農研機構 NARO

Roles of Agri-food Sciences in Global Socio-economic Development

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President

National **A**griculture and Food **R**esearch **O**rganization

※Former Executive Member of the Council for Science, Technology and Innovation
※Former Executive Vice President of Mitsubishi Electric Corporation

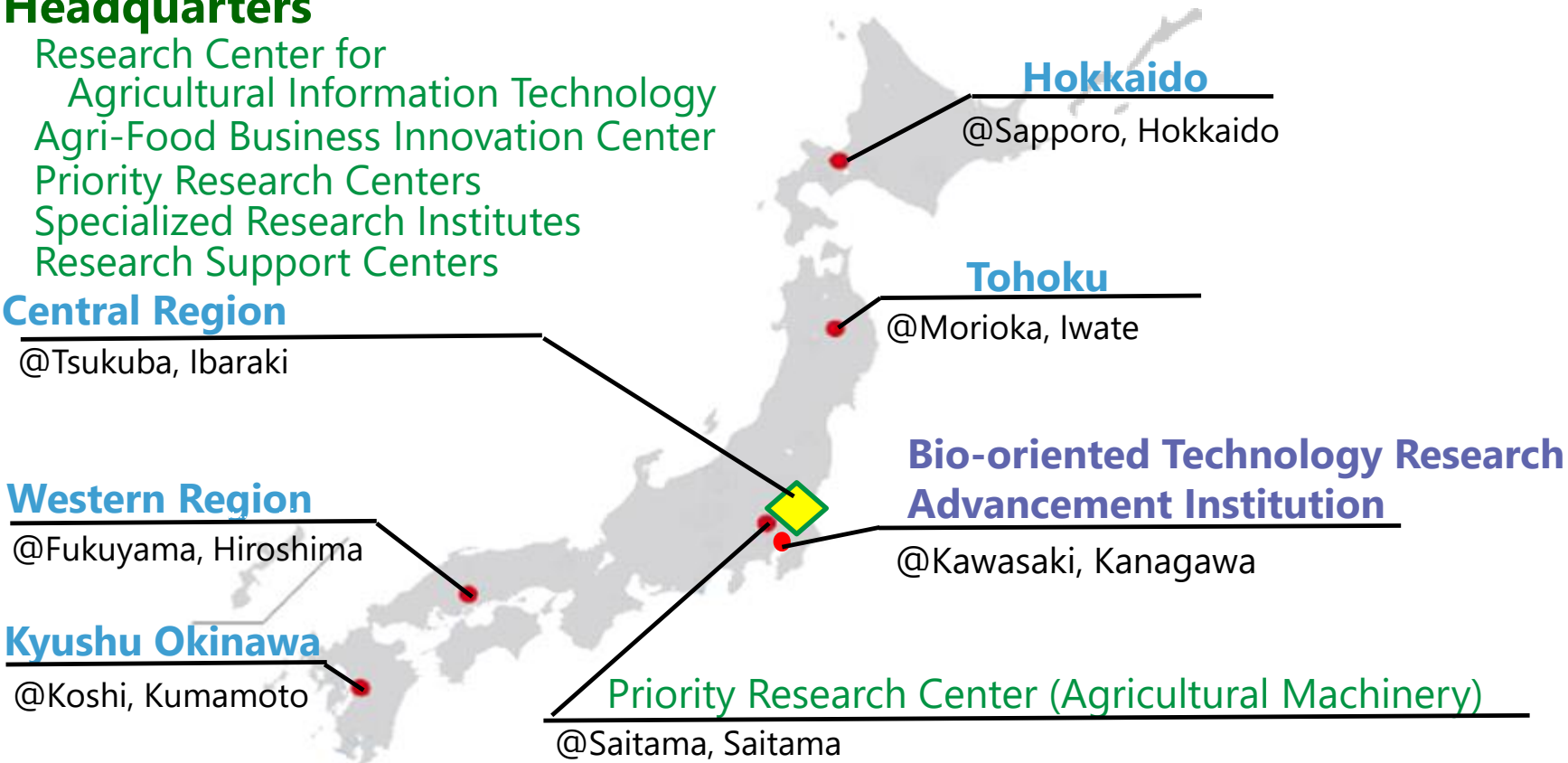
NARO

Overview of NARO

- Established in 1893
- Location of Headquarters: Tsukuba, Ibaraki
- Executive Board: 15 members
- 3,338 full-time employees (641 females) including 1,839 researchers (January 2019)
- Annual Budget：91.1B JPY
- Headquarters, 15 Research centers and institutes, 5 Regional Agricultural Research Centers, Funding Agency

Headquarters

Research Center for Agricultural Information Technology
Agri-Food Business Innovation Center
Priority Research Centers
Specialized Research Institutes
Research Support Centers



NARO's Impact on History of Modern Agriculture

Cultivar for Green Revolution

＊Norin10, the semi-dwarf wheat cultivar revolutionized the World of Wheat

Rice Genome Project (1998-2004)

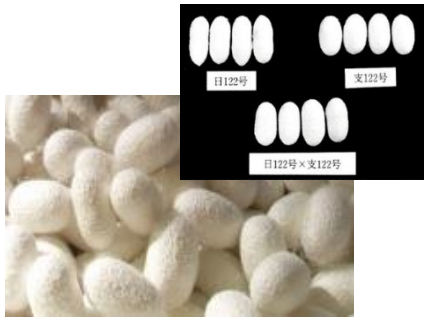
*NARO lead the International Rice Genome Sequencing Project

Fuji Apple

＊The world most eaten apple

Hybrid silkworm breeds

＊Hybrid silkworm breeds achieving high yield and quality of silk reduced silk price



Rice transplanter

＊The machines released farmers from hard-labor rice planting task

In vitro maturation and fertilization techniques of cattle oocytes

＊Widely used techniques in embryo transfer in cattle

Research Products –Breeding, Food Science-

NARO

Rice

Heat-tolerant rice cultivar

Soy

For tofu

Sweet Potatoes

Domestic share >50%

Strawberries

Peach flavor

Longer shelf life

Apple

Domestic share 50%

Asian pears

Domestic share 70%

Citrus

Grape

Very popular fruit in Asia

Chestnuts

Domestic share 50%

Home bakery machine for 100% rice flour bread

For people with gluten allergy

Functional beverages and Foods

'Benifuki' green tea

Antiallergic function

β-cryptoxanthin rich mandarin juice

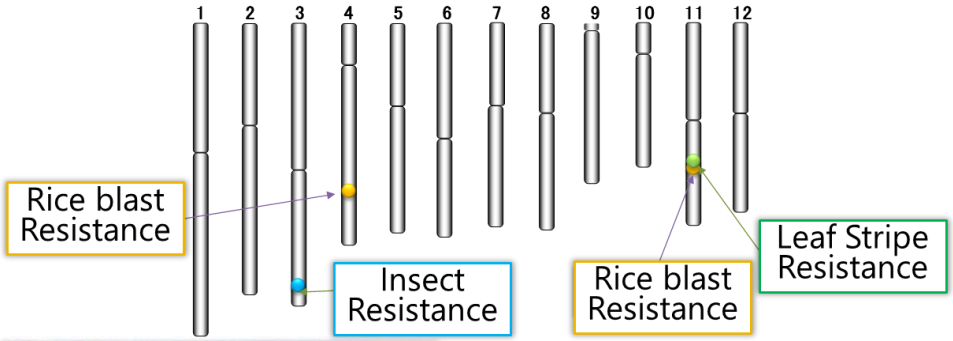
Maintain bone homeostasis

Lunch Box Style

Significant reduction in visceral fat

Research Products -Biotechnology-

Genome-based breeding



- New variety "Akiharuka" carrying genes for rice blast, leaf stripe and brown hopper resistance

High yielding rice generated by genome editing

- Genes related to grain size and number were modified
- Field trials started in 2017

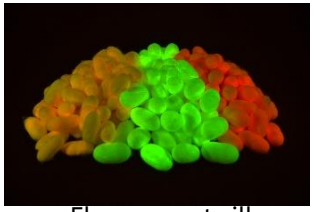
Field trial of the genome edited rice in Tsukuba

Transgenic "true blue" chrysanthemum flowers

- The "true blue" chrysanthemum flowers generated by introduction of two genes

Transgenic Silkworms as a biofoundry for protein production

- Silk warm system have advantage in producing some proteins



Fluorescent silk

Diagnostic reagents for osteoporosis

Cosmetic materials (Human collagen Ⅰ)

Research Products -ICT in Agriculture-

- Application of ICT technology to agri-machines enables smart paddy rice production
- ICT agri-machines increase profitability by saving labor

Robot tractors

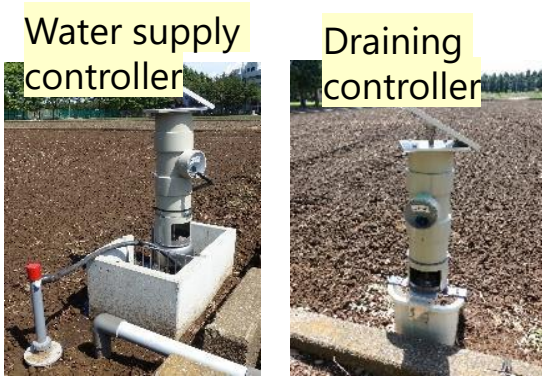
Robot transplanter

Robot combine harvester

＊ Labor efficiency is 160% by use of two **robot tractors**.

＊ Combined use of these four ICT agri-machines resulted in a 45% increase in one farmer's income through farm-size expansion.†

＊ Automatic & remote **water management system** reduces working hours by 80%.



Automatic & remote water management system

† In the case of the field trials in Chiba.

Research Products
—Genetic Resources, Disease Control and Services—

NARO

Genetic resources

Collection numbers @ 2018
Plant collections: 228,198
Microbe collections: 35,407
Animal collections: 1,971
DNA collections: 394,440


Storage can

Picking Robots


Storage room

■ Use of genetic resources

＊Development of new cultivars


Blast resistant lines

＊Restoration of traditional cultivar revivals


Traditional sake rice

Int'l collaboration


Maori's sweet potato cultivar 'Kumara' (NZ)

Plant & animal disease control

■ Detection methods and control strategies for transborder pathogens and insects

Animal diseases

＊Avian influenza
＊Swine fever
＊Foot-and-mouth disease
・・・etc.

Plant diseases

＊Virus, bacteria, fungi
＊Nematodes
＊Insects
・・・etc.

Spread of control technologies

NARO's virus rinderpest# strain for vaccine production is used as an International standard.

#The worst animal infectious disease in history with high lethality

Global Trends surrounding Agriculture

NARO

We are at a major turning point in human history

Global Trends

- ✓**Climate change**
- ✓**Population growth and aging**
- ✓**Globalization**
- ✓**Advancement of ICT and digitalization**

Concerns in Agriculture

- **Food shortage**
- **Labor shortage**
- **Increasing intense natural disasters**
- **Transboundary diseases and pests**

Use of ICT is highly expected to solve these problems

The 5th Science and Technology Basic Plan （FY2016-2020)

NARO

Ch.1 Basic Concepts

Ch.2 Acting to Create New Value for the Development of Future Industry and Social Transformation

✓ Fostering R&D and HR that Boldly Challenges the Future

✓ **Realizing a World-leading "Super Smart Society" (Society 5.0)**

✓ Enhancing Competitiveness and Consolidating Fundamental Technologies in a "Super Smart Society"

Ch.3 Addressing Economic and Social Challenges

✓ **Sustainable Growth** and Self-sustaining Regional Development

Ch.4 Reinforcing the "Fundamentals" for STI

✓ Developing High-Quality
✓ HR Strengthening Funding
✓ Reform Promoting Excellence in Knowledge Creation

Ch.5 Establishing a Systemic Virtuous Cycle of Human Resources, knowledge and Capital, for Innovation

✓ Enhancing Mechanisms for Promoting Open Innovation
✓ Enhancing the Creation of SMEs and Star-up Companies to tackle New Business Opportunities
✓ Strategic Use of International Intellectual Property and Standardization

Ch.6 Deepening the Relationship between STI and Society

Ch.7 Enhancing Functions for Promoting STI

Many challenges can be solved by STI

(Science Technology Innovation)

Matches with many SDGs

The Society 5.0 Concept

Society 5.0; The 5th generation of society, after Hunting & gathering society, Agriculture society, Industrial society, and Information society

① By integrating physical-space and cyber-space,

② Society 5.0 provides products and services to the people, regardless of their age, gender, region and language etc., and achieves both economic growth and resolution of social problems (including environmental conservation) simultaneously.

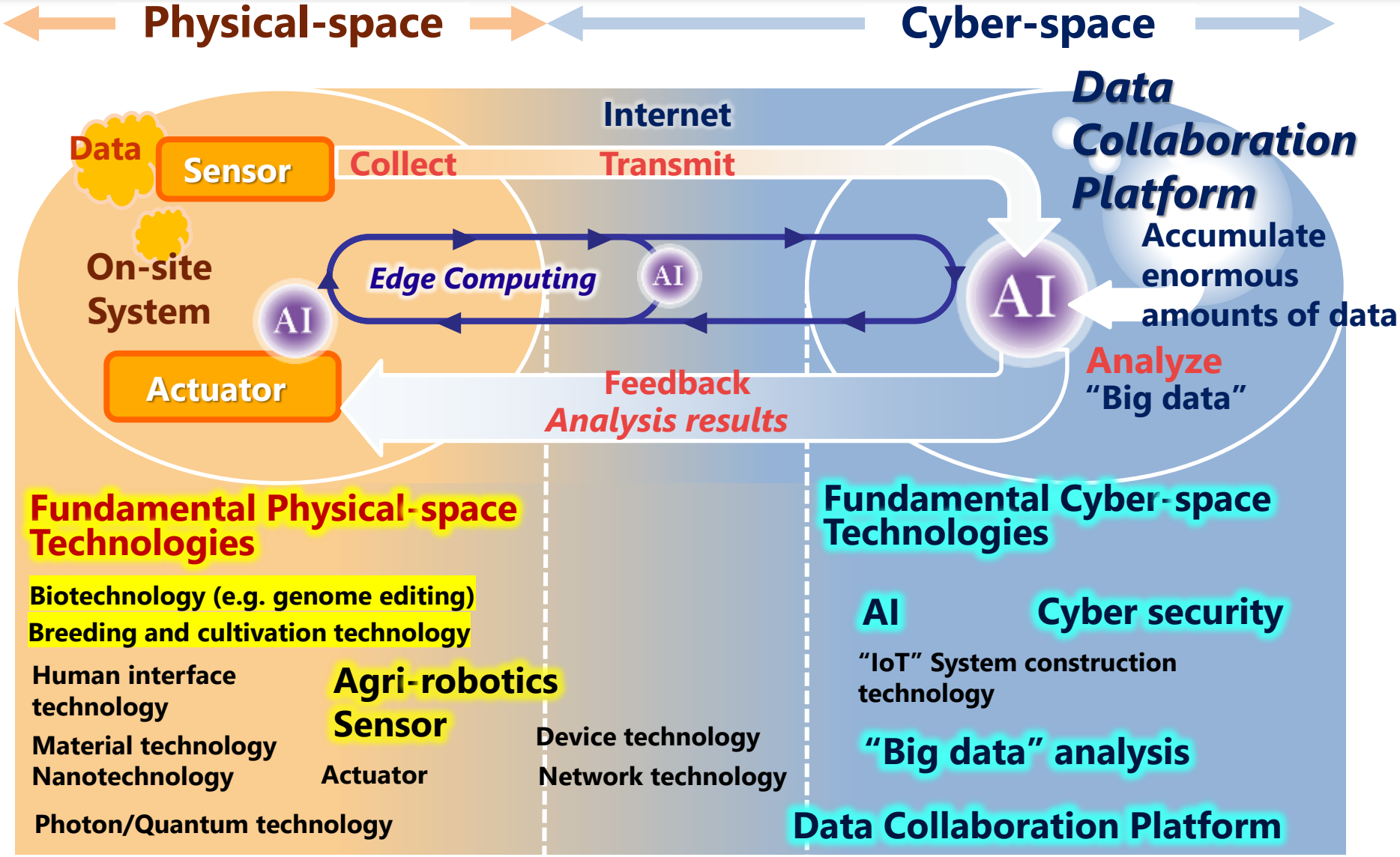
Declining birth rate and aging population, energy and resource constraints, regional economies in decline, natural disaster risk

Accumulating global problems such as overpopulation, shortage of foods and water, infections, terrorism, climate change

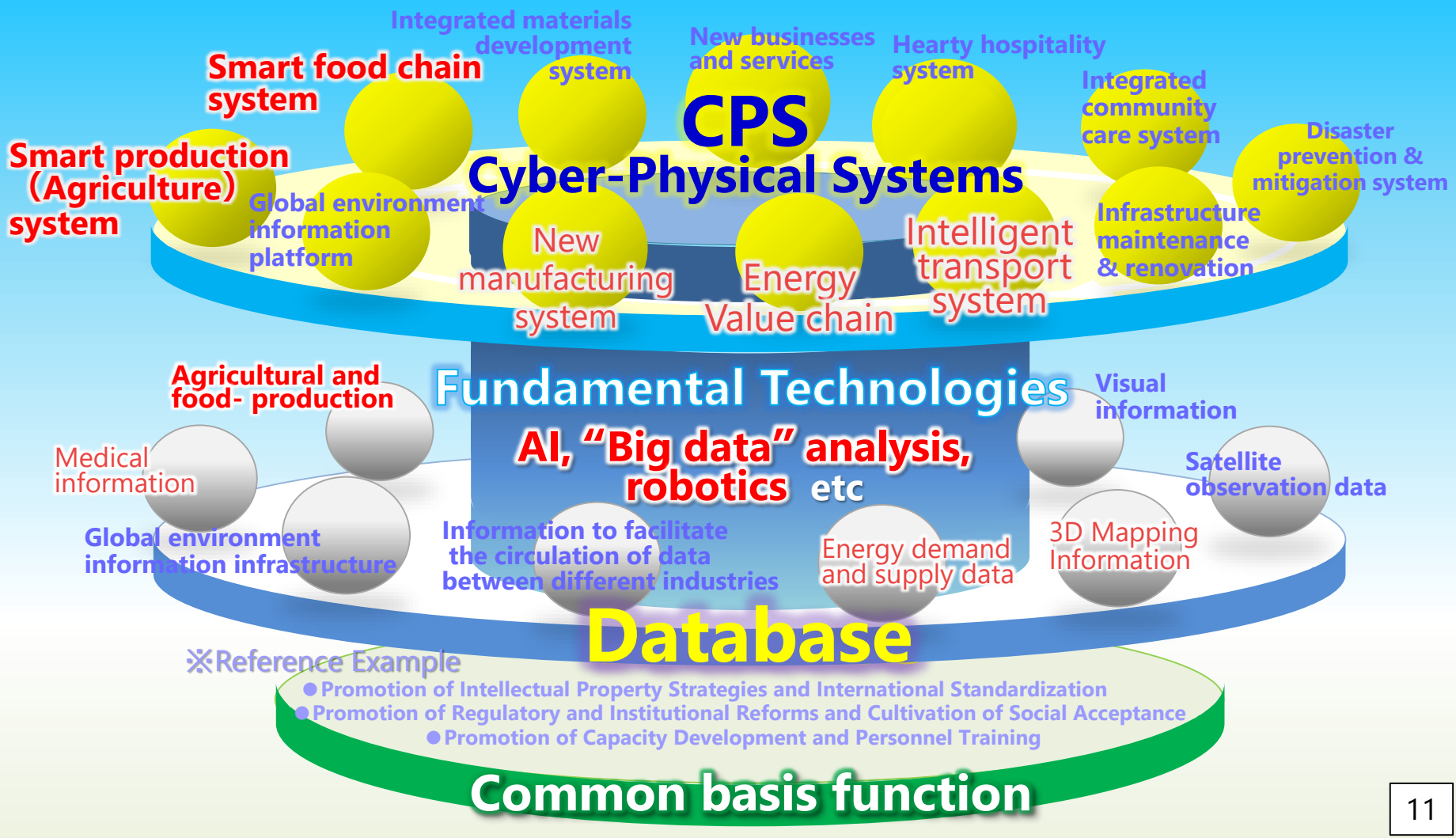
③ Human-centric society where people can live high-quality, prosperous and vigorous way of life.

A new concept launched by Japan which innovates not only industries but also society as a whole

System Structure and Fundamental Technology of "Society 5.0"



The "Society 5.0" Platform



Society 5.0 in Agri-Food Industries
-Smart Food Value Chain-

NARO

- Data from each process in food value chain are accumulated in the Agricultural Data Collaboration Platform 'WAGRI'.
- The accumulated data are analyzed by AI for optimization of the entire process for productivity improvement, reduction of waste, total cost cut, and technology matching

Breeding	Cultivation	Processing Distribution	Consumption
Smart Breeding	Smart Production	Smart Processing Smart Distribution	Smart Selling Smart Export
【Tasks】 Speeding-up the breeding process	【Tasks】 Productivity improvement under labor shortage	【Tasks】 Constant product supply Less change in prices	【Tasks】 Demand expansion Export promotion
● New breeding technologies ● Big-data based breeding	● Smart green house ● Self-driving agri-robots	● Automated packing & shipping systems ● Non-destructive inspection	● Long-shelf life technologies ● Prediction of market trends and demands

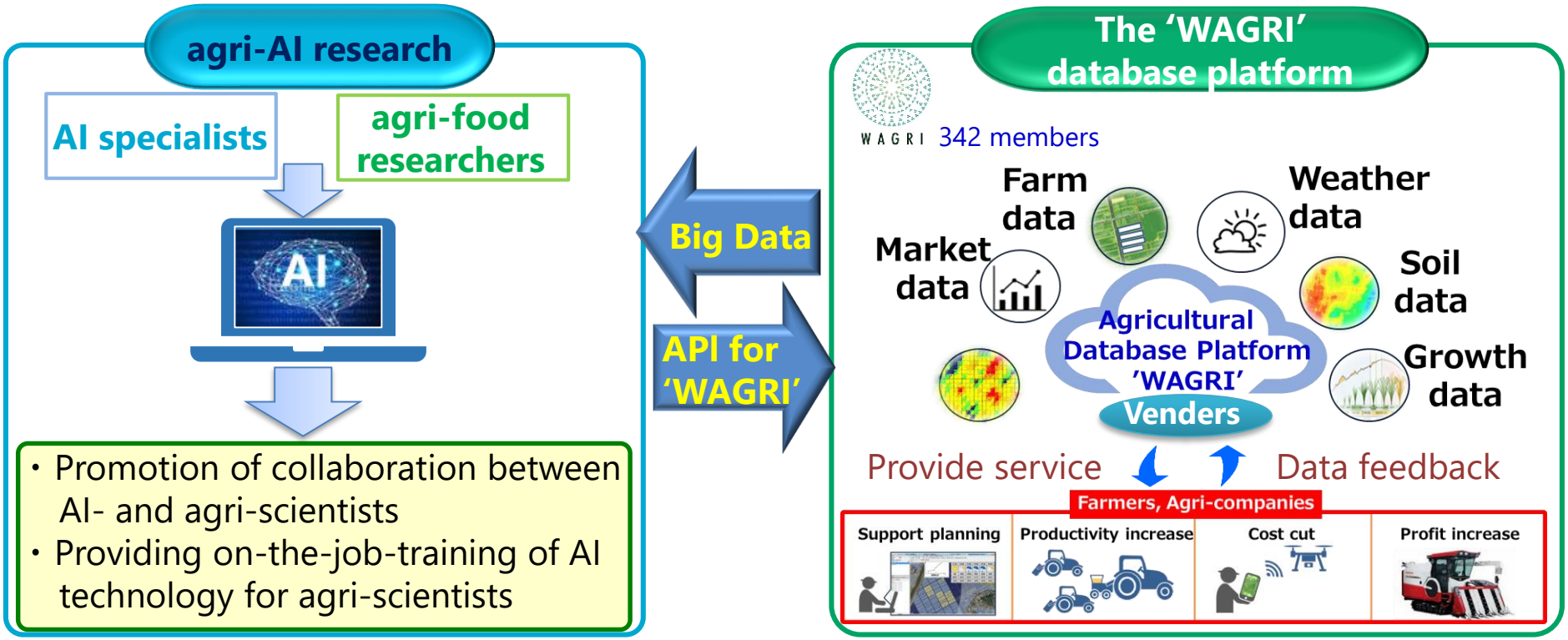
AI and Agricultural Database Platform ('WAGRI')

Data from each process are collected and analyzed by AI

Analyzed results are fed back to each process

Society 5.0 in Agri-Food Industries
-Research Center for Agricultural Information Technology-

- Research center for agricultural information technology (RCAIT), launched in October 2018, pursues application-oriented AI research using 'WAGRI'
- Operation of 'WAGRI' starts in April 2019
- RCAIT serves as the center for ICT-based agricultural research and ICT human resource development in Japan



Examples of research objectives

- Smart breeding, Smart pest control, and Operation of agri-robots

＊The data are open to agri-food sectors to improve productivity

On-farm Demonstration Trials of Smart Agriculture

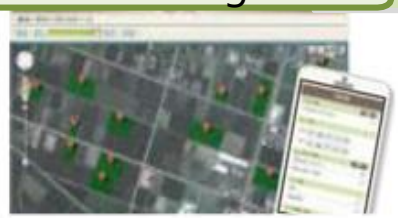
- Nationwide on-farm demonstration trails of Smart Agriculture started in March 2019
- Technologies for Smart Agriculture have been developed by the SIP national project

The trials started with **69 farm trials in 6 fields (paddy rice production, field and greenhouse cultivation, fruit, tea and livestock)** with **4.7B yen for 2019**

<Objectives>

∗ Accumulation of data through trials in 'WAGRI'
∗ Achievement of productivity improvement, cutting costs and increasing farmer income
∗ Improvement of performance, reliability, cost reduction of the agri-robots
∗ Promoting standardization for agri-robots
∗ Making proposals for revision of laws and regulation related to Smart Agriculture

Farm management



Farm management system

Cultivation

Robot tractors

Transplanting

Robot transplanter

Water management

Automatic & remote water management

Growth check

Drones

Harvest

Robot combine harvester

Society 5.0 in Agri-Food Industries
-Smart Food Value Chain in Kyushu-Okinawa Economic Region-

- Expand export of valuable agri-food products using high agroproductivity (2T yen) and the geographical advantage of the region
- Collaboration of NARO, industries, agricultural corporations, public research institutes & universities
- Strengthen agri-food industries in Kyushu & Okinawa for regional revitalization

Society for "Smart Food Value Chain in Kyushu-Okinawa Economic Region"

Kyushu Economic Federation

Kyushu cooperation for agri-promotion

Secretariat

Kyushu Economic Federation,
Kyushu Industrial Advancement Center,
MAFF Kyushu,
METI Kyushu

Kickoff symposium (January 2019)

Secretariat: NARO
President: Dr. Kyuma@NARO
87 member companies/institutes
250 attendees

Japan Agricultural Coop (JA), agri-companies

Industries

Universities

NARO

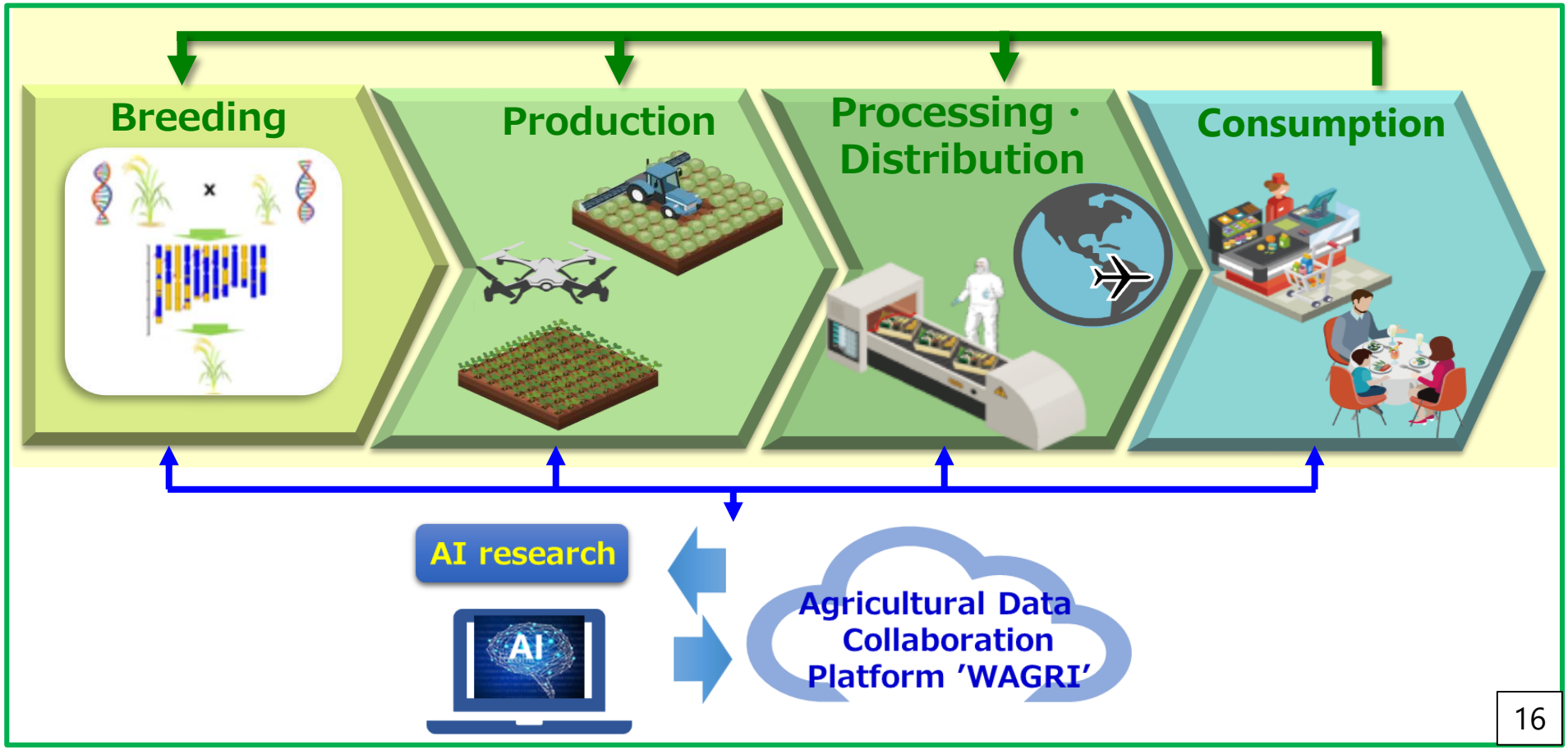
Collaboration aiming to strengthen agrifood industries

Public research Institutes

Financial sectors

NARO'S Actions for SDGs

SDGs achieved by realization of smart food value chain



Research Products towards SDGs

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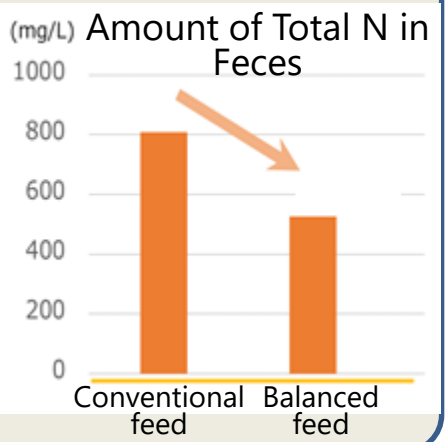
■Reduction of greenhouse gas emission in the livestock industry

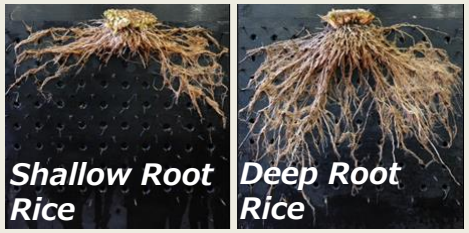
＊Amino-acid balanced feed reduced N_2O emissions in fecal materials



■Development of drought-tolerant rice cultivar

SATREPS
Science and Technology Research Partnership for Sustainable Development Program

＊Deep root rice cultivar for efficient uptake of water and/or nutrient



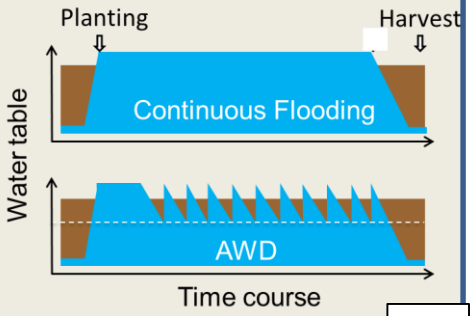
Under trials in South America

■Pest control of aphids by flightless Ladybird

＊Genetically flightless ladybirds used as environment-friendly biopesticides

■Reduction of greenhouse gas emission from paddy fields by water management

＊Alternate Wetting & Drying (AWD) system reduced water use and CH_4 emission by 30%



Practiced in South east Asia

Special Topics

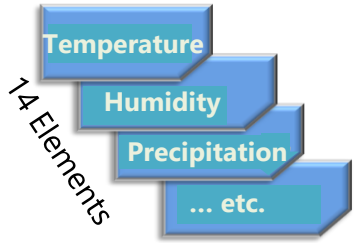
- Mitigation and Adaptation to Climate Change
- Transboundary Plant Pests

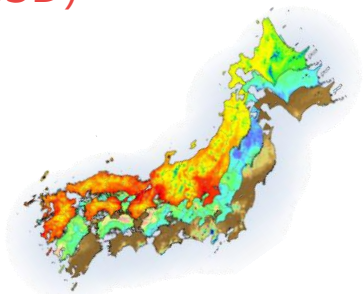
Climate Change
-Impact Assessment, Mitigation, Adaptation-

NARO

Impact assessment for climate change

■1-km grid square "Agro-Meteorological Grid Square Data (AMGSD)"

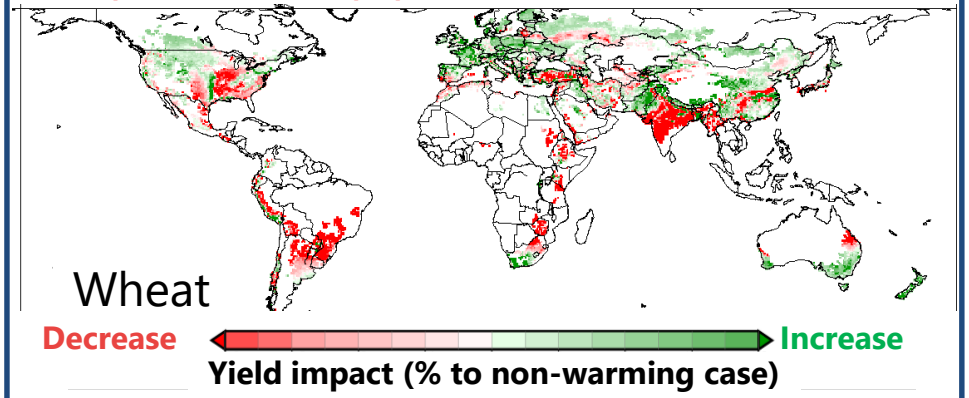




＊Climate data in AMGSD are used for crop growth management and climate change adaptation

Int'l collaboration

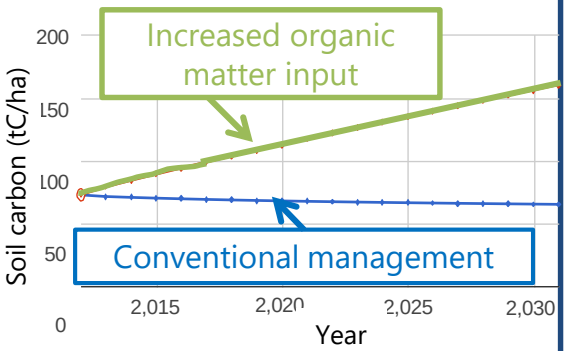
■Modelling method of climate change impact on crop production



Climate change mitigation

■Soil carbon calculating system

Input data
- Soil type
- Weather
- Management
  - ・Crop type
  - ・Cropping period
  - ・Carbon inputs



＊User-friendly web tool for calculating changes in soil carbon amount applicable for improvement of soil quality

Climate change adaptation

■New fruit cultivars adapted to global warming

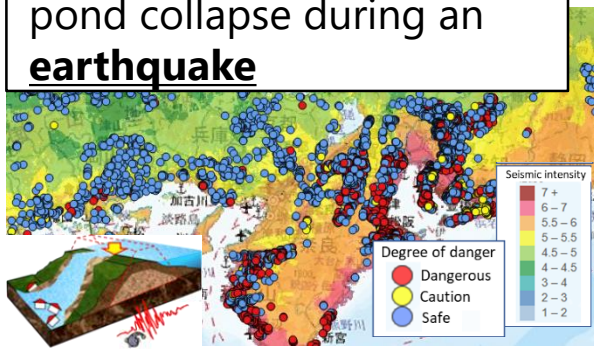
＊The new cultivars able to bear high quality fruit in warmer climate

Climate Change -Disaster Prevention and Mitigation-

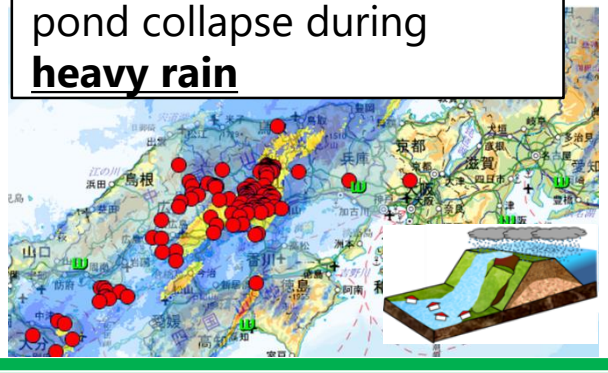
Disaster prevention support system for irrigation pond

- Realtime prediction of the irrigation pond collapse risk during natural disasters
- Information sharing via "Sharing Information Platform for Disaster Management" (SIP4D)

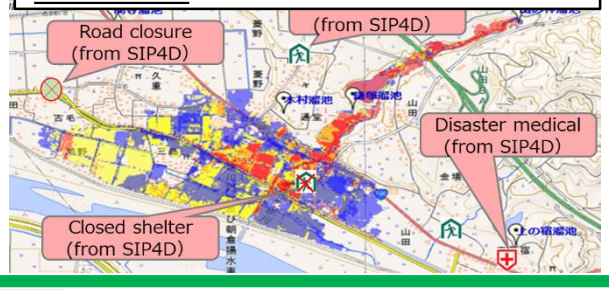
Predictions of irrigation pond collapse during an **earthquake**



Predictions of irrigation pond collapse during **heavy rain**

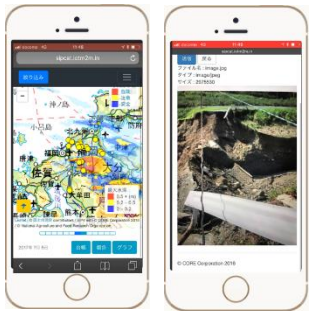


Predictions of **downstream damage** and information of **shelters**



Disaster prediction information on the Web

Sharing onsite disaster information using smartphones



- MAFF
- Municipalities
- Irrigation pond administrators

- Government
- Municipalities
- Residents

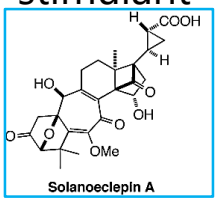
Transboundary Plant Pests —Detection & Control—

Development of effective control methods

＊Control of white cyst nematodes by trap crops or hatching stimulant

Trap crop

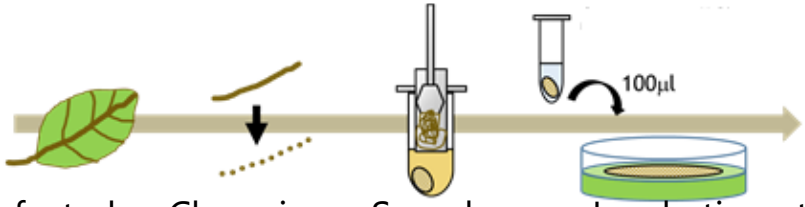
Hutching stimulant



Development of culture methods of pathogens

＊Development of a new culture method for diagnosis of citrus greening disease

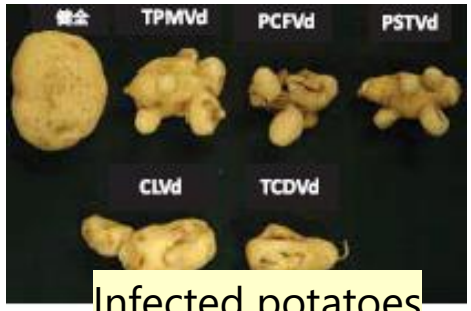
Damaged citrus



Infected leaves | Chopping Midribs | Sample collection | Incubation at room temperature

Establishment of detection methods

＊Seed-infective pospiviroids detection method to contribute greatly to plant quarantine in Japan



Infected potatoes

＊Sensitive and universal detection method of serious pathogens of fruit trees

Grapes infected by *Phytoplasma* spp. *Xylella* spp.

Transboundary Plant Pests
-Migration Simulation System-

Joint research project by NARO, Vietnam and JIRCAS

- **Migration prediction system of serious transboundary rice pests in Asia**

Rice planthoppers

＊Prediction of the timing and the area of immigration of Rice planthoppers

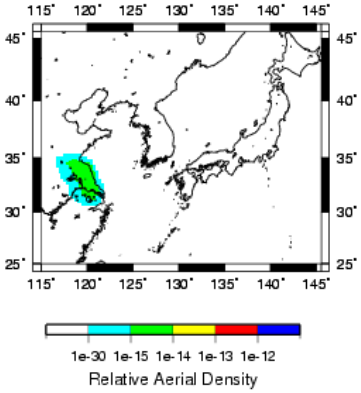
＊The information is spread via the network operated by the Japan Plant Protection Association (JPP-NET).

NARO

Weather forecasting data

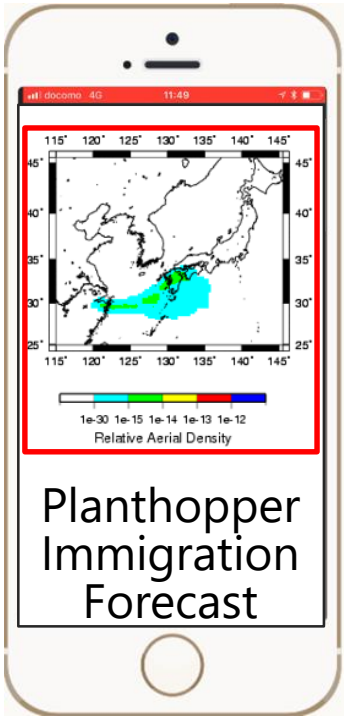
・Wind direction
・Wind speed

Migration prediction simulation



Information spread on line

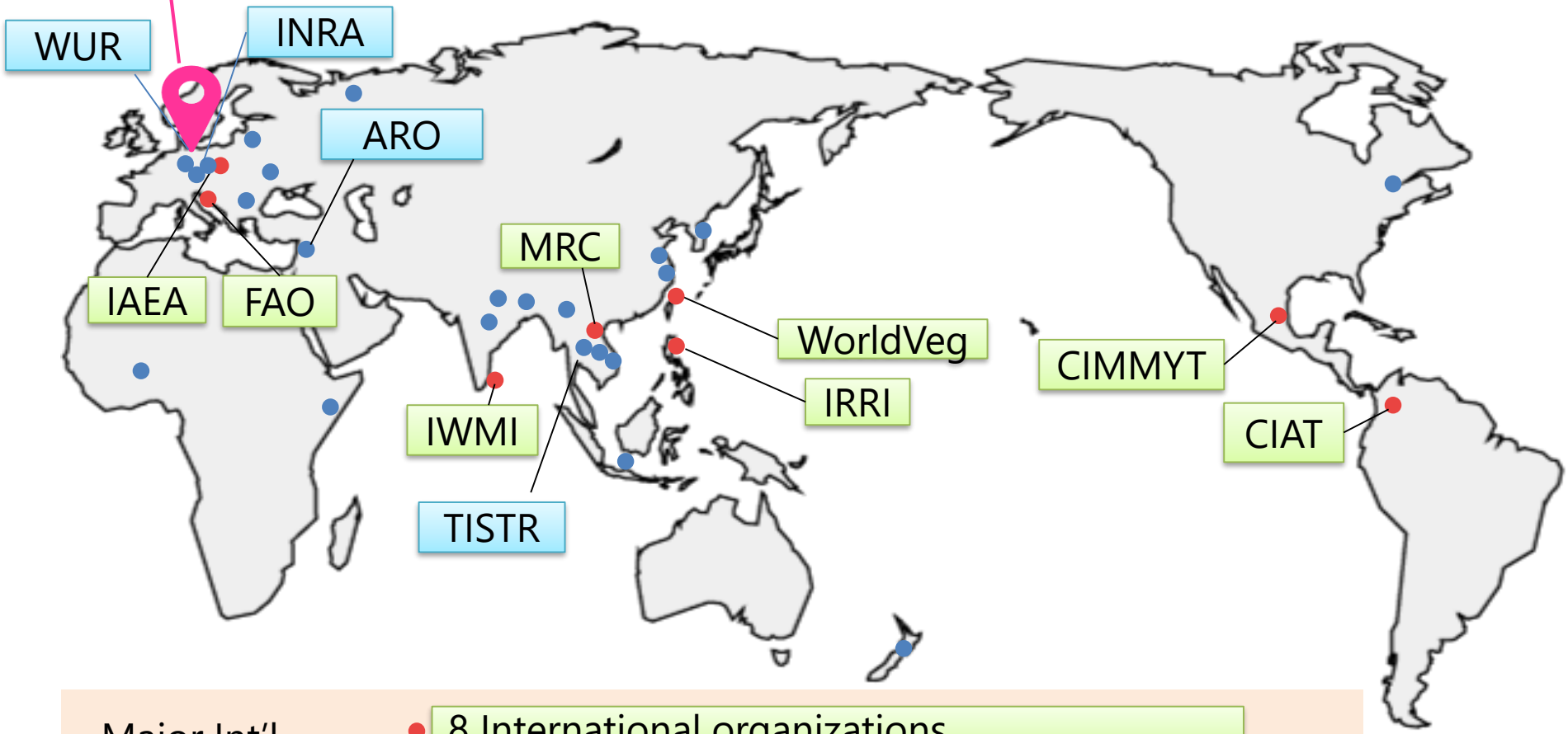
社団法人 日本植物防疫協会 JPP-NET



Planthopper Immigration Forecast

Overseas Office & Collaborating Organization

NARO EU office
@Wageningen University & Research (April 2018 - present)



Major Int'l Collaboration

- 8 International organizations
- 79 National research institutes & universities

NARO's Activity in International Frameworks

- *International Treaty on Plant Genetic Resources for Food and Agriculture* (*ITPGRFA*)
  ＊145 parties, Japan ratified in 2013.

- *International Seed Testing Association (ISTA)*
  ＊65 member countries, Japan joined in 1953.

- *The Monsoon Asia Agro-Environmental Research Consortium (MARCO)*
  ＊9 member countries（China, India, Korea, Japan, Pakistan, Philippines, Singapore, Sri Lanka, Vietnam), MARCO started in 2006.

- *Global Strategic Alliances for the Coordination of Research on the Major Infectious Diseases of Animals and Zoonoses, International Research Consortium for Animal Health (STAR-IDAZ-IRC)*
  ＊Labs from 13 countries（Argentina, Belgium, Canada, Denmark, France, Israel, Italy, Japan, Kenya, the Netherland, Tanzania, UK, US), the project stated in 2016.

- *International Plant Protection Convention (IPPC)*
  ＊183 member countries, Japan ratified in 1952.

- *OECD Tractor Codes*
  ＊26 member countries (e.g. US, Germany, Japan, UK, France, Italy, Korea, etc), NARO joined in 1966.

- *International Commission on Irrigation and Drainage (ICID)*
  ＊NARO joined in 1951.

Thank you very much for your attention