



India's 'fish-out-of-groundwater'

India's saline-affected crop plots are being transformed into small inland seas to create new aquaculture opportunities for local farmers

BY MELISSA MARINO

In a land-locked state in northern India, 1,000 kilometres from the nearest coast, a most unlikely enterprise is beginning to flourish: seafood. The new aquaculture ventures are being fed by salty water, pumped from underground to fill man-made ponds. It is the same salty water that has been partly responsible for the gradual degradation of the land, which has made it increasingly unfit to support traditional wheat and rice crops.

Drawing on the expertise of Australian and Indian scientists, the project aims to make saline-affected, unproductive lands in the two countries profitable again and create new industries from popular seafood species, including prawns and trout. It is being funded by ACIAR, the NSW Department of Primary Industries (DPI) (Fisheries), Murray Irrigation Ltd and the Central Institute of Fisheries Education (CIFE) India.

Across India and Australia millions of hectares of agricultural land is threatened by salinity. Management options, such as pumping rising saline groundwater from shallow aquifers into large ponds to evaporate, have been effective, but are expensive and offer little in terms of outputs.

The ACIAR aquaculture project aims to use saline water to transform otherwise useless agricultural land into lucrative inland seafood production grounds.

In India the program is leading towards a new industry in giant freshwater prawns (*Macrobrachium rosenbergii*), which are capable of living in non-saline water, but need saline water in which to breed.

In Australia the most promising species for potential mass production is rainbow trout (*Oncorhynchus mykiss*), which has been successfully grown in ponds using inland saline water pumped from underground.

For India the timing of the project, which

began in 2004, could not have been better. The country had been experimenting with the technology for more than 20 years and successful giant freshwater prawn farms were already operating at coastal sites. It had the experience, the know-how and Federal Government support for new farms.

In Haryana, home to the CIFE's specialist Rohtak Centre and experts in the field, there was also a massive salinity problem—half a million hectares.

"There are water-logging problems and salination problems and areas have become quite barren," says CIFE principal scientist Dr Narinder K. Chadha, now based in Mumbai. "Soil fertility is very low and productivity has gone down, so that is why, for many, aquaculture is the only option left."

Project leader in India, CIFE principal scientist Dr Sudhir Raizada, says the research could help turn around farmers' fortunes in a region where more than 50% of the groundwater currently

Senior scientist and project leader Dr Sudhir Raizada inspects a tank in a nursery at the Central Institute of Fisheries Education's Rohtak Centre.

Prawn hatchlings, approximately 10 days old, bred in saline groundwater at the CIFE prawn hatchery.



PHOTOS: MELISSA MARINO

story

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used to irrigate crops is saline. "It could go from a threat to an opportunity," he says. "What has been a tragedy for the public is an opportunity for the public."

CHEMICAL CHALLENGES

Although it is full of salt, the saline groundwater actually has a different chemistry profile to seawater, with generally lower levels of potassium, which is necessary for a prawn's

growth, and higher levels of calcium, which can be fatal to larvae.

Through a series of experiments at the CIFE Rohtak Centre, the researchers found adult prawns could live relatively well in low-level saline groundwater of 4–6 parts per thousand (ppt) salt without any extra potassium required; so well, that prawn weight rates per hectare were similar to common production on the coast.

This low-saline profile is readily found in water sourced from existing tube wells across the region, as is groundwater with higher salt content (6–10 ppt), which can be easily augmented with potassium to ensure optimal prawn growth.

But the researchers struck trouble when attempting to breed. "In the hatchery it was a very different story," says Australia's project leader Dr Stewart Fielder, who is based at the NSW DPI. "The larvae hatched and they pretty much all died soon after."

While existing Australian research on snapper had already confirmed that adding potassium to groundwater would make it more like seawater, it was only part of the picture. So the scientists set to work on analysing calcium as well as magnesium concentrations and ratios.

They quickly established that not only were levels of calcium too high in the groundwater, but so too was the ratio of calcium to magnesium. The trick then was to identify a simple, cheap and effective way to redress the balance on a large scale. And it took a stroke of genius to find it.

In a move of audacious simplicity, Dr Raizada applied a technique similar to that used to purify drinking water, passing the groundwater through negatively charged zeolites, which adsorb the positively charged magnesium and calcium ions.

The filtering process is simply repeated until enough calcium is removed. Magnesium is then added to bring the groundwater's chemistry up



Workers net fish grown at CIFE.

"Although we are working on different species, in different places, many problems we face are the same. This is a worldwide problem and it's growing day by day."

— DR SUDHIR RAIZADA

Senior scientist Dr N.K. Chadha (left) and Dr Sudhir Raizada watch as low-saline water is pumped from underground at CIFE.

Senior scientist Dr Sudhir Raizada with post-larval prawns bred in saline groundwater.



to a level that mimics seawater.

"I guess in hindsight you think, 'Gosh isn't that obvious', but until the bell rings it's not really that clear," Dr Fielder says. "That really was the key, and once we did that and got the chemistry ratios right, then everything fell into place."

VIABLE ALTERNATIVE INDUSTRY

Dr Raizada's discovery led to the first-ever successful breeding of giant freshwater prawns to post-larval stage in inland saline water. It was also a key breakthrough that was needed to ensure the project could result in a viable alternative industry for Haryana's small-scale farmers.

Without access to their own hatchlings, the farmers would be forced to pay for post-larvae to be flown up to 2,000 km from the coast to grow out in their ponds—too high an expense to make their new businesses profitable.

Also, that delivery of post-larvae would be at the discretion of coastal suppliers and likely to arrive much later than if inland growers had access to locally bred specimens, curbing the grow-out period and, therefore, the prawns' ultimate size and price.

Dr Raizada says the Rohtak Centre is now capable of producing about 500,000 freshwater prawn post-larvae per cycle, or 1.5 million per season. "Now, through this water, we have been able to produce seed that farmers can get on their doorsteps," he says.

The consistent supply of post-larvae is also thanks to another simple innovation implemented at the Rohtak Centre as part of the ACIAR project in the shape of heavy

polythene-covered, steel frame structures erected over selected ponds, known as polyhouses.

Functioning like a hothouse, the polyhouses ensure broodstock survive year-round as temperatures in Haryana, which can reach up to 50° C in summer, plummet to a fatal 0° C over the three months of winter.

But despite the freezing temperatures outside, the temperature inside the polyhouse never drops below about 17° C and trials have shown a 90% prawn survival rate.

Dr Fielder says this allows farmers to have post-larvae available just as the weather starts to warm up to make the most of a seven-month grow-out period from April to November. "We've pretty much got the whole production cycle sorted in terms of broodstock and post-larval product supply," he says.

Today, further research is planned on stocking additional species in the grow-out ponds so that when the prawn season finishes in November, business can be maintained over winter through, for example, Indian major carp or catfish.

The researchers will also collect on-farm production data from several trial growers that will feed into economic modelling to be used by new farmers and other investors. Extensive training workshops are also planned for hatchery operators and farmers.

CLIMATIC CHALLENGES

It is work that has funding for the next 12 months from ACIAR and CIFE to November 2009, but which has been disrupted in 2008 in Haryana by incessant monsoons,

which have flooded the ponds with freshwater. Work is expected to resume in March.

Back in Australia, inhospitable climatic conditions of the opposite type have also affected progress, with drought halting in its tracks a promising new Murray–Darling Basin rainbow trout aquaculture industry at Wakool, NSW.

"Our water source has dried up," says Dr Fielder, who is in the process of identifying an alternative site. "It will happen, I'm confident of that, it's just whether it will happen in the not-too-distant future. It's just got to rain, that's all."

But despite the recent setbacks, the knowledge gained through the collaboration is timeless in its value, Dr Fielder says. And it's knowledge that may never have been realised in isolation.

"We took our knowledge of water chemistry, especially regarding potassium, to India which solved some of the story and we've since learnt from them about the role of calcium/magnesium ratios in larval culture and how to address that," he says. "So there's been a really direct benefit to both countries, from both countries."

Dr Raizada also credits the polyhouse construction as a tangible result of the collaboration, which has pooled the knowledge of experts to address common issues and advance the new industries, despite different economic drivers, land availability issues and environmental protocols.

"Although we are working on different species, in different places, many problems we face are the same," he says. "This is a worldwide problem and it's growing day by day." ■