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FOCAL POINT ON FOOD SECURITY IN JAPAN

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RISING TO A STEEP CHALLENGE

THE JAPANESE AGRICULTURAL ROBOTICS INDUSTRY may be strengthened by its navigation of rugged terrain and small farms.

Japan's farming sector has been dealt a tricky hand, but necessity might just push the agricultural robotics industry forward.

Japan, a steep, densely packed island that imports more than half its food, faces unique food security challenges. Production of traditional Japanese agricultural products, such as rice, wheat, beef, dairy and sugar, has fallen by almost one third in the last 50 years. Ongoing population decline and a shift towards white collar jobs also means that the average number of farmers is on course for a decline of 50% by 2030, compared with 2005.

To add to this, roughly 40% of Japan's limited farmland is on hilly terrain, and mostly divided into small family-owned farms. To be more self-sufficient, the Japanese government began to fund 'smart agriculture' projects in 2014 to promote robotics and technologies that boost farm productivity. Under this initiative, Japan is developing everything from more efficient plant breeding, guidelines for food consumption and recycling technologies to export tracking and a large-scale agricultural data sharing platform. Its farm robotics are some of its most advanced contributions, and could have global impacts.

FIELDS OF DREAMS
There are roughly 500 million family farmers globally. In Asia-Pacific, the majority of farmland is less than five hectares per farm on average. The need for automated solutions for these farmers will become more important as wages in the region rise.

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RICE yields relatively high prices per hectare and will likely help lead robotics advances.

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Precise agricultural robots could reduce the amount of compacted ground and soil erosion on farms by **UP TO 90%**.

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The average Japanese farmer's **AGE IS 67**, whereas in the United States, the average farmer's age is closer to 59.

GRAEME KERNICH, chief executive of research entity FrontierSI

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Rice and robots

Automated dairy milking machines have been widely adopted since the 1990s, and driverless tractors have been used in the United States and Australia. But there, the automated tractors sometimes use expensive private satellite navigation data to work to a guidance accuracy of within 10cm. Most often on large, relatively flat farms.

With more than 80% of the world's rice produced in Asia-Pacific, rice automation is a significant aim for Japan's robotics research. However, the crop tends to be grown on smaller farms, while robots planting and fertilizing dense rice fields need to operate at an accuracy of 5cm, sometimes in tricky irrigated and terraced conditions — much different to the vast agricultural horizons of the Midwest, and outback Australia.

To achieve the accuracy required for rice, the Japan Aerospace and Exploration Agency (JAXA) is extending a hand from space. The Quasi-Zenith Satellite System (QZSS), first launched in 2010, is intended to improve upon the United States' GPS system and Russia's similar GLONASS system in Asia-Pacific. The quasi-zenith orbit configuration of these satellites, which loop in a figure eight across Japan and Australia, gives continuous coverage at high elevation angles, providing improved navigation in steep terrain and urban environments that obstruct satellite signals.

Already four satellites have launched and when fully deployed in 2023, QZSS will consist of seven satellites. While intended primarily for users in Japan, the orbit design could offer significant advantages to neighbouring east Asian countries, including Australia.

"Japan has difficult environmental conditions for positioning, so if agricultural robots work in Japan, they're very likely to work in other places," notes Graeme Kernich, chief executive of research entity FrontierSI. A consortium of Australian and Japanese researchers, including FrontierSI, has already tested Japanese robotic tractors guided by the QZSS on rice fields in New South Wales, achieving 5cm dynamic movement accuracy.

Safety first

The other technical challenge to tractors that move independently to till, fertilize or harvest crops is safety. New innovations in LiDAR, a technology that uses multiple rotating lasers to measure the proximity of objects, and other sensing systems, are also starting to reduce risks. Iseki and Co. Ltd., is one of the largest players in the field, and Katsushi Miwada, general manager of Iseki's Agri-Business Solutions Department has pointed out that manufacturers are moving forward on safety issues. At least three manufacturers in Japan have been producing automated tractors since 2018, part based on sensing and guidance technology produced through successive rounds of government funding. Iseki's Robot Tractor TJV655, released in 2018, can simultaneously till the ground, measure soil depth, and send relevant information to automated fertilizer dispensers, and also sense and avoid hitting obstructions.

Another constraint in Japan is cost, says Kazuki Ishida, an economist at Norinchukin Research Institute in Tokyo. In 2019, the TJV655 retailed for 12 million yen (US$110,000) with similar non-automated tractors costing a little more than half at 7.1 million yen (US$65,000), making it a difficult sell for small-scale farmers. And the cost of purchasing privately owned global positioning data can be prohibitive. Kernich notes that the GPS system, the European Galileo system, and GLONASS are currently free to use. "Japan is evaluating whether to make its centimetre level QZSS services freely available outside Japan." If it does, it will encourage use in machinery, he says.

Until costs come down, special visa conditions mean that Japan's farms are bolstered by overseas workers. But foreign workers aren't a long-term solution. "Foreign wage rises mean low paid Japanese agriculture work will likely still face labour shortages in future," says Ishida.

Taking the long view, countries in Asia-Pacific will also likely face their own labour issues from rising wages. This should see a growing need for automated farm solutions. Lucky for Japan, it will already have covered some difficult ground. ■

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