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AGRICULTURE AND FISHERIES JOIN FORCES

A NEW APPROACH TO FISH FARMING ON LAND that incorporates renewable energy and fresh, more sustainable systems promises both environmental and cost savings.

Several years ago, insurance provider Sony Life asked 800 Japanese high school students what they wanted to be in later life. The top picks included computer programmer, entrepreneur, civil servant and nurse. But two occupations, once popular in Japan, failed to make the list.

"Young people are no longer interested in becoming farmers or fishermen," says Akihiro Takemura, a marine biologist at the University of the Ryukyus (UR), in Okinawa, Japan.

▲ Fish farming may help bolster declining catches. Only 30,000 tonnes of the popular Pacific saury fish was caught by Japanese fleets in 2020, compared with 229,000 tonnes in 2014.

That comes as little surprise given the decline of the country's fishing industry. Although seafood has long been a major Japanese staple, demand has fallen sharply — in 2020, per capita consumption was 23.4 kilograms, roughly half that in 2001.

However, one of the biggest challenges, as the Japan Fisheries Agency outlined in its 2022 Fisheries Whitepaper, is the steep drop in production. Only 30,000 tonnes of the popular Pacific saury fish, for instance, was caught in 2020, compared with 229,000 tonnes in 2014.

But Takemura and his colleagues have an ambitious new plan to revamp the industry and make it more attractive to youngsters. "We want to merge aquaculture with agriculture and create a sustainable new industry," he says. "We want to carry out fisheries on land."

THE WIND AND SUN

The researchers launched their project earlier this year, calling it the 'Okinawa model'. The overall aim, says Takemura, is to produce high-quality, marine-based proteins in an efficient manner, which in turn will add value to both the fishery and agriculture industries. The Okinawa model will strive to be sustainable — by recycling resources, employing smart technology, and making use of renewable energy.

This new approach to farming and fishing could "solve many problems related to food production," he says, such as soil pollution, deforestation and land degradation.

There are two sides to the Okinawa model, explains Takemura — the biology aspect, which he leads; and the energy aspect, led by his colleague, Tomonobu Senjyu.

Mastering the use of renewable energy is key to the project's success, says Senjyu, an electrical engineer at UR. There are two drivers for this, rising energy costs and the need to reduce reliance on fossil fuels. "In our project, we aim to power the supply system with 100% renewable energy and have zero carbon dioxide emissions," he says.

Tessue Kawano

For the Okinawa model, he and his team are looking to develop a system that combines both wind and solar power, which helps regulate the supply when either the sun isn't shining or the wind isn't blowing.

"In summer the weather is often fine in Okinawa; we can get enough photovoltaic power, however, the wind speed is often low," explains Senjyu. "In winter, the weather is not as good; we can get wind power, but the photovoltaic power is often low." As power is needed for the aquaculture system all year, the researchers have created a system that takes advantage of both sources of renewable energy.

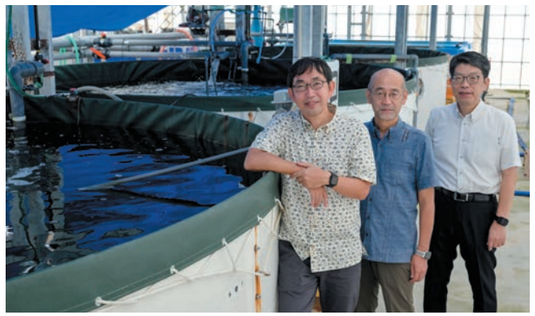
"Another important issue is the optimal control of this supply," says Senjyu. This involves managing the electrical load of batteries, and their charge and discharge cycles, among other factors. Good control equals a stable supply of electricity.

Senjyu and his team have already begun testing a prototype of their system at Nakagusuku Aquaculture Innovation Center (NAICe). The system can currently deliver between 20 to 30 kilowatts of power, but the team hopes to raise this by 100 times in the next five years.

A SMART SYSTEM

Senjyu's renewable energy system will help power the land-based aquaculture system that Takemura is developing. The aim is to rear grouper, a popular fish, in large tanks, quickly, sustainably, and healthily. His team has set up tanks for keeping 5,000 grouper at NAICe. The researchers vary the conditions in the tanks — light, temperature and salinity — to figure out which ones work best to optimize growth.

Shingo Udagawa



▲ (top, L—R) Akihiro Takemura, Fumihiro Haga and Tomonobu Senjyu are creating a new aquaculture system at Nakagusuku Aquaculture Innovation Center. Students (bottom) help with the 5,000 grouper being studied.

They are also testing how growing certain plants and algae, such as those that can remove microplastics, can complement fish breeding.

"WE'RE TRYING TO DEVELOP TECHNOLOGY THAT WILL ALLOW US TO RECOVER MORE THAN 80% OF THE NITROGEN AND PHOSPHORUS FOR FERTILIZER."

"We're selecting some salt-tolerant plants and trying to develop the aquaponics technology that will allow us to recover more than 80% of the nitrogen and phosphorus they produce for use as fertilizer," explains Takemura. The plants are cultivated separately and the water they are grown in, which contains the plant-derived residues, is then circulated to the fish tanks. In addition to boosting sustainability, the system also offers the added benefit of saving on feed costs.

"I believe we're the first in Japan to develop aquaponics using saltwater," he says.

An important part of the new system involves the use of artificial intelligence and the Internet of Things. Such smart technology will allow the researchers to monitor the water conditions, feed the fish remotely and collect data on their growth.

"By doing so, we can control the quality of the fish produced and its traceability too," says Takemura. "We can even control the best timing for fish growth — for example, if we know that Singapore needs this kind of fish in November, we can time it right."

Automating parts of the breeding process will also help save on labour costs, which have been rising in recent years.

FARAWAY FISHERIES

The researchers involved in this project will spend the next four years collecting data and perfecting the Okinawa model. They then plan to introduce their recirculating aquaculture system elsewhere in Japan, and to countries in Asia and the Pacific Islands.

The models will be customized to suit the needs of the specific location, explains Takemura. For example, the fish species and complementary plants cultured will be altered. The countries they have in mind for expansion are "places that have problems with aquaculture and fish resources, and not much land for agriculture either," he says. "So if we bring our system over, we can help with their development."

The Okinawa model project is part of UR's response to a post-pandemic call by the Japanese government to work towards a future society based on the United Nations Sustainable Development Goals (SDGs) — which the UN says are a global blueprint to achieve "a better and sustainable future for all".

Japan is trying to realize this by promoting collaborations between academia, industry, and the government, with universities being the main driving force to spearhead research and development, says Fumihiro Haga, a research administrator at UR and deputy project manager of the Okinawa model.

Takemura adds: "At the end of the day, we hope to create a sustainable and inclusive society in which young people from all over the world grow and provide food." ■

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