

# RESEARCH

## IMTA: THE CHINESE APPROACH

The Chinese model of integrated multi-trophic aquaculture (IMTA) was revealed to several European aquaculture specialists on a recent trip to a large scale coastal aquaculture project in Shandong Province, in the north east of the country.

### Rachel Mutter

China's massive production figures all began to make sense for a group of European aquaculture execs and scientists when the sheer scale of the country's operations were revealed on a recent tour of integrated multi-trophic operations in the country.

Organized by the European Aquaculture Technology and Innovation Platform (EATIP) in the framework of the European Union's ASEM Aquaculture Platform and hosted by Ocean University of China in Qingdao, the group visited two production systems on China's northeast coast.

The first site was coastal earth ponds and the second, cages and long lines in the open sea on the Shandong coast. Two large scale operations – one of each system – were visited, including associated hatcheries and an earthen pond aquaculture industrial park designed to promote small to medium sized aquaculture companies.

### Sea cucumber, jellyfish and shrimp

The large scale earth pond system visited by the group was owned and run by Shanghai-listed Chinese conglomerate Homey Group. The Homey operation works with a site of 50 square kilometres including hatchery production covering 30 hectares. "Many of the ponds looked to be a few kilometres in size," explains Neil Duncan, researcher at the Catalanian government research organization IRTA in Spain.

Homey farms mainly three species in the ponds: sea



**ALGAE:** Algae culture in the field station of Ocean University of China, north of Qingdao.



**SEA CUCUMBERS:** Land-based farms in Shandong province.

cucumber, jelly fish and shrimp. Annual sea cucumber production is 5,000 metric tons with a commercial value of CNY 700 million (€85.3 million/\$114.2 million), and annual jellyfish production is the same volume, but with a substantially lower market value of CNY 100 million (€12.2 million/\$16.3 million).

### Maximizing trophic levels

Sea cucumbers were grown to juvenile stage on corrugated clear plastic sections (approximately 50x50 centimeters) and stacked in crates to hold the sections vertical in tanks. The pre-juveniles were fed on algae and held with low light intensity in the hatchery before being transferred to





**GROW-OUT:** Floating pens for grow-out of sea-cucumber at Homey Company near Rongcheng.



**INNOVATIONS:** Experimental cage structure for sea-cucumber culture.

small floating cages (approximately 1x1 meter) in large ponds, to be grown in the surface water. The post juveniles were then transferred to the pond bottom to feed on deposited sediments and macro algae. The sea cucumber grow during the colder half of the year – in autumn, winter and spring, with temperatures reaching freezing point – and

during the summer months the sea cucumber “aestivates” – lies dormant – with no growth. During the warmer half of the year – in spring, summer and early autumn (when temperatures reach up to 25 deg C) – the water column is stocked with jellyfish and the pond bottom with shrimp. This farming system maximizes both the

use of different spaces in the water column – surface, water column and bottom – and different trophic levels to increase outputs in relation to inputs explains Shuanglin Dong, expert on integrated aquaculture systems at Ocean University of China. Nutrient budgets within this farm cycle are calculated as being at a 0-discharge level due



**LUNCH BREAK:** Workers at the IMTA operation in Ailian Bay.

to the included trophic levels (also including the adjacent seaweed farm).

**Government scheme leases ponds to start-ups**

Smaller earth pond operations were also visited, where the Chinese Government was leasing ponds to small scale farmers to grow sea cucumber and shrimp. Lined on the side with blocks and with a mud bottom, the ponds also included a small house and/or farm building as an office or storage space. “The site was a kind of industrial park for aquaculture where farmers could find everything they needed to start a new aquaculture business,” says Patrick Sorgeloos, coordinator of the ASEM Aquaculture Platform

“ It was impressive to see how the different species were grown together in such a way that waste output of one species was captured to provide food for another species. ”

Yngvar Olsen Duncan – NTNU, Norway



**ENVIRONMENTALLY-FRIENDLY:** Wind power is harnessed for onsite offices.



**SPAT COLLECTORS:** Scallop shells are for collecting abalone spat in the hatchery.

that facilitated the tour. In addition, the Chinese Government provides ponds in the aquaculture industrial park, free of charge, to Ocean University of China to conduct research to improve users' production.

### One hundred square kilometres of open-ocean IMTA

The open sea system visited was in Ailian Bay near Rongcheng and had an extension covering more than 100 square kilometres, being farmed by four principal companies.

The extension can actually be seen on Google earth, which shows a coastal fringe going approximately 5 kilometres out to sea in a matrix of blocks of long lines with pathways between the blocks for boat transport, explains René Robert, scientific manager of the Ifremer Group "Edible Mollusc Health", France.

A total of eight species were being farmed at the site; two species of macro algae (*Laminaria* and *Gracilaria*), three species of mollusc (abalone, oysters and scallops), a sea squirt, a sea cucumber and a fish species (flounder). "We were introduced to ecologists that had studied the nutrient cycles and interaction of the species being farmed in the different trophic levels, and the culture appeared to follow a natural ecological pyramid, with higher biomasses of macro algae, followed by molluscs, sea cucumbers and squirts and relatively few cages of flounder," says Sachi Kaushik, director of research at INRA, France.

The two macro algae species were grown downwards

from long lines supported by buoys. For example *Laminaria* were grown with the holdfast attached to the floating long lines/buoys and growing downwards, explain participants.

### Algae for molluscs and humans

At the time of the visit *Laminaria* was being harvested and *Gracilaria* was being planted, and this was the principal activity observed in the port.

"Boats arrived and trucks left the port stacked high with the macro algae. We saw the algae were being used as feed for molluscs but also for human consumption – we tried the algae in salads and as agar," says Ferenc Lévai, deputy manager at Aranypony Halászati and representative of the Hungarian Fish Farmer's Association at the Federation of European Aquaculture Producers (FEAP).

Sea squirts (*Tunicates*) were also grown attached to the long lines and buoys.

Scallops and oysters were grown in lantern cages suspended from the long lines and abalone and sea cucumber are grown in small cages (1x1 x 0.5 meters) sunk and attached to longlines. During the summer, abalone are fed *Laminaria* every 3-4 days and size graded 3 times a year. Sea cucumber feed on abalone faeces and periphyton – a complex mixture of algae, cyanobacteria, heterotrophic microbes and detritus attached to submerged surfaces in most aquatic ecosystems.

Feeding the caged abalone was a labor-intensive operation involving about 18 workers in one



**LARGE-SCALE:** Extensive coastal polyculture of fish (cages) and macroalgae and molluscs (buoys) in the bay of Ailian near Rongcheng.



**FOR MOLLUSC AND HUMAN CONSUMPTION:** Harvest of Laminaria macro-algae in the bay of Ailian.

group Walter Speirs, chairman of the Association of Scottish Shellfish Growers explains to *Fish Farming International*. Full abalone on-growing time is three years. Abalone juveniles are from hatcheries, with the pre-juveniles grown in raceways on roofing tiles (approximately 25x40 meters) laid horizontally or on corrugated clear plastic sections with most of the

small abalone on the underside. The juvenile production rooms are well lit with natural light passing clear greenhouse type roofing and the pre-juveniles are fed algae, says Speirs.

#### A holistic approach

The visit exhibited a different approach to aquaculture, where the whole ecosystem was considered in an almost holistic

way, Yngvar Olsen, professor in marine environmental research at NTNU, Norway, tells *FFI*.

It was impressive to see how the different species were grown together in such a way that waste output of one species was captured to provide food for another. This would result that inputs into the higher trophic species were used a second and even third time by lower trophic species, producing

more for a given input and also reducing waste output from the system, he says.

This 'extractive' culture is removing thousands of tonnes of nitrogen and phosphorus from the coastal environment, thus effectively reducing coastal eutrophication. "Such aquaculture should be considered in European coastal waters as a preventive measure against harmful algal blooms," says Robert, "as it could probably save on the considerable investments we do in monitoring mollusc toxicity before human consumption."

The enormous size of the project also stood out for the group.

This scale was probably only possible due to the careful management of the whole ecosystem to ensure that detrimental impacts did not negatively affect the environment that would in turn affect the system's production capacity and product quality, says Bela Buck, expert in offshore aquaculture and head of marine aquaculture at the University of Applied Sciences Bremerhaven, Germany.

"Often industry leaders or government officials talk of farming the seas as a kind of abstract solution to the growing worlds

Visions and opinions in this article are attributed to specific participants but are the result of formal and informal discussions among all participants – quoted and unquoted. The complete delegation consisted of Patrick Sorgeloos (Ghent University, Belgium), Jean Dhont (Ghent University, Belgium), Mario Stael (MarEvent, Belgium), Sadasivam Kaushik (INRA, France), Olivier Poline (Nouvelles Vagues, France), René Robert (Ifremer Brest, France), Bela Buck (AWI, Germany), Ferenc Lévai (Aranypony, Hungary), Yngvar Olsen (NTNU, Norway), Edvardsen Torgeir (SINTEF, Norway), Oddmund Otterstad (NTNU, Norway), Maria Leonor Nunes (IPMA, Portugal), Walter Speirs (ASSG, Scotland), Iciar Martinez (UPV-Ikerbasque-UiT, Spain), Leire Arantzamendi (AZTI, Spain), Neil Duncan (IRTA, Spain) and Alyssa Joyce (University Gothenburg, Sweden).

need for food, but in China they are farming the seas already.

"It shows how seafood aquaculture production can be increased whilst reducing production costs and waste output into the environment," says Maria Leonor Nunes, research coordinator of the Portuguese Institute for the Sea and Atmosphere.

Add to this the enormous scale of the Chinese coastal aquaculture and it is easy to understand the impressive Chinese production figures and how farming the sea is a promising solution to providing the growing world population.

In December, EATIP and ASEM Aquaculture Platform plan to organize a similar tour to Vietnam, focusing on pangasius and shrimp culture. For more information, contact Torgeir Edvardsen at [torgeir@eatip.eu](mailto:torgeir@eatip.eu).

## CAN LARGE SCALE COASTAL IMTA BE ACHIEVED IN EUROPE?

How have the Chinese achieved this large scale coastal IMTA?

The Chinese tour hosts told participants the Chinese Government was not involved and had no stake in private aquaculture operations – instead, its role is to provide the conditions and technology required to promote aquaculture development.

Providing the 'correct conditions' is carried out on two levels.

Applications are made to the central Chinese Government for concessions for large scale

operations using large areas – such as Homey's – and the application process, which includes studies such as environmental impact takes about one year.

On a smaller, SME scale, concessions can also be obtained via the same procedures with local government. Smaller operations can also apply to lease pre-constructed aquaculture facilities in a kind of aquaculture industrial park where ponds and buildings are built and then leased by the Government to stimulate and promote aquaculture businesses.

The Chinese Government also provides technology by financing research and development in universities and research institutions clearly aimed to strengthen the industry.

In effect the necessary technologies are provided free of charge and the technology transfer is rapid.

Some of the species under culture, such as sea cucumber, are relatively new aquaculture species and the massive productions observed highlight

how fast the technology transfer to the industry must be," says Patrick Sorgeloos, Coordinator of the ASEM Aquaculture Platform and co-organizer of the trip.

Another example of the technological push by the Government is the provision of ponds in the aquaculture park to Ocean University of China, where they are encouraged to conduct research to improve production.

"In Europe, research and development is also being directed to provide applied research for rapid aquaculture expansion and EATIP has this objective at the centre of its vision, explains Torgeir Edvardsen, EATIP representative in the ASEM Aquaculture Platform and organizer of the trip.

"However, we are not convinced that the many tiers of European administration controlling licensing and space have the ambition, desire or capacity to promote large scale coastal IMTA in Europe," says Sorgeloos.