Humble saltwater salad offers food and fuel alternative

Cultivation of salicornia promises food, fodder and fuel without using a single drop of fresh water.

BY CAM MCGRATH

A HARDY LITTLE PLANT THAT THRIVES in salt water promises to transform the barren coastal deserts and sun-bleached salt flats of the Middle East into green oases that feed the poor, fuel our vehicles and – quite possibly – help stave off climate change.

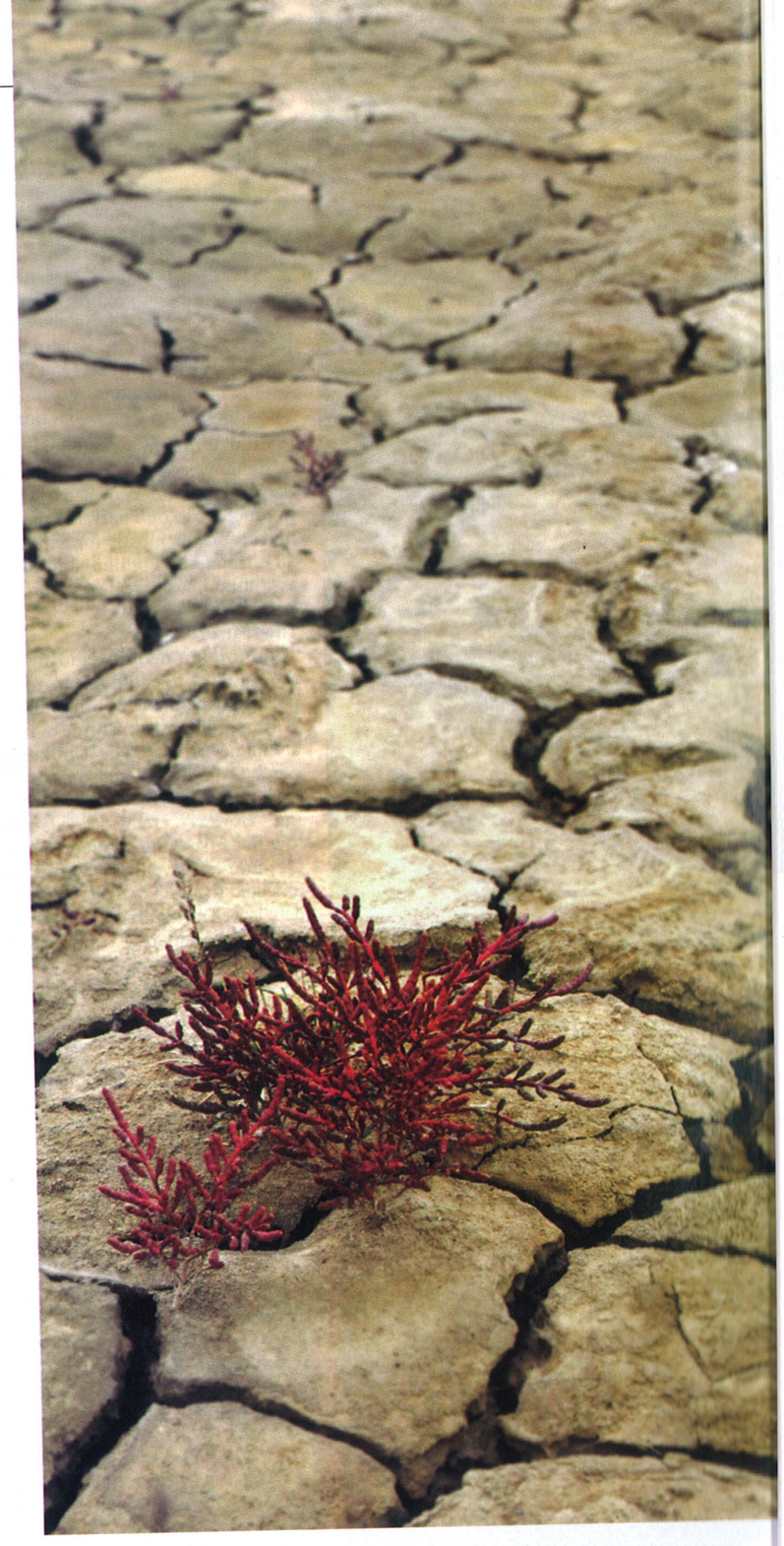
Salicornia, a salty, crunchy plant known in culinary circles as the salad herb "samphire", has traditionally been prized as an ingredient for haute cuisine. With high energy prices and concern over global warming, the halophyte (salt-tolerant plant) is now in demand for its other properties.

According to Hassan El Shaer, president of the International Society for Halophyte Utilisation (ISHU), salicornia contains more edible oil than soya beans, makes excellent animal fodder and yields a high-energy biofuel that can power jet aeroplanes. Better still – the plant can be grown without using a single drop of fresh water.

"Salicornia loves salt and can be grown intensively on saline land that would kill other plants," El Shaer explains.

University of Arizona researchers have found that salicornia seeds contain about 30% oil by weight, compared to 17-20% for soya beans, and can be processed into high-grade cooking oil or biofuel. The remaining 70% of the oil seed biomass can be used as animal feed, while the plant's stalks can be burned to produce energy or pressed into building material.

Experimental cultivation of salicornia oil seeds began in the 1970s. Rising oil prices and fuel-blending targets in industrialised nations have accelerated its development as an advanced biofuel.



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Unlike first-generation biofuels, which are produced primarily from food crops such as corn, wheat and sugar cane, second-generation biofuels such as salicornia do not compete with valuable land and freshwater resources. By utilising unproductive desert land and untreated seawater, salicornia-based biofuel projects can scale up without causing food or water shortages.

An integrated approach

Egypt was recently selected to host the world's first commercial-scale salicornia biofuel project. In March, Houston-based energy projects developer Energy Allied International announced a memorandum of understanding with saltwater agriculture pioneers The Seawater Foundation (TSF) and Global Seawater, Inc, to establish a seawater-irrigated salicornia plantation and biofuel plant on a 50,000-hectare plot in the country. Site selection is in progress with construction expected to begin in early 2011.

Tamer Nassar, Regional Vice President of Energy Allied International, says Egypt was chosen as the location for the project because it possesses all the key ingredients: unproductive arid land, readily available seawater and cheap, skilled labour.

"This project makes sense for the country on so many levels," he says. "About 95% of Egypt is unoccupied, it has unlimited access to seawater, there's high unemployment and a third of the workforce is already in agriculture."

New Nile Co, the joint company created to manage the project, will employ an integrated seawater agriculture system (ISAS) – a model developed in Mexico and tested in Eritrea. The integrated system operates on an engineered ecosystem comprised of aquaculture ponds, salicornia fields and mangrove forests. Waste products of each process are utilised as inputs for the next in a highly efficient closed-loop production cycle with multiple coproducts.

"The primary two products from this project will be seafood and biofuels," says Nassar. "Biofuel production will go to satisfying the European automotive and civil aviation market … while seafood [raised in the aquaculture ponds] will address food security in Egypt."

The ISAS model uses nutrient-rich effluent from saltwater shrimp and fish ponds to irrigate and fertilise nearby salicornia fields, while mangroves remediate the irrigation run-off and reduce the system's carbon footprint.

"The mangroves act as a carbon sink," explains Scott Kennedy, an associate professor at the Abu Dhabi-based Masdar Institute of Science and Technology (MIST). "They store carbon dioxide from the atmosphere as they grow, which offsets the carbon generated by burning the biofuel."

Pioneering efforts at commercial salicornia cultivation in the Middle East were unsuccessful. The Arabian Saline Water Technology Company (Behar) operated a small-scale ISAS in Saudi Arabia during the 1990s that produced seafood, animal feed, edible oil and samphire (though no biofuel) for several years before shutting down due to low demand.

But times have changed, and rising energy prices and the pressing demand for advanced biofuels are playing in the Egyptian project's favour.

"We have a captive market," Nassar says assuredly. "The European Union has passed regulations that require all aircraft to use blended fuels by 2012 or be subject to penalties. And by 2020 aeroplanes won't be permitted to land at EU airports unless they're using blended fuels."

Airlines are scrambling to secure sufficient biofuel feedstock for their fleets. While fine for powering automobiles, many first-generation biofuels such as ethanol cannot handle the extreme operating conditions of high-altitude jet flights. Salicornia has shown promising results in laboratory testing, with trial flights expected to commence later this year.

Further research

Much of the research work will be carried out on the salt flats near Abu Dhabi, where MIST, Honeywell's UOP, Boeing and Etihad Airways have agreed to jointly establish a 200-hectare ISAS and research institute. The project will use UOP technology to refine salicornia oil into a high-powered jet biofuel blend for trial flights by Etihad Airways. The aim is to optimise the ISAS production cycle and biofuel blending process in order to scale up to commercial production levels within five years.

Analysts expect investments in salicornia biofuel projects to grow exponentially in the coming decade, but project developers are looking beyond the balance sheets. They see an opportunity to build a business modelled on sustainable energy production with outcomes that could benefit humanity.

Carl Hodges, TSF's chairman and the chief architect of the ISAS model, envisions "seawater-based communities" built around giant man-made channels that draw seawater inland to irrigate barren coastal deserts. The scheme – based on a prototype built in Eritrea – would create millions of hectares of seawater-irrigated farmland, providing jobs and resources for growing coastal populations.

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Hodges estimates that just 50 seawater channels would displace sufficient water to mitigate the impacts of the predicted rise in sea level by 2020. Meanwhile, the greening of the desert would sequester enormous quantities of carbon dioxide, the primary agent in global warming.

While governments show no sign of committing to such a massive undertaking, halophyte crops such as salicornia are driving a paradigm shift in agriculture. Rather than trying to desalinate seawater and vast tracts of unproductive desert land, researchers are developing new techniques for cultivating salt-tolerant crops and utilising their by-products.

"Think of all the coastal desert communities, especially in the Middle East, where there is no freshwater for irrigation or the soil is suffering from salinisation," says ISHU's El Shaer. "Salicornia can be irrigated with brackish water or seawater, allowing people living in these [impoverished] communities to produce food, animal feed and bio-energy."

The benefits are incalculable. Worldwide, it is estimated that 950 million hectares of land – an area the size of the United States – are afflicted with salinity, which is increasing by over 10 million hectares a year.

Experimental seawater cultivation has demonstrated its potential, but successful commercial application will require farmers to adopt sustainable practices, integrate production cycles and learn new irrigation methods.

"It's an art form that we're going to have to master over time, as we've done with conventional agriculture over the past 10,000 years," says Nassar. ■