An Overview of Japan's Efforts for Smart Agriculture

"2018 Smart Technology Applications in Agricultural Production International Conference"

Date : 4-5 September, 2018
Venue: Room 102, Taipei International Convention Center (TICC),
No.1, Hsin-Yi Road, Sect. 5, Taipei 11049, Taiwan

Mitsuru HACHIYA

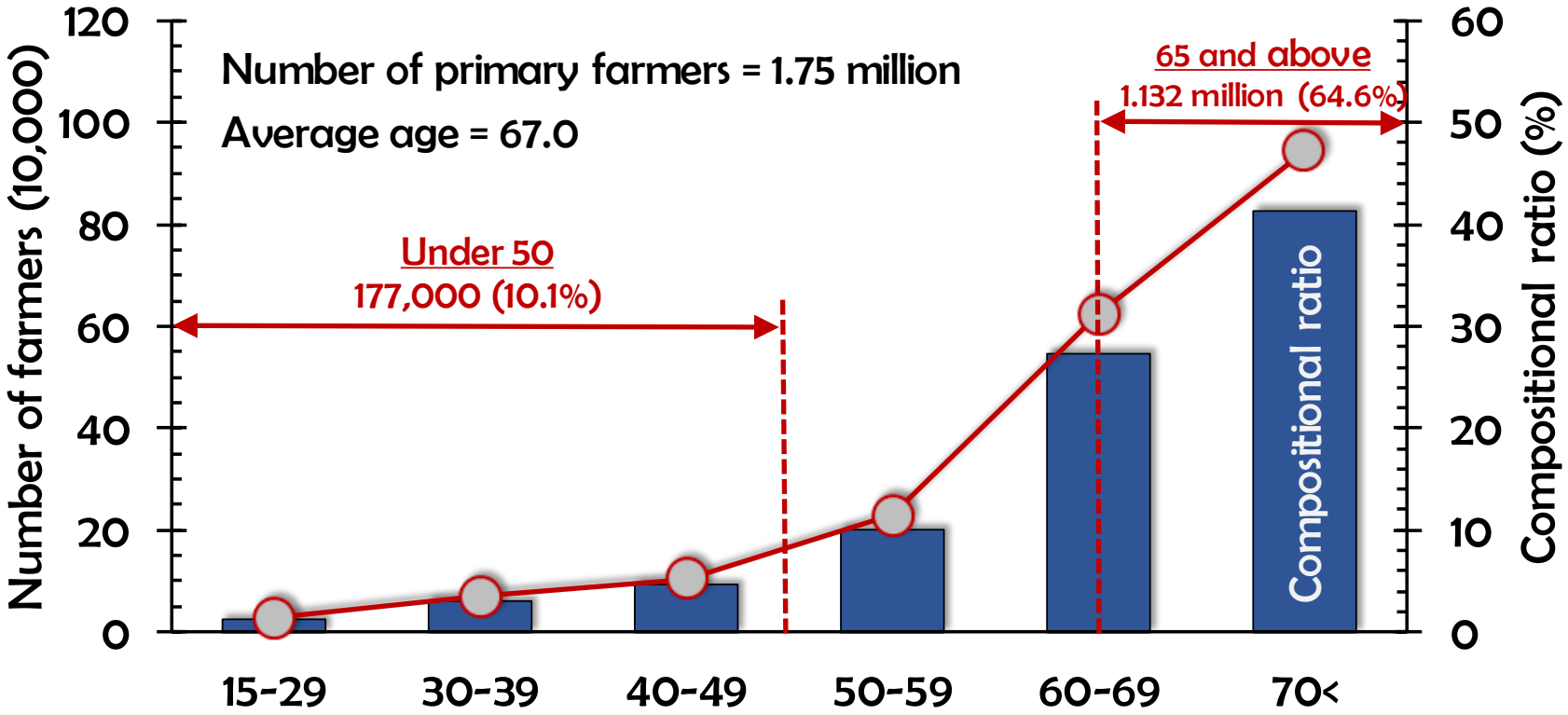
Director
Department of Innovative Engineering Research
Institute of Agricultural Machinery, NARO

Topics for Today

1. Current state of agriculture in Japan and expectations for ICT and robotics
2. Current state of agricultural ICT technologies already in service
3. Current state of smart farming technologies in development and its future outlook: Examples of land use (paddies, farms)
    1) water management system
    2) robotized tractor system
4. Summary and future plan

Current State of Agriculture in Japan

1. Diminishing number and overall aging of farmers
2. Decentralization and aggregation of field management, despite acquisition of abandoned farmlands
3. Loss of experience and intuitive knowledge due to retirement of veteran farmers
4. Free trade due to general agreement under TPP



Overview of Smart Domestic Agriculture

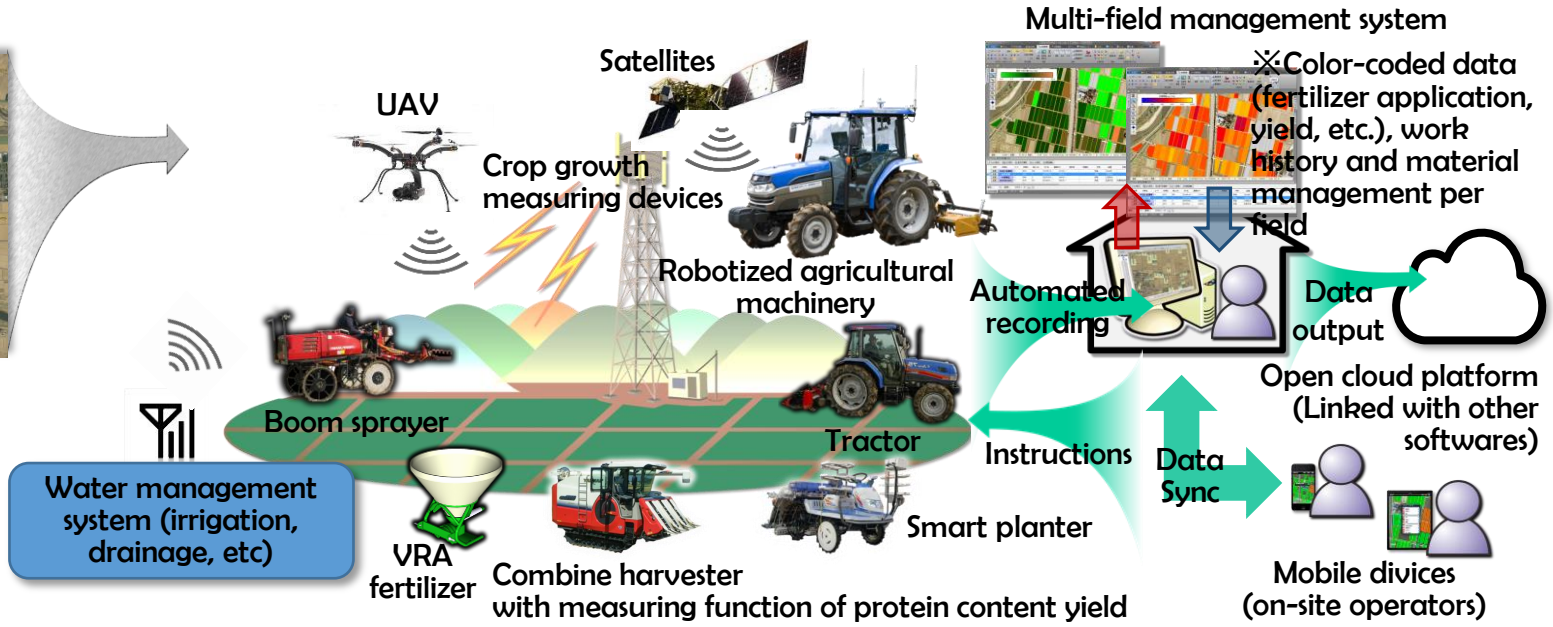
: in the case of land-based farming

NARO

Mechanization of paddy and land farming, adaptation for larger-scale operations

- Challenges: ① rapid decentralization of fields due to aggregation of farms, ② limitations to improvement in efficiency and labor-saving under current technologies, ③ increased area per machine, ④ simple upgrade in size and performance of machines are costly
- Needs: ① further improvement in productivity, reduced cost ② accommodate for climate change and decentralization of fields

Improvement in efficiency of multi-field farm management



Establishment of Japanese and Asian Smart Agriculture Systems

① Collection, analysis, and utilization of crop, field, and weather data, ② big data analysis (including the use of AI), ③ provide optimized work plan and crop management data, ④ remote control, self-driving, and securement of safety for farm machines and water management systems through robotics, ⑤ crop and field data collection and system feedback by farm machines, ⑥ Standardization of communication protocols

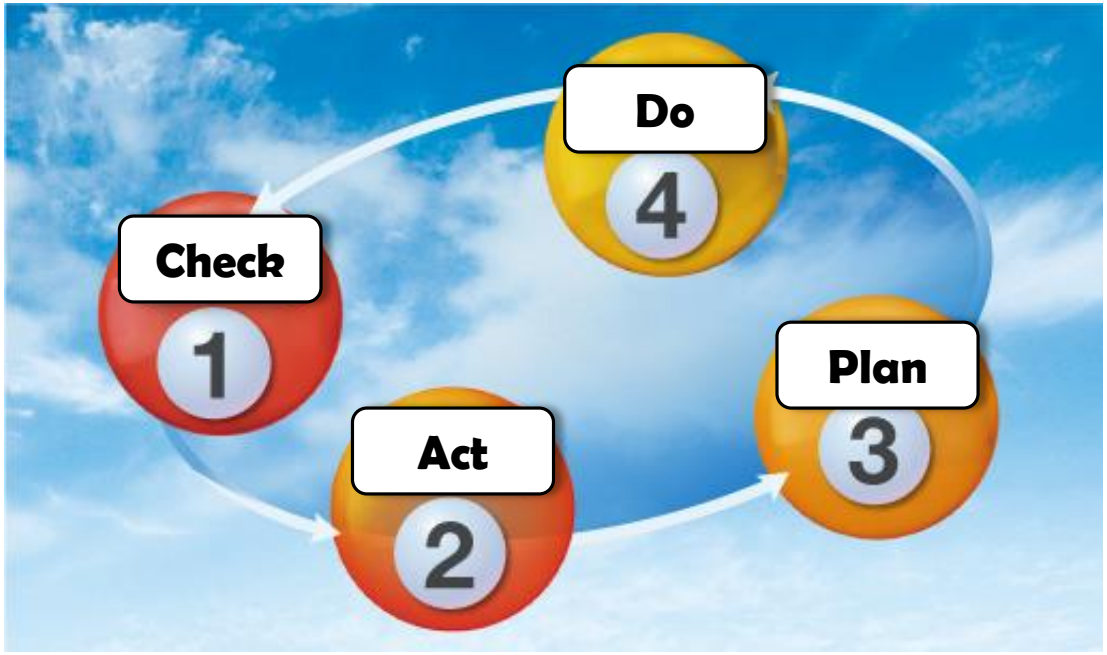
Leveraging ICT: Field Management System

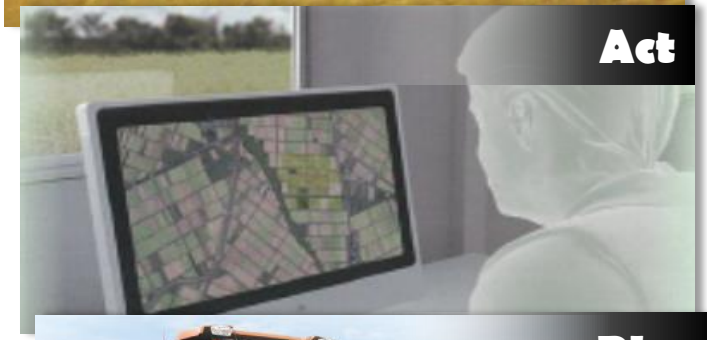
Table Overview and challenges in farmwork prior to implementation of the management system at an agricultural cooperative corporation (an example)

Cooperative policy	Characteristics	Problems
(1) Accept, in principle, all consigned farm fields	① Great consignment area, huge number of fields ② 1/3 fields in district underdeveloped ③ Needs improvement in waterways, etc.; last construction was 35 years ago ④ Much consigned land is in poor conditions, e.g., water inflow	①Time-consuming daily work instructions ②Frequent work mistakes due to false assumptions by staff ③Staff have trouble identifying field area, leading to errors in amount of fertilizers and agrochemicals applied ④Errors in orders for seeds, fertilizers, agrochemicals, challenges in inventory management ⑤Cannot verify work progress ⑥Difficulty in managing work records per field ⑦Difficulty in developing and maintaining cultivation records ⑧Enormous amount of paperwork for various forms, as well as errors in transcription
(2) Effectively utilize fields to secure income	① Rotate rice, wheat, soy, and vegetables to ensure production throughout the year ② Research for mitigating cost and labor per crop; organization and analysis of test data needed	
(3) Secure stable labor force	① Full-time staff hired. Other than the farmers themselves, many are outsiders unfamiliar with the land	

- Visualize production & management, convert techniques by innovative farmers & management know-how based on conventional experiences and intuition into data and manuals
- Apply such resources to secure & develop talented individuals who will inherit farming techniques

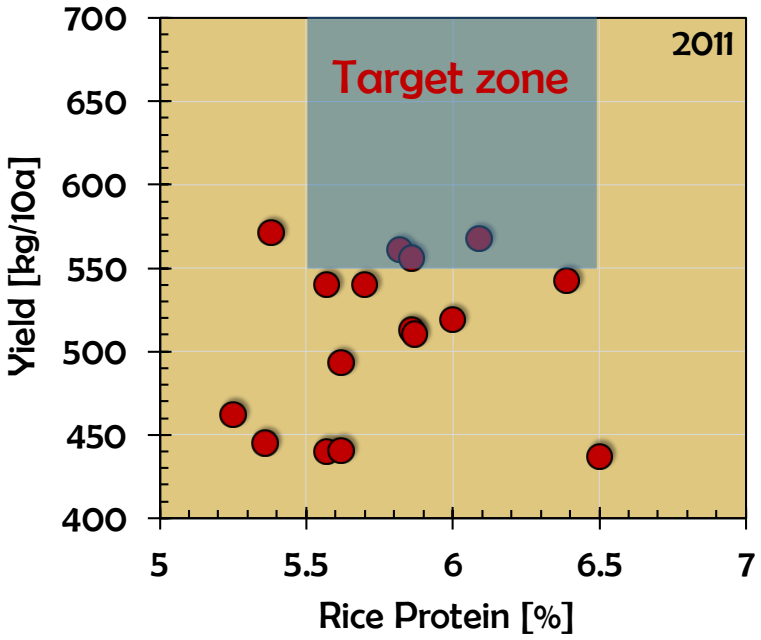
Field Management System with ICT

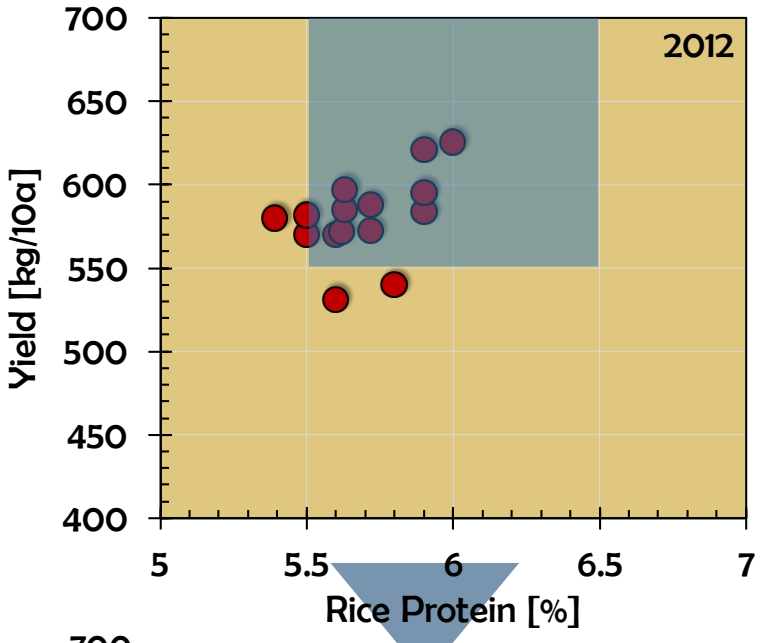


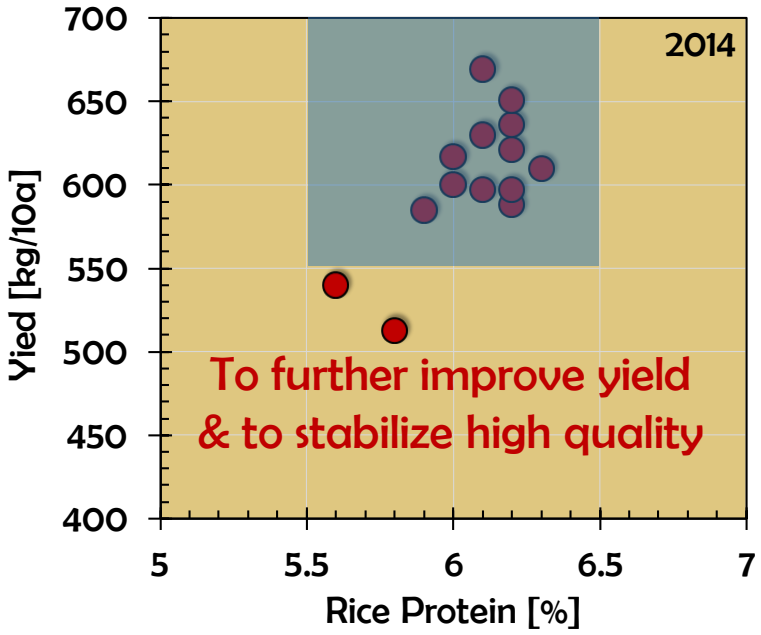


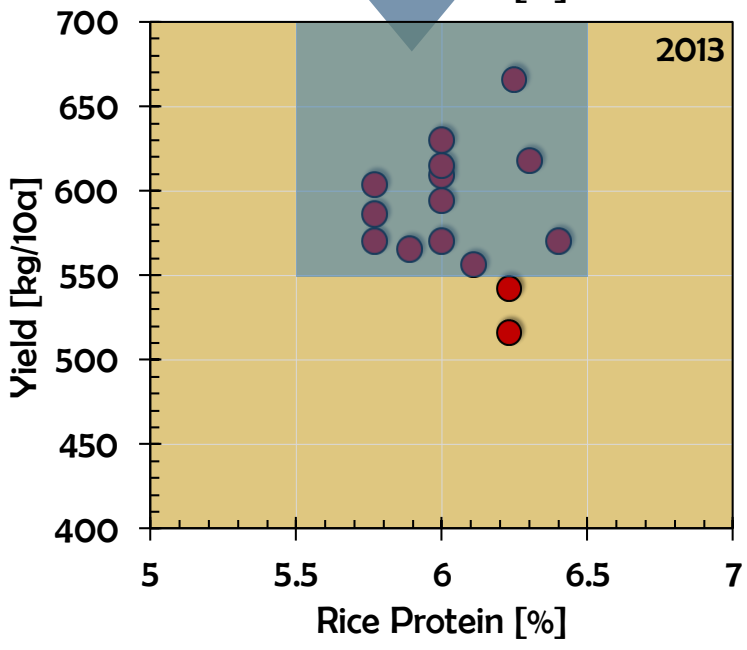
1. Check ☛ Collect data on taste, moisture, and yield per field via combines with protein content and yield measurement capabilities
2. Act ☛ Accumulate data and analyze field-specific issues via a field management system
3. Plan ☛ Develop optimized soil development and fertilizer application plan per field for the next season based on field-specific issues
4. Do ☛ Application of fertilizers at varying rate per field by rice planters with automated fertilizer adjustment capabilities

Field Management System with ICT





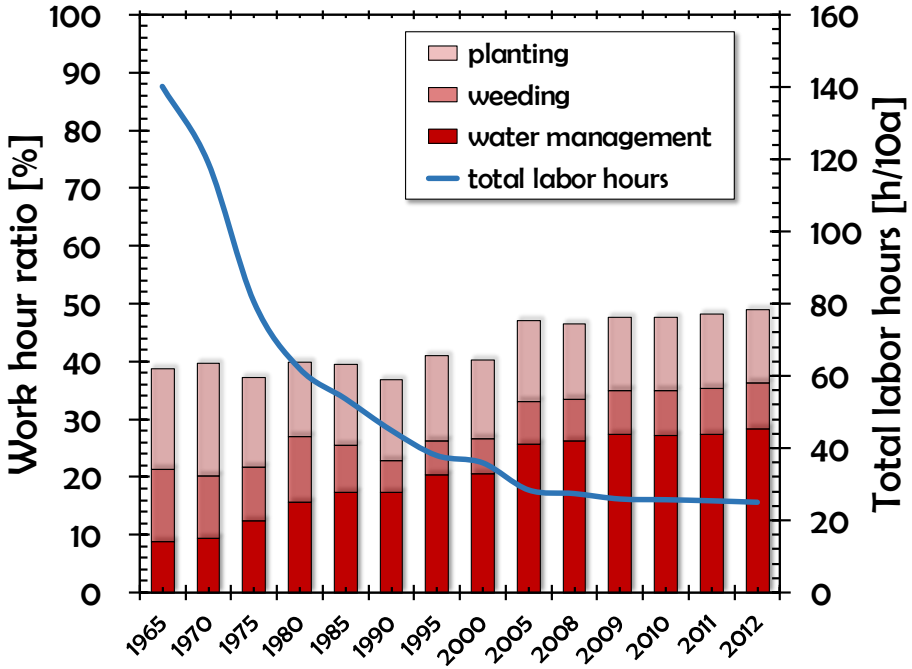




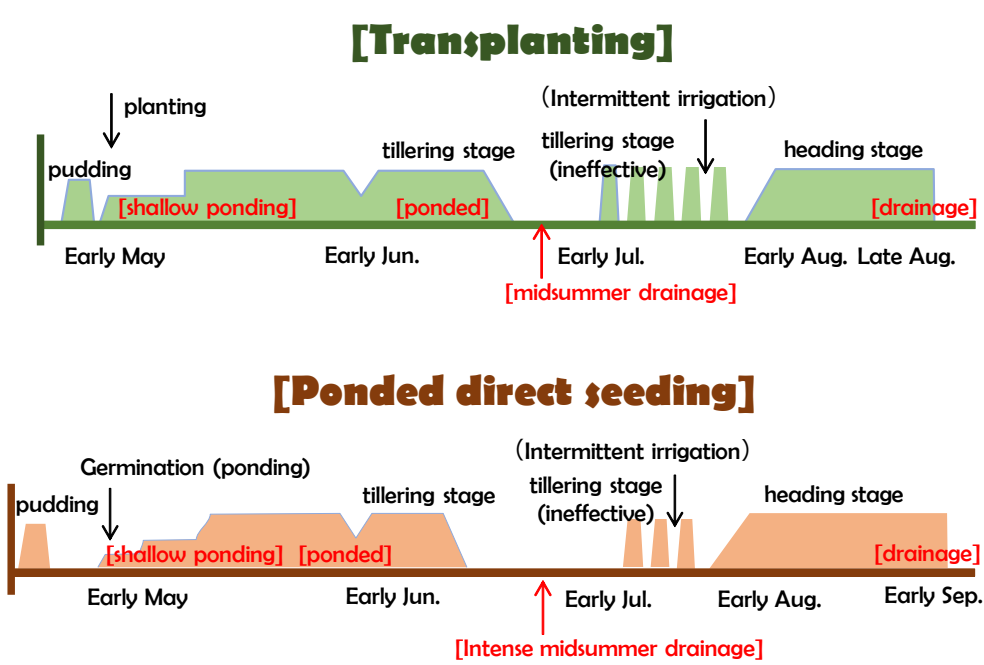
Water Management Support System

- Combination of multiple varieties, cropping season, and cultivation method in large-scale farm management, leading to concern for greater complexity and increased labor requirement in water management
- Increased time required for water management due to an increase in decentralized farmlands by aggregation of the land to remaining farmers
- Elaborate water management system that makes water management more efficient and contributes to stable production with even higher quality is essential

Hours required for Water Management



General Water Management in Paddies



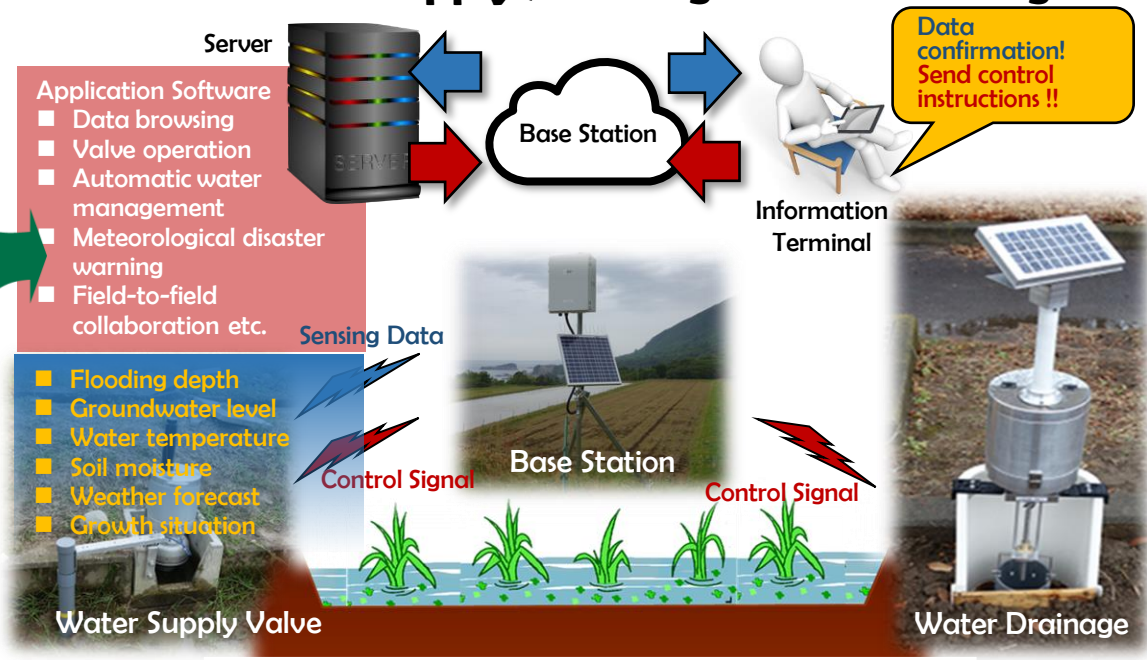
Water Management Support System

NARO

Existing Water Supply - Waterpower Equipment

- ✓ Water level control and suspension of water supply is done manually for each spout
- ✓ Drainage operations done entirely manually
- ✓ Flooding conditions must be confirmed visually on site, to check if water is circulating or not
- ✓ There is no connection between the water supply spout and the drain, making it difficult to deal flexibly with free-flowing irrigation and rainfall

Remote automatic supply / drainage device utilizing ICT



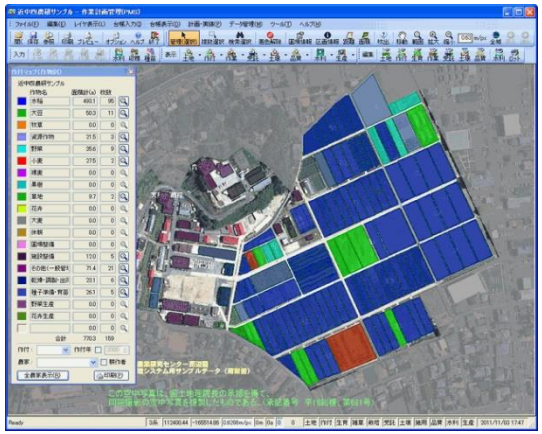
By sending sensing data such as rice paddy water level to the cloud, the user can remotely or automatically control the water supply valve / water outlet by using a mobile terminal, etc.

- ✓ A communication network is constructed using a specific power-saving wireless Wi-SUN and mobile communication (base station)
- ✓ The maximum distance between the radio is about 500 m and there is no communication fee between the radio
- ✓ Data accumulated from the slave unit by using Wi-SUN is transmitted to the server via portable communication at regular intervals over the Internet
- ✓ Communication cost is necessary only for base stations (communication cost: 1,000 yen / month / order)
- ✓ 1 base station / 10 to 30 ha (approximately 60 controllable slave units)

Water Management Support System

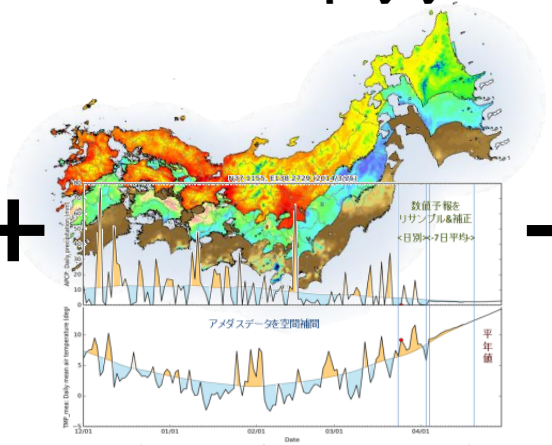
Links Other Web Contents

Field management system



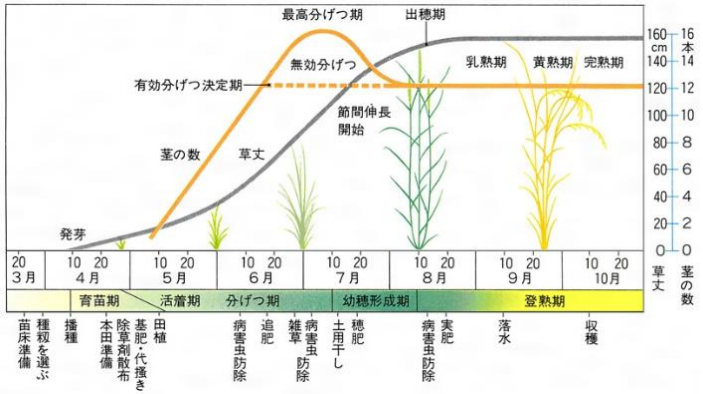
KSAS・AKISAI and so on

Weather data display system



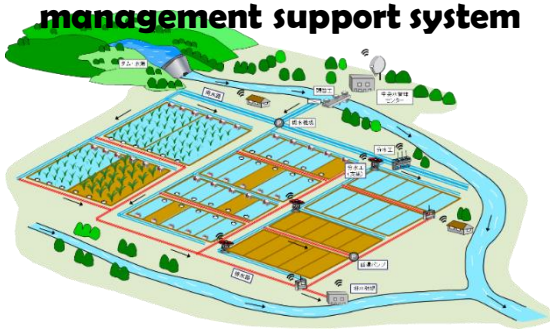
Weather prediction every 1km

Growth predictive model system of crops



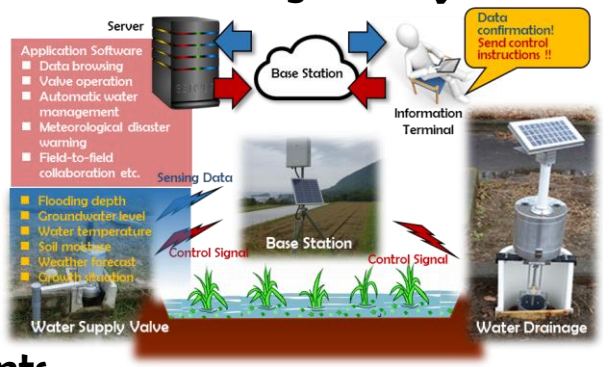
objects: a plurality of kinds of paddy rice and soybeans

Wide area water management support system



API server

Water management system

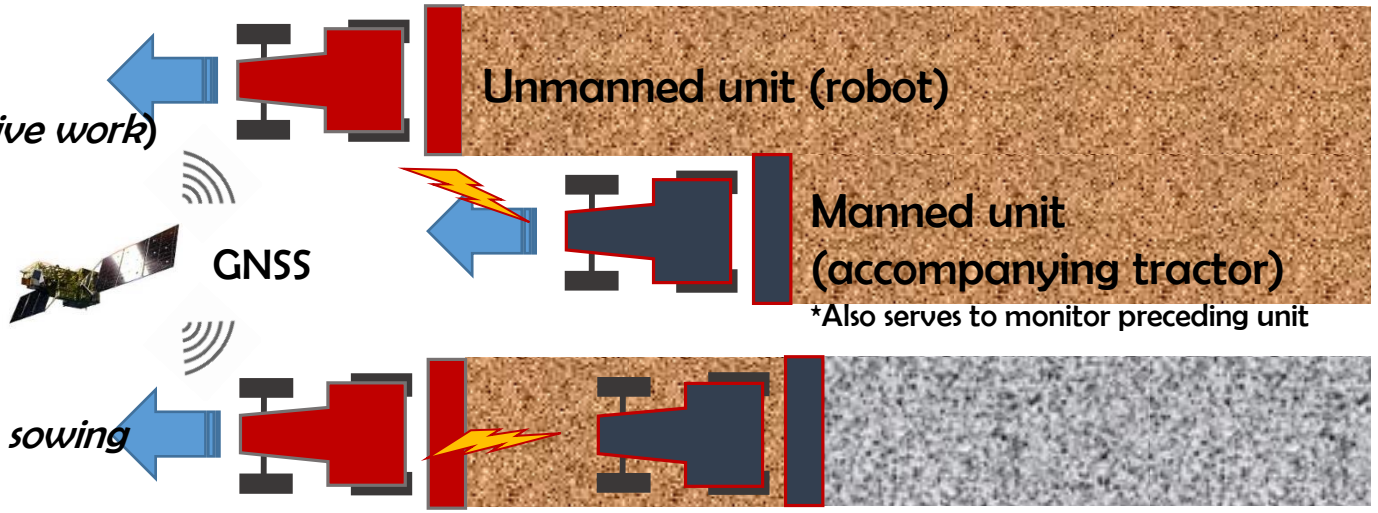


- ✓ Synergy effect utilization with link existing Web API contents
- ✓ To provide the optimum water management is generated simply by inputting the information-varieties, transplanting day and registering a location
- ✓ To centralize and automate operation management of irrigation pumps linked with cultivation management such as pest control

The Future of the Robot Systems

☛ **Practical use of "manned - unmanned cooperative work system" in 2018**

Case 1: double width tilling
(Multiple machine cooperative work)



Case 2: tilling + fertilization + sowing
(Simultaneous work)

☛ **"Unattended systems via remote monitoring"**
including interfield movement by 2020

Secure Safety

Establishment of highly automated agricultural machinery international standard (ISO / DIS 18497) and consideration for revision of international safety standard (IEC 62998)

⇒ Formulation of safety function evaluation test for robotic agricultural machines (evaluation method, evaluation criteria for safety function of human / obstacle detection)

The Future of the Robot Systems

Practical use of "manned - unmanned cooperative work system" in 2018

The Future of the Robot Systems

"Unattended systems via remote monitoring" including interfield movement by 2020

→ A work system in which potential planting area is doubled per operator by running 2 robot tractors

→ Secured safety by a remote monitoring recording device

→ One robot tractor introduced per field

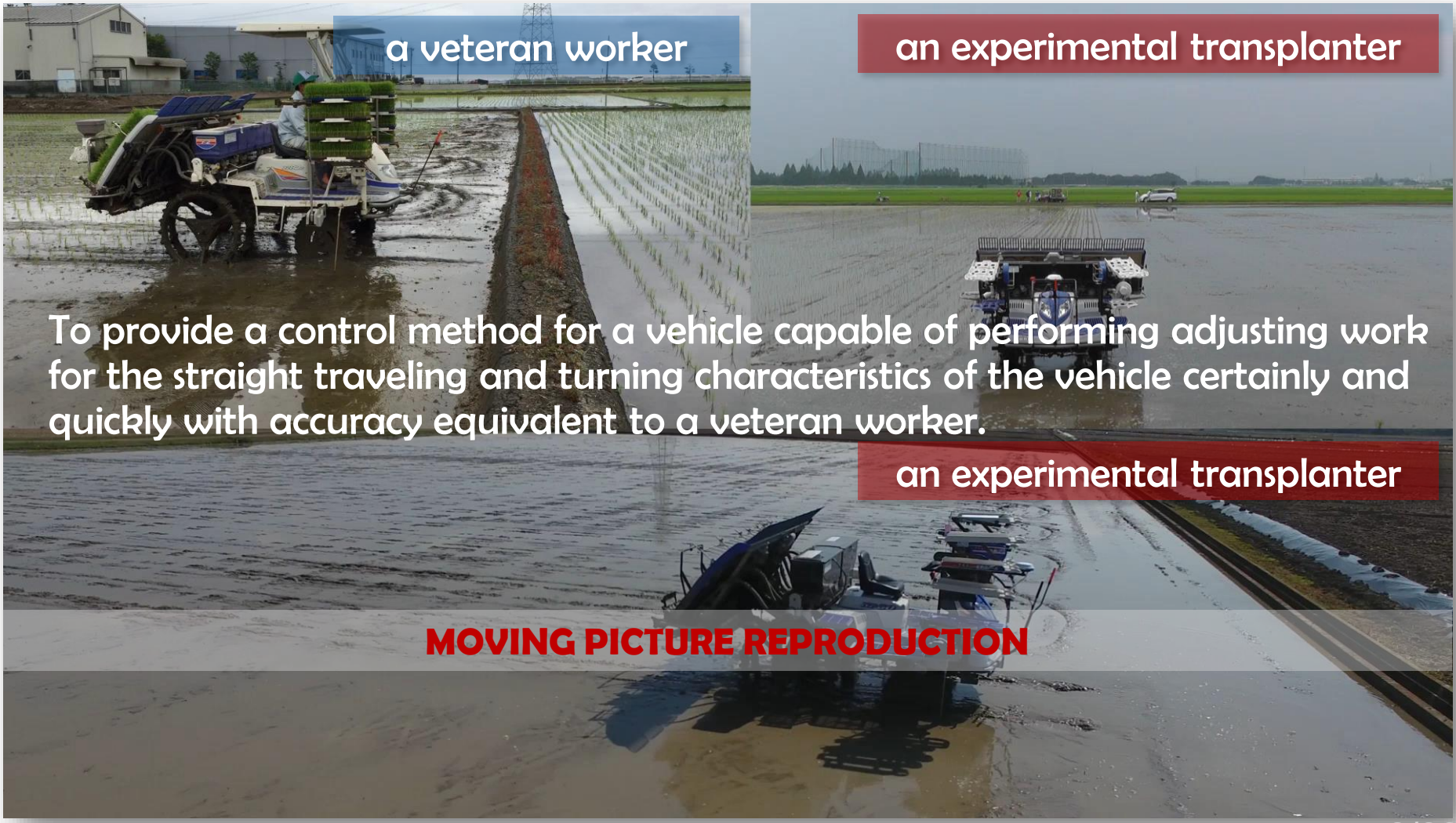
→ An operator performs inter-field migration of two robot tractors, work of the outermost area of the field, and monitoring

MOVING PICTURE REPRODUCTION

マルチロボット作業システムによる自動代かき作業

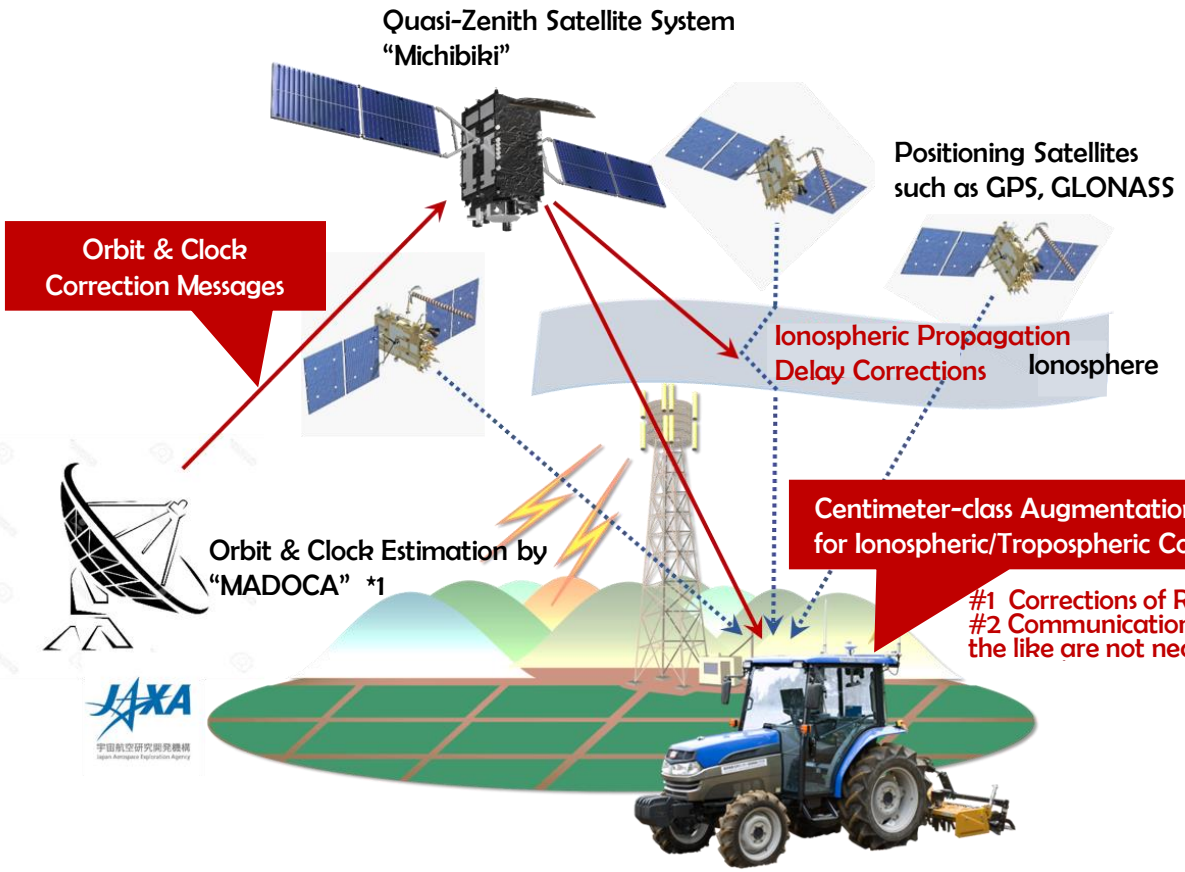
The Future of the Robot Systems

Autopilot Transplanter :

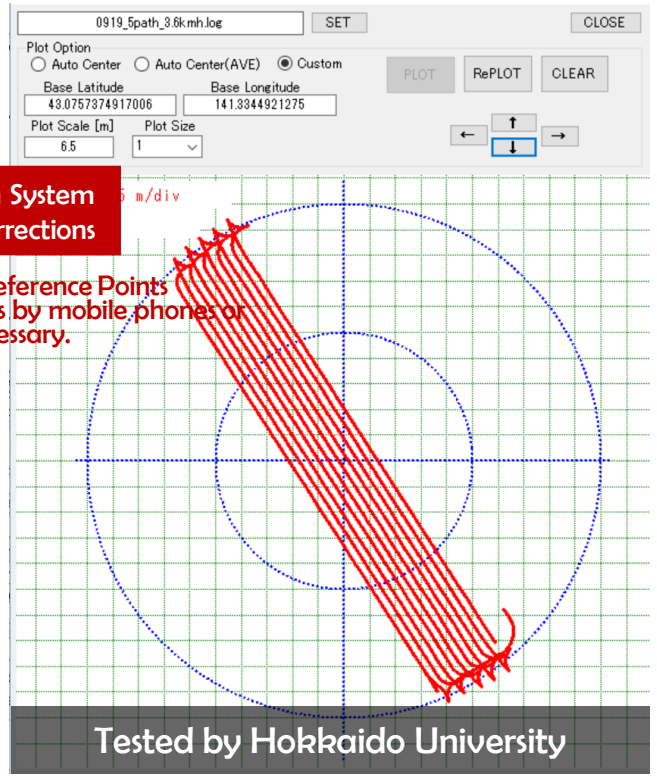


Social Implementation of Agricultural Robots

Low-cost and High-Accuracy Quasi-Zenith Satellite Positioning System



*1 : MADOCA (Multi-GNSS Advanced Demonstration tool for Orbit and Clock Analysis)



Quasi-Zenith Satellite System "Michibiki" will enter operation.

☛ The service will be started from November 1 of this year.

(By National Space Policy Secretariat, Cabinet office, March 2, 2018)

Social Implementation of Unmanned Farm Operation System

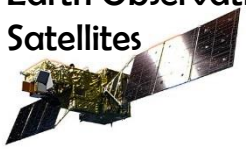
NARO

Outcomes	Descriptions and Effects	The timing of practical application
Robot Tractor (single) 	· Automated operations via remote monitoring accompanied by manned tractor.	To be implemented in FY 2018
Multi-robot Tractor System for Farm Work 	· Automated operations by two tractors via remote monitoring. · Operation efficiency is 160% and over.	At an early stage after FY 2018
Autopilot Transplanter 	· Automated operations via remote monitoring (visual observation). · Enabled transplanting operations together with seedling feeding by one person. · The same accuracy as skilled persons.	At an early stage after FY 2018
Robot Combine (riding type) 	· Automated operations by two combines via remote monitoring. · Operation efficiency is 170%.	At an early stage after FY 2018
High-accuracy receivers for quasi-zenith satellite system “Michibiki” 	· They do not require base stations and enhanced positioning performance by centimeter-class augmentation. · Reduced costs (JPY 300,000).	To be implemented in FY 2018 (monitoring product was sold in FY 2017)
Water Management System for Paddy Fields 	· Automatic controls for hydrant/waste plugs. · 80% reduction in water management labors.	Started advance sales from March 2018

Toward the Realization of Data-Driven Smart Agriculture

NARO

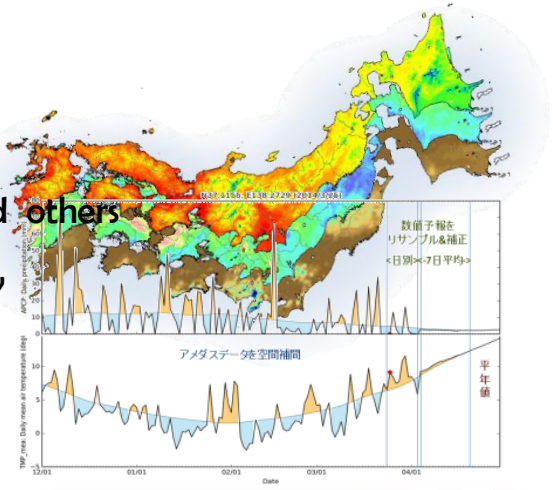
Earth Observation Satellites



UAV

Observation and Collection of Spatial Data

Weather Data and Cultivation Models and others



Yields and Other Data

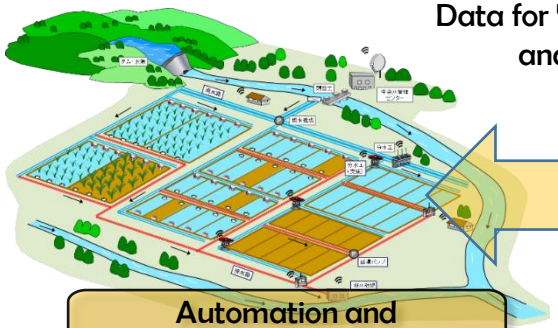
Cultivation History and Other Data

Work History

Data in Agriculture Coordination Platform

Consolidate and Analyze the Data

Data for Water Temperatures and Water Levels



Automation and Intellectualization of Water Management System

Farming Management System

Automation and Intellectualization of Agricultural Machinery

Support system for farming management by collection and analysis of farm fields and spatial information

Summary and Future Plans

- In Japan, the most pressing challenges is strengthening our efforts on the smart agricultural production technologies front.
- Improvement of the efficiency of water management, which is the most labor-intensive aspect of paddy rice cultivation : Improvements are underway with the intent to reduce the cost of introduction before the system is put to practical use.
- The robotization of agricultural machinery using satellite positioning systems, is entering the stage of practical application.
- As we move toward the implementation of robotic agricultural machines, it is important to plan for the social infrastructure and environmental maintenance by creating rules to ensure safety.