Initiatives in the Primary Industries (Agriculture, Forestry, and Fisheries) Utilizing Advanced Technology of the NTT Group

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Abstract

Currently in Japan, primary industries such as agriculture are facing problems including a shrinking working population, an aging working population, and a decreasing area of agricultural land. *Agritech*—which utilizes the Internet of Things, big-data analysis, artificial intelligence (AI), and robot technology in the agricultural industry—is attracting attention as a trump card to solve these problems. In this article, concrete initiatives involving agritech, focusing on utilization of the NTT Group's AI-related technology called corevo®, are introduced, and future directions are discussed.

Keywords: agritech, AI, animal husbandry, rice cultivation

1. Increased focus on *Agritech*

Japan's agriculture industry is facing problems such as a shortage of labor due to a decrease in the number of agricultural workers and low productivity. In recent years, attention has been paid to *agritech*[*1]—which utilizes the Internet of Things (IoT), big-data analysis, artificial intelligence (AI), and robot technology in the agricultural industry—as a key to solving these problems.

In particular, efforts utilizing AI have started both in Japan and abroad as support for and substitution of the *eyes* and *brains* of agricultural professionals (exemplary farmers), whose numbers are steadily decreasing. The NTT Group is also engaged in research and development and service creation of agritech unique to telecommunications carriers by utilizing its AI-related technology called corevo®. We are exploring its use for verification and demonstration purposes in the areas of rice cultivation, dry-field farming, and livestock farming as well as promoting social implementation of our agritech services.

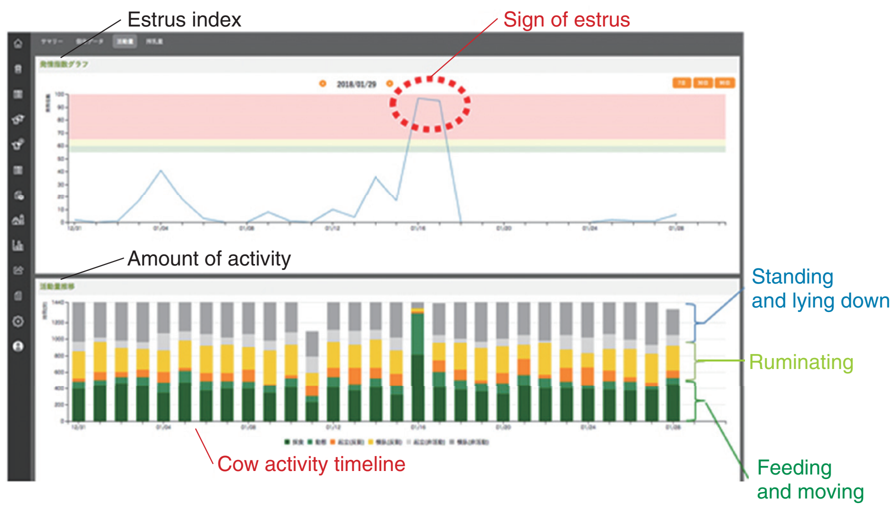
2. Technology applications in the animal husbandry field

Applications of NTT technology in farming have been ongoing for some time, and one important area is animal husbandry. Two examples of such applications are described in this section.

2.1 Technology use in breeding cows

In farm management, it is very important to grasp livestock information on individual animals and herds such as the state of health and signs of estrus and labor required for efficient breeding in a timely manner. NTT TechnoCross is providing real-time visualized information via a data-analysis platform called IoT Data Analysis Suite—which identifies seven key behaviors (i.e., feeding, drinking, ruminating, moving, standing up, lying down, and standing still) from sensor information recorded by tags attached to cows—as part of a service called U-motion® provided by desamis Co., Ltd., a leader in

*1 Agritech: The combination of agriculture and technology.



Source: Created using materials of desamis

Fig. 1. Screen shot of U-motion®.

the animal husbandry field.

We also provide a service to notify the farmer of a cow's condition in terms of signs of estrus, disease (poor condition), and difficulty in standing up at appropriate timings by analyzing the accumulated data (**Fig. 1**). In particular, the effect of an alert function that promptly detects cows with standing difficulty (which risk sudden death if they cannot stand up) is significant in the beef cattle industry, in which individual animals are traded at 1 to 1.5 million yen (8000 to 13,000 US dollars). As the introduction of U-motion advances, more cases of cattle with standing difficulty are being detected and accumulated, and analysis accuracy is improving accordingly.

Moreover, if a dairy cow becomes sick, milk yield will be affected. Utilizing U-motion makes it possible to promptly detect and deal with diseases, and it is thus expected to have various beneficial effects such as minimizing decreases in milk yield.

Pastures of cow-feed grass also have a major impact on the amount and quality of milk. For example, when fog forms at the time the grass is being cut, the grass moistens, and the quality of feed for the livestock deteriorates; occasionally, all of the feed must be discarded. Also, if the feed has poor quality as a result of that moisture, the cows lose their appetite, and milk output falls. However, it is difficult to grasp the generation of fog because it is difficult to distinguish it from clouds, so expectations for new technology in the livestock field have increased.

Accordingly, NTT Communication Science Laboratories (hereafter, CS Labs), HALEX Corporation of the NTT DATA Group, the Japan Meteorological Agency, the Hamatonbetsu Evergreen TMR (total mixed rations) Center in Hokkaido (a cow-feeding-service center), and other bodies have collaborated in integrating weather-related big data collected from the meteorological satellite *Himawari* using techniques such as spatio-temporal data analysis by CS Labs (part of the corevo AI technologies) and the expertise of HALEX as a private weather company. The aim of this integration is to predict the risk of fog development and support decision making at grass harvest time before fog forms (**Fig. 2**).

2.2 Application to breeding pigs

There are various challenges involved in the breeding of pigs. One crucial issue is weight control before shipping because pig prices are determined by the weight of a pig at the time of shipment. Accurately grasping the pig's weight is also important in managing a pig's health. The required feed changes as piglets grow into pigs, and if the appropriate feed is not given at the appropriate timing, the pig's health and the quality of its meat will be affected. Consequently, it is necessary to give feed that matches the body weight of the pig.

The method of weighing pigs at the time of shipment is to use scales exclusively designed for pigs to weigh pigs individually or to conduct a collective

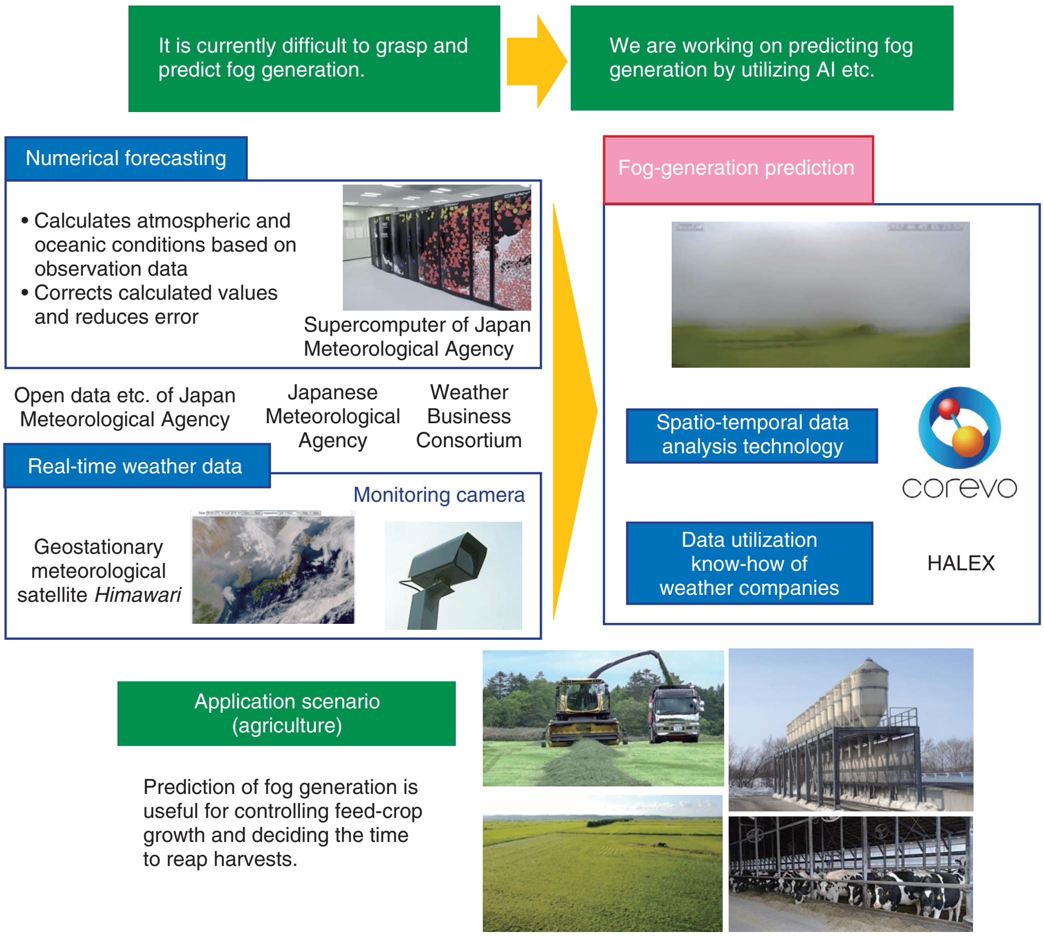


Fig. 2. Conceptual diagram of predicting risk of fog generation.

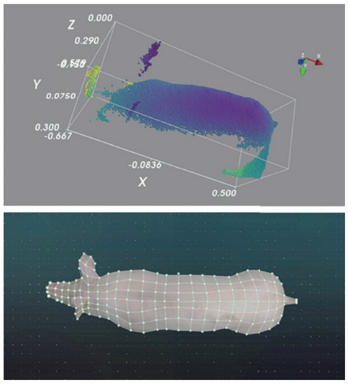
measurement. However, both methods are costly and troublesome and place a burden on pig farmers. Until now, the timing of shipping has been determined according to the age of the pig (in months) and the skilled eye (called *mekan* in Japanese) of an expert, so more experience of skilled people was needed.

In collaboration with ITOCHU Feed Mills Co., Ltd., NTT TechnoCross is developing Digital Mekan—which applies measurement logic incorporating corevo AI image-recognition technology to accurately estimate the weight of pigs (**Fig. 3**). Although Digital Mekan was originally developed as an application for smartphones, it is currently being developed as a packaged solution including dedicated hardware. It is almost complete, and a dedicated unit is being developed and set for early release.

3. Applications to rice cultivation

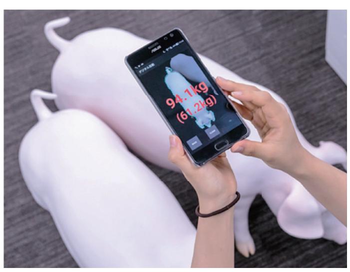
The agriculture, forestry, and fisheries industries operate in step with nature, and consequently, they can suffer from damage peculiar to the natural world. One such example is damage from pests. On a global scale, it is said that 20–30% of agricultural production capacity is lost because of damage caused by pests and weeds. A loss on that scale amounts to a quantity of food for hundreds of millions of people, equivalent to the hunger population of the world. Meanwhile, the burden on farmers to come up with countermeasures such as dealing with climate change, diversifying cultivated crops, and guarding against invading pests from overseas as a result of internationalization of agricultural distribution, are getting ever heavier.

As a member of a project of the Ministry of Agriculture, Forestry and Fisheries of Japan, NTT DATA



Source: NTT TechnoCross document

(a) Measured image



Source: NTT TechnoCross document

(b) Displayed image

Fig. 3. Digital Mekan for estimating pig's weight.

CCS (hereafter, DATA CCS) is working with Nihon Nohyaku Co., Ltd. to develop a diagnostic system to identify pests and weeds in rice fields. By combining image analysis utilizing AI technology of DATA CCS, the knowledge and expertise of Nihon Nohyaku on pesticide manufacturing, and the large amount of pest images possessed by Nihon Nohyaku, we are aiming to construct a system to provide real-time feedback of information such as potential pests, their respective countermeasures, and recommended pesticides to farm workers. This system, for example, will enable a farmer or an agricultural advisor to match a photo of a pest taken with a smartphone with images stored in a pest database (**Fig. 4**).

In addition, as a new initiative, we are developing a mechanism for discriminating the growth stage of paddy rice by using deep learning with images, focusing on changes in the shape of paddy rice. The rice-growing cycle is roughly divided into five stages: tilling, panicle differentiation, meiosis, heading, and ripening. To raise the yield, taste, and quality of rice, it is necessary to know precisely the timing of the start of panicle differentiation and to provide additional fertilizer*2 at the appropriate time. However, that timing is presently determined based on the long experience and intuition of exemplary farmers or by a more scientific approach such as microscopic examination. These approaches, however, are accompanied by the twin problems of a shortage of successors and the large amount of labor required.

In collaboration with Ibaraki Prefectural Agricultural Experiment Station, DATA CCS has taken the initiative in constructing a mechanism to determine the start of differentiation of panicles by employing deep learning (a kind of nondestructive testing). In particular, each growth stage is classified using images taken by a fixed camera, and the shape of the rice at the time of capturing the image is determined. We are currently expanding this mechanism to cover other crops and deploying it in a wider region. We have already applied for international patents on this system.

4. Future development

Agritech is moving from the verification and demonstration phase to the social implementation phase. Under these circumstances, companies in the NTT Group have been individually promoting product development and deployment. From now onwards, however, we will accelerate the construction of a mechanism for linking each product and accumulated data in such a manner that will strengthen our competitiveness.

For example, with regard to rice cultivation, by linking together the above-mentioned mechanisms for pest and weed disease diagnosis, growth diagnosis, sensing technology and weather and map information of the NTT Group, and future forecasting technology under development in our laboratories, we aim to establish a total diagnosis and prediction service for rice cultivation (**Fig. 5**). Moreover, by coordinating the rice production utilizing ICT (information and communication technology) with the NTT Group's digital food value chain linking agriculture and food [1], we are establishing a mechanism for supporting people involved in agriculture in terms of sales as well as production. By doing so, we aim to create agriculture that is profitable from the aspects of both saving labor and increasing profit.

*2 Additional fertilizer: Fertilizer applied after seeding or transplantation.

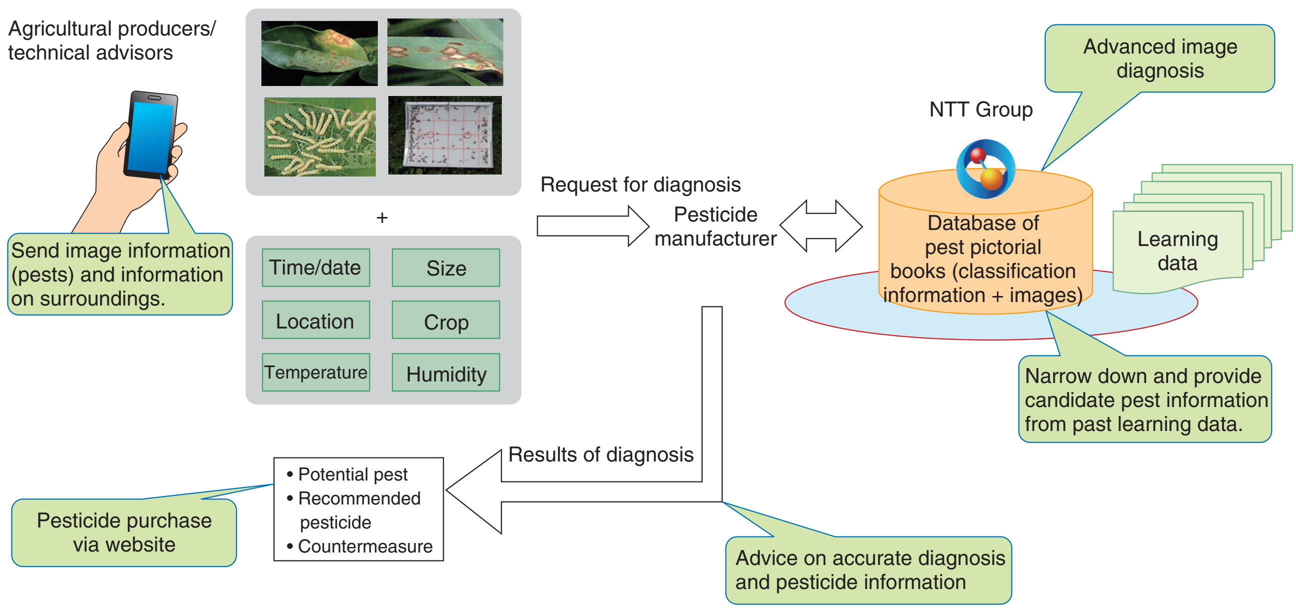


Fig. 4. Illustration of pest diagnosis system.

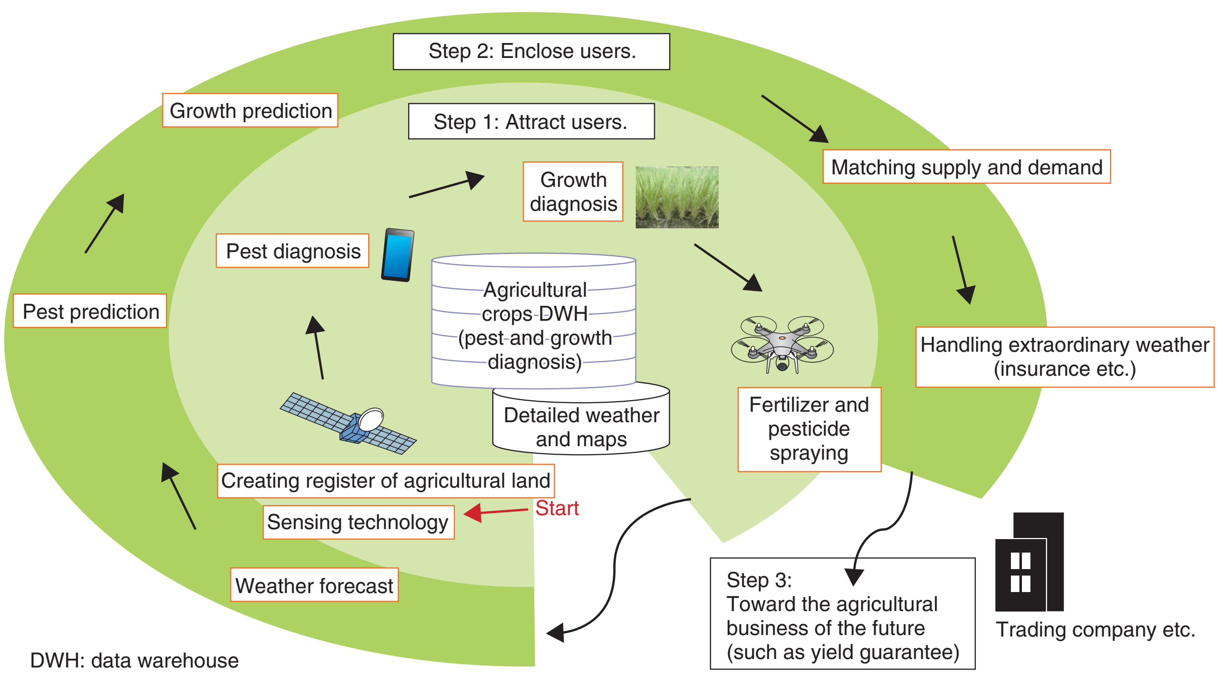


Fig. 5. Illustration of total support service for rice cultivation.

Furthermore, we are thinking beyond simply exporting rice produced in Japan and are planning to expand into Asian countries where rice cultivation is as prosperous as in Japan. That is, we aim to roll out the above-mentioned rice production support mechanisms created in Japan under the concept of *Made by Japan*.

From now onwards, we will continue to contribute to the development of primary industries with a view to globalization with the aim of making the NTT Group a *value partner* that will continue to be selected by numerous companies.

Reference

[1] Y. Kusumi, "B2B2X Collaboration in the Primary Industry Sector: Agriculture, Forestry, and Fisheries," NTT Technical Review, Vol. 17, No. 1, pp. 14–19, 2019.
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He received a B.S. and M.S. in nuclear engineering from Osaka University in 1993 and 1995. He joined NTT in 1995 and was assigned to the long distance communication business division. He then worked at the network engineering center, where he designed a network system for personal handyphone systems. He also worked at NTT Communications in the carrier sales division, where he was in charge of wholesale business for foreign companies and later, for planning global strategies. He is at NTT again, where he is responsible for ICT business creation for the agriculture domain.

Trademark notes