COSTEA
ENSEMBLE, POUR RELEVER LES DÉFIS DE L'AGRICULTURE IRRIGUÉE

THEME
Reuse of wastewater in agriculture

POLICY BRIEF COSTEA – REUSE | 2023

THE REUSE OF TREATED WASTEWATER IN AGRICULTURE: THE KEYS TO SUCCESSFUL IMPLEMENTATION AND OVERCOMING OBSTACLES

To address the increasing pressure on water resources due to population growth and high demand from the industrial and agricultural sectors, declining water availability, the deterioration of the quality of water bodies and the impacts of climate change, the reuse of treated wastewater (REUSE) has become a real alternative to safeguard natural resources, make up for shortages of conventional water resources, particularly in agriculture, and improve water security, sustainability and resilience.

REUSE programmes still face numerous technical, economic, social, regulatory and institutional challenges. Certain questions related to water quality and the assessment of long-term environmental, agronomic and health impacts remain unanswered. In addition, the economic benefits and financial performance of reuse for irrigation are difficult to assess and demonstrate. In order to propose solutions and avenues of reflection to identify levers for developing REUSE, six countries with contrasting contexts were the subject of the COSTEA study aimed at highlighting the lessons learned from REUSE projects, the difficulties encountered and recommendations for the success of REUSE projects.

COSTEA's structuring vision is to place REUSE at the heart of integrated water resource management on a territorial scale, so that it can constitute a sustainable alternative for improving water and food security in countries. The five key messages that emerged from COSTEA's work are as follows:



KEY MESSAGES

1
REUSE should be planned into the water cycle as a fully-fledged component of integrated water resource management.

2
Sewage sludge and septage should be considered as a source of recoverable by-products and agricultural inputs rather than a constraint to be managed.

3
Consolidate a governance framework conducive to the development of REUSE by strengthening procedures and the political, institutional and legal framework.

4
The cost-effectiveness of REUSE should better integrate the social and environmental benefits, while relying on a clear definition of the role of the actors (both women and men) and the economic model.

5
Controlling the health and environmental risks linked to REUSE requires REUSE project stakeholders to develop key components to anticipate risks and propose solutions adapted to the uses and territories.

REUSE, also known as water recycling, recovers volumes of water from domestic wastewater, then treats it sufficiently to be safely reused for beneficial purposes such as agriculture. REUSE projects have been undertaken in most countries around the world. COSTEA has chosen to focus on six countries (Algeria, Bolivia, Morocco, Palestine, Senegal and Tunisia) where they are particularly numerous and which are working to develop an appropriate framework for the use of recycled water in irrigated agriculture. What are the main lessons learned from their experience of reusing wastewater, and which avenues should be explored to take advantage of this resource to support more sustainable and resilient agriculture?

1 Issues at stake and objectives of the action

REUSE in irrigated agriculture is at the heart of several issues, demanding a concordance between multiple expert opinions and different actors, the economic viability of projects, the availability of funding, technical constraints, sensitive health and environmental issues and, in some cases, public acceptance. Therefore, the key factors for the successful planning of water reuse include not only technical know-how and the right regulatory and institutional framework, but also economic, environmental and social considerations.

Planned REUSE experiences have often failed for reasons related to poorly functioning treatment processes, limited institutional capacity, or the insufficient financial capacity of local communities to pay for water treatment services. Paradoxically, unplanned water reuse practices for irrigation purposes are very common but present a high health and environmental risk.

These issues highlight the interest in identifying and analysing the successes and constraints of REUSE projects in each of the COSTEA target countries from several perspectives (technical, institutional, economic and social), to carry out a benchmark of them, particularly in regulatory and institutional terms, and to make recommendations to decision-makers that could lead to progress in existing REUSE projects and guarantee the success of future projects.

The 'REUSE' project, which is the subject of this policy brief, addresses these issues and contributes to tackling the following challenges:

- Sustainably managing REUSE operations by integrating the entire value chain, from wastewater collection to the final product resulting from REUSE;
- Taking advantage of the opportunities offered by REUSE and the possibilities of recovering its by-products by distinguishing two scales for REUSE: the peri-urban scale and the scale associated with extensive sanitation systems in rural areas;
- Developing a good governance framework for REUSE projects through the coordination of operations, the involvement of actors at different levels, the clear division of responsibilities between sanitation and reuse actors, the adaptation of the monitoring and control systems of the value chain to the context, and the inclusion of farmer users;
- Improving regulation through standards for the use of treated wastewater and sludge that are adaptable to the context of use;
- Renewing the approaches for evaluating the profitability of REUSE projects within the framework of integrated and territorial management, in order to better assess the economic and financial balance of projects.

The general objective of this project was to analyse the conditions for the success of REUSE and to provide keys to decision-makers and actors in REUSE projects to identify opportunities to develop or improve existing or planned REUSE schemes. The ambition is to support public policies to promote the roll-out of this practice, which aims to be sustainable, efficient and innovative, by tackling all aspects of the problem and targeting all actors involved.

The specific objectives of the study were to: (i) produce knowledge on the different aspects of REUSE and on different sites, in response to local needs and ongoing operations, (ii) capitalise on feedback by identifying pilot projects, good practices and developing reference tools, while learning from the difficulties encountered, and (iii) network national and regional actors and create opportunities for exchanges between COSTEA members with expertise in reuse, to capitalise on and transfer what has been learned through the work carried out, and strengthen multi-actor dialogue to support the emergence of sustainable projects, designed in an integrated vision of REUSE.

By conducting this project simultaneously in six countries and applying it to two scales of operations:

formal operations in peri-urban contexts and decentralised operations in rural areas, this study aims to promote the structuring of REUSE projects around the issues of sustainable irrigated agriculture and to draw conclusions on the main factors of success. Depending on the regulatory, institutional and socio-economic frameworks of each target country, the conditions for success and possibilities for improvement have been analysed from different angles to support the implementation of REUSE projects that best guarantee the sustainability, viability and safety of the operations and the associated products.

2 Presentation of the methodology and contextual elements

The REUSE Structuring Action was launched in December 2020. As international operator, Société du Canal de Provence (SCP), was in charge of coordination and facilitation in order to document REUSE systems and experiences for the six countries (Algeria, Bolivia, Morocco, Palestine, Senegal and Tunisia) through collective and participatory workshops, and including wastewater reuse projects in small extensive systems in small localities (<1000 population equivalent) and urban and peri-urban treatment plants.

In connection with SCP, pairs of national operators in each of the six countries played a reference role by ensuring a national interface to carry out the work of identifying experiences, for the choice of the study sites, and to facilitate the national and local workshops with the participation of the various target actors and national supervisory authorities.

Countries of intervention of the REUSE SA

Country	Pilot sites and study scales
Algeria	Wadi el Bir (centralised approach) and Tafilalet eco-district (decentralised approach)
Bolivia	Sacaba (centralised approach) and Cliza (decentralised approach)
Morocco	Tiznit (centralised approach) and Sidi Abdallah el Bouchouari (decentralised approach)
Palestine	Jericho (centralised approach) and Anza-Jenin (centralised approach)
Senegal	Niayes and Thiès (centralised approaches)
Tunisia	Sfax Sud and Nabeul Souhil (centralised approaches)



The study was organised in five stages:

1. The development of a common intervention methodology for the six target countries;
2. Analysis of the REUSE situation in each country and a comparative summary of the six countries;
3. The choice of two exemplary operations for each country corresponding to the two scales selected, and the organisation of four participatory workshops, two at national level and two at the level of the study sites;
4. The development of a regulatory and institutional benchmark for the six countries;
5. The organisation of a final feedback seminar leading to the recommendations of the study.

For each of the countries, the first national workshops, which were held with institutional actors (ministries, state agencies, research, civil society, etc.), were devoted to validating the situational overviews and selecting sites based on a multi-criteria evaluation applying each of the four themes and following the logic of the two levels of scale. The local workshops for each of the selected sites brought together the local actors and users involved in REUSE operation (decentralised services, local authorities, WWTP managers, women and men farmers, value chain actors, etc.) in order to collectively identify the main difficulties encountered as well as the key success factors of REUSE projects. The second national workshops formalised national recommendations for the development of REUSE.

To close the study, a feedback seminar held on 14 and 15 June 2022 in Tunisia, brought together all of the actors to share the conclusions and agree on the collective follow-up to be given to this structuring action.

At the end of the study, a community of experts was created made up of COSTEA members interested in this topic, the international operator, national operators, institutional focal points, researchers and international organisations.

In the Mediterranean region, several international organisations have launched similar initiatives for the development of REUSE in the region. In order to provide collective support, COSTEA took steps to consult with the Sahara and Sahel Observatory (OSS), the Food and Agriculture Organization (FAO) and the Mediterranean Water Institute (IME), to ensure that the various studies are complementary and bring specificities to the reflections led by these organisations on this subject. The situational overview of REUSE in the six target countries, presented briefly below, is based on documentary research that has provided a rich bibliographic database available on COSTEA's website.

Algeria

Of the 200 wastewater treatment plants in operation in 2021, 17 were subject to REUSE for irrigation purposes, mobilising a volume of 18 million m^3 of purified water which has been used for agricultural purposes to irrigate 11 500 hectares, notably fruit trees (date palms, olive trees, etc.) and some cereals. The reuse potential amounts to 45 000 hectares from 81 purification systems in operation and under construction. The REUSE governance process consists of three interconnected stages: the concession study, sanitary control and water use. Each stage involves a number of actors. In rural areas not connected to the public sewage system, unplanned REUSE initiatives are carried out by local actors such as farmers and civil society. Algeria does not currently have a regulatory text on sludge management.

Bolivia

Bolivia has a regulatory framework for the conservation, protection and use of water resources but no specific framework for wastewater reuse. A regulatory framework governs the quality of all water bodies, and quality classes are assigned to different types of crops. It is estimated that more than 7 000 ha (2% of the country's irrigated production area) is subject to direct or indirect wastewater reuse. Approximately 40% of the wastewater volumes from the country's WWTPs are reused indirectly. The direct reuse of effluents is practised in 8% of WWTPs and the treated wastewater reuse systems are self-managed by the farmers themselves.

The classification of water bodies according to their quality and suitability for use (and reuse) must be carried out in strict compliance with the maximum permissible values of 80 parameters. In addition, reuse is only envisaged for the production of high-stemmed crops and not for the production of vegetables. With regard to sludge management and reuse, the country's experience is still limited.

Morocco

In 2021, there were 156 operational WWTPs and 79 WWTPs under construction. The volume of treated wastewater is approximately 400 million m^3, not counting the water discharged into the sea from the outfalls of coastal cities. Agricultural REUSE is struggling to emerge while other uses, such as watering of golf courses and green spaces and industrial use, have proven to be operational and are being developed with strong support from the Moroccan government. Indeed, despite a strong national will to develop agricultural REUSE, projects are in a mixed situation between stalling and attempting to start up (20 million m^3/year by 2021). No large-scale project is operational to date and only small pilot projects (400 to 1 000 m^3/day) have been carried out and made it possible to develop technical reference systems and strengthen scientific skills. Sludge management is not sufficiently integrated into the 'water' value chain, although initiatives have been stepped up in the last decade, encouraged by the National Shared Sanitation Programme (PNAM, Programme national d'assainissement mutualisé).

Palestine

With the scarcity of water resources and lack of access to water, Palestine considers treated wastewater as one of the sources of water that can be used for different purposes, including agriculture. The Palestinian Water Authority (PWA) considered REUSE as one of the five strategic 2017-2021 objectives for the water sector. Currently, more than two thirds of the wastewater collected in the West Bank and Gaza is treated by 22 WWTPs producing 48 million m^3 of treated wastewater annually, However, not all treated wastewater meets the REUSE specifications and standards set between 2010 and 2012, partly due to the poor operation of some treatment plants.

There are already planned REUSE operations in Ramallah (green areas), Jenin (for agricultural use on 500 ha), Gaza (for less than 5% of wastewater) and other large cities in Gaza and the West Bank. On a small scale, there are about 15 small wastewater treatment plants that practice REUSE, often after extensive treatment. There is no experience of sludge management on an operational scale; all of the practices and projects are either at pilot or research project level.

Senegal

Senegal has a legal, institutional and regulatory framework for REUSE. However, only three cases of planned REUSE were identified, at the pilot stage and supported by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO). These sites are located on the northern outskirts of Dakar and in the Thiès area and use a volume of 600 000 m^3 of treated water for the irrigation of market garden crops. The main reuse of sludge currently concerns septage from non-collective or semi-collective sewerage (latrines). It is used for agricultural purposes after a summary treatment. It is in this context that there is currently a whole value chain for the recovery of septage in market gardening activities in the Niayes area and for the two pilot sites of Patte d'Oie and Pikine.

Tunisia

Tunisia was a pioneer in agricultural REUSE, which began in 1965. According to the latest available report on REUSE, there are 31 irrigated schemes with an irrigable area of 7 437 ha, of which 22 are operational with an area of 6 387 ha. There were 122 WWTPs in 2020 treating a volume of 287 million m^3 annually. However, the WWTP stock is ageing, which explains the non-functionality of some schemes. The REUSE regulatory framework is in place but bacteriological analyses are infrequent and the sanitary measures (protective equipment for farmers, vaccination, ban on direct grazing) as defined in the REUSE specifications are often not respected. No monitoring of the water salinity or soil is carried out in the majority of projects. As far as sludge is concerned, the Tunisian regulatory framework aims to protect public health and the soil under the country's specific climatic conditions. Restrictions on use are applicable to market gardening. It is also forbidden to use liquid sludge and non-sanitised sludge.

In 2015-2016, an action plan for sludge management was broken down into four regional master plans (Greater Tunis, North, Centre and South) which defined the sludge treatment and recovery chains (agricultural, energy and landfill), infrastructure planning and accompanying measures.

3 Results of the study, key messages and limits of the approach

The analyses resulting from the COSTEA REUSE action make it possible to formulate a number of messages and recommendations which are developed below. These aim to contribute to the emergence of sustainable agricultural REUSE projects to meet the challenges of adapting to climate change, the social and economic development of territories, and the introduction of technical, institutional and economic innovations to ensure the success of projects.

THE 5 KEY MESSAGES IN DETAIL

1. **REUSE should be planned into the water cycle as a fully-fledged component of integrated water resource management.** Much of the world's agricultural land is irrigated by unplanned wastewater reuse systems, i.e. reuse with or without treatment after return to the natural environment and dilution via surface or groundwater. The lack of planning does not allow for the necessary control of the health and environmental risks or the cost-effectiveness of wastewater treatment (where it exists). The planned reuse of wastewater in agriculture, on the other hand, consists of integrating REUSE into the hydrological cycle as an integral component of integrated water resource management on a territorial scale. It thus aims to make REUSE safe through an adequate treatment of the wastewater according to the intended uses and their required quality, and the environmental sensitivity of the surroundings. REUSE planning is not incompatible with an indirect reuse of the water after it has passed into the natural environment. In this case, self-purification phenomena can be taken into account in addition to treatments by purification processes (barrier effect). REUSE planning also includes the question of monitoring and controlling water

quality throughout its cycle to ensure that the level of water treatment effectively matches the intended use and environmental requirements. In this respect, Bolivia has an interesting regulatory framework that classifies all water bodies (including treated wastewater) into categories according to the quality of the water. On the basis of this, the regulations impose a water class depending on the different types of irrigated crop.

2 **Sewage sludge and septage should be considered as sources of recoverable by-products and agricultural inputs rather than a constraint to be managed. Although septage is perceived as a difficult issue to manage, it is in fact an opportunity and an asset for territories.** This by-product, even more than wastewater, represents on the one hand, an environmental and health risk, and on the other, a nutrient resource that can contribute to improving the organic matter content of soils and their fertility. Sludge management can be a relevant option, as shown by the example of Senegal, where several secondary towns have treatment plants for septage that is recovered and used in agriculture as substitute fertilisers. We also note the emergence of a parallel market for untreated septage, which is risky from a health point of view and requires support from the public authorities. Spreading sludge after its stabilisation seems to be another relevant solution, which would also make it possible to maintain the moisture and organic matter content of the soil, which is crucial in irrigated agriculture in hot climates. The development of the sludge value chain requires a systemic territorial approach that involves stakeholders at the local level and at each stage of the chain in order to progress towards complete and functional services. Strategic plans for septage management should cover the whole territory and define implementation actions by area, taking into account urban development, land use, types of habitat and the characteristics of the sanitation systems. Communication and coordination mechanisms in the different planning and management phases will enable the value chain to become a real driver of local development.

3 **Consolidate a governance framework conducive to the development of REUSE by strengthening procedures and the political, institutional and legal framework.** The major obstacles to the development of REUSE projects are largely associated with political and institutional constraints. Conflicting policies and a lack of institutional support often explain the failure of REUSE projects. The main success factors to be considered in the definition of this framework are: (i) **the prioritisation of REUSE in water policy to promote a more efficient use of water resources**, through regulations, financial resources and incentives. This support at government level encompasses national policies and sectoral strategies, but also the receptiveness of local authorities and decision-makers; (ii) **the coordination of stakeholders**, and their involvement through the designation of an operations coordinator, the definition and application of the roles and responsibilities of each actor in the chain, strong commitment from the authorities, an operational governance framework for projects and capacity-building strategies; (iii) **the national and international harmonisation of standards** in order to reduce the excessive differences in standards between countries, which constitute a serious barrier to trade. The harmonisation of regulations could be progressively strengthened as each country gains experience; (iv) **the consideration of the socio-cultural dimension** at different scales, through formal mechanisms for consulting women and men farmers and consumers at the design stage and throughout the life cycle of projects; (v) **effective risk management**: REUSE always involves a certain level of risk in terms of the quality of the treated water and of the agricultural products and the uses to which it is put (see message 5). To mitigate this, it is recommended that the Sanitation Safety Plan (SSP) developed by the WHO be integrated into the planning process for REUSE projects, in order to identify the risks and define the measures to be taken to reduce the health risks generated by the

use of wastewater and sludge in agriculture.

4 **The cost-effectiveness of REUSE should better integrate the social and environmental benefits, while being based on a clear definition of the role of the players and the economic model.** Conventional economic and financial evaluation methods almost systematically make REUSE projects unjustifiable. This is mainly due to the fact that the social aspects (for example, the involvement of local people in small rural REUSE projects) and environmental aspects (in relation to the preservation of other water resources through substitution effects) are undervalued in conventional analyses, even though they are - or should be - considered to represent considerable added value in terms of the general interest. However, examples from countries such as Palestine show that the sustainability of REUSE projects in its three components (economic, but also social and environmental) can be approached through methodologies such as life cycle analyses or cost-benefit analyses that explicitly take into account externalities of a social nature (job creation and fertiliser savings) and environmental nature (preservation of surface and groundwater quality and ecosystem services), as well as the benefits of the multi-use of water (industry, green spaces, etc.). Nevertheless, to ensure the sustainability of REUSE projects, it is essential to clarify its institutional and financial set-up as soon as possible (Who finances the storage and distribution infrastructures? Who is in charge of the operation? What remuneration for the reused water?)

5 **Controlling the health and environmental risks linked to REUSE requires REUSE project stakeholders to develop key components to anticipate risks and propose solutions adapted to the uses and territories.** Health and environmental risks are among the main concerns regarding REUSE in agriculture. Achieving health and environmental objectives requires monitoring and evaluation of the system, the definition of the responsibilities of the monitoring and control institutions and services, documentation of the status and operation of the treatment, and independent confirmation that it is functioning properly. A risk analysis approach is recognised as the basic methodology for developing standards for the safety of water users and agricultural products. Where a REUSE project involves an extensive treatment process attached to a decentralised rural sanitation system, the health risks can be addressed by adopting a WHO 'multi-barrier'-type approach, supported by local development and project guidance rather than an approach based on restrictive limit values.

Upon the completion of COSTEA's work, it was apparent that REUSE is a field that requires continuous innovation to fill the gaps raised and remove the constraints to its development. Much of the existing knowledge comes from laboratory or field research without a real horizontal (between institutional actors) and vertical (integrating farmers and consumers) interconnection. It is imperative to develop methods to increase the level of local expertise and support institutional capacities. COSTEA therefore recommends setting up **living labs for REUSE based on the interconnection and development of the COSTEA study sites to support innovations in REUSE projects.**

A COSTEA-REUSE living lab will be set up with the teams involved in the study (experts, institutions, farmers, local civil society) to create, in a participatory approach in each of the countries and at the level of their pilot sites, research and development poles producing innovative educational tools and services in the various REUSE disciplines. The study sites will thus serve as showcases for disseminating and communicating good practices, research results and the various approaches tested (cost-benefit analysis, life cycle analysis, etc.). This living lab could be opened to other countries and pilot sites on an international scale.

Limits of the approach

Despite the interesting results obtained, the implementation of this project nevertheless had certain limitations. This was the case, for example, with the choice of sites representing the two scales, which was not possible in all of the countries due to the non-existence of case studies (Senegal) or the preferences of the institutions (Tunisia). The national and local workshops also created expectations among institutions and actors to translate the study's recommendations into concrete projects in the field, which are beyond the scope of this study but which could be the subject of future projects.

The living labs could be set up as long-term collaborative platforms for disseminating knowledge, capitalising on experience and producing information to improve REUSE processes.

4 COSTEA outputs in relation with the study

- **The country synthesis reports** — Global synthesis ↗ · Palestine ↗
- **A workshops report (Palestine)** — Download the PDF ↗
- **A benchmark report on wastewater reuse regulation and governance in agriculture** — Download the PDF ↗
- **A final synthesis report with recommendations** — Download the PDF ↗
- **A documentary database** — Browse the database online ↗



Find out more:
https://www.comite-costea.fr/en/our-focus-areas/treated-wastewater-reuse-reuse/