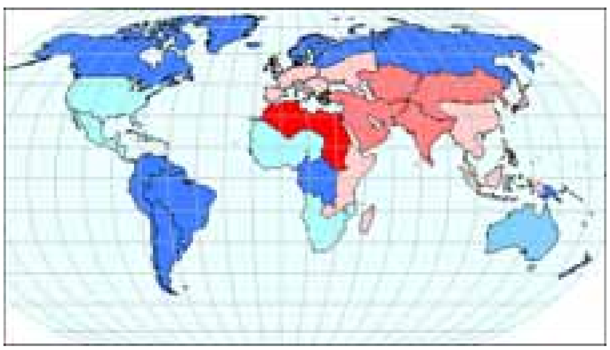
Policy Brief

Use of saline water in agriculture to improve livelihoods in West Asia and North Africa

West Asia and North Africa include the water-scarcest countries of the world. Per capita availability of fresh water in 1995 was less than 1000 m^3 per annum for most of North Africa and less than 1500 m^3 per annum for the Middle East, Central and South Asia (Figure 1). By 2025, all these areas are predicted to have less than 1000 m^3 per person per annum (dark red areas in Figure 1), many of them much less, particularly in West Asia and North Africa. Efficient and effective use of all water, including saline water, is therefore a priority for these regions.

1995



2025

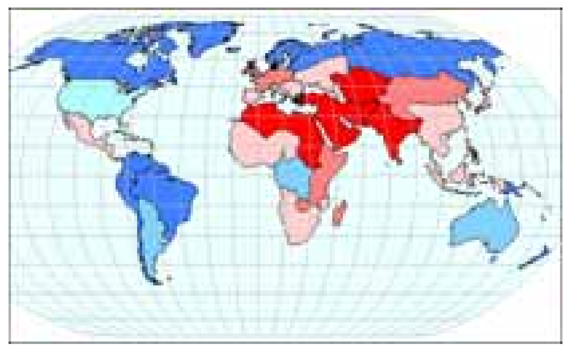


Figure 1. Global water availability 1995-2025 (*Source:* UNESCO)

But what factors determine when saline water can and should be used to supplement other water resources? And to what extent can saline water contribute to improved livelihoods? Case studies of the potential to use saline water for crop and forage production in four countries in West Asia and North Africa – Egypt, Jordan, Syria and Tunisia – were conducted in 2004 by the International Center for Biosaline Agriculture (ICBA) to answer these questions. The main findings are summarized below.

Factors favoring exploitation of saline water for agricultural production

Several generic criteria can be used to identify sites with potential for agricultural production using saline water. The more criteria a site satisfies, the more likely is saline agriculture to be viable.

Water resources

- Limited fresh water resources
- Sustainable quantities of non-fresh water available from groundwater, surface water, agricultural drainage water or other sources
- Sustainable quality of non-fresh water resource, within acceptable range for target uses
- Acceptable cost of accessing water

Target areas and communities

- Poor people already in situ or willing to move to the area
- Farmers willing to adopt novel practices

- Presence of development projects in the area as potential vehicles and catalysts for technology transfer
- Existing markets for agricultural products

Agricultural systems

- Availability of degraded or marginal land that can be devoted to saline agriculture
- Small-scale livestock farming and mixed farming with demand for feed and forage
- Availability of infrastructure, e.g. wells, irrigation and drainage systems, for effective water management
- Potential for alternative high-value production, e.g. using groundwater directly for fish farming or small-scale desalination for horticultural crops

Applying these criteria in the study countries led to identification of several areas that are considered to have high potential for use of saline water in agricultural production. The areas and the criteria for their selection are shown in Table 1.

Options for use of saline water

Although the study focused on direct use of saline water for agriculture – crop, tree or fish production, an important finding was that there were other significant potential uses for saline water in improving livelihood. Saline water can be desalinated for indirect use in producing high value crops or for other uses, such as drinking water in water-scarce environments. Saline water is a resource that can be used to improve the environment; for example, in afforestation or coastal rehabilitation, or for creating leisure or recreational facilities, such as golf courses, parks and nature reserves. The quantity and quality of water as well as the prevailing socio-economic circumstances determine which of these uses is most likely to be appropriate. However, production of crops is one option that could be especially promising for direct use of saline water in water-scarce environments.

Food, feed and forage crops that tolerate salinity

The level of salinity in the water is the prime determinant of its direct use for plant production. Higher salinity levels increasingly restrict productivity and the range of plants that can be grown, but a large number of plant species can grow and produce in the presence of salt, particularly animal feed and forage species that can fit well into livestock and mixed farming systems.

Different plant types tolerate salinity to varying degrees. Most of them react badly to salt and grow less well in its presence. However, one group of plants, the halophytes, actually prefers salt and grows better in saline conditions. Figure 2 indicates the typical reaction of different plant types to salinity. Fruits and vegetables are generally sensitive to salinity and their growth and yield drop rapidly with increased levels. Field crops are generally more tolerant, are little affected by low levels of salinity, but their growth and yields diminish quite rapidly as salinity increases. Halophytes, on the other hand, show enhanced growth and yields in the presence of low and moderate salinity that only decline slowly as salinity increases; many are able to grow and reproduce in seawater.

Within each of these groups of plants, there is considerable variation in reaction to salinity. Even among fruits and vegetables, for example, there are some that tolerate salinity to a surprising degree. Some examples of useful plant species and their salinity tolerances are listed in Table 2 below. Many of these are well known crops that are widely cultivated for food and feed. They also include halophyte species that can provide green matter suitable for feed and forage for animal production.

Depending on the level of salinity, many plant species can be grown using saline land and water. The economics of production depend greatly on the specific conditions where they are found. However, there are indications that a range of plants can make profitable use of saline resources that would otherwise be unused. There are also potential environmental gains from vegetating barren land, although care must be taken to avoid negative effects of salt on soils and underlying aquifers.

Table 1. Indicative prospects for agricultural production in Egypt, Jordan, Syria and Tunisia

Country	Potential area	Favoring criteria
Egypt	Central and NE Sinai (Al Arish, Sheikh Zouid, Rafa, Wadi Al Arish)	1. Saline groundwater fed by seawater intrusion and rain 2. Population of poor Bedouin 3. Government policy and existing projects to settle Bedouin 4. Existing government intervention to support small farmers hit by decline in access to Palestinian markets 5. Existing mixed farming system (livestock, dates and vegetables) amenable to introduction of salinity tolerant forages
	SE desert (north of Hurgada, between Red Sea and Nile valley)	1. Large reserves of non-fresh groundwater 2. Area already used to relocate landless poor 3. Existing projects to support farmers through techniques for rainwater harvesting and storage of flash floods to supplement groundwater 4. Existing commercial farming initiatives that are amenable to new agricultural systems (e.g. jojoba farming in Wadi Dara area)
Jordan	Azraq	1. Reserves of saline groundwater in deep aquifers and in shallow aquifers that have become saline due to over extraction of water 2. Widespread poverty with 70-80% of population receiving government assistance 3. Predominantly livestock farming, significant forestry areas, limited irrigated agriculture 4. High demand for forages, currently met by importing from outside the region, particularly during winter 5. Positive response of farmers to forage halophyte shrubs and trees introduced by earlier IAEA project
	Khaldieh	1. Saline groundwater plentiful 2. Third poorest governorate in the country 3. Mixed farming – irrigated summer vegetables and fruit trees, rainfed olives, large livestock herd including significant dairy industry 4. Earlier income-diversification project faced forage shortages
Syria	Margins of irrigated areas of Euphrates basin (Deir Az-Zohr to Iraqi border)	1. Over 200 drainage wells with significant non-fresh water 2. Large population of poor sheep herders who also own land 3. Mixed farming systems – irrigated field crops and livestock grazed on rangelands 4. Severe forage shortages in both good and poor rainfall seasons
Tunisia	Medenine and Tataouine provinces of southern Tunisia	1. Plentiful saline groundwater in deep aquifers (70-250 m) 2. Population of small farmers, mainly dependent on livestock 3. Mixed farming system of olives, field crops, forage and livestock 4. Existing active forage markets 5. Tataouine development project targeting development of agriculture

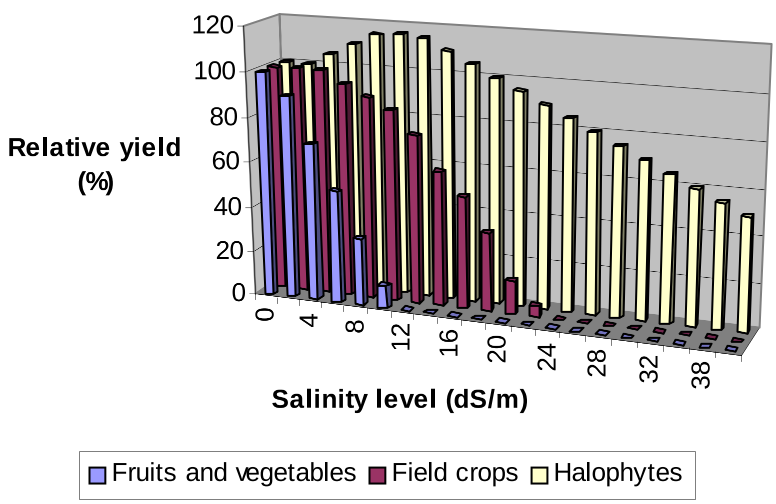


Figure 2. Relative yields of fruits and vegetables, field crops and halophytes at different salinity levels

Table 2. Salinity tolerant crops and other plant species

Crop / Plant Species	Salinity Range[1]	Tolerance
Fruits and vegetables		
Date palm (*Phoenix dactylifera*)	4.0 – 18.0	Tolerant
Olive (*Olea europea*)	na	Moderately tolerant
Asparagus (*Asparagus officinalis*)	4.1 – 29.0	Tolerant
Beet (*Beta vulgaris*)	4.0 – 14.0	Moderately tolerant
Grain crops		
Barley (*Hordeum vulgare*)	8.0 – 18.0	Tolerant
Sorghum (*Sorghum bicolor*)	6.8 – 9.9	Moderately tolerant
Wheat (*Triticum* spp)	6.0 – 13.0	Moderately tolerant
Rice (*Oryza sativa*)	3.0 – 7.2	Moderately sensitive
Forage crops and shrubs		
Sudan grass (*Sorghum* spp)	2.8 – 14.0	Tolerant
Alfalfa (*Medicago sativa*)	2.0 – 8.8	Moderately susceptible
Rhodes grass (*Chloris gayana*)	na	Tolerant
Drop seed grass (*Sporobolus virginicus*)	na	Tolerant
Salt grass (*Distichlis spicata*)	na	Tolerant
Buffel grass (*Cenchrus ciliaris*)	na	Tolerant

[1] Lower figure represents the threshold level at which depression of yield begins; the higher figure represents the level at which 50% yield loss occurs (*Sources*: Hall, 2001 [quoting Mass, 1986; Shannon, 1997]; Horrocks and Vallentine, 1999). na = data not available.

Conclusions

Suitable plant species for saline irrigated farming systems have been identified and new types continue to be developed. Appropriate water and soil-nutrient management and agronomic practices need to be worked out, however. Much of this is specific to locations and must be done on site. The economics of production are also likely to vary according to the prevailing supply and demand conditions and need to be verified.

Saline irrigated agriculture can help address poverty and food insecurity in some marginal areas, conserve soils and vegetation cover, and stimulate rural employment and stem movement of population to cities. It is therefore in the interests of governments of water-scarce countries to stimulate the introduction of saline irrigated agriculture and other uses of saline groundwater through appropriate policies, regulations and laws, ensuring coherence across all the sectors likely to be involved. These include agricultural research policies, water resource management regulations and laws, market support policies and social development policies for rural areas.