

WOMEN PRESERVE “AGRICULTURAL” HERITAGE UNDER WATER REUSE IN TUNISIA

LES FEMMES PRÉSERVENT LE PATRIMOINE « AGRI-CULTUREL » GRÂCE À LA RÉUTILISATION DE L'EAU EN TUNISIE

O. Mahjoub¹, J. L. Ullman^{2,3}, and S. Harigua⁴

ABSTRACT

Reclaimed water (RW) has been adopted as an alternative water resource to help secure water and food for local communities in arid regions. In the Oued Souhil area, northeast Tunisia, the use of RW for irrigation rescued citrus-based agricultural systems suffering water shortage and preserved the orange blossom steam distillation sector; the latter is a longstanding seasonal tradition practiced by rural women. Despite the important role women play in water management, their actual contribution to the water reuse sector remains underexplored and their perspectives on global changes are rarely considered. For the first time, this study explores the combined perception of RW reuse and climate change by women practicing blossom flower distillation to comprehend their role in anchoring this cultural heritage under local circumstances. A survey of 30 close-ended and open-ended questions revealed that 90% of women were reusing RW since the 1980's. Overall, 90% accept RW because of its availability - regardless of its quality and because of groundwater degradation. However, only 30% are satisfied with RW use. Regarding climate change, women have observed reduced rainfall, higher temperatures, and prolonged summer seasons, which can accelerate flower blooming and disrupt the harvesting schedule, eventually impacting product quality and its marketability. For 93% of the participants, blossom steam distillation is a cultural heritage, passed down through family traditions and 100% indicate it provides a reliable source of income. More than 90% of interviewees emphasized the necessity of improving RW reliability and quality to maintain agricultural activity. Hence, preserving the cultural heritage of blossom steam distillation is closely linked to rural women empowerment and to the sustainability of RW reuse through improved practices and appropriate resilience measures to global changes; this calls for a transdisciplinary approach to inform policy decisions for both the agricultural and the industrial sectors.

Keywords: Reclaimed water; Arid regions; Climate change; Harvesting schedule; Source of income.

RÉSUMÉ

L'eau recyclée a été adoptée comme ressource alternative pour aider à garantir l'approvisionnement en eau et en denrées alimentaires des communautés locales dans les régions arides. Dans la région de l'Oued Souhil, au nord-est de la Tunisie, l'utilisation de l'eau recyclée pour l'irrigation a permis de sauver les systèmes agricoles basés sur les agrumes, qui souffraient d'une pénurie d'eau, et de préserver le secteur de la distillation à la vapeur des fleurs d'oranger ; ce dernier est une tradition saisonnière de longue date pratiquée par les femmes rurales. Malgré le rôle important que jouent les femmes dans la gestion de l'eau, leur contribution réelle au secteur de la réutilisation de l'eau reste peu étudiée et leurs

¹ Laboratory of the Valorization of Non-Conventional Water Resources (LR16INRGREF02) National Research Institute for Rural Engineering, Water, and Forestry, Tunisia, Carthage University, Hedy Karrai St. P.O Box 10, 2080, Tunisia Email: olfa.mahjoub@ingref.ucar.tn

² Department of Biological Systems Engineering, University of Nebraska-Lincoln, Lincoln, NE, USA Email: Jeffrey.Layton.Ullman@gmail.com

³ Laboratory of the Valorization of Non-Conventional Water Resources (LR16INRGREF02) National Research Institute for Rural Engineering, Water, and Forestry, Tunisia, Carthage University, Hedy Karrai St. P.O Box 10, 2080, Tunisia Email: olfa.mahjoub@ingref.ucar.tn

⁴ The Water Users' Association (GDA) Souhil, Nabeul, Tunisia. Email: sabrinegdasouhil@gmail.com

points de vue sur les changements mondiaux sont rarement pris en compte. Pour la première fois, cette étude explore la perception combinée de la réutilisation des eaux recyclées et du changement climatique chez les femmes pratiquant la distillation des fleurs d'oranger afin de comprendre leur rôle dans la préservation de ce patrimoine culturel dans le contexte local. Une enquête comportant 30 questions fermées et ouvertes a révélé que 90 % des femmes réutilisaient les eaux usées depuis les années 1980. Dans l'ensemble, 90 % d'entre elles acceptent ces eaux en raison de leur disponibilité – indépendamment de leur qualité – et de la dégradation des nappes phréatiques. Cependant, seules 30 % se déclarent satisfaites de leur utilisation. En ce qui concerne le changement climatique, les femmes ont constaté une baisse des précipitations, une hausse des températures et un allongement de la saison estivale, ce qui peut accélérer la floraison et perturber le calendrier de récolte, affectant à terme la qualité du produit et sa commercialisation. Pour 93 % des participantes, la distillation à la vapeur des fleurs constitue un patrimoine culturel transmis par les traditions familiales, et 100 % d'entre elles indiquent qu'elle constitue une source de revenus fiable. Plus de 90 % des personnes interrogées ont souligné la nécessité d'améliorer la fiabilité et la qualité des eaux usées rurales afin de maintenir l'activité agricole. Par conséquent, la préservation du patrimoine culturel que constitue la distillation à la vapeur des fleurs est étroitement liée à l'autonomisation des femmes rurales et à la durabilité de la réutilisation des eaux usées rurales grâce à des pratiques améliorées et à des mesures de résilience adaptées aux changements mondiaux. Cela appelle à une approche transdisciplinaire pour orienter les décisions politiques tant pour les secteurs agricoles qu'industriels.

Mots-clés : Eau recyclée; Régions arides; Changement climatique; Calendrier de récolte; Source de revenus.

INTRODUCTION

Worldwide, climate change is adversely impacting water availability and quality, which in turn severely diminishes agricultural production especially in regions that are increasingly reliant on marginal-quality water resources (Qadir et al., 2025). Water pollution is also worsening worldwide and climate change is contributing to the deterioration of water quality through increasing temperatures, fluctuating rainfall patterns, and intensified extreme weather events (Zou et al. 2023). Under global change, wastewater reuse is recognized as an untapped resource to bridge the gap between increasing water demand and the shrinking supply to guarantee water and food security in arid regions (WWAP, 2017). Building climate resilience while using treated wastewater as a means of drought mitigation to sustain agriculture is an example of the circular economy applications to sustainably and safely managed wastewater systems (Corvella et al., 2014).

The United Nations has declared 2026 as the International Year of the Woman Farmer with an aim to close gender gaps and improve livelihoods. Women represent over 40% of the global agricultural workforce (FAO, 2026) and their dependence on agriculture makes them particularly vulnerable to shocks to the sector resulting from climate change (Botreau et Cohen, 2020). The importance of involving women in water management has been recognized since the 1977 United Nations Water Conference, the International Drinking Water and Sanitation Decade (1981-90) and the International Conference on Water and the Environment (1992). Women hold key responsibilities in household and community water management; when women are actively involved in water governance, the outcomes are more sustainable and equitable (Silva Rodríguez de San Miguel, 2019). Rural women are disproportionately affected by climate change due to their role both in domestic and agricultural activities. Women may hold water-anchored cultural heritage that can be endangered if they are not fully involved in decision-making. A gendered impact of climate change in MENA Region was highlighted by Naoum (2024).

The participation of rural women in the wastewater reuse sector is often overlooked due to the lack of gender-disaggregated data. Several gaps exist regarding the contribution of women in the water reuse sector, more particularly in developing-countries facing water shortage. When women are well informed, they can contribute to tackling social acceptance and barriers towards water reuse and management (Abi-Ghanem et al., 2013; Mapezda et al., 2022).

To date, the triangulation of climate change, wastewater management, and gender has failed to make the voice of rural women heard in many regions because of factors like exclusion from decision-making, oversight of their contribution in the labor force, and under-estimation of their role in health preservation. In the MENA region, women are not provided adequate and timely access to essential information, including procedures and protocols for reuse (Mateo-Sagasta et al., 2023).

In Tunisia, women represent 35 to 40% of the agricultural labor hand (INS, 2024) but data on women involved in water reuse sector are lacking. Under the prevalent water management conditions, rural women are facing several challenges related to extreme events that would disrupt their role in the resources management and subsequently their economic stability (Mazhoud et al., 2025). Oued Souhil, in northeastern Tunisia, has been using RW for irrigation since the early 1980's. Despite longstanding experience, there is a knowledge gap on the women's role in reuse at various scales. An early initiative explored the role of women in the safe water reuse for agriculture through the UN-Water project "Safe Use of Wastewater In Agriculture (SUWA)" supported by the UN-Decade of Decade Programme on Capacity Development. This recognized the importance of empowering women by providing more information on the safe reuse of RW to protect human health, and to promote good practices to mitigate human health and environmental risks (UNW-DPC, 2012). This paper aims to explore the perception of rural women practicing orange blossom flower distillation, under climate change conditions, to comprehend their practices in RW reuse and their role in anchoring this cultural heritage in Oued Souhil irrigated area. Orange blossom distillate, also known as orange flower water, is used as a food flavoring, skincare product, and in aromatherapy. The study intends to make the role of rural women in water reuse visible and to showcase the importance of enhancing their social, economic and cultural role.

MATERIAL AND METHODS

Location and climatic parameters of the area of Oued Souhil irrigated with RW

The Oued Souhil region is located in the Governorate of Nabeul (36°27'45.42"N, 10°42'10.57"E), northeastern Tunisia (Figure 1). The region exhibits a semi-arid climate with a mild winter, warm summer, and occasionally high temperatures in the spring season; temperatures are typically range from 5.6 to 32.5°C (ONAGRI, 2026). Rainfall is highly variable with values varying between 400 and 600 mm/year. Evapotranspiration may exceed 1800 mm per year, resulting in a substantial water shortage, rendering irrigation necessary to guarantee a reliable agricultural production.



Figure 1. Location of Tunisia, Nabeul and the irrigated area of Oued Souhil

Water resources

Groundwater: The Nabeul-Hammamet Aquifer used to be the main water resource in Nabeul region (Bouzaidi, 1990). During the 1940's, it was officially declared restricted for the creation of new wells. Between the 1960's and 1970's, intensive exploitation of coastal aquifers led to significant salinization. From 1980 to 2010, groundwater extraction from the aquifer doubled, further intensifying pressure on

the resource. Currently, more than 20% of shallow aquifers are overexploited, thus becoming improper for irrigation. Usually, groundwater is used for animal watering and domestic usage (Chaïeb et Mamou, 1999) in addition to irrigation.

Agricultural irrigation and reclaimed water management: Initially, the reuse of RW in agriculture in Oued Souhil started in 1979 with the aim to reduce the pressure on the Hammamet-Nabeul Aquifer (Rekaya, 1986), for enabling the replenishment and to fill the gap of water deficit for irrigation to preserve the agricultural production. Currently, the irrigated area of Oued Souhil covers about 280 ha while the area connected to the irrigation network and equipped with valves is 263 ha but actually only 158 ha are irrigated using RW. The area was established to be used by up to 447 farmers, but only 134 are actual beneficiaries of RW. The cropping system consists of citrus trees (90 ha) of various cultivars, olive trees (40 ha) and forage crops (28 ha) (GDA Souhil, 2024). More than 70% of farmers are members of the water association, and this percentage varies across the years. Cultivated areas - and consequently irrigation water consumption - also fluctuate annually. Since 1999, the management of the irrigation water was assured by a Collective Interest Group (GIC), currently referred to as the Agricultural Development Group (GDA).

RW in Oued Souhil is supplied by two wastewater treatment plants (WWTP) - SE3 and SE4 - through a pipeline feeding a 4500m³ storage basin located upstream of the irrigated area. Accordingly, RW is distributed by gravity among the irrigated lands (Figure 2). The WWTP- SE4 was built in 1979 and was rehabilitated in 2016 by upgrading its treatment capacity from 9,585 m³/day to 27,000 m³/day; now it is one of the largest among the 18 WWTP in the Nabeul region. The WWTP is equipped with a tertiary treatment using sand filtration and UV disinfection, and it is expected to be self-sufficient in energy thanks to biogas production. However, these improvements are not yet effective. The WWTP-SE3 was constructed in 1981 with a treatment capacity of 3,500 m³/day. It processes wastewater generated from tourism activities, university residences, and hospitals in the region. It started supplying Oued Souhil 2004. RW has been reused for irrigation in Oued Souhil area for over 45 years. Currently, up to 20% of the RW is reused for irrigation (GDA Souhil, 2024), the rest is discharged into the sea despite the high acceptance of reuse by the farmers' community and the increasing demand.



Figure 2. Overview of the location irrigated area of Oued Souhil (yellow contour), WWTP-SE3 and WWTP-SE4

Recent research highlighted the conjunctive use of RW and groundwater by farmers for the sake of either a timely water supply for irrigation, or for improving RW water quality (Mahjoub et al., 2022). In addition to RW supply interruption caused by power disruption during peak energy consumption, pathogen outbreaks may occur at the WWTP during the summer season, which can disrupt the RW distribution for several weeks resulting in serious water shortages. Other factors behind the uneven supply of RW are related to irrigation water governance and the technical shortcomings of the existent infrastructures (GDA Souhil, 2014).

Interviews and questionnaire

Taking into consideration the number of women involved in the water reuse sector in Oued Souhil based on the records of GDA Souhil, this study intended to cover the entire female community (i.e., 31 women). However, due to field constraints, the methodology was adjusted to the local context. The selection of the interviewees was based on two main criteria. First, land size was considered for the classification of the interviewees in order to have an even distribution among the different categories (Figure 3). Overall, the majority of the farm-plots do not exceed 1 ha. Second, the reachability and availability of the women was considered because of the family chores and responsibilities, the seasonality of the agricultural activity and steam distillation, and other personal constraints. Accordingly, 14 women were interviewed with the support of the GDA. Despite the limited sample size, it is deemed to be representative of the rural women community in Oued Souhil.

The questionnaire comprised 30 close-ended and open-ended questions asked in the local Tunisian Arabic dialect for better comprehension. It covered various topics like the climate change perceptions, agricultural practices, wastewater reuse, blossom steam distillation, and the impact of the prevailing conditions on the agricultural sector.

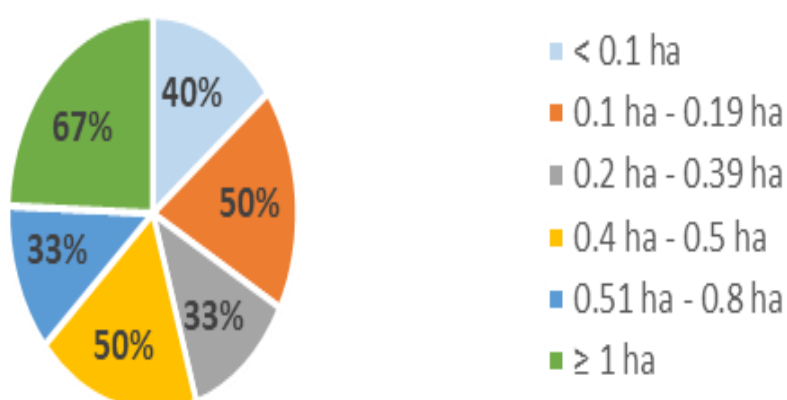


Figure 3. Distribution of the selected interviewees based on land size category in Oued Souhil area (%)

RESULTS AND DISCUSSION

Socio-demographic characterization of the interviewees

Half of the interviewees are aged more than 60 years and more than 93% are either illiterate or went to only primary school. Regarding land tenure, 64% of women are owners and 43% are farmer's wives; some are both land owners and managers of their father's or husband's land. The educational level in Oued Souhil informs on the traditional archetype of the rural society and social norms. In Tunisia, the illiteracy rate among females is 22% and is particularly pronounced in rural area. Access of females to land is an exception as only 5% of the agricultural lands are owned by women and more than 60% are involved as labor hand (INS, 2024). Therefore, women in Oued Souhil are considered relatively privileged.

Land exploitation and water resources management

The cultivated agricultural lands irrigated with RW in Oued Souhil have an area comprised between less than 0.1 ha (called “Marjaa” in the local Arabic dialect) and more than 1 ha with a majority (80%) covering less than 0.5 ha; Mahjoub et al. (2022) mentioned that 75% of the agricultural land in Oued Souhil is less than 1 ha. The plots occupied by bitter orange trees and exploited by women range from 0.03 to 2 ha. Indeed, such small plots are generated by the successive division through inheritance, resulting in the exacerbating problem of land fragmentation with subsequent impacts on the economic viability and profitability. Meanwhile, the phenomenon is socially and culturally accepted and informs on farmers’ emotional attachment to land as an integral part of their identity and family heritage (Garau et al., 2025). Regarding groundwater, the majority of respondents (86%) have farm wells on their lands and 36% are still using them for irrigation. Irrigated agriculture was practiced by 57% of women before the establishment of RW reuse in the region, meaning they likely had to replace groundwater use with RW or use them conjunctively. Before water reuse, farmers used to rely on groundwater resources to cultivate not only citrus trees but also garden crops. The reuse of RW in agriculture entails complying with the national regulations prohibiting growing garden crops and a full compliance with the standards’ established in 1989 (NT 106.03 (1989)) defining the threshold values of the physico-chemical and biological quality parameters for the reuse of RW in agriculture (INNORPI, 1989).

For RW, more than 70% of respondents have their land equipped with an individual valve. Water resource availability and accessibility can affect the timeliness of distribution and subsequently the response to water shortage. According to participants, availability of RW (90%), the degradation of the groundwater resources (50%) and the insufficient supply from aquifers (40%) are the top three reasons behind the acceptance of the reuse of RW for crops irrigation (Figure 4) but none mentioned the presence of nutrients as one of the benefits of the reuse. Visibly water availability (quantity) is a prevailing factor, regardless of the quality. The latter can be improved through the conjunctive use of groundwater and RW either by blending or by alternating the resources (Mahjoub et al., 2022).

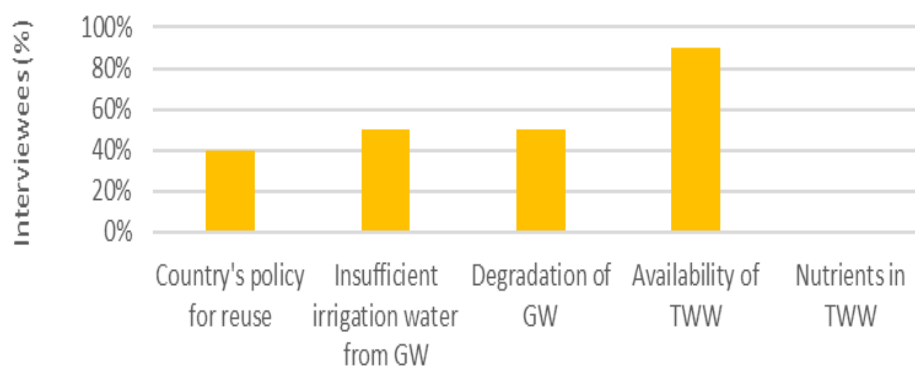


Figure 4. Reasons behind the reuse of RW for agricultural irrigation (TWW: treated wastewater; GW: groundwater)

Climate change perception and impacts on traditional agricultural practices

All women agree that the region is undergoing a change of the climatic parameters over the years with variations in rainfall and drought periods. The majority (93%) stated that there is a trend of decreased rainfall, especially in winter (100%) (Figure 5). The duration of the winter season is shrinking for 64% of the interviewees and for 57% the duration of summer is longer with an increase of drought period for 43%. Regarding temperature, 79% of women think that it is becoming higher in summer season and are expanding over longer periods (Figure 6). All the respondents think that changes in climate phenomena have an impact on the agricultural activity. Almost 80% announced that there is no change in the distillation products in terms of quantity and quality; though as expressed by some women “high temperatures accelerate the blooming which would press the farmers to harvest the blossoms more

quickly since early March. If the weather is rainy, farmers proceed to harvesting in April and they may expect higher quality of the flowers and of the distillate”.

The majority related impact of the change in climate parameters to other factors like the wider spread of disease (93%), an increase of the water demand (86%), an enhanced use of chemical fertilizers (86%) and an increase of the need in labor hand (86%). Meanwhile, 36% of women noticed a decrease in soil fertility (Figure 7).

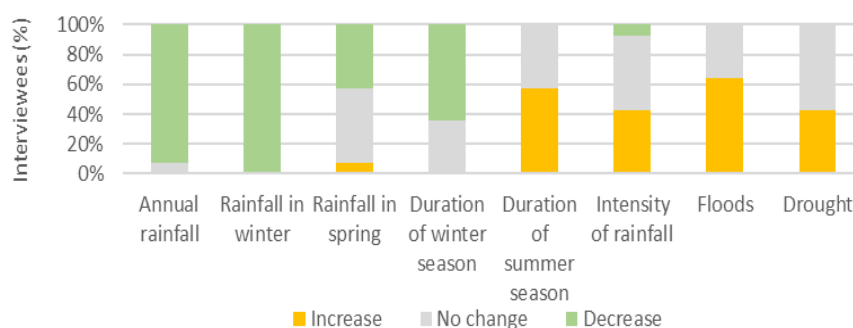


Figure 5. Climate change perception by women from the rainfall perspective

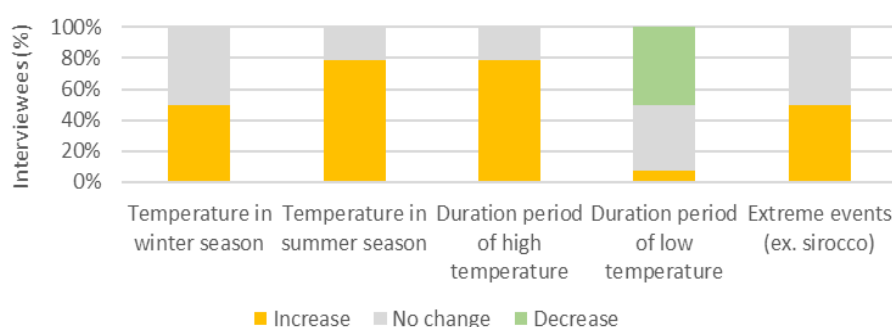


Figure 6. Climate change perception by women from the temperature perspective

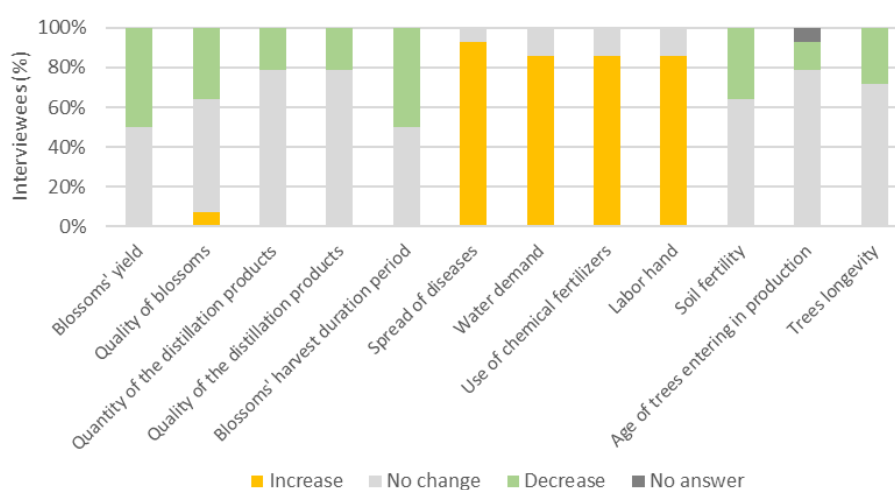


Figure 7. Women's perception of the impacts of climate change on various parameters

Blossoms' steam distillation practices and cultural heritage

The majority of women (93%) mentioned inheriting the practice of orange blossom steam distillation from their elders and family members, indicating how far the transfer of this cultural heritage is imbedded in the regional traditions. Women declared that they prefer using the traditional technique for the distillation, with about 7% adopting ancient devices. Yet, the majority are inclined to mix the traditional and the modern techniques, but none have fully modernized their practices to date. This observation is supported by the fact that 64% of women acknowledged practicing steam distillation before the 1980's before the start of RW reuse. This informs on the need of an alternative water resource, i.e., reclaimed water, to support the activity and reflects on the importance of the regional cultural heritage and its perpetuation through the generations even under very scarce water conditions. It was noticed that all women are tending to diversify the distillation activity by integrating other types of crops, like roses, rosemary, thymus, and geranium.

From an economic perspective, all the interviewees confirmed that steam distillation is a secure source of income as it allows a full coverage of the expenses. As per product commercialization, women prefer to rely on traders for selling blossoms on the local market (64%). When performing the steam distillation by themselves, 50% of women acknowledged keeping part of the distillates for their own use, mainly for culinary for medical purposes. Overall, the income generated from the orange blossom steam distillation is entirely meant to cover household expenses for 100% of the interviewees, with no allocation for personal spending, showing the significant contribution of this traditional activity to the family financial stability. Thanks to RW reuse, the steam distillation sector is contributing to the empowerment of rural women in Oued Souhil. This activity, rooted in community cultural heritage, is in line with the national strategy for the economic and social empowerment of women and girls in the rural areas.

CONCLUSIONS

Bitter orange blossom steam distillation is a deeply-rooted traditional practice in the Nabeul region. This cultural heritage was explored from women farmers perspectives practicing RW reuse in Oued Souhil area. This heritage perpetuated through the generations is increasingly threatened by global change, perceived mainly as a decrease of rainfall and increase of temperatures. The impact of climate change is exacerbated by the untimely supply of RW and the variability of its quality. The emotional value of farm land and the high acceptance of water reuse by the rural community are counterbalancing these challenges. Steam distillation is an economically viable activity that represents a secure source of income for women and their families. Despite its limitations, the study flagged relevant aspects related to gender mainstreaming in agricultural irrigation using RW. Women's contribution in the water reuse sector in Oued Souhil and their role in preserving the cultural heritage of the bitter orange blossom steam distillation is worth a thorough investigation at a larger scale to integrate female labor involved in irrigation, field work, and harvesting. It is highly relevant to deepen the analysis of the resilience of women, as holders of this "agri-culture", to climate change under water reuse conditions and examine the factors that contribute to an effective preservation of traditional knowledge.

REFERENCES

- Abi-Ghanem, R., L. Carpenter-Boggs, R.T. Koenig, J.L. Ullman, K.M. Murphy and C.D. Pannkuk. 2013. Access to agricultural inputs, technology and information, communicating with farmers, and the role of women in agriculture: perceptions of Iraq extension agents. *Journal of International Agricultural Extension and Education* 20: 6-18. <https://doi.org/10.5191/jiaee.2013.20101>
- Botreau, H. and Cohen, M.J. 2020. Gender inequality and food insecurity: A dozen years after the food price crisis, rural women still bear the brunt of poverty and hunger, In Marc J. Cohen (Eds), *Advances in Food Security and Sustainability*, Elsevier, 5: 53-117. <https://doi.org/10.1016/bs.af2s.2020.09.001>
- Bouzaidi A. (1990). Quelques résultats et réflexions sur l'irrigation des agrumes. Centre de Recherche en Génie Rural, Tunisie. 9 pages.

- Chaïeb H., Mamou A. 1999. L'expérience tunisienne dans le domaine de la recharge artificielle des nappes phréatiques. DGRE, Tunisie. 8 pages.
- Crovella, T., Paiano, A., Falciglia, P. P., Lagioia, G., Ingrao, C. 2024. Wastewater recovery for sustainable agricultural systems in the circular economy – A systematic literature review of Life Cycle Assessments, *Science of The Total Environment*, 912: 169310. <https://doi.org/10.1016/j.scitotenv.2023.169310>
- FAO, 2026. <https://www.fao.org/woman-farmer-2026/en> (accessed 20/06/2026).
- Garau, E., de Abreu, G., Perez-Ramirez, I. et al. 2026. Diverse values of nature can drive transformative change in the WEFE nexus governance in Mediterranean countries. *Sustainability Science*, 21: 283-303 <https://doi.org/10.1007/s11625-025-01757-w>
- Institut National des Statistiques, 2024.
- Mahjoub, O., Mauffret, A., Michel, C., Chmengui, W. 2022. Use of groundwater and reclaimed water for agricultural irrigation: Farmers' practices and attitudes and related environmental and health risk. *Chemosphere* 295: 133945 <https://doi.org/10.1016/j.chemosphere.2022.133945>
- Mapedza, E., Dessalegn, B., Abdelali-Martini, M., Al Hariry, H. Gender mainstreaming guidelines 122-141. In: Mateo-Sagasta, J.; Al-Hamdi, M.; AbuZeid, K. (Eds.). *Water reuse in the Middle East and North Africa: a sourcebook*. Colombo, Sri Lanka: International Water Management Institute (IWMI). <https://doi.org/10.5337/2022.225>
- Mateo-Sagasta, J.; Nassif, M. H.; Tawfik, M.; Gebrezgabher, S.; Mapedza, E.; Lahham, N.; Al-Hamdi, M. 2023. Expanding water reuse in the Middle East and North Africa: policy report. Colombo, Sri Lanka: International Water Management Institute (IWMI). 18p. <https://doi.org/10.5337/2023.203>
- Naoum, R. F. 2024. Bridging the Gender Gap: Mitigating the impacts of climate change on women in MENA with a focus on the agriculture sector. In: *Sustainability can't wait! VII. BBU International Sustainability Student Conference Proceeding*. Budapesti Gazdasági Egyetem, Budapest, pp. 398-430. https://doi.org/10.29180/978-615-6886-04-0_17
- ONAGRI, 2026. Données Climatiques station Oued Souhil Nabeul DGGREE. <https://catalog.agridata.tn/fr/dataset/station-oued-souhil-nabeul-dggree>
- Mazhoud, H.; Boucif, A.; Ouhibi, A.; Hajji-Hedfi, L.; Chemak, F. 2025. Investigating the Gender-Climate Nexus: Strengthening Women's Roles in Adaptation and Mitigation in the Sidi Bouzid Region. *Climate*, 13, 164. <https://doi.org/10.3390/cli13080164>
- Qadir, M., Drechsel, P., Jones, E. R. 2025. Domestic wastewater treatment and agricultural reuse progress and reporting challenges. *Discover Water*, 5:74. <https://doi.org/10.1007/s43832-025-00244-8>
- Rekaya M. (1986). Expérimentation pilote de recharge artificielle à partir des eaux usées traitées. Cas de la nappe de l'Oued Souhil (Nabeul). DGRE, Tunis.
- Silva Rodríguez de San Miguel, J. A. 2019. Gender and water governance in Mexico. *Management of Environmental Quality: An International Journal*, 30: 695-713, <https://doi.org/10.1108/MEQ-09-2018-0166>
- UNW-DPC, 2012. Mid-term Proceedings on Capacity Development for the Safe Use of Wastewater in Agriculture. Eds. Ardakanian, R., Sewilam H., Liebe, J. Proceedings Series N°8, UNW-DPC, Bonn, Germany.
- Zou, XY, XY Peng, XX Zhao and CP Chang .2023. The impact of extreme weather events on water quality: International evidence. *Natural Hazards*, 115, 1-21. <https://doi.org/10.1007/s11069-022-05548-9>
- WWAP (United Nations World Water Assessment Programme). 2017. The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource. Paris, UNESCO.