

Using Seawater for Agriculture: A Different Strategy in the Climate Crisis Era

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Abstract

Globally, the sustainability of agricultural production is being negatively impacted by decreasing precipitation, increasing temperatures, and erratic weather patterns brought on by climate change. Because of this circumstance, looking for alternate water sources has become necessary, especially in areas where water is scarce. This study weighs the benefits and drawbacks of using desalinated or diluted seawater in agricultural production. Seawater use has been successfully applied in hydroponic systems, greenhouse cultivation, and with salt-tolerant plant species, according to research published in the literature. Nonetheless, some technical and financial constraints still exist, such as the potential for soil salinization, the high energy needs, and the effects on the environment. The creation of solar-powered desalination systems and photothermal evaporators in recent years has offered long-term ways to get around these restrictions. Additionally, in the context of seawater-based agriculture, phytoremediation techniques and salt management techniques targeted at maintaining soil health have grown in significance. According to the study's findings, seawater can be regarded as a feasible substitute water source when designing water-efficient and climate-resilient agricultural systems. Last but not least, incorporating different renewable energy sources (such as wind, solar, and geothermal) into desalination systems lowers the cost of producing water and improves energy efficiency and enhances the systems' suitability for agricultural use

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Tarım İçin Deniz Suyu Kullanımı: İklim Krizi Döneminde Farklı Bir Strateji

Öz

İklim değişikliğinin neden olduğu azalan yağışlar, artan sıcaklıklar ve düzensiz hava koşulları, küresel ölçekte tarımsal üretimin sürdürülebilirliğini olumsuz etkilemektedir. Bu durum özellikle su kaynaklarının kısıtlı olduğu bölgelerde alternatif su kaynakları arayışını zorunlu kılmıştır. Bu çalışma, tarımsal üretimde arıtılmış veya seyreltilmiş deniz suyunun kullanımının avantaj ve dezavantajlarını değerlendirmektedir. Literatürde yayımlanan araştırmalara göre, deniz suyunun kullanımı; hidroponik sistemlerde, sera tarımında ve tuza dayanıklı bitki türleriyle birlikte başarıyla uygulanabilmiştir. Ancak, toprak tuzluluğu riski, yüksek enerji gereksinimi ve çevresel etkiler gibi bazı teknik ve ekonomik kısıtlar hâlâ mevcuttur. Son yıllarda geliştirilen güneş enerjisiyle çalışan tuzdan arındırma sistemleri ve fototermal buharlaştırıcılar, bu kısıtların uzun vadeli olarak aşılmasına yönelik çözümler sunmuştur. Ayrıca, deniz suyuna dayalı tarım bağlamında toprak sağlığının korunmasına yönelik fitoremediasyon teknikleri ve tuz yönetim yaklaşımlarının önemi giderek artmaktadır. Çalışmanın bulgularına göre, su kullanım etkinliği yüksek ve iklim değişikliğine dayanıklı tarımsal sistemlerin tasarlanmasında deniz suyu uygulanabilir bir alternatif su kaynağı olarak değerlendirilebilir. Son olarak, rüzgar, güneş ve jeotermal gibi farklı yenilenebilir enerji kaynaklarının tuzdan arındırma sistemlerine entegre edilmesi; su üretim maliyetini düşürmekte ve enerji verimliliğini artırmaktadır. Bu durum ise sistemlerin tarımda kullanım uygunluğunu güçlendirmektedir.

Anahtar Kelimeler

Alternatif strateji
Deniz suyu
İklim değişikliği
Küresel ısınma



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Introduction

Around the world, the effects of the climate crisis are becoming more noticeable. The sustainability of agricultural production is in danger due to meteorological factors like increasing evaporation rates and erratic precipitation patterns, which are increasing the strain on available water resources (Rockström et al., 2017). The scarcity of existing water resources, especially in areas with inadequate water supplies, calls into question the effectiveness of traditional irrigation techniques and, as a result, calls for the investigation

of novel and alternative water sources for agricultural purposes (Mekonnen and Hoekstra, 2016). Because of its enormous abundance and the growing viability of desalinating it thanks to technological advancements, seawater has become one of the most popular alternative water sources (Elimelech and Phillip, 2011).

Recent research has shown that hydroponic systems, greenhouse cultivation, and the production of crops with a moderate tolerance to salt can all benefit from the use of diluted or desalinated seawater (Feria-Díaz et al., 2021). Such practices must be applied with an inclusive strategy that takes into account not only technical aspects but also energy costs, environmental effects, and soil health effects if they are to be more widely accepted. By using a literature-based analysis to investigate the effects of the climate crisis on agricultural production, this study seeks to assess the integration of diluted and desalinated seawater into agricultural systems.

Climate Crisis and Agriculture

The idea of the "climate crisis" draws attention to global warming, the ensuing climate change, and the effects that go along with it. In addition to increasing temperatures, climate change causes other meteorological variables to vary over time and space. For example, sea levels are rising, extreme weather events like droughts and floods are becoming more common, evaporation rates are rising, and precipitation is changing in terms of frequency, amount, distribution, and type. Both living and non-living elements of the Earth are impacted by these changes, and it is anticipated that their effects will worsen with time. One of the sectors most immediately impacted by climate change is agriculture (Saylan, 2021).

Agriculture is a very complex and dynamic system. Along with vital elements like soil and plants, weather patterns are also very important in this system. Any weather event, present or future, will surely have an impact on agricultural operations. The agricultural sector includes fisheries, aquaculture, forestry, food processing, crop cultivation, and livestock production. Agriculture includes the entire supply chain up to consumption, not just the production stage. It is essential to social welfare, food security, income generation, and the growth of the national economy. Meeting important climatic conditions—in particular, rainfall and temperature—is crucial for successful agricultural production in order to carry out these duties. Furthermore, adverse effects from extreme events like droughts, floods, hailstorms, and tornadoes must be prevented, and weather conditions must be in harmony with the physiological requirements of plants and animals (Dellal, 2021). Because it directly depends on climate factors like temperature and precipitation, the agricultural sector is the one most impacted by the climate crisis (Demirbas, 2022). These effects were grouped under a number of important themes in a study assessing how the climate crisis has affected agriculture. Reduced yield, increased pest and disease incidence, altered crop production schedules, increased irrigation water requirements, altered crop patterns, rising product prices, increased use of agrochemicals and water, and ultimately higher production costs are the main effects noted (Akalin, 2014).

The UN (2025) reports that in recent years, the economic losses in nations hit by climate-related disasters have topped 2.24 trillion USD. Natural disaster-related economic losses are rising worldwide, with the agriculture industry being especially vulnerable. Therefore, it is crucial to increase agriculture's resilience against the climate crisis in order to reduce the short, medium, and long-term negative effects and to guarantee food security. A new and practical strategy for diversifying water resources to reduce the impacts of drought conditions, particularly those linked to the climate crisis, on agricultural production is the use of purified or diluted seawater as part of sustainable agricultural practices.

Sustainable Agricultural Practices

Natural resources today are being degraded and depleted due to the effects of the climate crisis and increasing competition for land and water use. In addition to other users and larger populations, farmers in particular are facing serious impact both now and in the future. Global food demand is predicted to rise by more than 30% when food allocation concerns, waste, and overproduction in some parts of the world are

ignored. As a result, meeting this increased demand will be extremely difficult for global agriculture. However, in recent years, there has been a growing awareness of the need to ensure that food production is both socially and environmentally equitable in addition to increasing it. Nevertheless, current agricultural production systems are coming under more and more strain due to the growing demands brought on by population growth and the depletion of natural resources. Rethinking and reorienting these systems toward more sustainable practices is crucial to ensuring global food security (Wezel et al., 2014; Piñeiro et al., 2020).

In agriculture, "sustainability" refers to the best possible management of the resources and natural systems that farms use. By encouraging more effective use of natural resources and strengthening the ability to adapt to climate change, sustainable agricultural practices contribute to the protection of ecosystems. Thus, implementing sustainable farming practices can have a major positive impact on the environment and society. Crop rotation, zero tillage or less tillage than traditional methods, embracing diversity, planting cover crops, integrated pest management, agroforestry techniques, integrating livestock and crop production, and precision farming methods are a few examples of sustainable practices. Furthermore, one significant area of application within sustainable agriculture is the use of treated or diluted seawater during drought conditions brought on by climate change (Piñeiro et al., 2020).

Properties of Seawater and Potential for Agricultural Use

Globally, seawater has enormous potential, especially as a resource that ought to be used for agriculture in areas where water is scarce. However, a comprehensive understanding of its physical and chemical properties is necessary prior to its direct use. According to research, the average amount of dissolved salts in seawater is around 3.5%. According to an analysis, sodium chloride makes up the majority of these salts, along with other essential components such as sulfate, magnesium, calcium, and potassium (UNESCO, 1981). Most plants may be toxically affected by this high salinity level. These consequences, which eventually result in decreased productivity, could include limited plant growth, poor root uptake of water, and degradation of soil structure (Rhoades et al., 1992).

Nowadays, desalination techniques are favored to render seawater suitable for use. Technologies like reverse osmosis (RO) and multi-stage flash distillation (MSF) can be used to purify seawater for drinking and agricultural irrigation (Shannon et al., 2008). The use of desalinated water improves productivity under regulated environmental conditions and helps produce high-quality crops, particularly in greenhouse cultivation. However, problems like brine waste disposal, desalination's high energy requirements, and the related infrastructure needs need to be handled well. Thus, crop species, local conditions, and water management techniques should all be carefully taken into account when planning the use of seawater for agricultural irrigation (Martinez-Alvarez et al., 2020).

Key concerns like transmission and distribution infrastructure requirements, production and delivery costs, energy requirements, and possible farmer subsidies were assessed in a study on the use of seawater as a sustainable agricultural practice carried out in southern Spain. Technical evaluations, quantitative and descriptive data collected from irrigation district managers, and one-on-one interviews with a representative desalination group served as the foundation for the analysis. Seawater desalination has become a clear and practical strategy to maintain socioeconomic development and food production in irrigated areas, and the results show that it effectively reduces constraints on irrigated agriculture. However, the high energy requirements and related costs were found to be the primary obstacles to the widespread adoption of seawater desalination (Antolinos et al., 2020).

Important questions about the sustainable use of seawater to guarantee crop production were addressed in a study carried out in the Segura River Basin. Among these were the following queries: (1) how much energy is needed to produce and distribute desalinated seawater, and how this affects crop carbon emissions; (2) environmental issues like low nutrient concentrations and the possibility of soil sodicity, which could have an adverse effect on soil physical characteristics. The study's primary strengths can be summed up as follows: (1) Seawater desalination provides an infinite supply of agricultural water to reduce

the risks of drought exacerbated by the climate crisis; (2) Adding desalinated seawater to existing water sources can greatly improve crop yield and quality. But the study also found a number of issues with the use of seawater: Due to its high energy consumption, desalinated seawater is the most costly of the available water supply options; (2) the high boron (B^{3+}) concentrations in desalinated water frequently surpass the tolerance thresholds of many crops grown in the Segura Basin; and (3) the water-energy nexus becomes more noticeable during the desalinated seawater production process. According to the study's economic analysis, desalinated seawater can only completely replace conventional water sources for crops cultivated in greenhouses. However, it is thought that in order to maintain economic viability for a wider variety of crops, desalinated seawater must be mixed with less expensive water sources (Martínez-Alvarez et al., 2017).

Lu et al. (2024) aimed to identify policy options by using a productivity analysis and a household economic optimization model in the context of seawater agriculture. According to the findings, modern management tools, the integration of cutting-edge technologies and high-tech equipment, and the adoption of a market-oriented business philosophy are all necessary for the advancement of seawater-based agriculture and the improvement of agricultural systems. In order to improve the efficacy of seawater-based agriculture, the study pinpointed four main areas of focus: Enhancing the safety aspects of agricultural production to reduce potential environmental risks; (2) planning and optimizing high-level designs for agricultural production areas; (3) increasing financial support and bolstering scientific and technological capacity; and (4) encouraging the diversification of business models and the synergistic growth of recently founded enterprises.

Despite having a negative impact on crop growth and yield, seawater or saline water is still the only irrigation option available in many drought-prone areas of the world. Desalination techniques can be viewed as a sustainable substitute water source for irrigation in order to solve this problem. However, the emissions of dangerous air pollutants and the risks of fossil fuel resource depletion make the use of fossil fuel-based desalination facilities for agricultural water supply unsustainable. According to the study, in areas with high levels of solar radiation, solar energy is the most suitable energy source to integrate with desalination plants (Gorjian, et al, 2022).

The Use of Treated or Diluted Seawater in Agricultural Production

A Texas study looked at the use of treated groundwater with characteristics similar to those of seawater for agricultural irrigation. The study assessed the suitability of technologies like reverse osmosis and electro dialysis, especially in areas with high-value crop production. Two of the main issues raised were the high energy costs of these systems and the disposal of brine waste. The study specifically pointed out that one of the biggest obstacles to inland desalination processes is the environmentally safe disposal of brine waste. In conclusion, treating and using saline water for irrigation in agriculture could be a viable way to alleviate water scarcity, but it is important to carefully weigh the costs and environmental effects (Nargi, 2024).

Three distinct irrigation treatments were tested under hydroponic and conventional growing systems to investigate their effects on fruit quality in a study on the tomato cultivars Ramyle and Racymo. The following was the definition of the treatments: T1: Using desalinated seawater for irrigation, T2: Using a combination of desalinated seawater and well water, and T3: Using well water for irrigation. With values as high as 5.8 °Brix, the results demonstrated that tomatoes cultivated hydroponically and treated with T3 had the highest soluble solids content. However, sensory evaluation determined that the differences in T1 (<0.6 °Brix) were not detectable. Similarly, it was discovered that, in terms of consumer preference, T3 fruits were marginally more acidic than T1 fruits (by 0.06%). The firmness of tomatoes grown hydroponically was 1.1 to 1.2 times greater than that of tomatoes grown conventionally. The highest nitrogen content, ranging from 21 to 23 units, was also found in the hydroponic T3 samples. While the hydroponic T1 samples produced the highest lycopene content (peaking at 41.1 mg kg⁻¹) and the most intense red coloration, the Racymo cultivar displayed higher color index values than Ramyle. When all the findings are taken into account, it was

determined that using desalinated seawater only results in slight quality variations that are not substantial enough to influence consumer acceptance. Indeed, tomatoes that were irrigated with desalinated seawater also showed an increase in their overall antioxidant content (Antolinos et al., 2020).

The profitability of growing tomatoes in a greenhouse with desalinated seawater for irrigation was evaluated in a study carried out in southeast Spain. Soil-based and hydroponic systems were among the cultivation systems compared, and they used various irrigation water sources of differing quality. The results showed that using only desalinated seawater for irrigation raised fertilization costs by 34% in soil-based systems and 20% in hydroponic systems. In hydroponics, water costs increased by 30%, while in soil, they increased by 48%. Consequently, the overall cost of production went up by 3% in soil cultivation and 5% in hydroponic systems. When desalinated seawater was used instead of local water sources, these increases were discovered to be comparatively smaller. Additionally, compared to the area's traditional water sources, desalinated seawater was found to improve both product quality and yield despite its higher salinity (Martínez-Granados et al. 2022).

The purpose of Javeed et al. (2021) was to evaluate the growth performance of vegetables such as eggplant, pepper, and tomato under irrigation with freshwater–seawater mixtures at concentrations of 5% (T1), 10% (T2), and 20% (T3), respectively. The following criteria served as the basis for the evaluation: (1) biomass yield, crop growth, water use efficiency (WUE), water consumption, and water productivity (WP); (2) gas exchange parameters and photosynthetic pigments; (3) quality attributes and concentrations of mineral nutrients; (4) Ascorbic acid, protein content, and lipid peroxidation. According to the results, tomato yield significantly decreased under T2 and T3 treatments, but pepper and eggplant growth was unaffected. Values for water consumption decreased for every treatment. On the other hand, WUE dramatically rose in every crop as the concentration of seawater rose. Leaf tissues were found to have higher concentrations of other mineral elements and a higher Na⁺ content. These results imply that the mineral composition, quality characteristics, and productivity of pepper and eggplant are not significantly impacted by particular ratios of seawater to freshwater mixture. All three seawater mixtures, however, showed increased sensitivity in tomato plants. Furthermore, it was discovered that lower salt concentrations (between 5% and 10%) were required to produce final products with better nutritional quality and favorable organoleptic qualities.

A pot experiment was conducted to determine the effects of diluted seawater on the yield and growth of eggplant. Calixto F1 eggplants were grown for three months under irrigation with five different salinity levels in the water (2.0%, 1.5%, 1.0%, 0.5%, and 0%). Evaluation criteria included leaf development, plant height increase, stem diameter growth, individual fruit weight, and the number of harvested fruits. In addition, the physicochemical properties of both the growing medium and the seawater used for irrigation were analyzed. The results indicated that overall growth parameters were not significantly affected by varying salt concentrations. Moreover, at the 0.5% salinity level, no substantial increase in fruit yield was observed. These findings suggest that certain concentrations of seawater in irrigation can enhance eggplant productivity without compromising plant development or health (Cruz and Almoguera, 2025).

There are other types of crops that can be grown with seawater that has been treated or diluted. Glasswort, or *Salicornia bigelovii*, has characteristics similar to those of sunflower oil and contains about 33% oil. Additionally, it can be used to produce animal feed and biofuel (Anonymous, 2025a). It has been determined that the nutritional value of nipa grain (*Distichlis palmeri*) seeds is equivalent to that of traditional cereals, making them fit for human consumption (Anonymous, 2025b). The yield and quality of lettuce have been found to be unaffected by diluted seawater (at concentrations ranging from 2.5% to 5%). This suggests that mildly salinized water can be used to grow lettuce (Turhan et al. 2014). Many crops can be grown under irrigation with water that is mildly saline, according to research done in the Netherlands. White cabbage, broccoli, red onions, potatoes, and carrots are some of these crops (Rossiter, 1977; Glenn and Brown 1999; Nicks, 2014; Atzori et al., 2016; USDA, 2025). In Somaliland, greenhouses irrigated with desalinated seawater are used to successfully grow crops like strawberries and cucumbers. These methods provide the required irrigation water by treating seawater with solar energy (Paton, 2018).

Practices for Preserving Soil Health in Saline Water-Based Agriculture

In a study conducted by Ashraf et al. (2008), the feasibility of sustainable agriculture using seawater irrigation under soil-based conditions was investigated. The study also offered a number of possible fixes for issues brought on by salinity. Although some vascular halophytic plants can be irrigated with seawater to complete their life cycle, it was discovered that they thrive in environments with lower concentrations of seawater. Even these concentrations were too high for the majority of farmed crops, according to experimental trials employing seawater mixtures ranging from 10% to 20%. The study underlined that soil structure could deteriorate in the absence of efficient leaching. However, in certain instances, small-scale seawater irrigation in coastal regions was recommended as a feasible solution and even thought to be potentially cost-effective. For instance, Eu-halophytes and Recepto-halophytes, could be used in phytomelioration initiatives to produce fiber materials, secondary metabolites, and horticultural products. Furthermore, some halophytes were suggested for use in phytoremediation of salt or sand deserts, dried seabeds, and saline-alkaline degraded lands. It was mentioned that specific procedures might be needed for seedling or sapling establishment depending on the field conditions. The study also underlined that only in non-saline conditions is it possible to achieve high crop yields per unit area in arid climates. Long-term soil salinity control requires sustainable irrigation and leaching systems, which adds to the expenses. The main finding was that irrigation cannot be sustained without proper drainage. Effective salt removal technologies, like reverse osmosis, solar-powered systems, and photovoltaic devices, are also required to maintain low soil salinity levels because freshwater is still vital to human life, even though they come with a higher operating cost.

The study underlined that saline irrigation and the ensuing soil salinization pose a worldwide threat to agriculture and ecosystems. Long application times, high expenses, high energy requirements, the possibility of secondary pollution, and an elevated risk of soil degradation were identified as the drawbacks of conventional remediation techniques. In this regard, a sustainable technique for lowering soil salinity was presented: the biomimetic photothermal evaporator (NW-PPy). The foundation of this system is the polymerization of pyrrole to create a polypyrrole (PPy) coating on a substrate made of nonwoven fabric. By improving photothermal efficiency, the created material allows for targeted salt removal from the soil and quick water evaporation. Salts are transported upward from the soil to the evaporation surface, where salt crystallization takes place, by the NW-PPy evaporator. Consequently, salts are successfully separated from the soil matrix, lowering the salinity of the soil. The evaporator reached a high evaporation rate of $2.74 \text{ kg}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$ when exposed to solar radiation. Soil salinity levels were lowered by about 80% during a 10-day outdoor experiment. Additionally, tests of plant growth using lettuce seeds showed that treated soils significantly improved stem diameter and germination. The evaporator's low environmental impact and economic viability were validated by techno-economic analysis and life cycle assessment. The study concludes that this strategy is a viable and long-term way to reclaim saline-irrigated or naturally saline soils (Wu et al., 2025).

Evaluation of Desalination Efficiency Using Various Energy Sources

Wind, solar, and geothermal energy were evaluated in a study examining the benefits and drawbacks of different renewable energy sources for water treatment. The results showed that the methodical incorporation of various renewable energy sources into water treatment systems can offer a more stable and dependable energy supply because individual renewable sources are erratic. The study also found that nuclear-assisted desalination might be a viable substitute (Al-Obaidi et al., 2023).

With the development of renewable energy technologies, high energy costs—one of the main obstacles to the sustainable use of seawater in agriculture—have become easier to control. According to a Kuwaiti study, up to 68 million cubic meters of water can be produced yearly using a variety of renewable energy sources (Alshawaf and Alhajeri, 2024).

According to a Portuguese study, the cost of desalinated water could be lowered by about 33% by incorporating photovoltaic solar energy systems in place of grid electricity. The suggested remedy was

determined to be in line with the Sustainable Development Goals of the UN, specifically supporting Goals 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), and 8 (Decent Work and Economic Growth) (Apolinário & Castro, 2024).

Tashtoush et al. (2023) examined various desalination techniques, including membrane distillation, solar-driven processes, humidification–dehumidification, reverse osmosis, forward osmosis, and hybrid systems. Evaluating recent developments in renewable energy, especially solar energy, for desalination applications and identifying obstacles, unmet research needs, and chances for process enhancement were the main goals. According to the findings, hybrid systems have a great deal of promise for lowering energy usage. For example, combining membrane distillation and forward osmosis resulted in a notable decrease in energy consumption, going from 0.89 kWh/m³ to 0.64 kWh/m³. Additionally, compared to standalone reverse osmosis, the combination of reverse osmosis and humidification–dehumidification enhanced freshwater output by up to 38% while lowering energy requirements. But the study also noted that there are still issues, especially with regard to integrating concentrated solar collectors—like photovoltaic thermal (PVT) and concentrated photovoltaic thermal (CPVT) technologies—into hybrid desalination systems (Tashtoush et al., 2023).

Conclusion

In order to guarantee the sustainability of agricultural production in the face of mounting pressures from climate crisis-induced meteorological variability, this study investigated the possible application of diluted or desalinated seawater. The agricultural industry is still seriously threatened by drought, climate change, and dwindling freshwater supplies. Given this, using seawater as a substitute water source becomes a smart move that helps diversify water supplies and adapt to climate change.

The production of salt-tolerant or halophytic plant species, greenhouse cultivation, and hydroponic systems can all benefit from the use of diluted or treated seawater, as numerous studies in the literature have shown. Essential quality parameters have mostly been maintained in crops like peppers, tomatoes, lettuce, and eggplants, and in certain instances, improvements in antioxidant content and water use efficiency have been noted. The extensive use of seawater in agriculture is still severely constrained by problems like waste management, soil health, and energy expenses.

Economic sustainability is hampered by the high energy requirements of seawater desalination, especially in large-scale applications. However, a promising development in desalination systems is the incorporation of renewable energy sources, especially solar energy. Low-carbon modular solutions and photothermal evaporators have demonstrated the ability to lower energy expenses and lessen their negative effects on the environment. These technological advancements facilitate the wider use of seawater in sustainable agriculture and improve overall system efficiency.

Another serious problem that needs to be carefully managed is soil salinization, which is caused by the buildup of salts. Thus, it is crucial to incorporate advanced water treatment technologies, phytomelioration, and photothermal desalination into seawater-based irrigation systems. In addition to lowering soil salinity, these techniques present viable options for both environmental sustainability and economic viability.

In conclusion, when combined with appropriate crop selection, diligent soil condition monitoring, and sustainable energy resource planning, the use of diluted or treated seawater in agriculture can be regarded as a feasible and sustainable alternative, especially in water-scarce regions. Planning procedures that are sensitive to local conditions and comprehensive evaluations of technical, economic, and environmental aspects are necessary for scaling up such practices.

Author Contributions

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Committee Approval

As the authors of this study, we confirm that we do not have any ethics committee approval.

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