Romanian agriculture

Water-saving measure	Water-saving potential	Investment requirement	Technical complexity	Suitable farm scale	Regional applicability
Irrigation infrastructure rehabilitation	High	High	High	Medium–large / collective	High
Drip irrigation	High	Medium–high	Medium	Small–medium	High for suitable crops
Improved sprinkler irrigation	Medium–high	Medium	Medium	Medium–large	High
Soil-moisture-based irrigation scheduling	High	Low–medium	Medium	All farm sizes	Very high
Precision and variable-rate irrigation	High	High	High	Medium–large	Medium–high
Soil organic matter improvement	Medium	Low–medium	Low	All farm sizes	Very high
Mulching and residue management	Medium	Low	Low	Small–medium	High

The comparative assessment indicates that no single measure combines high water-saving potential, low investment requirements, and universal applicability. Soil-moisture-based irrigation scheduling and soil-water conservation measures appear particularly suitable for broad implementation because they can be adapted to different farm sizes without requiring major regional infrastructure. In contrast, irrigation-system rehabilitation, treated wastewater reuse, and groundwater recharge may provide substantial benefits but depend on higher investment and coordinated implementation. Precision irrigation occupies an intermediate position: its potential is high, but adoption is more dependent on farm size, equipment compatibility, technical expertise, and access to capital. These differences support a differentiated regional strategy in which measures are selected according to local farming systems rather than applied uniformly across Western Romania (FERERES and SORIANO, 2007; KADER et al., 2019).

Cooperation among farmers is especially relevant in areas served by common irrigation infrastructure. Water user associations and agricultural cooperatives can facilitate collective investments, infrastructure maintenance, shared monitoring equipment, and access to technical expertise. Cooperation may be particularly valuable for small and medium-sized farms that cannot individually finance advanced irrigation technologies.

Economic instruments should support, rather than undermine, sustainable water management. Grants, preferential credit, and green financing can accelerate investment in efficient irrigation and water-storage systems. Public support should preferably be connected to

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measurable improvements in water-use efficiency, soil conservation, and environmental performance.

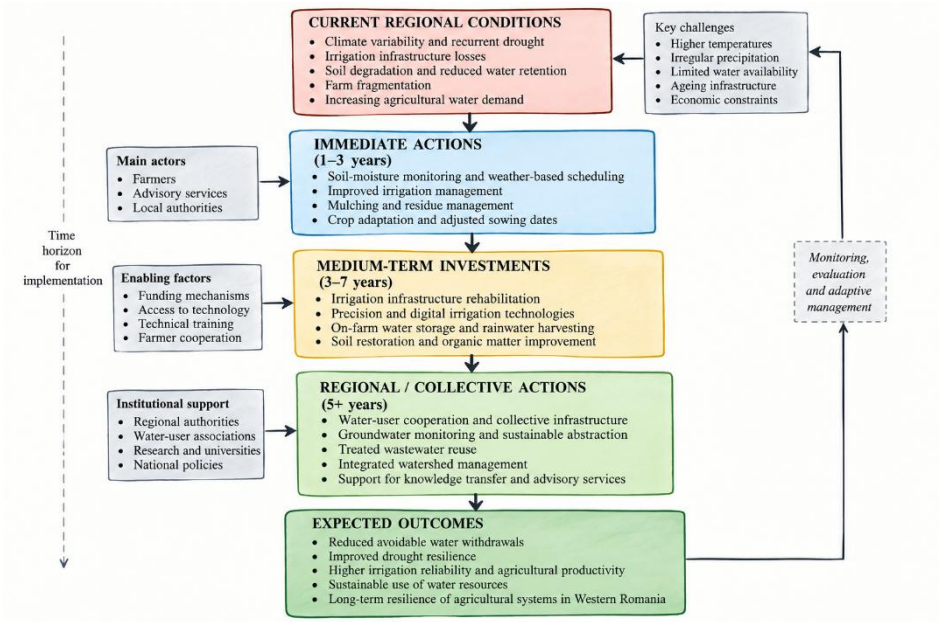


Figure 2. Proposed implementation pathway for reducing agricultural water consumption in Western Romania

Farmer education is equally important. Even advanced irrigation systems can waste water if they are incorrectly operated. Training should therefore include irrigation scheduling, interpretation of soil moisture measurements, maintenance of irrigation equipment, drought management, soil conservation, and use of weather information.

For Western Romania, a regional water-saving strategy should consequently integrate farm-level interventions with watershed-scale planning. Rivers, groundwater bodies, irrigation networks, drainage systems, wetlands, and agricultural soils are interconnected components of the same hydrological system. Excessive abstraction in one area may affect water availability elsewhere, while drainage and runoff from agricultural land can influence downstream water quality. An integrated regional strategy could therefore prioritize irrigation modernization in areas with the highest agricultural value and drought exposure, while simultaneously supporting soil restoration, water storage, monitoring, and crop adaptation. Digital information systems could provide farmers and authorities with updated information on precipitation, soil moisture, groundwater conditions, irrigation demand, and drought risk (figure 2).

The combination of these measures is likely to generate greater benefits than isolated interventions. For example, efficient irrigation combined with higher soil organic matter can reduce both application losses and irrigation frequency. Adding soil moisture sensors can further optimize timing, while drought-tolerant varieties can reduce the consequences of unavoidable water deficits. At regional level, these measures can be strengthened through transparent water allocation, effective monitoring, and cooperation between farmers, researchers, local authorities, and water-management institutions.

CONCLUSIONS

Reducing agricultural water consumption in Western Romania represents an increasingly important objective under conditions of rising temperatures, recurrent drought, irregular rainfall, and growing competition for freshwater resources. The agricultural potential of the region can be maintained only if water is managed more efficiently at farm, irrigation-system, and watershed levels. The principal challenges include seasonal water deficits, aging irrigation infrastructure, conveyance and application losses, uneven adoption of precision technologies, declining soil water-retention capacity, fragmented agricultural structures, financial constraints, and insufficient monitoring of water withdrawals. Climate change is likely to intensify many of these pressures by increasing evapotranspiration and the frequency of periods with high crop water demand.

Modernization of irrigation infrastructure is an essential component of the solution. Efficient distribution systems, drip and appropriately managed sprinkler irrigation, soil moisture monitoring, weather-based scheduling, and precision technologies can reduce unnecessary water application. However, technical efficiency should be accompanied by monitoring of actual water withdrawals to ensure that improvements produce genuine water savings at regional scale (FERERES and SORIANO, 2007; KADER et al., 2019).

Soil management should receive equal attention. Increasing soil organic matter, maintaining crop residues, using mulches and cover crops where appropriate, and reducing unnecessary soil disturbance can improve infiltration and water retention. Healthy soils can function as important water reservoirs and reduce crop vulnerability between rainfall events.

Crop diversification, drought-tolerant varieties, and flexible planting calendars can further reduce exposure to water scarcity. Rainwater harvesting, farm ponds, treated wastewater reuse, and carefully managed groundwater resources can diversify supplies and improve resilience during dry years.

Institutional and economic measures are necessary to support these changes. Farmer training, water user associations, improved monitoring, digital advisory services, access to financing, and transparent allocation rules can facilitate adoption and ensure that water-saving investments generate long-term environmental and economic benefits.

In conclusion, sustainable reduction of agricultural water consumption in Western Romania cannot be achieved through a single technology or policy measure. It requires an integrated strategy combining efficient irrigation, soil restoration, climate-adapted crops, supplementary water sources, digital monitoring, financial support, and cooperative governance. Such an approach can reduce pressure on freshwater resources while maintaining agricultural productivity and farm profitability. The long-term objective should therefore be not simply to use less water, but to obtain greater and more stable agricultural value from every unit of water consumed while preserving groundwater, rivers, soils, and ecosystems. By integrating technological innovation with sustainable soil management and effective regional governance, Western Romania can strengthen its agricultural resilience and develop a more sustainable relationship between food production and increasingly limited water resources.

BIBLIOGRAPHY

DATTA, S., TAGHVAEIAN, S., 2023 – Soil water sensors for irrigation scheduling in the United States: A systematic review of literature, Agricultural Water Management, 278: 108148, Elsevier, Netherlands. DOI: 10.1016/j.agwat.2023.108148.

EL-BELTAGI, H.S., BASIT, A., MOHAMED, H.I., ALI, I., ULLAH, S., KAMEL, E.A.R., SHALABY, T.A., RAMADAN, K.M.A., ALKHATEEB, A.A., GHAZZAWY, H.S., 2022 – Mulching as a Sustainable Water and Soil Saving Practice in Agriculture: A Review, Agronomy, 12(8): 1881, Switzerland. DOI: 10.3390/agronomy12081881.

FERERES, E., SORIANO, M.A., 2007 – Deficit irrigation for reducing agricultural water use, Journal of Experimental Botany, 58(2): 147–159, United Kingdom. DOI: 10.1093/jxb/erl165.

GUI-BACHNER RAZVAN, LAURA ȘMULEAC, 2025 Smart water management in agriculture-using infowater pro software for efficient irrigation. Research Journal of Agricultural Science, 29-36.

HASHEM, M.S., QI, X., 2021 – Treated wastewater irrigation—A review, Water, 13(11): 1527, Switzerland. DOI: 10.3390/w13111527.

KADER, M.A., SINGHA, A., BEGUM, M.A., JEWEL, A., KHAN, F.H., KHAN, N.I., 2019 – Mulching as water-saving technique in dryland agriculture: review article, Bulletin of the National Research Centre, 43: 147, Egypt. DOI: 10.1186/s42269-019-0186-7.

LEVINTAL, E., KNIFFIN, M.L., GANOT, Y., MARWAHA, N., MURPHY, N.P., DAHLKE, H.E., 2022 – Agricultural managed aquifer recharge (Ag-MAR)—a method for sustainable groundwater management: A review, Critical Reviews in Environmental Science and Technology, 53: 291–314, United States. DOI: 10.1080/10643389.2022.2050160.

LUP, A., MIRON, L., ALIM, I., 2017 – Irrigation investments in Romania. Size, results, efficiency, Romania.

MADHUPRIYA, KUMAR, S., PANDEY, G., KUMAR, R., & YADAV, S., 2025 - Global Water Availability and Its Consumption in a Changing Climate: Management Strategies. Global Water Scarcity: Causes, Impacts, and Management Strategies, 291-310.

PELEA, G.N., COSTESCU, I.A., MAN, T.E., 2016 – Current management issues in exploitation and maintenance of irrigation systems in Western part of Romania. Case study of uniform application of irrigation, Procedia Engineering, 161: 1827–1832, Elsevier. DOI: 10.1016/j.proeng.2016.08.678.

PRĂVĂLIE, R., SÎRODOEV, I., PATRICHE, C., ROȘCA, B., PITICAR, A., BANDOC, G., SFÎCĂ, L., TIȘCOVSCHI, A., DUMITRAȘCU, M., CHIFIRIUC, C., MĂNOIU, V., IORDACHE, Ș., 2020 – The impact of climate change on agricultural productivity in Romania. A country-scale assessment based on the relationship between climatic water balance and maize yields in recent decades, Agricultural Systems, 179: 102767, Elsevier, Netherlands. DOI: 10.1016/j.agsy.2019.102767.

RAMOS, T.B., DAROUICH, H., PEREIRA, L.S., 2024 – Mulching effects on soil evaporation, crop evapotranspiration and crop coefficients: a review aimed at improved irrigation management, Irrigation Science, 42: 525–539, Germany.

ROSSING, T., 2010 - Water scarcity, climate change, and the poor. Reducing Poverty, Protecting Livelihoods, and Building Assets in a Changing Climate, 21.

SIDLAUSSKAS, G., BERNOTAS, S., 2022 – Some factors affecting seed yield of spring oilseed rape (Brassica napus L.). Agronomy Research, 1 (2): 229-243, Lituania MODEL

ȘMULEAC, L., ȘMULEAC, A., PAȘCALĂU, R., BAKLI, M., & JURAKHON, R., 2025 - The blue crisis: intersections of water scarcity and climate change. Research Journal of Agricultural Science, 57(2), 215.

VIJULIE, I., MATEI, E., MANEA, G., COCOȘ, O., CUCULICI, R., 2012 – Assessment of agricultural land fragmentation in Romania, a case study: Izvoarele Commune, Olt County, Acta Geographica Slovenica, Slovenia. DOI: 10.3986/AGS52206.