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
Professor, Research Faculty of Agriculture

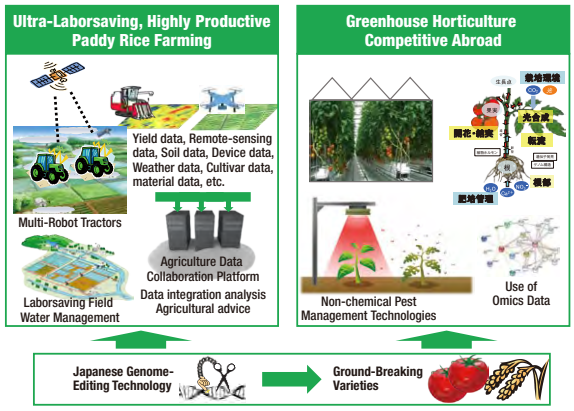
Profile

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

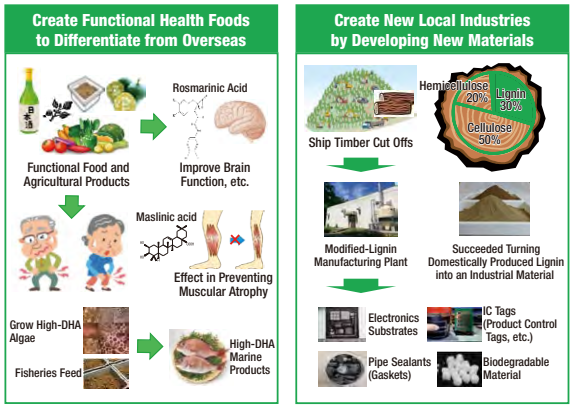
1. Incorporate robotics, ICT, genome and other leading-edge technologies to produce a uniquely Japanese smart, ultra-laborsaving, and highly productive agriculture models

Incorporate robotics, ICT, AI, genome-editing and other leading-edge technologies to produce an environmentally sound, ultra-laborsaving and highly productive agriculture



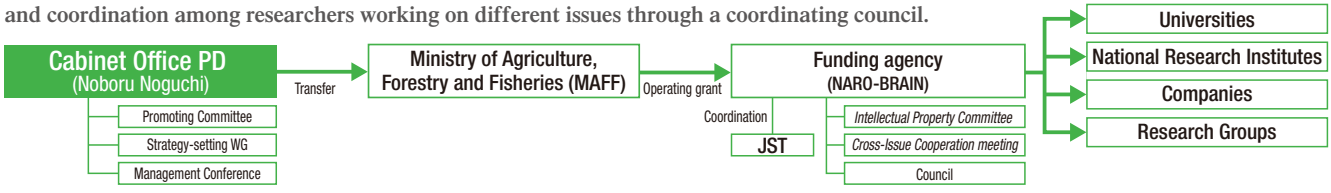
2. Enhancing the value of agricultural, forestry, and fishery products by developing new materials and offering distinct, functional foods for health, etc. by making use of techniques of medicine and engineering

- Differentiate Japanese foods by finding health functionality
- Create regional industry by new materials from unused resources



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.



Exit Strategies

Introduce farmland structural reform and integrate new technologies at agricultural locations

Promote large-scale farmland consolidation and integrate technologies for smarter agricultural practices. Promote 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 users

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.

Progress to Date

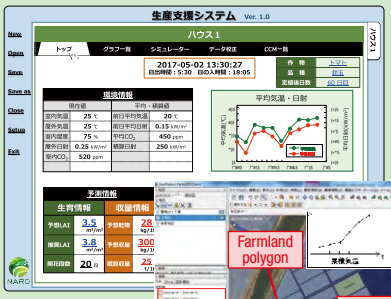
Development progressing steadily towards social implementation

- To dramatically improve the efficiency and productivity of paddy field work, we developed an auto-driving multi robot tractor, a group of smart agricultural machines, a remote/automatic water management system, a cultivation management support system, etc. and they are now in the commercialization phase.

Self-driving multi-robot tractors

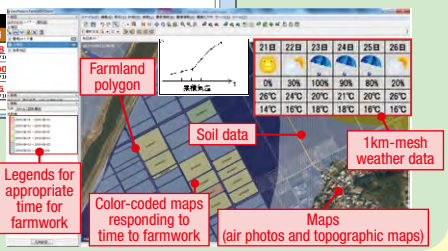
Remote/automatic water management system

- Regarding the greenhouse horticulture, we developed a tomato nursery system and cultivation management support system, and achieved annual yield (55t/10a or more with a sugar content of 5 or more) exceeding the target by the demonstration test.



Growth prediction tool for greenhouse tomato production

- To realize Society 5.0, we constructed a prototype of Agricultural Data Collaboration Platform and started our trial operation.



Example of service by Agricultural Data Collaboration Platform

- We succeeded in the creation of genome-edited individuals in crops such as rice and tomato, and there is a possibility of commercialization.
- Evidence acquisition necessary to show the new functionality of food is in progress with respect to γ-oryzanol (brown rice), procyanidin (black bean), maslinic acid (olive) etc.

Genome-edited tomato with high-content of GABA and without exogenous gene

- We succeeded in the production of high value-added modified lignin from wood and are developing various industrial products (electronic circuit board, gasket, interior and exterior materials for automobiles)

Production of modified lignin and development of industrial products made of it

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."

Uniquely Japanese Ultra-Laborsaving and Highly Productive Smart Agriculture

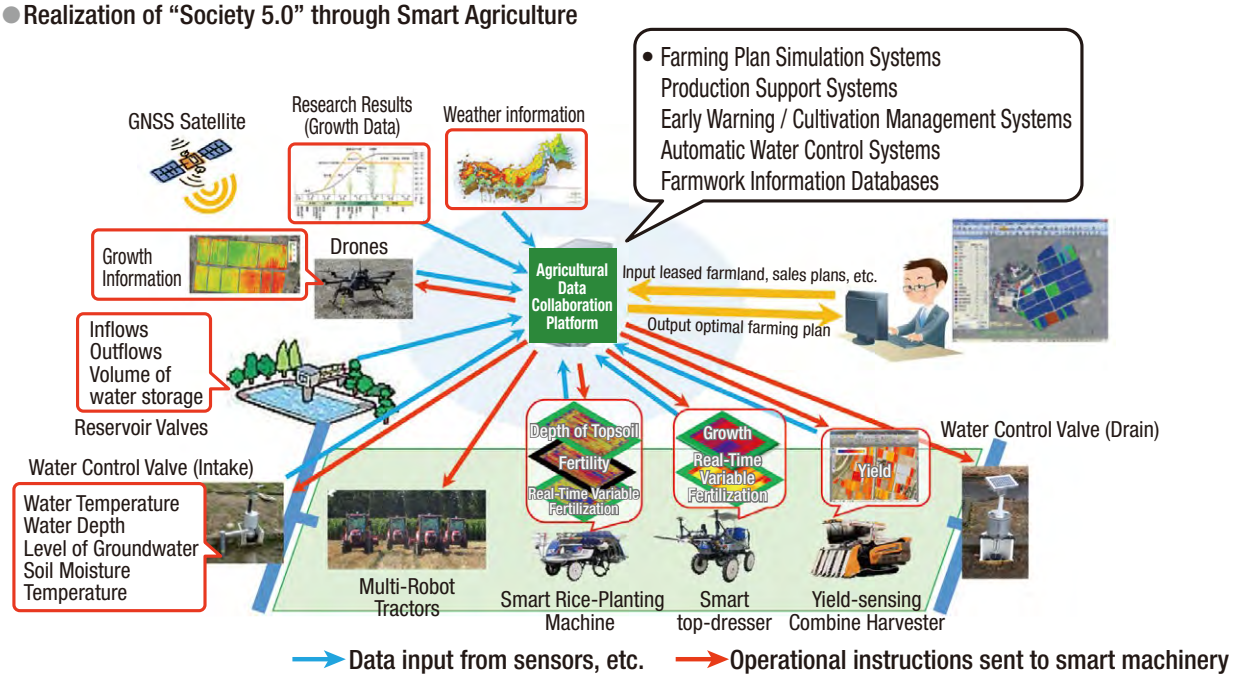
As the core persons engaged in farming in Japan decrease in number and increase in age, there has been a rapid rise in the number of large-scale management entities, and so the time is ripe for structural reform in agriculture.

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

● Realization of "Society 5.0" through Smart Agriculture



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program started developing "Agricultural Data Collaboration Platform" (WAGRI), which is a data platform that allows all kinds of data to be shared and accessed. This includes data from various agricultural ICTs, farm equipment, sensors and other sources irrespective of vendor and manufacturer, as well as results and information produced by NARO and other research institutes. Regarding WAGRI, we built a prototype, started pilot operation in December 2017, and established the WAGRI Council to increase the diversity of participating companies, and as of July 2018, we have participants from more than 200 organizations. In the model areas, we are currently conducting demonstration tests in which farm producers utilize data provided by various agricultural machine manufacturers via WAGRI.

Developing Functional Health Foods, New Varieties and New Materials

The program has developed foods effective for maintaining and improving health statuses (brain cognition, 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. In fact, the Thai government has received high interest in smart agricultural technology developed at SIP, and participating institutions have already carried out local demonstrations of robot tractors. Looking ahead to the development in Asia, we will carry out field demonstration test etc. in Japan and Thailand in future.

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."

Examples of social implementation (Scheduled to be marketed by the end of SIP)

- Robot tractor (picture)
- Low-price receiver for QZSS

- Remote/automatic water management system (Already marketed)

- Raising seedling apparatus for tomato
- LED for natural enemy attraction (picture)
- Edge-colored adhesive plate

Future development for social implementation

Agricultural Data Collaboration Platform	Prototype developed Pilot operation started Council established	NARO is responsible for operation base and will start full operation from FY2019	Diffusion and deployment to agricultural producers
Lignin	Cost reduction of modified lignin production and development of high value-added products	Forestry Agency conducts feasibility study (FS)	To early pilot plant construction
Others (Social implementation of genome-edited crops)	Information exchange and consultation with regulatory authorities aiming for the first genome-edited crop to be commercialized	Legal handling of genome editing crops will be clarified	To commercialization of high GABA content tomato

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.