



Food and Agriculture for the Future

**NARC**

**NARO Agricultural Research Center**

With the aim of a stable supply of food and sustainable development of agriculture, we promote research and technological development that satisfy both producers and consumers.





Advanced production management support systems

Development of innovative technologies for the next generation

Challenges of coping with global-scale issues

Development of new cultivars and innovative technologies

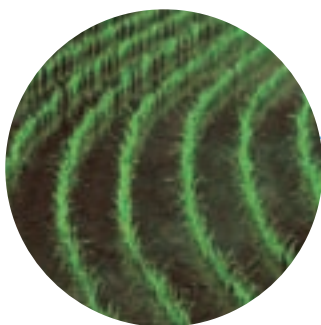
Environmentally friendly management of pest and weeds

Environmentally friendly farming system

Nutrient management of soil and crops that promotes nutrient circulation

Scientific elucidation of the conditions that support organic farming and cultivation techniques

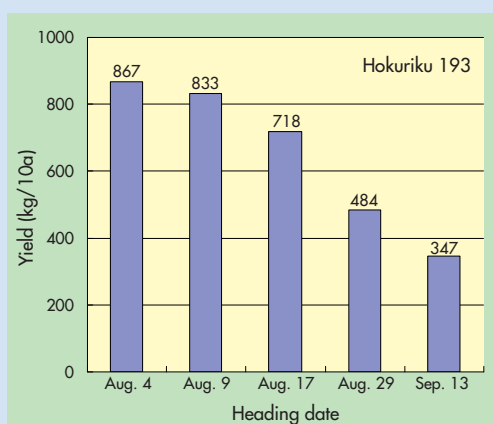
# High-Productivity Systems of Crop Rotation on Paddy Field



## Basic technology for low-cost, stable and high-yield production

Stable, high-yield cultivation techniques for rice and soybean will be developed as a basis for constructing systems of crop rotation on paddy field with an excellent cost: performance ratio. For rice, production techniques involving high-yield cultivars that meet new demands, such as for forage and rice flour, will be developed. For soybean, cultivation techniques that make the best possible use of the functioning of root nodules will be established.

### Information



Increased yields of high-yield rice variety resulting from "advanced heading" and "improved ripening"



Air-assisted seeder



Improvement in seedling establishment by fungicide treatment



Soybean root nodules and a cross-section of a root nodule

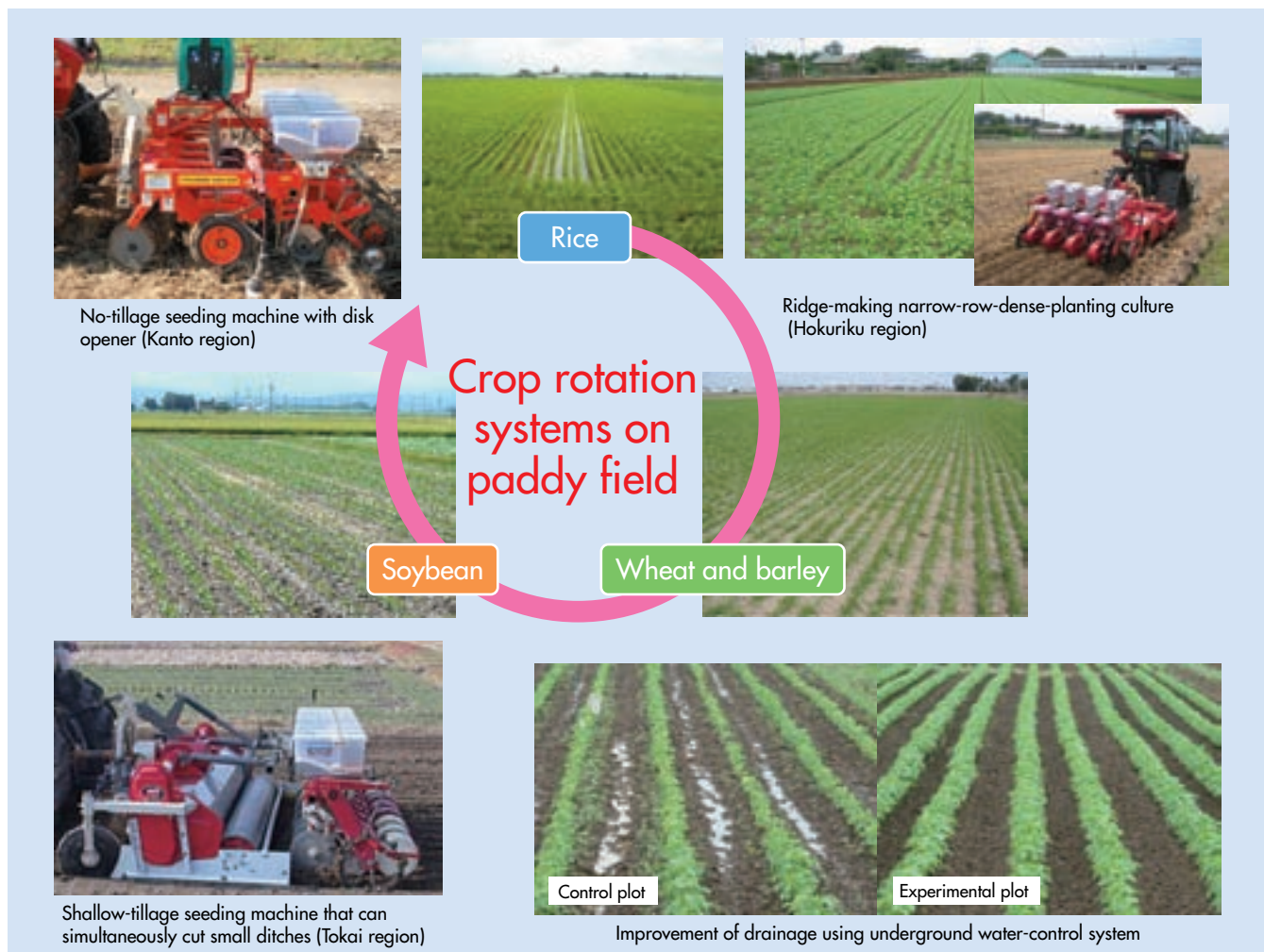
### Research tasks

- We will develop stable, high-yield management techniques for high-yield indica rice varieties suited to the climate of Japan.
- We will develop low-input rice production techniques (i.e., reducing the input of chemical fertilizers).
- We will develop labor-saving rice production techniques that result in reduced costs, such as efficient direct-seeding techniques.
- By clarifying the relationship between the properties of soil and nitrogen fixation of root nodules, we will develop cultivation techniques for the stable, high-yield production of soybean.
- We will identify diseases affecting soybean growth and will develop control techniques.

## Systems of crop rotation on paddy field in the Kanto, Tokai, and Hokuriku regions

Establishing crop rotation systems based on rice, barley, wheat, and soybean, along with low-cost, high-yield production systems, is an important task, directly linked to the improvement of Japan's food self-sufficiency ratio. In the Hokuriku region there has been a demand for efficient, low-cost systems of crop rotation on paddy field that can overcome heavy clayey soils and heavy snowfall.

### Information



### Research tasks

#### Kanto and Tokai regions

-To reduce production costs and working hours, we will develop multiple-crop rotation systems of four crops in two years or five crops in three years by using an underground water-control system that makes drainage promotion and sub-irrigation possible.

#### Hokuriku region

- On the basis of a multiple-cropping system of three crops (rice, barley or wheat, and soybean) in two years, we will develop labor-saving techniques to easily rotate crops, and cultivation techniques that take full advantage of cultivars and regionality, a multiple-cropping system which meets the conditions of the region.

- We propose employing low-cost crop rotation systems on paddy field using an underground water-control system.

# High-productivity systems of crop rotation on paddy field



## Supporting the development of farm management and regional agriculture

It is important to scientifically analyze the socioeconomic and natural conditions relating to agriculture and contribute to the development and revitalization of individual farmers and regional agriculture by taking measures on the basis of this analysis.

### Information

Example of a farm management model:  
year-round grazing on paddy through the collaboration of a livestock farm and crop farm



Spring/summer: Grass  
Crop farming



Fall: Forage rice in the field



Winter: Forage rice WCS  
Livestock farming

- (1) Reduces farm maintenance
- (2) Promotes farm business expansion
- (3) Prevents arable fields from being abandoned

- (1) Reduced transportation cost between fields and cattle barn
- (2) Labor saving in terms of livestock breeding
- (3) Expansion of scale
- (4) Improvement in the forage self-sufficiency ratio

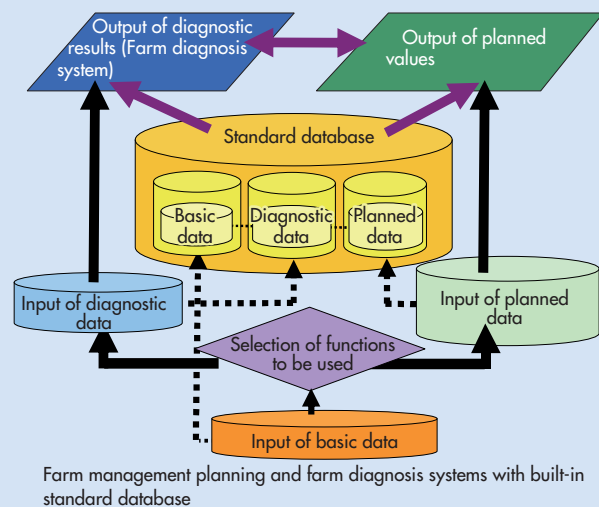
### Farm management decision support systems

#### Contents

Program for analyzing structural changes in regional agriculture, Ver.1.01  
Farm management plan support system, Z-BFM Ver.1.10  
Farm management decision support system, Ver.3.11 "FarmanDess"  
Management model for supporting rational selection of cropping systems in paddy

#### Manuals

- Organization strategies and management measures for the development of community-based group farming
- For a smooth succession of farm management—The process and the point
- The points of organization of community-based group farming

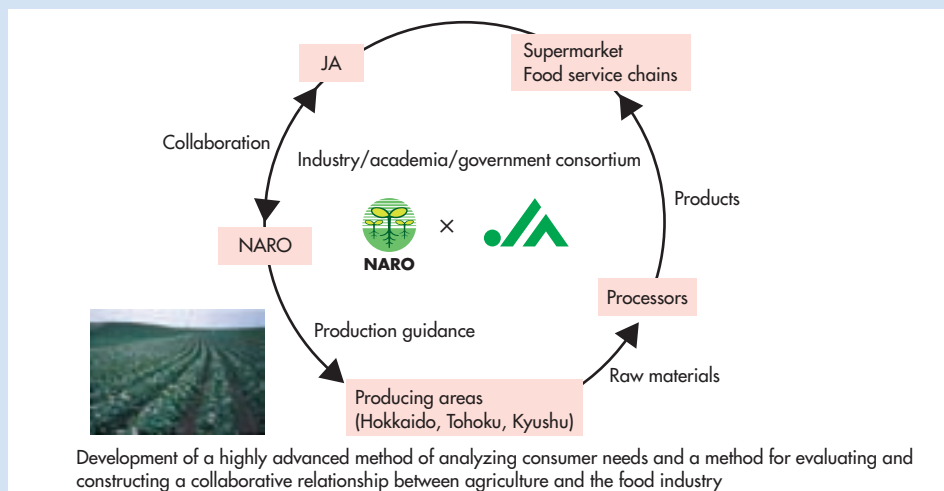
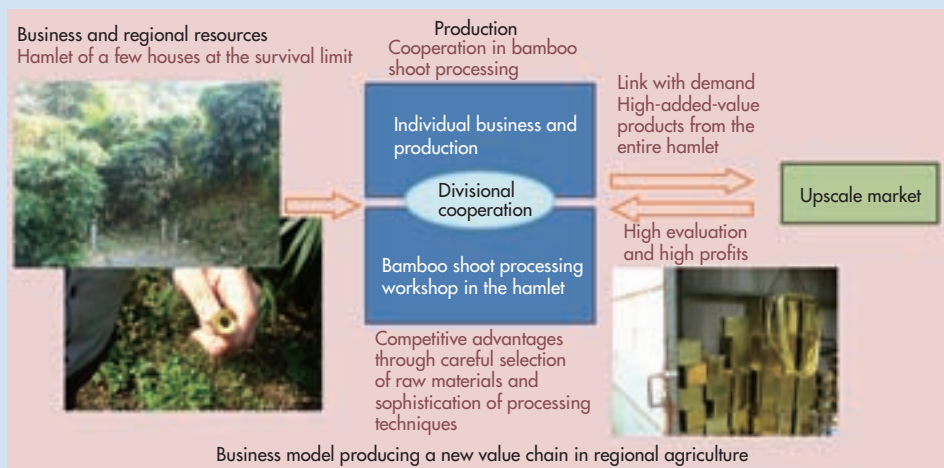


### Research tasks

- We present the direction of the development of agricultural technologies through trend analysis of regional agriculture. We evaluate leading production techniques by a method we developed to evaluate environmentally friendly farming techniques.
- To encourage young farmers to engage in farming, we will establish systems for new entry to agriculture, such as succession of farm management to unrelated persons, and human resources training methods. We will also establish a new business management system through the development of farm management plan systems incorporating databases of crop-specific techniques and accounts, and farm diagnosis systems.

To achieve agricultural business diversification and integration, it is important to contribute to the construction of new business models of regional agriculture through collaboration with a primary industry and the food industry

## Information



## Research tasks

- With the aim of improving productivity by using new techniques and cultivars developed by NARO, we construct business models for regional agriculture and examine the validity of the model using on-farm demonstrations.
- To support the development of high-added-value products through collaboration between agriculture and the food industry, we will develop a system for collecting and analyzing data on consumers' purchasing and consumption of agricultural products. We then establish a method to build a collaborative relationship with the food industry through the operation of a consortium, using the core of new techniques and cultivars developed by NARO, and we will try to systematize the relationship through quantitative evaluation of the effects of collaboration.

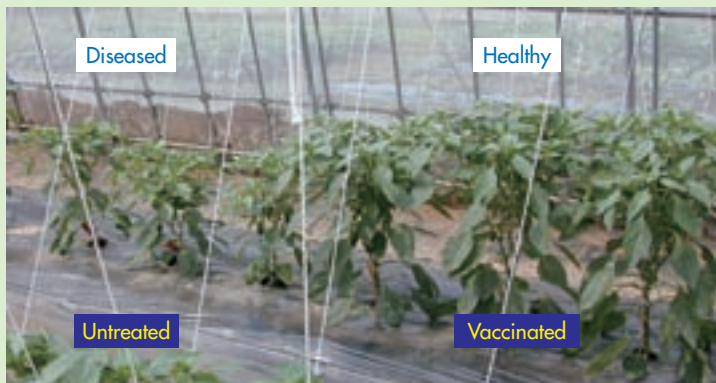
# Environmentally friendly farming system



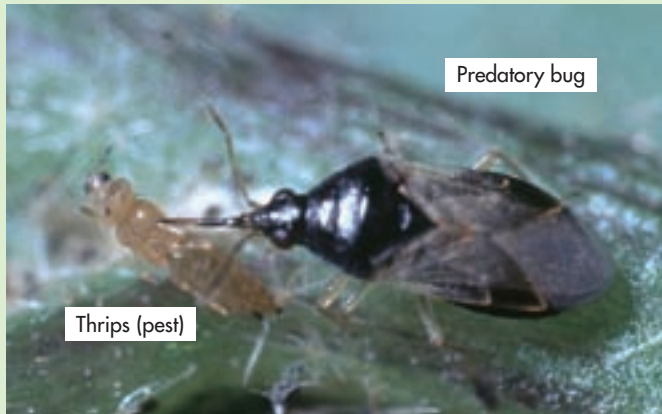
## Environmentally friendly management of pest and weeds

Integrated Pest Management (IPM) systems, which depend on a combination of biological and cultural control (such as natural enemies and vegetation management), not on chemical control by pesticides, constitute an important technology system that supports food safety and security.

### Information



Prevention of mosaic disease on bell peppers by the treatment of plant virus vaccine



Control of a pest (thrips) by a native natural enemy (predatory bug)



Control of rice blast disease using a resistant cultivar

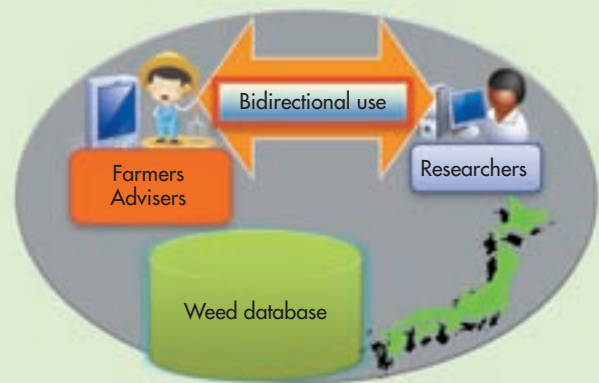
### Research tasks

- We will develop alternative pesticide techniques (such as virus vaccines) which utilize biological functions. In addition, by systematically combining interactions among crops, vectors, and pathogens, and their related techniques, we will develop IPM systems to use against plant diseases.
- We will develop technologies for evaluating and managing environmentally friendly farming by using native natural enemies, and we will establish IPM systems that rely on a combination of introducing effective materials for preserving and augmenting natural enemies and vegetation management.
- To develop technologies for the continuous use of disease-resistant varieties of plants, we will construct a simulation model of blast disease incidence using population genetic methods.

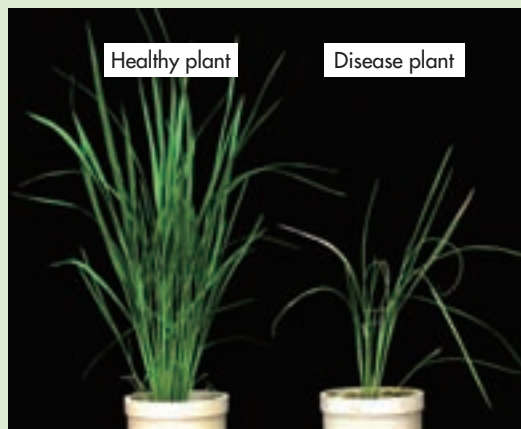


## Information

Exotic weeds (red morning glory) blocking soybean



Prevention of exotic weed spreading by early-warning systems



Prevention of rice stripe disease transmitted by small brown plant-hopper



Small brown plant-hopper  
Vector insect of rice stripe virus disease

## Research tasks

- To prevent the spread of exotic weeds, we will construct warning systems using the exotic weed databases, which researchers and people on the farm can use bi-directionally, along with long-term weed management systems.
- We will establish risk assessment methods for pests that have not yet emerged in Japan but have occurred overseas, develop diagnosis and technologies for forecasting plant disease epidemics, and present a spread prediction and risk-avoidance strategy for emerging and re-emerging pests and diseases

# Environmentally friendly farming system



## Nutrient management of soil and crops that promotes nutrient circulation

In an increasingly recycling-oriented society, there has been demand for soil management techniques that promote the use of organic resources such as compost, reduce environmental load by proper nutrient management, and make full use of the functions of crops and soil microbes.

### Information

Rapid analysis of available nitrogen in upland soil



Simplified evaluation of soil, fertilizers, and materials, and optimization of fertilization by the use of organic resources

Improvement in the properties and condition of livestock manure compost and its appropriate use



Support system for a compost records database to calculate the application rate of manure compost

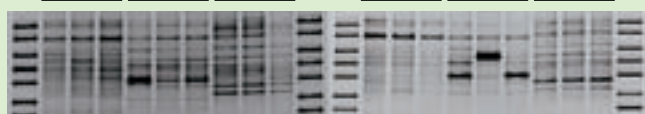
Gray lowland soil

Chemical fertilizer   Cow manure   Swine manure



Light-colored andosol

Chemical fertilizer   Cow manure   Swine manure



Analysis of variation of soil fungal community structure resulting from the application of organic matter

Without endophyte

With endophyte



Use of a nitrogen fixation function of endophytes to reduce the amount of nitrogen fertilizer

### Research tasks

- By simply evaluating soil and organic materials and improving nutrient-use efficiency, we will develop efficient nutrient-use techniques.
- To reduce the amount of phosphate fertilizers, we will improve fertilization methods and develop techniques to use nutrients accumulated in the soil.
- We will develop a method of analyzing soil productivity in which the soil microbiological population is used as an indicator, and will develop soil management techniques using microbial functions.
- We will develop methods to diagnose nutritional status and stress, along with quality evaluation techniques using biomarkers.
- We will clarify the improving and stabilizing factors in the symbiotic nitrogen fixation of endophytes, with the aim of achieving a 30% contribution of nitrogen fixation.

## Scientific elucidation of the conditions that support organic farming and cultivation techniques

The mechanisms of pest and weed control techniques and nutrient management techniques used by advanced organic farmers will be elucidated scientifically. In addition, model systems of crop rotation on paddy or upland fields, which adopt paddy-upland rotation, will be constructed to contribute to an expansion in the production of organic products and the promotion of sustainable agriculture.

### Information



Rice-soybean crop rotation system in organic farming



Application of rice bran and mechanical weed control



Potato scab and pest control using antagonistic microorganisms



Soybean root necrosis and reductive soil disinfestation

### Research tasks

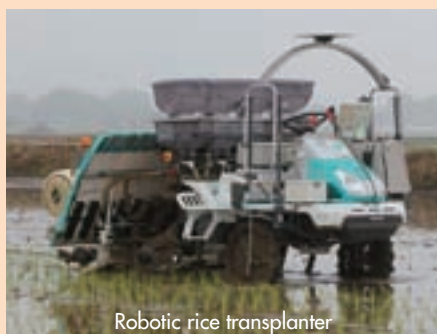
- We will develop a model of crop rotation systems in organic production on paddy fields (rice, soybean, etc.) which adopts paddy-upland rotation.
- We will examine the effect of regulating weed growth (through mechanical weed control, double puddling, rice bran, etc.) conducted in organic farming of paddy rice, and will develop weed control techniques by combining such techniques.
- We will develop disease control techniques for potatoes by using antagonistic microorganisms.
- Focusing on techniques for raising vigorous seedlings using smoked rice hull and soil solarization, we will develop models of crop rotation systems for the organic farming of vegetables.
- We will develop a method for evaluating organic farming from the viewpoint of life cycles.



## Advanced production management support systems

The development of innovative technologies, including precision and automated technology (robotics technology) and information technology, is indispensable for establishing agricultural production systems that appeal to the next generation and for the development of production management support systems.

### Information

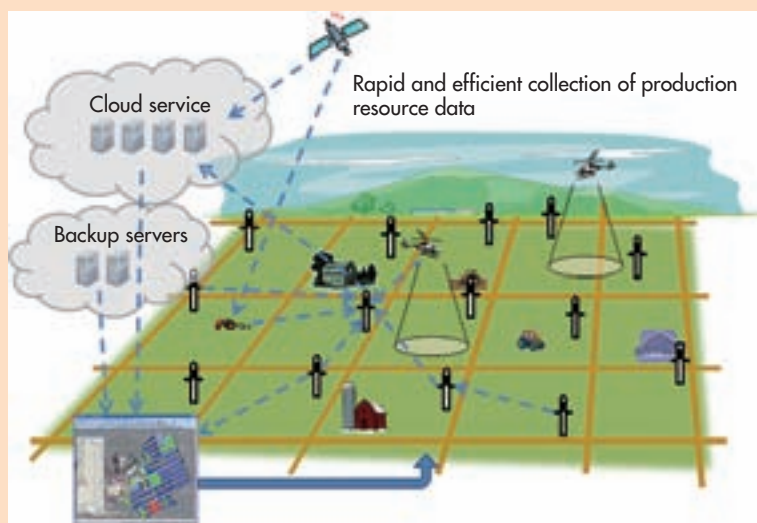


Robotic rice transplanter

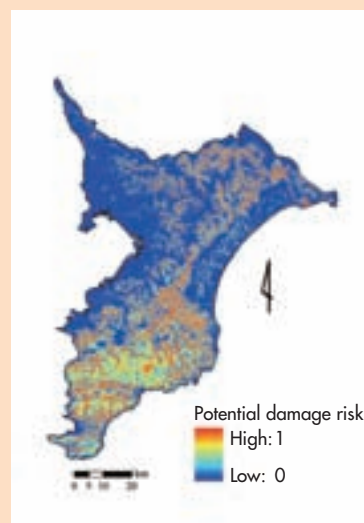


Robotic combine harvester

These machines work automatically, based on high-precision GPS data.



Data integration, mapping, analysis, and process management support



Risk map of agricultural damage by wild boar

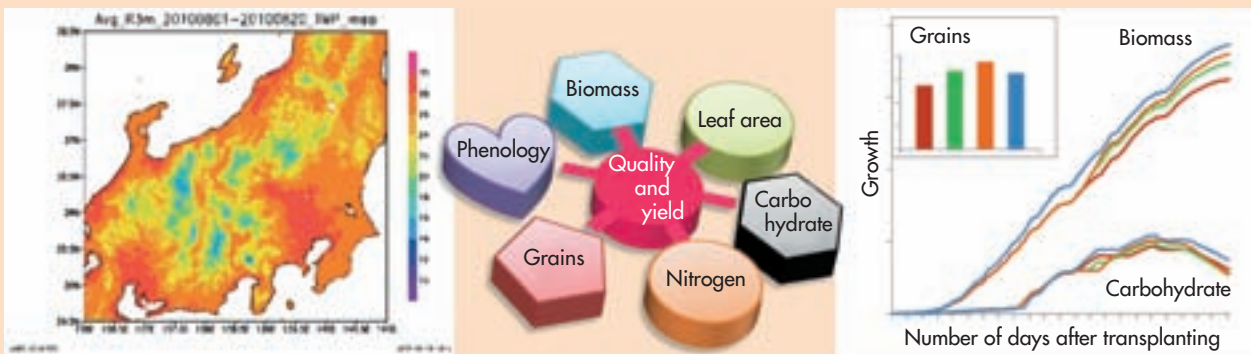
### Research tasks

- For the production of crops such as rice, wheat, and soybean, we will construct an advanced labor-saving system in which automated farm machines carry out farm work such as tillage, soil preparation, fertilization, sowing, transplanting, and harvesting.
- We will develop monitoring technologies for agricultural data that reflect the actual state of production sites, customizable recording systems for agriculture using a handy terminal device, and technologies supporting the management of the crop production process.
- To efficiently handle massive amounts of multidimensional agricultural data, we will develop data collection and management methods, data analysis theory and methods, and advanced modeling methods to support crop breeding.
- We will develop wildlife monitoring systems, damage prediction technologies, and a web-based information system for wildlife management.

## Challenges of coping with global-scale issues

Crop models that support farming to adapt to climate change will be developed, and decision support systems for reducing the risk of high-temperature injury will be constructed. In addition, high-quality edible oils made from crops such as rape seed and sunflower and efficient biofuel production systems will be developed to help mitigate global warming.

### Information



Simulation of response to fertilization of rice plants, based on grid-square weather data and a crop model.



Rape seed used as a raw material for biofuel



Transportable biofuel production system

### Research tasks

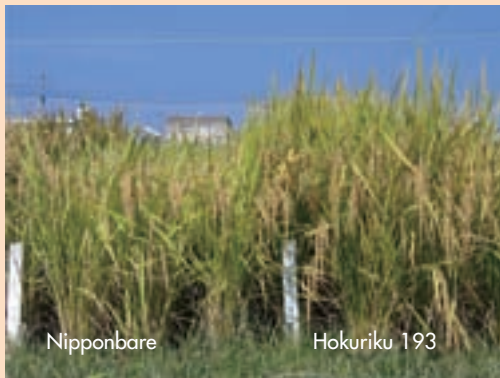
- We will develop growth models for major crops (rice, wheat, and soybean).
- We will develop technologies to predict the rice yield and high-temperature damage, including the occurrence of chalky grains.
- We will construct crop growth models and crop management support systems on the basis of grid-square weather data.
- We aim to have continuous stable production of biomass crops on abandoned agricultural land.
- We will develop techniques for finding productive uses for unused resources such as rice straw.
- We will develop techniques to efficiently produce liquid fuel from waste edible oil.



## Development of new cultivars and innovative technologies

In order to improve the food self-sufficiency ratio and provide a stable supply of food, a dramatic leap in yield and expansion in the uses of crops such as rice is desirable. Accordingly, we will promote the rearing of cultivars of rice and barley for new uses, clarification of their properties (including high-yielding ability and environmental stress resistance), development of breed cultivars with such properties, and improvement in the efficiency of breeding using DNA markers.

### Information

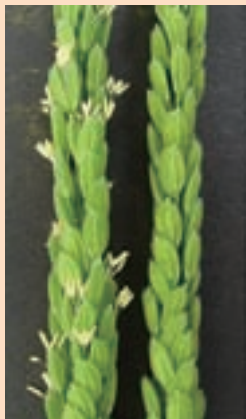


Very high-yielding indica rice cultivar: Hokuriku 193

Grain quality improvement under high-temperature ripening



Rice grain quality is improved (there are fewer chalky grains) when the expression of phospholipase D is suppressed (right) compared to normal rice (left) grown under high-temperature ripening conditions.



Cultivar purity is maintained by preventing pollen from dispersing.



Normal cultivar Cleistogamous rice  
The lodicule (arrowed) elongates.



Underwater growth assay for the selection of wet-injury-tolerant barley

### Research tasks

- We will breed cultivars for forage rice and silage that are suitable for livestock feed.
- With the aim of improving productivity dramatically and stabilizing quality and yield against weather variation, we will clarify the mechanisms of high-yielding and high-temperature resistance.
- To prevent cross-pollination and to maintain cultivar purity, we will develop rice cultivars that are less likely to flower under various environmental conditions.
- We will develop a new barley cultivar tolerant of wet-injury and snow mold, with high growth stability under increasing climate changes.

## Information



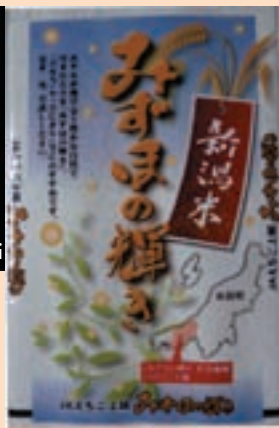
A cultivar suitable for cooked rice for curry and rice: Kareimai



Grains of boiled rice do not clump and are apt to be covered with curry sauce.



Large-grained, good-tasting cultivar "Mizuhonokagayaki"



High-amylose-content, hard-to-stick noodles



Rice noodle product made from Koshinokaori

A high-amylose-content cultivar suitable for rice noodles: Koshinokaori

## Research tasks

- We will breed rice cultivars for the food-service industry that can cope with climate change (such as recent warming trends) and can be cultivated at low cost.
- We will breed high-yield rice cultivars that can be produced at low cost and are suitable for processing rice for rice flour bread and rice flour noodles.
- We will breed new barley cultivars that can be cultivated in heavy snowfall regions or cold climates and can generate demand.

# Research exchange forum

Short training programs and in-service training programs  
Cooperation with universities (graduate partnership schools)  
Collaboration of industry, academia and government (joint research and agreement research)  
Open Labs

## Information

### Technical training programs and internship

Staff members at experimental research institutes - and those (in Japan and abroad) who are engaged, or will be engaged, in agricultural research or work - can learn to use the relevant technologies.

### Commissioned researcher system

This is a system for accepting staff members working in other organizations that conduct agricultural research (such as national or municipal institutes, universities, private companies) and for providing instruction in experimental research.

### Graduate partnership schools

NARC makes agreements with partner universities (the University of Tsukuba, the University of Tokyo, Niigata University, etc.) and provides postgraduate education using NARC's facilities and human resources.

### Joint research and agreement research

This is a system in which other organizations (such as public research institutes, universities, private companies) and NARC carry out cooperative research based on a common theme. In principle, the research costs required for joint research are charged to each. The system of agreement research is applied to research that (it is assumed) will not generate intellectual property to provide a rapid start for the researchers using simple procedures.

### Open Labs: Joint research facilities for the collaboration of industry, academia and government have been established.

**Joint Laboratory Building for the Development of Environmentally Sound Pest Control Technology**  
Research on the development of pest control technologies has been carried out in this Lab. It is equipped with various kinds of microscopes, protein or gene analyzers, closed greenhouses, etc.

**Joint Industry/Academic/Government Research and Development Facility for Biomass-Resource Energy**  
Efficient biomass energy conversion technologies have been developed in this Lab. The emphasis is on developing biodiesel fuels.

**Joint Laboratory Building for the Development of Budding Technologies**  
The application of technologies used in biology-engineering interdisciplinary research to agricultural research has been developed in this Lab.  
It is equipped with mass spectrometers, electron microscopes, a micromachining room, etc.



Joint Laboratory Building for the Development of Environmentally Sound Pest Control Technology



Joint Industry/Academic/Government Research and Development Facility for Biomass-Resource Energy



Joint Laboratory Building for the Development of Budding Technologies



## Cooperation with farmers Exchange with citizen

### Information

#### On-farm technology demonstration

With the aim of disseminating a new technology developed by NARC, a researcher who developed the new technology provides on-farm technical guidance (explanatory meetings, lecture meetings, demonstrations, etc.) in response to farmers' demand.



On-farm technology demonstration

#### Farmers who cooperate in experimental research on the farm

NARC certifies as "NARC Research Cooperators" those farmers who cooperate in, and conduct on their own initiative, on-farm demonstration experiments. The new technology will be presented and disseminated to the surrounding area through their demonstration experiments.

#### Annual meeting with key farmers

An annual meeting has been held to strengthen the relationship between the researchers in NARC and NARO Institute of Crop Science (NICS) and advanced key farmers, who cooperate in promoting research conducted by NARC and NICS and in disseminating technologies developed by NARC and NICS.



Open days in the summer vacation

#### Open days

Open days are conducted to introduce NARC's research activity to the public. Open days in the summer vacation are also conducted to allow children to get close to science.

#### Public lecture

To provide the public with an understanding of NARC's agricultural research, NARC's researchers deliver a friendly lecture on topics on their special fields in Tsukuba Agriculture Research Hall on the second Saturday of every month.

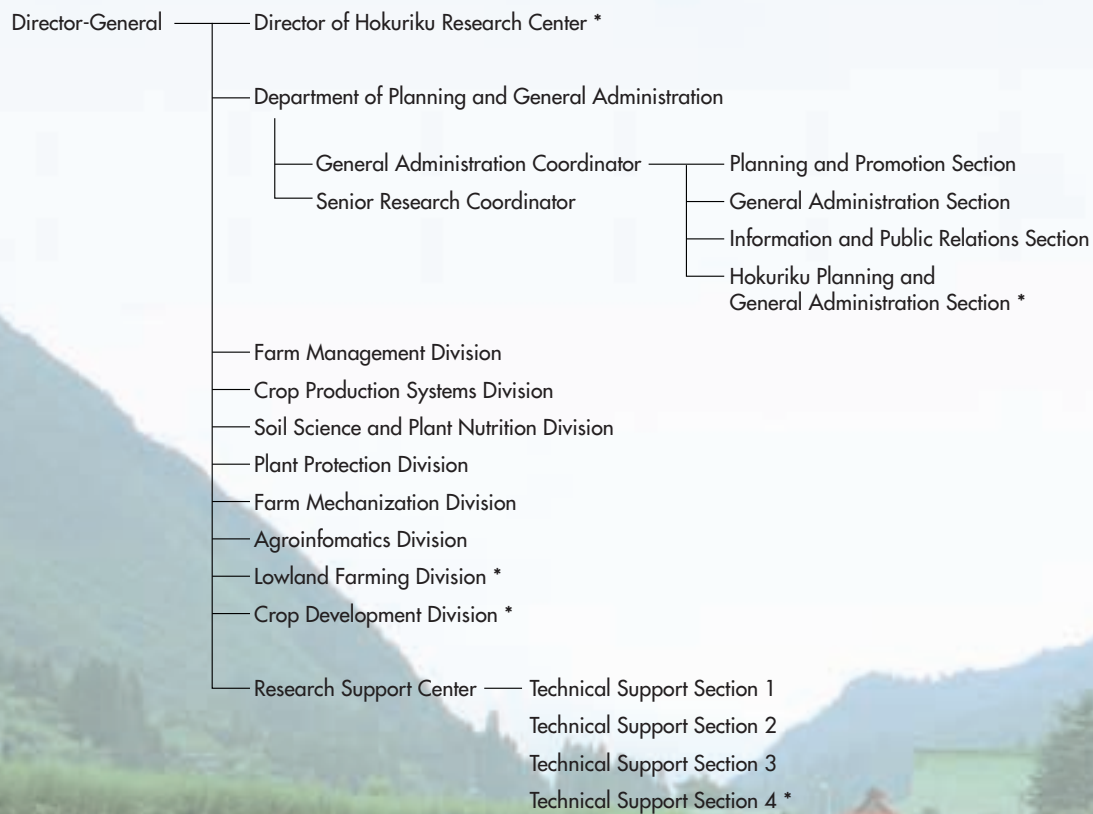


Public lecture

#### Science Camp

NARC runs a Science Camp, which provides high school students with full-scale experiments and practical training in science and technology. It is sponsored by Japan Science and Technology Agency.

## Organization



\*: Hokuriku Research Center

### April 1, 2001

The National Agricultural Research Organization was reorganized as a national research organization after the integration of 12 research institutes addressing agriculture technology research. National Agriculture Research Center and Hokuriku Agricultural Experiment Station were consolidated into the National Agricultural Research Center, NARO.

### October 1, 2003

The National Agricultural Research Organization and the Bio-oriented Technology Research Advancement Institution integrated to form the National Agriculture and Bio-oriented Research Organization.

### April 1, 2006

The National Agriculture and Bio-oriented Research Organization, National Institute for Rural Engineering, National Food Research Institute, and the National Farmers Academy were integrated to form the National Agriculture and Food Research Organization, NARO.

## Research Projects

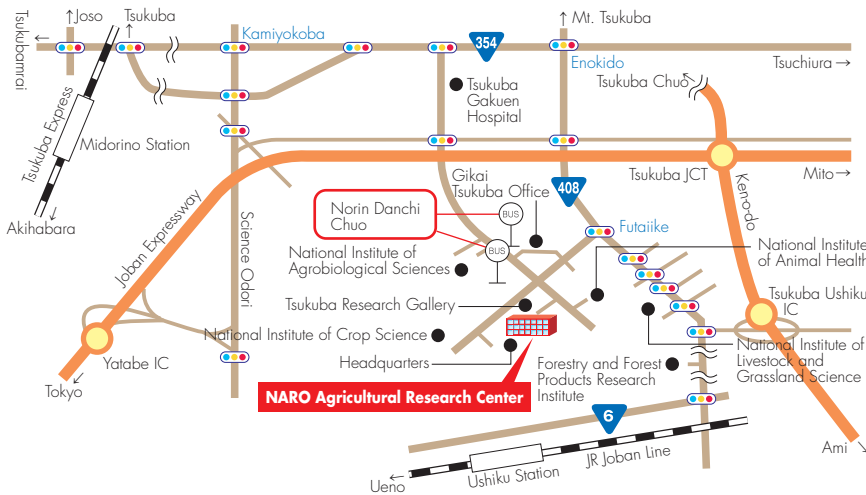
Low-input, High-yield Rice Production Technology  
High Soybean Productivity  
Paddy Rotation System With Subsurface Irrigation-Drainage Facility  
Paddy Rotation System on Heavy Clayey Soil  
Rice Breeding and Utilization  
Rice Yield Physiology  
Barley Breeding and Utilization  
Rice Biotechnology  
Agrotechnology Estimation  
Business Model  
Management Methods  
Coordinated Feed Production

Soil Fertility Management  
Soil Biological Fertility  
Plant Nutrition  
Plant Disease Control  
Insect Pest Management  
Weed Management  
Rice Disease Resistance  
Pest Risk Assessment  
Organic Farming System

Robot Farming  
Agricultural Informatics  
Advanced Statistical Modelling  
Agrometeorological Crop Modelling  
Crop Management under Climate Change  
Biomass Energy Conversion  
Vertical Coordination in the Agricultural Food system  
Wildlife Damage Management

# Access

## Tsukuba



### By train

JR Joban Line, Ushiku Station  
(Please check JR East timetable.)  
Tsukuba Express, Midorino Station  
(Please check Tsukuba Express timetable.)

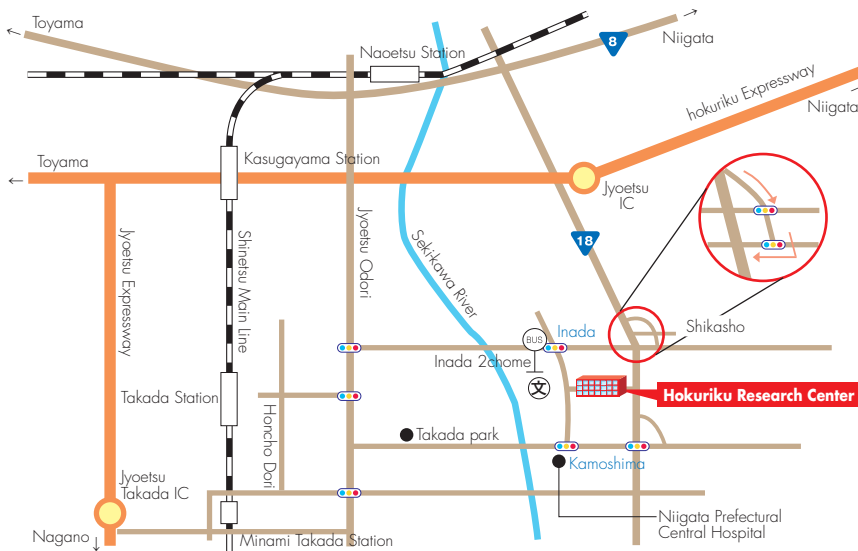
### By bus

**Kanto Tetsudo bus from Ushiku Station West Exit**  
Take a bus for Daigaku Byoin, Yatabe Shako, Seibutsuken Owashi Campus, Tsukuba Bus Center, or Daigaku Chuo. Get off at Norin Danchi Chuo (about 20 minutes)

**Kanto Tetsudo bus from Midorino Station**  
Take a bus bound for Yatabe Shako, Norin Danchi Chuo, and Enokido. Get off at Norin Danchi Chuo (about 15 minutes)  
\*Note: Buses do not run on weekends & holidays

**TUKU-Bus from Tsukuba Center**  
Take a bus "Southern shuttle" bound for Kukizaki General Services Counter. Get off at Norin Danchi Chuo (about 20 minutes)

## Hokuriku



### By bus

**Kubiki bus from Takada Station**  
Take a bus for the suburbs via Inada 2chome, Get off at Inada 2chome (about 5 minutes)

## National Agriculture and Food Research Organization (NARO)

### NARO Agricultural Research Center

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Tel.+81-29-838-8481, Fax.+81-29-838-8484  
URL: <http://www.naro.affrc.go.jp/narc/>

### Hokuriku Research Center

Inada1-2-1, Jyoetsu, Niigata, 943-0193 Japan  
Tel.+81-25-523-4131, Fax.+81-25-524-8578

### Tokai Research Station

360 Kusawa, Ano, Tsu, Mie, 514-2392 Japan  
Tel.+81-50-3732-6450