

# First White Paper: Advancing Water- Smart and Climate-Resilient Agriculture in Europe.



**Rodrigo Sedano** *projects@watereurope.eu*

**Andrea Rubini** *andrea.rubini@watereurope.eu*

**Ana de León** *ana.deleon@watereurope.eu*

## INTRODUCTION & CONTEXT

Water is a fundamental resource for agriculture, ecosystems, and society at large. In Europe, the increasing frequency and intensity of droughts, combined with rising competition for water, represent a pressing challenge for the agri-food sector. Agriculture is responsible for approximately one quarter of total water use in the European Union, with significant regional variations and often limited availability during critical growing seasons. Climate change is expected to exacerbate these imbalances, putting further pressure on farmers and rural communities.

The recently published European Water Resilient Strategy (WRS) reinforces this concern, setting out a framework to safeguard Europe's water resources and ensure long-term water security. Its objectives, strengthening resilience to droughts, improving water efficiency, and integrating water considerations across all sectors, provide an essential policy backdrop for projects like GEORGIA.

Ensuring the sustainable use of water in agriculture is therefore a strategic priority for Europe. The European Green Deal, the Farm to Fork Strategy, the Common Agricultural Policy (CAP), the WRS and the EU Climate Adaptation Strategy all recognise the need for more resilient food systems and

improved water management practices. At the same time, the Water Framework Directive provides the overarching legislative framework to protect water bodies and promote sustainable use.

Despite these frameworks, several barriers remain. Traditional irrigation practices often lead to inefficiencies, water losses, and in some cases, environmental degradation. The reuse of alternative water sources, such as treated wastewater, is still limited due to regulatory, technical, and social constraints. Digital tools for water monitoring and precision irrigation are advancing rapidly but remain unevenly adopted across Member States.

Against this backdrop, the GEORGIA project has been launched to provide innovative solutions that enhance the resilience of European agriculture to drought. By integrating circular water use strategies, nature-based solutions, advanced monitoring, and artificial intelligence-driven decision support, GEORGIA aims to demonstrate scalable approaches that can increase water efficiency, safeguard ecosystems, and support sustainable farming practices across different climatic regions of Europe.

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## BARRIERS AND ENABLERS

The transition towards water-smart agriculture requires not only technological innovation but also favourable economic, regulatory, and social conditions. GEORGIA identifies a range of barriers that limit the adoption of innovative irrigation solutions, while also highlighting enablers and drivers that can accelerate their uptake across Europe.

Several technical challenges remain significant. The integration of new tools into existing farm systems is often complex, with interoperability between digital platforms still limited. Variability in soils, crops, and climatic conditions adds further complications, making it difficult to ensure consistent performance. Farmers require technologies that are reliable and user-friendly, yet many solutions remain fragmented or too demanding for routine use.

Economic barriers also hinder widespread adoption. The upfront investment required for advanced irrigation infrastructures, sensors, or water reuse systems is often prohibitive, particularly for small and medium-sized farms. In many cases, financing mechanisms and business models capable of reducing these costs are underdeveloped, leaving potential adopters without practical options.

Regulatory complexity further slows progress. While the Water Framework Directive and the EU regulation on minimum requirements for water reuse establish important foundations, national and regional permitting procedures are often fragmented, lengthy, and uncertain. This creates hesitation among both farmers and investors who are considering water reuse or sludge application.

Social and behavioural factors add another layer of difficulty. The acceptance of reused water and biosolids remains uneven, with concerns about safety, quality, and consumer perception influencing farmer decisions. In addition, variations in digital literacy across farming communities can reduce willingness to experiment with AI-driven tools or mobile applications.

At the same time, several strong enablers are driving change. Policy alignment with the European Green Deal, the Farm to Fork Strategy, the Climate Adaptation Strategy, and the Circular Economy Action Plan provides a supportive framework that legitimises and promotes innovative solutions. Technological advances are also expanding rapidly, with sensors, data platforms, and artificial intelligence becoming increasingly affordable and effective. Equally important is farmer engagement: participatory pilots, co-creation activities, and training strengthen trust, build ownership, and ensure that solutions address real needs. Finally, economic incentives, including subsidies, EU funding programmes, and emerging green finance mechanisms, are helping reduce investment risks and stimulate adoption.

By recognising barriers while leveraging enablers, GEORGIA contributes to building the right conditions for scaling water-smart agriculture. This integrated perspective ensures that innovation is not only technically feasible but also socially accepted, economically viable, and aligned with European policy priorities.

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## BARRIERS AND ENABLERS SOCIO-ECONOMIX AND ENVIRONMENTAL IMPACTS

GEORGIA's innovations are designed not only to improve water efficiency but also to deliver tangible socio-economic and environmental benefits. By combining circular water use, NBS, and digital decision-support tools, the project contributes to more resilient farming systems and more sustainable rural economies.

From a socio-economic perspective, the project engages more than 1,200 farmers directly in its demonstration activities and reaches over 89,000 stakeholders through broader dissemination and capacity-building efforts. This active involvement ensures that the solutions developed are aligned with user needs, grounded in real farming practices, and socially accepted.

The adoption of water-smart solutions is expected to help farmers maintain or increase yields under conditions of water stress, while at the same time reducing costs associated with inefficient irrigation and fertiliser use. By introducing digital tools such as mobile applications and decision-support systems, GEORGIA also contributes to digital inclusion and strengthens the skills and confidence of farmers in using new technologies. These elements together enhance the resilience of rural communities, supporting their long-term socio-economic viability.

On the environmental side, GEORGIA advances sustainability by promoting circularity and resource efficiency. The reuse of treated wastewater, the harvesting of rainwater, and the application of soil moisture retention technologies reduce pressure on freshwater resources and limit abstraction from rivers and aquifers. At the same time, the use of innovative soil conditioners such as BioWAG enhances soil structure and water-holding capacity, while nature-based practices help reduce runoff and preserve ecosystem functions. These measures support biodiversity and protect aquatic habitats, contributing to healthier ecosystems at farm, catchment, and regional levels. By strengthening the ability of farming systems to cope with increasingly frequent droughts, GEORGIA also delivers a direct contribution to climate adaptation in line with European strategies.

Finally, the project generates new opportunities along the agricultural value chain and within the broader water innovation market. By validating digital twins, advanced sensors, geocomposites, and other technologies, GEORGIA stimulates demand for water-smart solutions and services. It also contributes to the development of circular economy approaches by demonstrating the safe use of reclaimed wastewater and sludge as valuable resources rather than wastes. These advances create space for new business models and advisory services in irrigation management, offering potential for replication and expansion across Europe.

Through this combined set of socio-economic, environmental, and market impacts, GEORGIA illustrates how innovation in water management can extend beyond the individual farm to support the resilience of rural communities, the sustainability of ecosystems, and the competitiveness of the European agri-food sector.

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## POLICY AND INNOVATION PATHWAYS

The innovations developed and demonstrated in GEORGIA contribute directly to European efforts to make agriculture more resilient, sustainable, and resource efficient.

Yet their long-term success depends on the creation of policy and innovation pathways that allow solutions to move beyond experimental pilots and into widespread practice. This requires both an enabling regulatory environment and mechanisms that support knowledge transfer, financing, and adoption at scale.

From a policy perspective, GEORGIA aligns closely with several key European strategies. The European Green Deal and the Farm to Fork Strategy call for systemic changes in food production to reduce environmental impacts while safeguarding productivity. The Climate Adaptation Strategy highlights the need to address increasing drought risks, while the Water Framework Directive provides the overarching framework for achieving good water status across Member States. The recent EU regulation on minimum requirements for water reuse is particularly relevant, as it establishes standards that can facilitate the safe uptake of reclaimed water for irrigation. By demonstrating safe and effective reuse practices, GEORGIA provides evidence that can inform the practical implementation of these policies at national and regional levels.

At the innovation level, the project advances a model in which circular and digital solutions are deployed in combination and tailored to local conditions. This integrated approach requires pathways that connect technology providers, farmers, water managers, and policymakers in a common framework. Knowledge transfer and training play a critical role here, ensuring that farmers and cooperatives have both the technical understanding and the confidence to adopt new practices. Demonstration cases and participatory engagement activities carried out in GEORGIA show how co-creation builds ownership and accelerates acceptance of innovation.

Financial mechanisms and market frameworks are equally important for supporting uptake. Innovative water reuse infrastructures, advanced sensors, and AI platforms often require significant investment, which may be challenging for smaller farms. Targeted subsidies, green financing

instruments, and the creation of markets for water-smart products and services can help bridge this gap. By identifying and addressing economic barriers, GEORGIA contributes to the development of viable business models for sustainable irrigation.

Finally, the project demonstrates the importance of building a long-term roadmap for replication and scalability.

This includes assessing transferability across different climatic zones, evaluating compatibility with national regulations, and ensuring that innovations can be integrated into existing water governance structures.

By doing so, GEORGIA contributes to the establishment of innovation pathways that are not only technologically advanced but also socially inclusive, economically viable, and policy compliant.

GEORGIA also supports the objectives of the European Water Resilient Strategy, which promotes sustainable and secure management of Europe's water resources through resilience-oriented policies, integrated planning, and innovative governance. The project translates these policy ambitions into tangible models for the agricultural sector, combining digital, circular, and nature-based approaches. In alignment with a vision of a Water-Smart Society and Economy, GEORGIA contributes to a systemic transformation where water is recognised as a strategic resource for sustainability, resilience, and prosperity, thus enabling an economy that thrives within the limits of Europe's water ecosystems.

Through this combined approach, the project supports the broader European transition towards climate resilience, circular economy practices, and sustainable food systems, offering practical guidance on how innovation in water management can be mainstreamed across the agricultural sector.

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## CONCLUSIONS AND KEY MESSAGES

GEORGIA demonstrates how the **integration of circular water management, nature-based solutions, and advanced digital tools** can materially improve the resilience of European agriculture to drought and water scarcity. By validating this combined approach across seven pilots in six countries, the project shows that a single logic can be adapted to diverse climatic, hydrological, and farming conditions without imposing a one-size-fits-all recipe.

A defining feature of GEORGIA is its co-creation model. The engagement of more than 1,200 farmers and outreach to tens of thousands of stakeholders underline that adoption follows trust, and trust follows participation.

Pilots are designed with farmers and cooperatives, not only for them.

This ensures that recommendations reflect operational realities (labour, timing, equipment), that dashboards and mobile views stay intelligible, and that reuse protocols and soil-water measures become part of routine practice rather than add-on experiments.

The evidence base points to tangible socio-economic, environmental, and market benefits. On farms, better informed decision making supported by in-situ sensing, drone and satellite observations, Crop Digital Twins, and explainable AI, can lead to sustained or increased productivity - quantitatively and qualitatively - and decrease negative agri-environmental impacts, while reducing costs and agricultural inputs. Furthermore, explainable AI tools build trust of end-users in digital technologies and facilitate adoption. At the same time, tertiary-treated wastewater, rainwater harvesting, atmospheric water condensation, and soil-water retention reduce pressure on freshwater, stabilise plant water status in dry spells, and curb runoff and nutrient losses, with co-benefits for biodiversity and climate adaptation. For markets, the project clarifies where service models (e.g., advisory subscriptions, cooperative platforms, remote irrigation control) can unlock value and how circular resources can be mobilised within existing supply chains.

Scaling these gains requires enabling frameworks. Three elements are decisive. First, policy alignment that connects pilot protocols to European and national instruments, Green Deal, Farm to Fork, CAP, Climate Adaptation, and the EU Water Reuse Regulation, so reuse classes, monitoring routines, and governance roles are unambiguous. Second, economic incentives and viable business models that recognise both farm-level costs and catchment-level benefits, including options for cooperative services, public-private partnerships, and green finance that address CAPEX and OPEX. Third, knowledge transfer mechanisms that travel: practice abstracts, transferability notes, and training materials that specify what can be generalised, what must be locally tuned, and which data or institutional preconditions are essential.

Credible metrics remain a cornerstone of replication. GEORGIA distinguishes efficiency from optimisation and reports both, avoiding rebound effects and making trade-offs transparent for farmers and authorities. To bridge data-rich and data-poor settings, the project advances

simulation capacity and federated learning, improving models without moving raw data and thereby protecting confidentiality while accelerating learning across sites.

Some constraints persist, interoperability between platforms, uneven digital literacy, and social acceptance of reuse and biosolids, but the project addresses them with open APIs and data schemas, explainable recommendations with uncertainty bands, targeted capacity building, and dashboards that surface water-quality indicators relevant to crop categories.

Continued attention to these enablers, combined with fit-for-purpose incentives under CAP and national reuse regimes, will determine the speed and breadth of uptake.

Key messages from GEORGIA are clear and actionable. Integration beats isolation: circular water options, soil-health measures, and digital decision support deliver the strongest gains when orchestrated together. Scaling requires tackling technical, regulatory, and financial barriers in parallel: interoperability and standards, clear reuse rules and monitoring, and bankable service models and incentives. People make systems work: sustained involvement of farmers and communities is the decisive ingredient for durable change. Taken together, these insights form a roadmap for advancing sustainable water use in European agriculture and for strengthening the resilience of the agri-food sector to the climatic challenges ahead.

GEORGIA embodies the vision set out in the EU Water Resilient Strategy, turning its objectives into concrete pathways for water efficiency, reuse, and resilience in agriculture. The project illustrates how innovation, collaboration, and informed policymaking can shape a truly Water-Smart Europe.

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