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Using desalination for agriculture irrigation in GCC countries: state of art and future outlook

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ABSTRACT

The Gulf Cooperation Council (GCC) countries are located in an arid and hyper arid region with a scarcity of freshwater resources. Due to limited conventional water resources and deterioration of groundwater, they invested in non-conventional water resources such as desalination and the reuse of treated wastewater. With an area of about 2.6 million km^2, population of 56.4 million in 2021, per capita renewable water of less than 100 m^3 (about 86 m^3 in 2021), and food self-sufficiency ratio less than 15%, using desalination innovative technologies to reduce the cost and energy consumption can be help in using desalinated water efficiently in agriculture production. The current GCC seawater desalination capacity is about 18.2 million m^3/d. Recent studied indicate that the total annual GCC water demand will increase by 40% in 2030 and may reach more than 50 billion cubic meters (BBC). Using innovative technologies in desalination can play an important role in improving the water and food security in GCC if it combined with high efficiency irrigation and agriculture production systems. At present GCC countries use two major desalination technologies in large-scale desalination plants: thermal technologies (about 7.67%) and membrane-based technologies (33%). Among the total contracted and in online desalination plants across the globe in 2021, 47% of them are located in the GCC countries. At present about 20% of the GCC countries desalination production is used in agriculture sector and it is expected to be increased in the near future. As the demand for potable and irrigation water increases in the region, research and development related to innovations in desalination and innovations in agriculture production systems gaining momentum. In this paper the use of sustainable and cost-effective desalination technologies, such as reverse osmosis (RO), membrane distillation, and forward osmosis, in agriculture will be assessed technical, environmentally and economically. This assessment will focus on the current and recent trends in membrane desalination processes used for agricultural purposes. The challenges being faced with desalinating seawater and brackish water will be discussed. A specific focus was placed on the viability of hybrid desalination processes and other advanced recovery systems to obtain valuable irrigation water. A comparison between

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various membrane desalination technologies in terms of efficiency and resource recovery potential will be analyzed. Lastly, concluding remarks and research opportunities of membrane technologies will be discussed.

Keywords: Desalination; Innovations; Food security; Agriculture; Membrane technologies