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Feasibility assessment of desalination application in Australian traditional agriculture

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HIGHLIGHTS

- This is a first assessment of desalination application in agriculture in Australia.
- Groundwater is the most likely feedwater source for cost-effective desalination.
- Australian farmers are unlikely to pay >AU$1.2/kL for agricultural water.
- Combined water and food production paradigm is required for successful desalination.
- Desalination in agriculture is effective in controlled environment-greenhouses.

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ABSTRACT

Within some data limitations, the paper provides a first assessment of areas in Australia with potential for implementing desalination technologies to supply agricultural water. At the national scale, these areas were identified based on a set of selected criteria: distance from land currently used for irrigated agriculture and feedlots; distance from town sites; exclusion of areas of environmental protection; exclusion of areas with surface elevation greater than 600 m AHD; and exclusion of regions with limited groundwater resources. Industries involved in the production of high-value crops are most likely to benefit from desalinated water as they use more-efficient irrigation practices and have the highest gross value of irrigated agricultural production. Groundwater was identified as the most likely feedwater source for cost-effective desalination, which is also the case worldwide. Brine disposal is a major factor in overall cost effectiveness of desalination. When feedwater salinity is relatively low, mixing permeate with feedwater leads to an increase in water production and a reduction in water cost. It was estimated that Australian farmers are unlikely to pay more than AU$1.2/kL for agricultural water. Generally for agriculture, desalinated water is still more expensive than water from other sources; however, there are likely to be circumstances when the costs could be comparable.

Contents

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1. Introduction

Population growth, food security concerns, climate change impacts on agriculture, freshwater resource overuse and land degradation worldwide are forcing international scientific communities to look for alternatives to current resource management approaches. This includes all aspects of our water resources and their availability to support ever-growing demands. Opportunities in generating cost-effective and potentially climate-independent water resources of controlled quality for agriculture could be linked with desalination technologies [22].

Desalination allows a widening utilisation of available resources by producing freshwater from saline or brackish natural water sources. As conventional water production costs have been rising in many parts of the world and costs of desalination declining over the years, desalination has become more economically attractive and competitive. [15] estimated that by 2015 the costs of freshwater treatment, wastewater reuse, and desalination are likely to be similar, at least in the USA. However, currently, desalinated water produced worldwide (77.4 million m^3/day, [14]) still comprises less than 1% of the total worldwide water use and only 2% of the total desalinated water production is currently used for agriculture.

According to [7], many countries are beginning to use desalinated water in agriculture, albeit at varying rates. The highest proportions of desalinated water use in agriculture occur in Spain (where current installed capacity is 1.4 million m^3/day and 22% is used in agriculture for irrigation of herbs, fruit, olives and vineyards) and Kuwait (current installed capacity is in excess of 1 million m^3/day and 13% is used for agriculture). Saudi Arabia, the world's largest single producer of desalinated water, accounting for about 30% of global capacity, uses only 0.5% of its desalination capacity for agricultural purposes. Other countries which use desalinated water for food production are Italy (desalination capacity 64,700 m^3/day — 1.5% for agriculture), Bahrain (620,000 m^3/day — 0.4%), Qatar (0.1%) and the USA (1.3%). National assessments of the applicability of desalination technologies to support agricultural water supply are currently underway in Chile, China and Australia.

The strategic necessity of a safe, reliable and local food supply in these countries is driving the uptake of desalination where it provides a reliable source of water of appropriate quality for agriculture at a competitive price. With the predicted significant growth in global food demand over the coming decades [13], it is expected that desalination may play an increasing role to support sustainable agricultural productivity in Australia and globally.

1.1. Water use in Australian agricultural irrigation

The agriculture industry is a major water user in the Australian economy, accounting for between 65% and 70% of water consumption in a typical year [21]. The three commodities in Australia using the highest irrigation volumes (in 2010–11) were cotton (1900 GL), pasture for grazing (1200 GL), and rice (766 GL). Irrigated agricultural land comprises only 0.5% of all agricultural land in Australia but produces 30% of the total gross value of agricultural production of AU$41.8 billion (2008–09).

In Australia, irrigation involves a variety of irrigation methods from flood irrigation to sub-surface drip irrigation, which have varying capital costs and water-use efficiencies. The majority (68%) of the irrigation water is applied as surface irrigation, 23% is applied by sprinklers, and 9% is applied through drip application [1]. The higher cost irrigation systems are generally used for high-value crops. Such crops in 2010–11 resulted in a total gross value of irrigated agricultural production (GVIA P) of AU$12.9 billion (or 28% of the total value of agricultural production).

Fruit trees, nut trees, plantation or berry fruits; vegetables for human consumption; nurseries, cut flowers and cultivated turf; and grapevines as high value crops collectively consumed 1333 GL (20%) of the total volume of water used on irrigated agriculture in 2010–11. These four crop categories were also valued at AU$7.2 billion, or 56% of the GVIAP for 2010–11 [2]. As a result of their relatively low water consumption (compared to the rest of irrigated agriculture in Australia) and their relatively high return, these four high-value crop categories are considered to be the most likely crops to benefit from desalination technology.

Fig. 1 depicts total water use for irrigation of high-value crops in Australia. The largest water demand was identified on the eastern border of SA and western parts of NSW, where there are significant areas of irrigated grapevines. When sources of water for irrigation are considered, surface water dominates, comprising 76% of total water use in irrigation (Table 1). This proportion is above 80% in New South Wales (NSW), Victoria (Vic), Tasmania (Tas) and the Australian Capital Territory (ACT). Groundwater provides a greater proportion of agricultural water than other sources in the Northern Territory (NT) (67%) and South Australia (SA) (53%) [2].

Despite Australia's limited water resources, its water price is relatively low. It was estimated to be unlikely that farmers are willing to pay more than AU$1.2/kL [3]. Sometimes irrigators pay an extra or premium price for a water supply which has greater reliability. Therefore, more-reliable water through desalination can increase its value by providing both a risk-buffering value as well as an additional water-

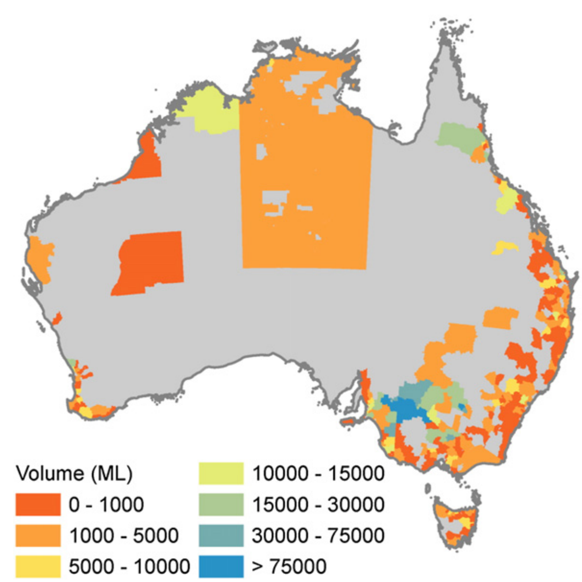

Fig. 1. Approximate volume of water used for irrigated agriculture for the four selected crop categories of high value (grey colour shows the regions where these crops are not established).