NTT's Vision for the Future of Agriculture, Forestry, and Fisheries—Simultaneously Improving Production Capacity and Sustainability

Yoshikazu Kusumi, Kanji Yoshitake, and Takuya Murayama

Abstract

The NTT Group has set agriculture, forestry, and fisheries as one of its priorities. In particular, we are working to implement Smart Agri—namely, optimizing the entire food value chain from breeding to production, distribution, sales, and consumption by using the Group's cutting-edge technologies, assets, and services and collaborating with forward-thinking partners. In response to growing concern about global environmental issues, we have begun new initiatives that will enable the agricultural industry to coexist in harmony with nature while improving its production capacity. This article describes issues concerning the agriculture, forestry, and fisheries industries and provides an overview of NTT Group's initiatives, specific examples, and future developments related to such industries.

Keywords: IOWN, coexistence with global environment, regional circular economy

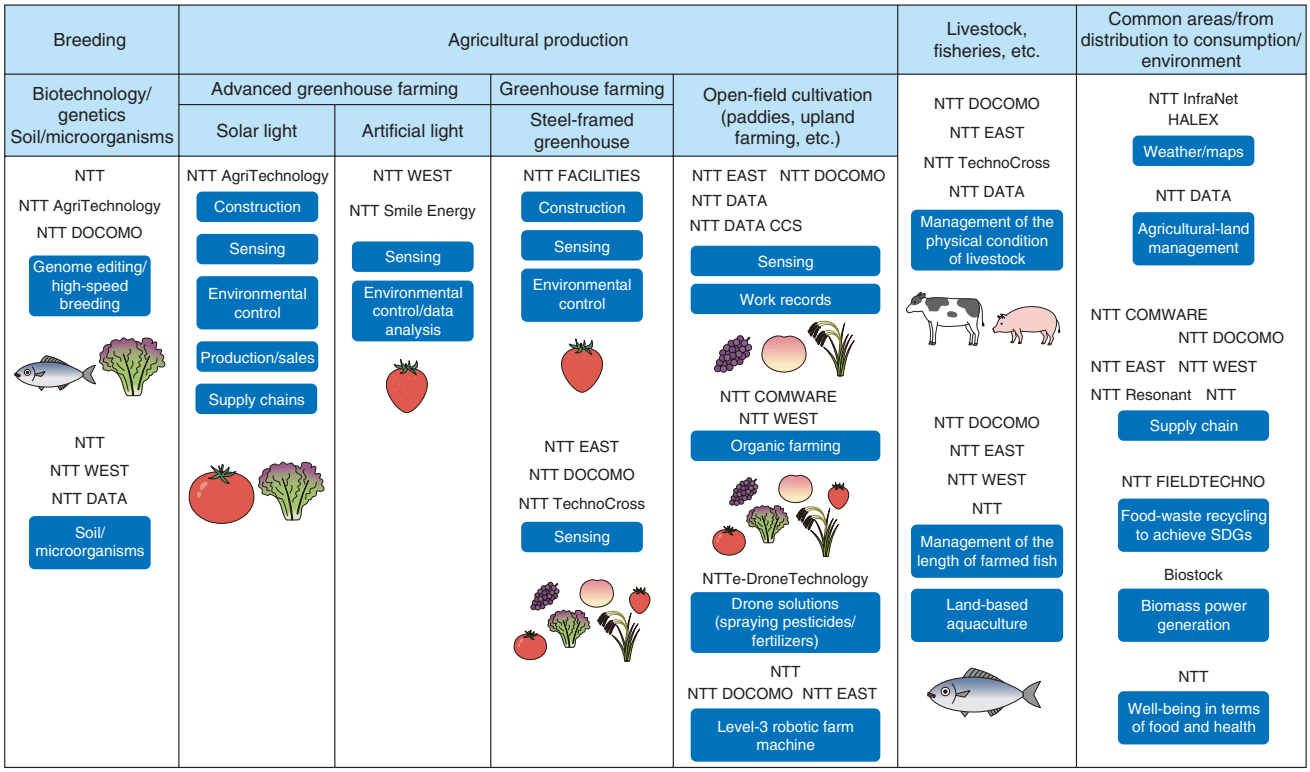
1. Issues concerning agriculture, forestry, and fisheries

The agriculture, forestry, and fisheries industries are indispensable for the survival of humankind; however, they face challenges such as a declining and aging workforce and decreasing production capacity and food self-sufficiency rate in Japan. This trend holds not only for agriculture but also for fisheries and forestry. It is particularly evident in the fisheries industry, in which the number of fishery workers has decreased from 392,000 in 1988, almost 30 years ago, to 152,000 in 2018, and over that period, fishery production has plummeted from 12.78-million tons to 4.42-million tons [1]. Once ranked first in the world in terms of fishery production, Japan has now dropped to eighth place. On a global scale, owing to the population explosion, demand for protein will exceed supply by 2030, resulting in a shortage of protein, including that from marine resources.

The agriculture, forestry, and fisheries industries are the only ones of the many industries that directly work with nature and enjoy its bounty. Accordingly, in addition to securing food by increasing production capacity, achieving sustainability is becoming increasingly necessary by maintaining and developing these industries in harmony with nature while taking environmental aspects into consideration.

2. Overview of NTT Group's initiatives

Against the above-described backdrop, the NTT Group is striving to strengthen the competitiveness and sustainable development of the agriculture,



SDGs: Sustainable Development Goals

Fig. 1. NTT Group's food and agricultural solution map (including research and development and field demonstrations in progress).

forestry, and fisheries industries through collaboration between NTT laboratories, which possess cutting-edge technologies, and approximately 30 group companies (**Fig. 1**) [2]. Combining NTT's Innovative Optical and Wireless Network (IOWN)*1 and the nationwide telecommunications infrastructure, assets, and services of NTT Group companies, we will create new value through innovation in the food and agriculture sector with forward-thinking partners.

For example, we want to build an ecosystem in which stakeholders in the food value chain can benefit by combining the following efforts: (i) digital breeding, which artificially modifies some of the properties of agricultural and fishery products by genome editing*2 and culture technology to dramatically and safely improve growth rates, carbon-dioxide absorption, etc. while giving due consideration to safety; (ii) ultra-labor saving and automation of agricultural work by using robotic farm machines and drones; (iii) digital transformation of agricultural-product distribution by which sellers and buyers make transactions in a virtual market built in cyberspace on the basis of supply-and-demand forecast information; and (iv) scientification of food and health to improve mental and physical well-being. Among the initiatives listed in Fig. 1, the Feature Articles in this issue introduce genome editing/high-speed breeding and soil/microorganisms [3], biomass power generation [4], drone solutions [5], and supply chains [6].

3. Specific examples of initiatives

3.1 Aiming to restore Japan's fisheries industry

The NTT Group has formed a capital alliance with Regional Fish Institute, Ltd. (RFI) [7], a venture

*1 IOWN: A next-generation information and communication infrastructure that NTT is promoting for practical use around 2030.

*2 Genome editing: A technique for altering a specific base sequence of a gene in an organism in a manner that improves the trait carried by that gene. It differs from genetic modification with which new characteristics are added to cells by introducing a gene extracted from another organism.

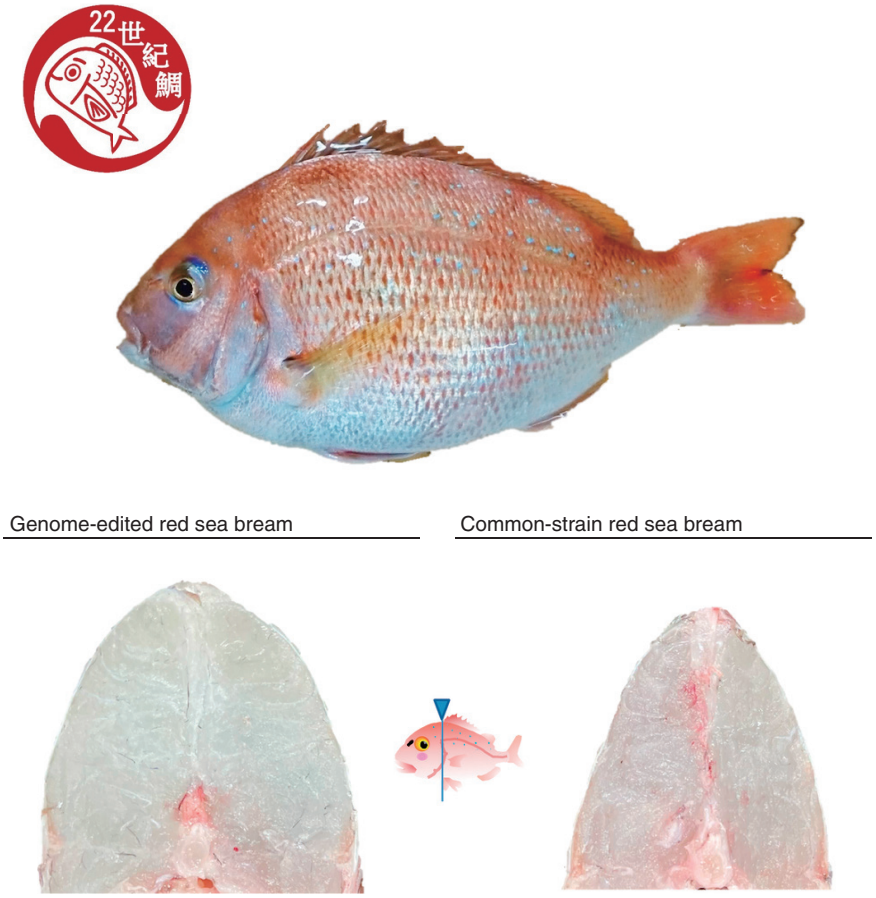


Fig. 2. Comparison of 22nd Century Bream and the common strain.

company originating from Kyoto University and Kindai University, with the aim of making Japan's fisheries industry the best in the world again and solving the global protein crisis. The alliance's land-based aquaculture business raises juvenile fish and shellfish in an Internet-of-Things-enabled environment using genome editing that deactivates a targeted gene in the DNA of those fish and shellfish in a manner that causes natural mutations through their natural resilience. When this technique was used to raise fish, the volume of the Japanese red sea bream increased up to 1.6 times more meat than the common strain while receiving 20% less feed, and the tiger pufferfish grew 1.9 times faster than the common strain while receiving 40% less feed and requiring much less rearing time. The seafood produced using this technique satisfy Japan's safety standards and have been branded and marketed as the world's first genome-edited animal foods under the names "22nd Century Bream" (**Fig. 2**) and "22nd Century Pufferfish." Through this initiative, we will add value to the Japanese aquaculture industry and transform it into a sustainable growth industry. In collaboration with RFI, we will create a future in which Japan's fisheries industry can solve the protein crisis, which is a global issue, as soon as possible.

3.2 Aiming for coexistence with the global environment

The agriculture, forestry, and fisheries industries enjoy blessings from the land, sea, and rivers; however, the global environment is becoming ever-more threatened every year as it faces issues such as climate change. NTT has announced a new environmental and energy vision called "NTT Green Innovation toward 2040" [8] to simultaneously achieve zero environmental impact and economic growth. As one of the efforts to reach this goal, NTT and RFI have started an experimental demonstration of carbon-dioxide conversion technology in which we apply

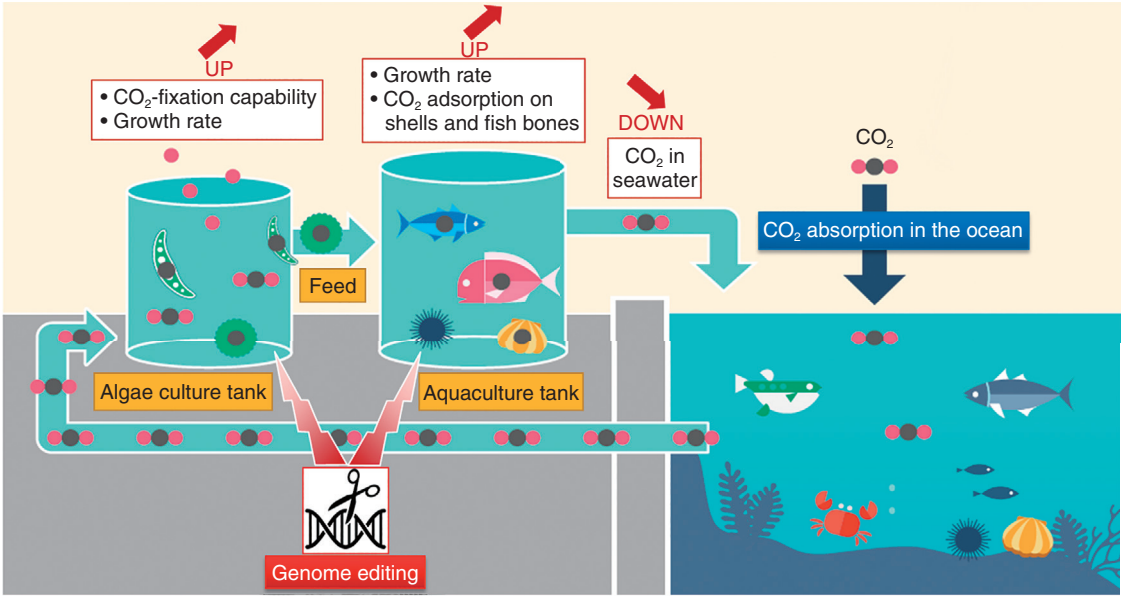


Fig. 3. Technology to reduce carbon dioxide in the ocean by applying genome-editing technology.

genome editing to algae, fish, and shellfish that can reduce the amount of carbon dioxide dissolved in the ocean (**Fig. 3**). In the normal food chain from algae to fish and shellfish, atmospheric carbon dioxide is absorbed into the ocean; however, the amount of carbon dioxide emitted into the atmosphere is increasing every year due to human activities, such as conversion of forests to agricultural land and urbanization, and the amount of carbon dioxide retained in the atmosphere cannot be reduced beyond the current level.

Accordingly, NTT will research and develop genome-editing technology for increasing the amount of carbon-dioxide fixation[*3] in algae, and RFI will research and develop genome-editing technology for increasing the amount of carbon fixed in the bodies of fish and shellfish. By applying these two genome-editing technologies to the food chain from algae to fish and shellfish, we aim to establish a carbon-dioxide conversion technology that synergistically increases the total amount of carbon cycling in the ocean. In the future, this technology will be applied to increase production and improve the quality of fish and crops [9].

4. Future developments

To create a sustainable society in the future, we believe it is necessary to develop agriculture, forestry, and fisheries not only from the perspective of productivity improvement but also from the perspective of coexistence with the global environment. To make these efforts sustainable and effective, our future society will also require the formation of regional circular economy zones in which each region takes advantage of its unique strengths, makes the most of its local resources, and forms a self-reliant and decentralized society while helping and complementing each other among regions (**Fig. 4**).

As for the aforementioned land-based aquaculture for increasing carbon-dioxide fixation in the ocean, electricity (charges) consumed by temperature control and water circulation accounts for about 40% of the total cost, and how to reduce this cost is one of the keys to success. As a solution to this cost problem, we are investigating the use of recyclable energy sources that fully use resources and land that are not being used effectively in the region. Examples under investigation include (i) biomass power generation using waste, residue, and livestock manure generated on farms and (ii) solar power generation, for which installation sites are lacking in Japan, using abandoned farmland. These energy and heat sources can also be used in advanced greenhouse facilities and

*3 Carbon-dioxide fixation: A process in which inorganic carbon (such as carbon dioxide) is converted into organic-carbon compounds (such as sugars) and incorporated into the body of living organisms.

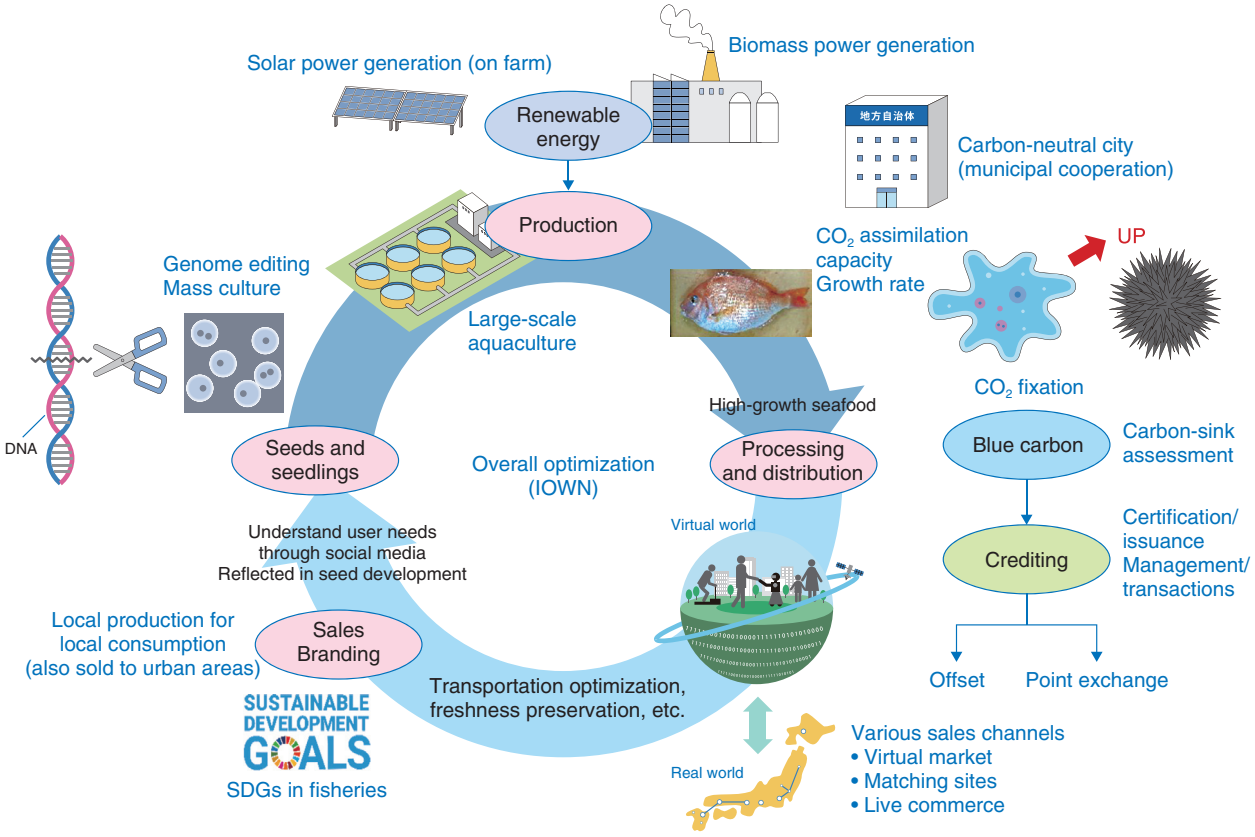


Fig. 4. A regional circular economy zone (centered around land-based aquaculture).

livestock sheds. It will also be possible to develop new business models, such as a new financial business based on agriculture and the environment by establishing a system in which, for example, credits obtained by reducing or absorbing greenhouse-gas (e.g., carbon dioxide) emissions can be exchanged for various points issued by private companies, and the points are used as local currencies in an economic zone while increasing incentives for implementing environmental initiatives. We aim to create a "sustainable regional circular society" through the overall optimization of information flow, logistics, and money flow generated by these activities using cutting-edge technologies and innovations such as IOWN.

The NTT Group will continue to deepen its efforts as a group of companies that support local communities. In particular, we will collaborate with various partners to integrate cutting-edge technologies and innovative business models while taking the challenge of developing agriculture, forestry, and fisheries industries in harmony with the global environment and creating regional circular economy zones.

References

[1] Fisheries Agency, "Circumstances Surrounding the Fisheries Industry," Apr. 2021 (in Japanese). https://www.jfa.maff.go.jp/j/council/seisaku/kikaku/attach/pdf/210416-6.pdf

[2] Website of NTT, "Initiatives for Agriculture," Mar. 2021. https://group.ntt/en/magazine/blog/agriculture/

[3] T. Oozeki and K. Yamane, "Data-driven Soil Cultivation Promoted by NTT DATA," NTT Technical Review, Vol. 20, No. 6, pp. 26–28, June 2022. https://ntt-review.jp/archive/ntttechnical.php?contents=ntr202206fa4.html

[4] S. Inoue, "An Urban-circular Ecosystem in Which Food Waste from a Company Cafeteria Is Recycled Using an Ultra-compact Biogas Plant," NTT Technical Review, Vol. 20, No. 6, pp. 16–21, June 2022. https://ntt-review.jp/archive/ntttechnical.php?contents=ntr202206fa2.html

[5] A. Yamasaki, Y. Sekiguchi, S. Suzuka, S. Kitagawa, H. Sase, and Y. Tsutsumi, "Development and Implementation of Connected Drones with Agriculture as a Starting Point," NTT Technical Review, Vol. 20, No. 6, pp. 22–25, June 2022. https://ntt-review.jp/archive/ntttechnical.php?contents=ntr202206fa3.html

[6] H. Terasaki and T. Kusumi, "Selling Agricultural Products to Consumers Online through Marchel by goo," NTT Technical Review,

Vol. 20, No. 6, pp. 29–33, June 2022.
https://ntt-review.jp/archive/ntttechnical.php?contents=ntr202206fa5.html
[7] Website of Regional Fish Institute, Ltd., https://regional.fish/en/
[8] Press release issued by NTT, "NTT Group's New Environment and Energy Vision 'NTT Green Innovation toward 2040,'" Sept. 28, 2021.
https://group.ntt/en/newsrelease/2021/09/28/210928a.html
[9] Press release issued by NTT, "NTT and RFI to Start Demonstration Experiment with the Aim of Reducing Carbon Dioxide in the Ocean - The World's First Application of Genome Editing to the Carbon Cycle of Algae and Fish and Shellfish with Containment Measures -," Nov. 12, 2021.
https://group.ntt/en/newsrelease/2021/11/12/211112a.html

Yoshikazu Kusumi
Senior Manager, Strategic Business Creation Team, Research and Development Planning Department, NTT.
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, planning global strategies. He is with NTT again, where he is responsible for ICT business creation for the agricultural industry.

Kanji Yoshitake
Senior Manager, Strategic Business Creation Team, Research and Development Planning Department, NTT.
After graduating from Tokyo University of Science in 1998, he was assigned to system engineering for public and educational institutions at NTT EAST. He then was engaged in service development work for routers, Wi-Fi, etc. He currently works at NTT and is responsible for creating an ICT business for the agricultural industry.

Takuya Murayama
Manager, Strategic Business Creation Team, Research and Development Planning Department, NTT.
He received a B.S. and M.S. in applied physics from Waseda University, Tokyo, in 2005 and 2007. He joined NTT in 2007. His research interests include lifelog systems and service design. He is a member of the Institute of Electronics, Information and Communication Engineers. He currently works at NTT and is responsible for creating an ICT business for the agricultural industry.