Technologies for Creating Next-generation Agriculture, Forestry and Fisheries

Creating Agro-innovation

Making Agriculture, Forestry and Fisheries into a Growth Field Using Big Data, IoT and AI

The goal of this program is to establish a uniquely Japanese system of production, creating a smart, eco-friendly, ultra-laborsaving and highly productive agriculture model. The success of this program will result in intellectual property and standardization that may be adopted throughout the world. Moreover, this program will establish a globally competitive Japanese brand of agricultural, forestry and fishery products that are healthy and delicious, securing Japan's status for these products in overseas markets. Another goal of this program is to derive new materials from unused resources, advancing a value-adding strategy to create new regional industries. To achieve these objectives, this program is pursuing an all-Japan approach, transcending the boundaries of ministries, industries, and fields of specialization. Ultimately, this program intends to turn the agriculture, forestry and fishery industries into a growth sector.

Program Director

Noboru Noguchi

Hokkaido University Graduate School of Agriculture
Vice Dean, Professor,
Research Faculty of Agriculture

Profile

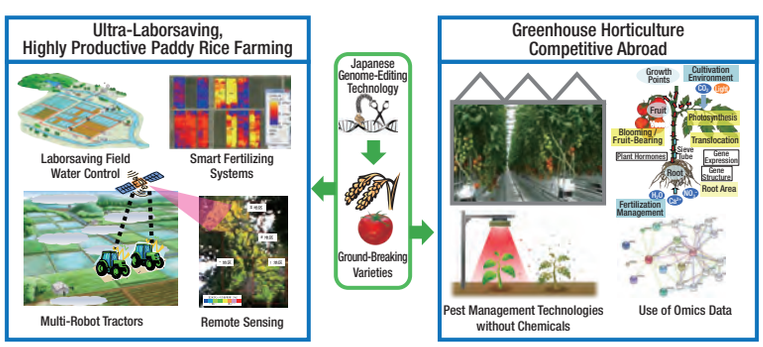
Professor Noboru Noguchi was awarded a Ph.D. from the Hokkaido University Graduate School of Agriculture in 1990. He took a post as an assistant in the Hokkaido University Faculty of Agriculture the same year, becoming an Assistant Professor in the Research Faculty of Agriculture in 1997. He assumed his current post in 2004. Prof. Noguchi served as a Council Member of the Science Council of Japan from 2005 to 2014, remaining an associate member as of 2015. He was named president of the Japan Association of International Commission of Agricultural and Biosystems Engineering in 2006, Vice-chairman of the Japanese Society of Agricultural Informatics in 2007, and Chairman of the Japan Society of Agricultural, Biological and Environmental Engineers and Scientists in 2011.
In 2014, Prof. Noguchi was named Sub-program Director for Technologies for Creating Next-generation Agriculture, Forestry and Fisheries. He became the Program Director in 2016.

Research and Development Topics

1. Incorporate robotics, ICT, genome and other leading-edge technologies to produce uniquely Japanese smart, ultra-laborsaving, and highly productive agriculture models

(1) Utilize automation technology and data science to create a new paddy-field agriculture model that offers the benefits of being ultra-laborsaving, highly productive, and resistant to environmental change

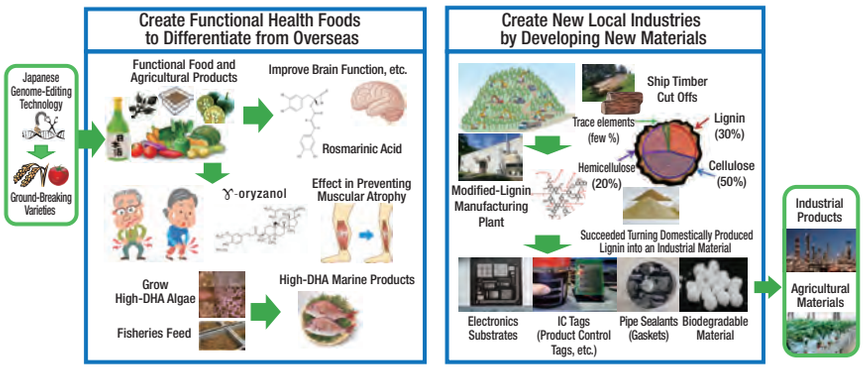
(2) Establish a highly productive Japanese-style method of greenhouse horticulture to produce vegetables that are both delicious and cost-competitive abroad



2. Enhance the value of agricultural, forestry, and fishery products by developing new materials and offering distinct, functional health foods, etc. made using techniques from medicine and engineering

(1) Create next-generation functional health foods to differentiate Japanese food and agricultural products from those overseas

(2) Convert low-availability local resources into high-value products



Exit Strategies

Introduce farmland structural reform and integrate new technologies at agricultural locations

Promote large-scale farmland consolidation and integrate technologies for smarter agriculture practices. Promote the agriculture, forestry, and fisheries industry as a high-growth, high-income industry.

Introduce products tailored to market and consumer needs through public-private cooperation

Establish a structure for early stage participation and cooperation by private sector companies involved in food, seedlings, equipment, ICT, materials, etc. Conduct globally strategic research and development, promoting the wider adoption of results.

Engage in the wider adoption of new technologies and business models from the viewpoint of the user

Conduct research, development and demonstration together with forward-thinking farmers, regional public testing grounds, and private companies. Create business models clearly stating the new technologies and results.

Engage in intellectual property management, etc., for global technology rollout

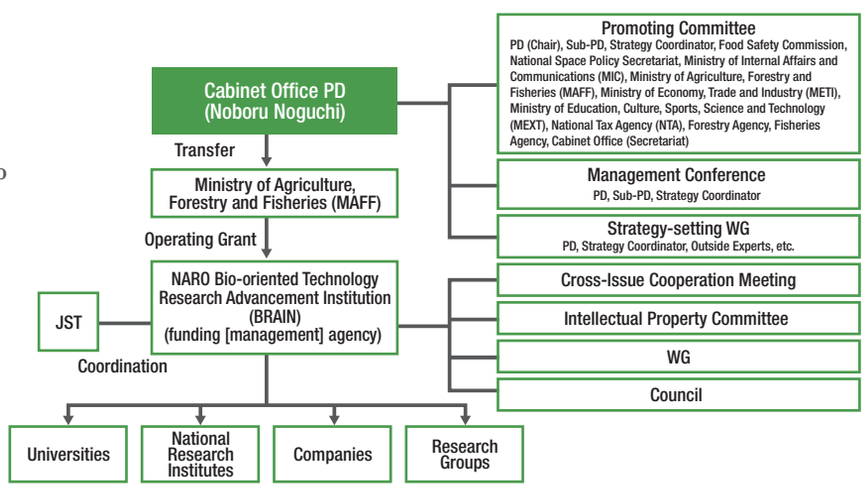
Promote comparative technologies as a package that combines seed varieties, cultivation techniques, etc. Engage in more technology export and overseas consulting businesses.

Pursue initiatives tied to structural and regulatory reforms

Introduce structural reform toward farmland consolidation and regulatory handling of new breeding technologies. Pursue technological development tied to regulations and systems related to international harmonization, ISO, and other international standards.

Implementation Structure

Establish a strategy-setting working group (WG) under the Program Director (PD) and determine exit strategies. Arrange for Sub-PDs to take the lead on progress management, etc., for individual issues. Promote information sharing and coordination among researchers working on different issues through a coordinating council.



Progress to Date

Development progressing even faster than initially planned

This program is currently developing a number of technologies designed to dramatically improve the efficiency and productivity of paddy rice farming, including self-driving multi-robot tractors and smart agricultural machinery, paddy-field water control systems and cultivation management support systems. In greenhouse horticulture, seedling culture systems and cultivation management support systems are currently being developed. Work on building an Agricultural Data Platform has also commenced with an aim of realizing Society 5.0. The program has also succeeded in creating plants of genome-edited rice, tomatoes and other crops, opening the way to develop new ground-breaking varieties. Necessary evidence is being collected to demonstrate the new health functionality of food. The program also succeeded in manufacturing high-value-added modified lignin from wood, and is currently developing a variety of industrial products.

●Self-driving multi-robot tractors

Program Director **Noboru Noguchi** Interview

Creating an Internationally Competitive Agricultural Model under Society 5.0 for the Agriculture, Forestry and Fishery Industry

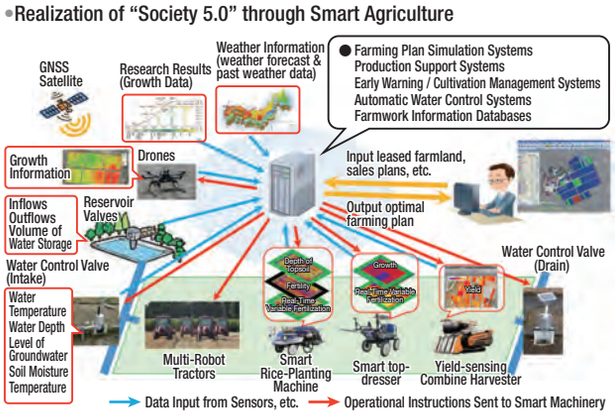
The program for creating next-generation agriculture, forestry and fisheries technologies has produced concrete successes in a number of areas. These areas include automatically driven farm equipment, omics-based breeding technology, new functional foods, and new materials developed out of discarded waste. Big Data (collected from research institutes and on-site IoT) and associated AI analysis technologies represent keys to future growth in this field.

Professor Noboru Noguchi took over the post of Program Director (PD) in October 2016, replacing Professor Takeshi Nishio. Says Prof. Noguchi, "Converting farming into a growth industry is the objective of the program for Technologies for Creating Next-generation Agriculture, Forestry and Fisheries. This was true when the project began and is still true today." Having followed the progress of the project as a Sub-PD since its inception, Prof. Noguchi says, "To date, we have been delving deep into a variety of issues. Going forward, we must establish connections among these issues. We are working to achieve Society 5.0 in the agricultural sector. This means using Big Data, IoT, and AI to meet the numerical targets defined in the June 2016 Japan Revitalization Strategy."

Following the Japan Revitalization Strategy to Organize, Integrate Issues

The key performance indicators (KPI) under the Japan Revitalization Strategy include lowering rice production costs 40% in 10 years, boosting exports of food and agricultural products to ¥1 trillion by 2020 and ¥5 trillion by 2030, and expanding the sixth industry market size to ¥10 trillion in the 2020s. Many specific targets have been set, including the use of the Quasi-zenith Satellite System, marketing self-driving systems for tractors and unmanned work systems (with human monitoring) for use in farm fields, and performing R&D on value-added products using lignin. Prof. Noguchi says, "We have narrowed the scope and organized our research topics to align SIP with this strategy." Specifically, the original 19 research consortia across seven fields have been consolidated to coincide with two final objectives. The project is now addressing 335 issues, or about 70% of the 480 issues in fiscal 2015. The two final objectives are (1) to realize a uniquely Japanese smart, ultra-laborsaving and productive agriculture model, and (2) to enhance the value of agricultural, forestry, and fishery products by developing new materials and offering distinct, functional health foods. Both objectives take advantage of the latest technologies in data science, ICT, robotics, and genomics.

•Realization of "Society 5.0" through Smart Agriculture



Uniquely Japanese Ultra-laborsaving and Highly Productive Smart Agriculture

As the core persons engaged in farming in Japan decrease in number and increase in age, there has been a rapid rise in the number of large-scale management entities, and so the time is ripe for structural reform in agriculture.

To increase labor efficiencies in farm work, research is being advanced into autonomous farm equipment such as unmanned tractors and unmanned combine harvesters, and systems are being developed to automate water management in paddy-fields. Since position control and safety are extremely important to farm equipment, the first objective will be to introduce autonomous operations overseen by human monitors sometime in 2018, with an ultimate objective of adopting completely autonomous operations in the future.

Land-based agriculture, such as paddy-rice farming, can benefit from information including weather data, growth information collected by drones, environmental data obtained from fields, and yields at the time of harvesting. This information can be analyzed in combination with crop cultivation models and other accumulated databases to identify optimal timing for seeding and fertilization, leading to advancements in yields and quality.

In the greenhouse horticulture of tomatoes and other plants, as well as the development of optimal cultivars, the program aspires for high quality and high yield, by comprehensively analyzing Big Data of gene expressions, protein, metabolites and other omics data, and maximizing the plant's capacity according to environmental conditions.

To achieve smart agriculture that makes good use of such data, the program initiated development of the "Agricultural Data Platform"—a data platform that will allow all kinds of data to be shared and accessed, including data from various agricultural ICT, farm equipment, sensors and other sources irrespective of vendor and manufacturer, as well as results and other information produced by NARO and other research institutes.

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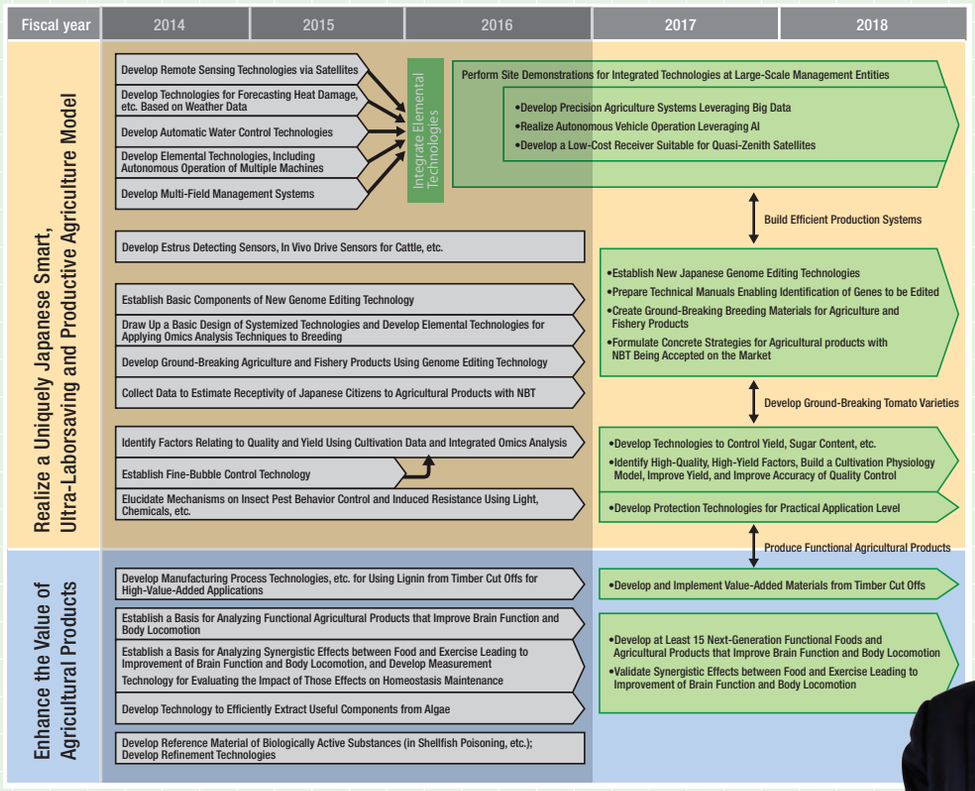
Developing Functional Health Foods, New Varieties and New Materials

The program has developed foods effective for maintaining and improving health functions (brain function, body locomotion function, etc.), planning to bring several types of products to the market during fiscal 2016. The program aims to develop a total of 15 new products during the project period. Using Japanese genome editing technology, breeding efforts will yield better-tasting varieties rich in functional components and ground-breaking varieties that are resistant to disease. Program researchers are also conducting ongoing research to extract lignin from wood waste to create strong materials highly resistant to heat. This research is leading to the formation of business models based on the use of timber off cuts. Ultimately, we plan to develop uniquely Japanese agriculture models and forestry models, leveraging these technologies into intellectual property, making Japanese agriculture more competitive against the rest of the world. At the same time, Japan will look to export these technologies to countries in Asia, Oceania and beyond.

Finally, Prof. Noguchi says, “There are many issues to address in the agriculture, forestry and fisheries industry. But with AI technology, we can rapidly analyze Big Data collected by IoT and research institutes. These results should allow us to solve many of those issues. Achieving ‘Society 5.0’ for agriculture will turn Japan’s agriculture, forestry and fisheries into an internationally competitive growth industry. Many farmers will be able to make a lifetime income comparable to workers in other industries while working a commensurate number of hours.”

Future Plans

The program will continue to organize issues to align with the two consolidated objectives. Each fiscal year, program leaders will set milestones linked to exit strategies, make evaluations and improvements, and continue to develop and prove technologies for use in society.



By aligning individual research efforts and leveraging synergies to achieve Society 5.0 for agriculture, we will build a next-generation agriculture, forestry and fisheries industry powerful enough to grow and compete on the global stage.