D2. Strategy: Developing Technical Documents in Non-technical Language

Technical Report on Investigating and Documenting the Social and Economic Impact of Irrigation Systems

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Contents

1. Introduction

In this report, we explain the economic and social impact of irrigation systems in the Japanese context.

1 Defining “economic impact of irrigation systems"

➡ Increase in productivity owing to the work of irrigation systems.

2 Defining "social impacts of irrigation systems"

➡ Irrigation system as infrastructure that provides a stable and safe food supply and secures livelihoods for all people.

3 How to think about "Development of technical documents in a non-technical language"

- This report is composed with reference to the White Paper on Agriculture, Food, and Rural Areas in Japan.
- In its preface, it is stated that "we hope that this report will further deepen the public's understanding and interest".
- Therefore, by referring to the White Paper, we have prepared a technical document in non-technical language that can be easily understood by laypersons.

2. Economic impact of irrigation systems

2.1 Farmland accumulation and intensification for commercial farmers

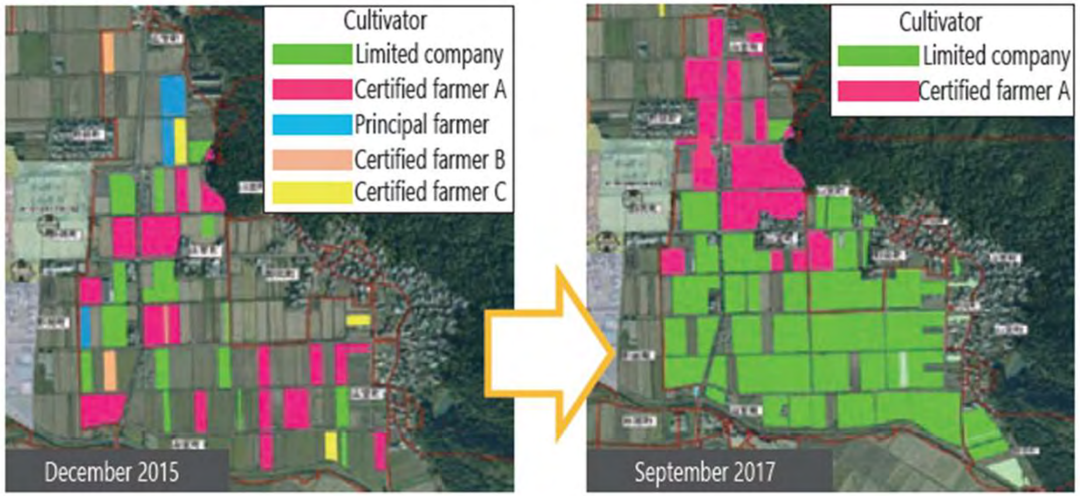
2.2 Reduction of production costs by promoting smart agriculture

2.3 Strengthening the production areas through conversion to highly profitable crops

Farmland accumulation and intensification

As of March 2020, 67% of Japan's total rice paddy area has been developed into large plots of 50 a or more, which contributes to farmland accumulation and intensification.

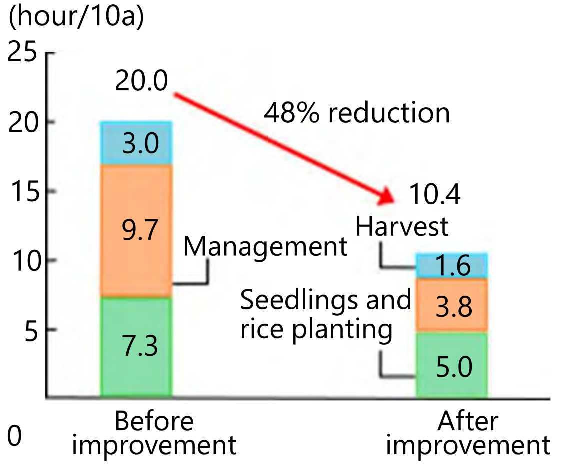
Farmland Banks



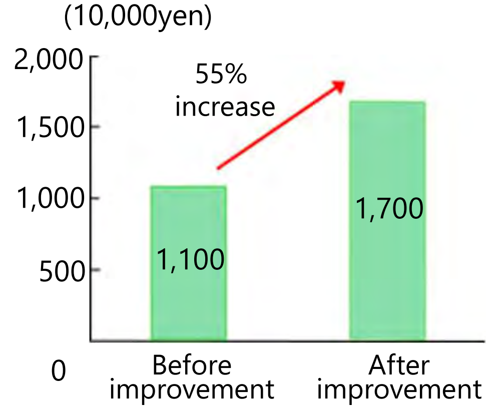
Farmland Banks borrow scattered and complex farmlands in the region and redistribute it to commercial farmers.

Effect of farmland accumulation and intensification

Farmland accumulation and intensification with Infrastructure improvements reduce commercial farmers' working hours and raises their income.



Changes in labor hours for Rice Cultivation in the district of Nishigo-Hokubu



Example of farmer's income improvement in the district of Nishigo-Hokubu

Commercial farmers

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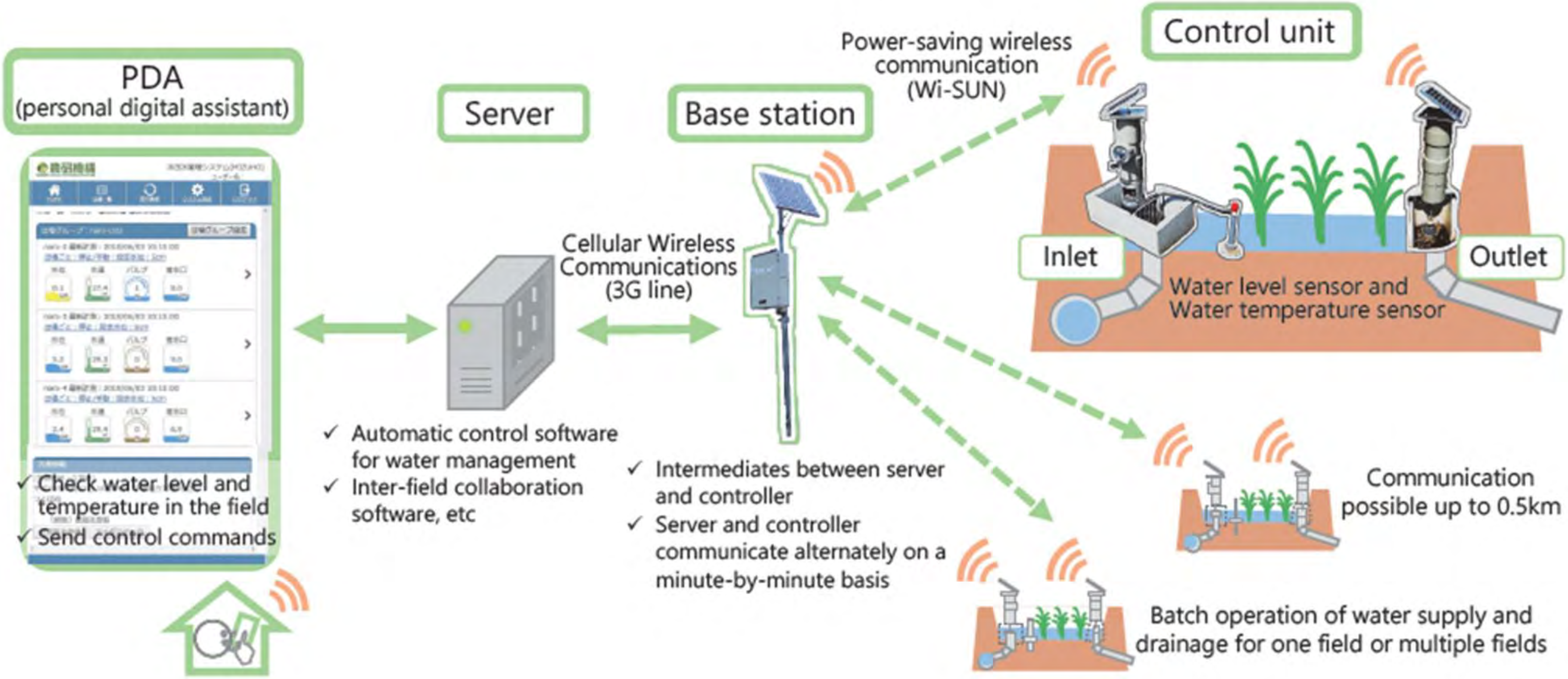
Promoting smart agriculture

Labor shortages are becoming more severe because of an aging workforce and other factors.

➡ Smart agriculture technology is being introduced to improve the management at production sites to save labor and reduce production costs.

Automatic Water Management System



- Remotely and automatically supply and drain water to rice paddy fields using information obtained from water level sensors installed in the fields.
- Field trials have shown that the system has reduced the time required to patrol rice paddy fields by an average of 87%.

Automatic Water Management System

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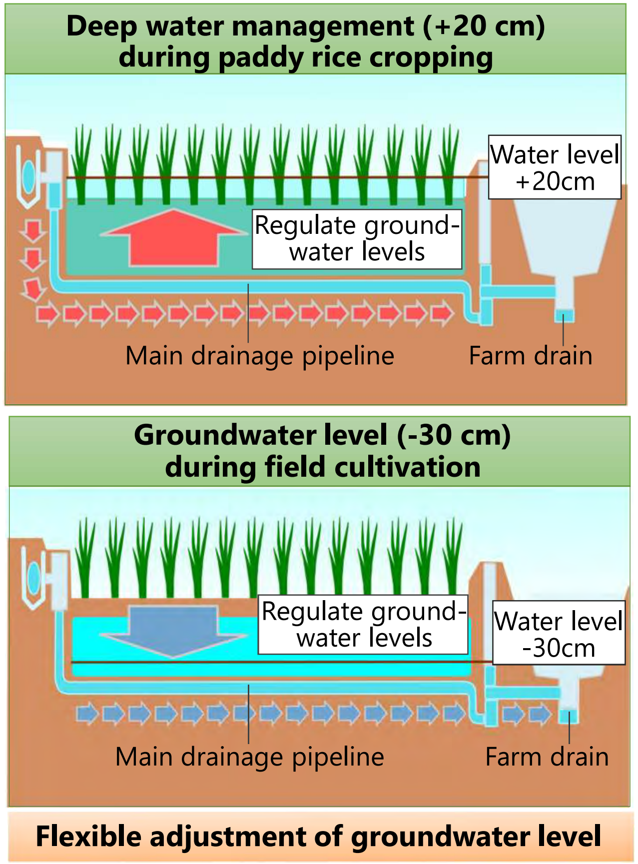
Groundwater level control system

Control the groundwater level to a suitable level for crop growth conditions, allows for the water level to be set between 20 cm above and 30 cm below the surface.




Before system introduction (soybeans)


After system introduction (soybeans)

Conversion to highly profitable crops from rice

- Groundwater level control system has led to a shift from a rice-centered farming system to one that incorporates highly profitable crops (vegetables and fruit trees).

- In order to actively promote the shift to highly profitable crops, measures are being implemented to support production areas that cultivate highly profitable crops in rice paddies.

3. Social impact of irrigation systems

3.1 Repairing and updating outdated agricultural irrigation facilities in a systematic and efficient manner

3.2 Irrigation ponds maintenance triggered by a torrential rainfall disaster

3.3 Promotion of river basin disaster resilience and sustainability by utilizing farmland and agricultural irrigation facilities

The reason for repairing and updating outdated agricultural irrigation facilities

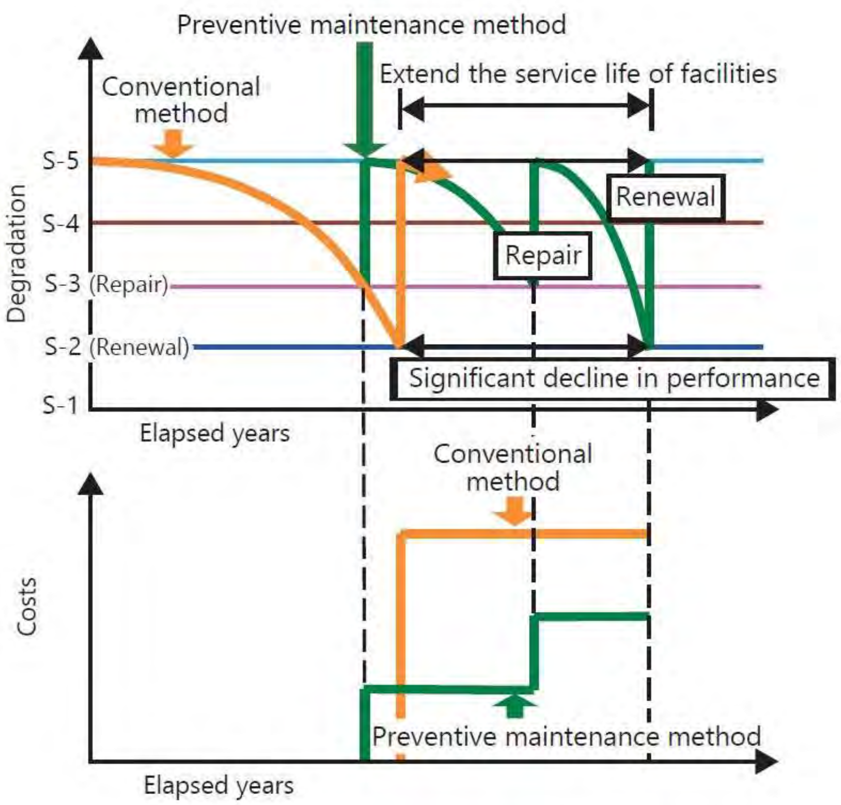
- Agricultural irrigation facilities are important infrastructure that provides a stable food supply and protects the lives and property of people.
- The infrastructure asset value is estimated to reach 32 trillion yen on a reconstruction cost basis.
- Japan is particularly prone to flood damage due to frequent heavy rains and typhoons. However, outdated agricultural irrigation facilities are becoming vulnerable to natural disasters.

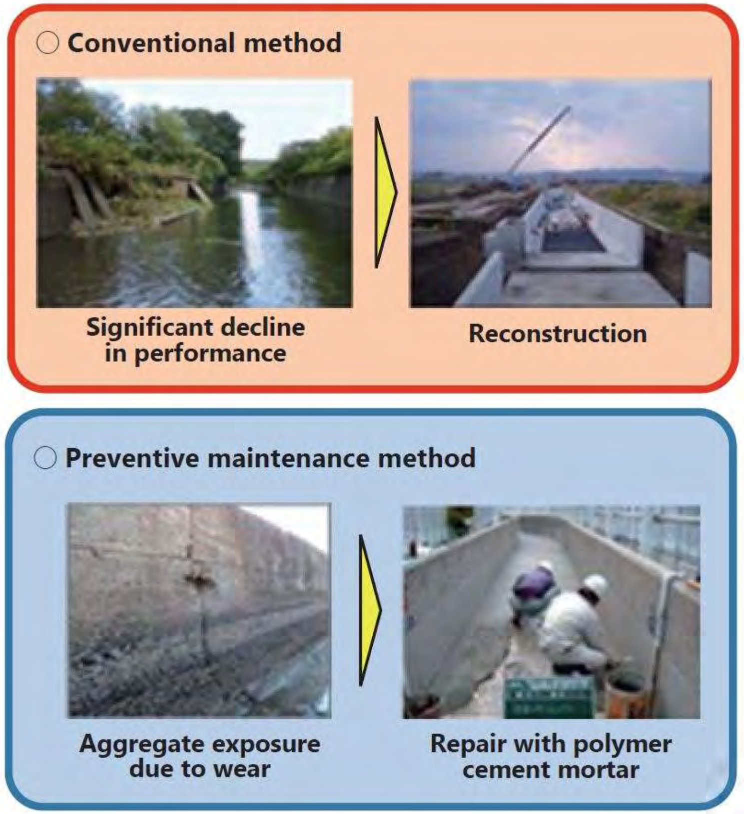
➡ As agricultural irrigation facilities continue to age, maintenance and preservation are important issues.



Repairing and updating outdated agricultural irrigation facilities in a systematic and efficient manner

- Stock management is being promoted to implement appropriate measures systematically and efficiently.
- Renewal methods based on inspections, functional diagnosis, and monitoring of agricultural irrigation facilities.





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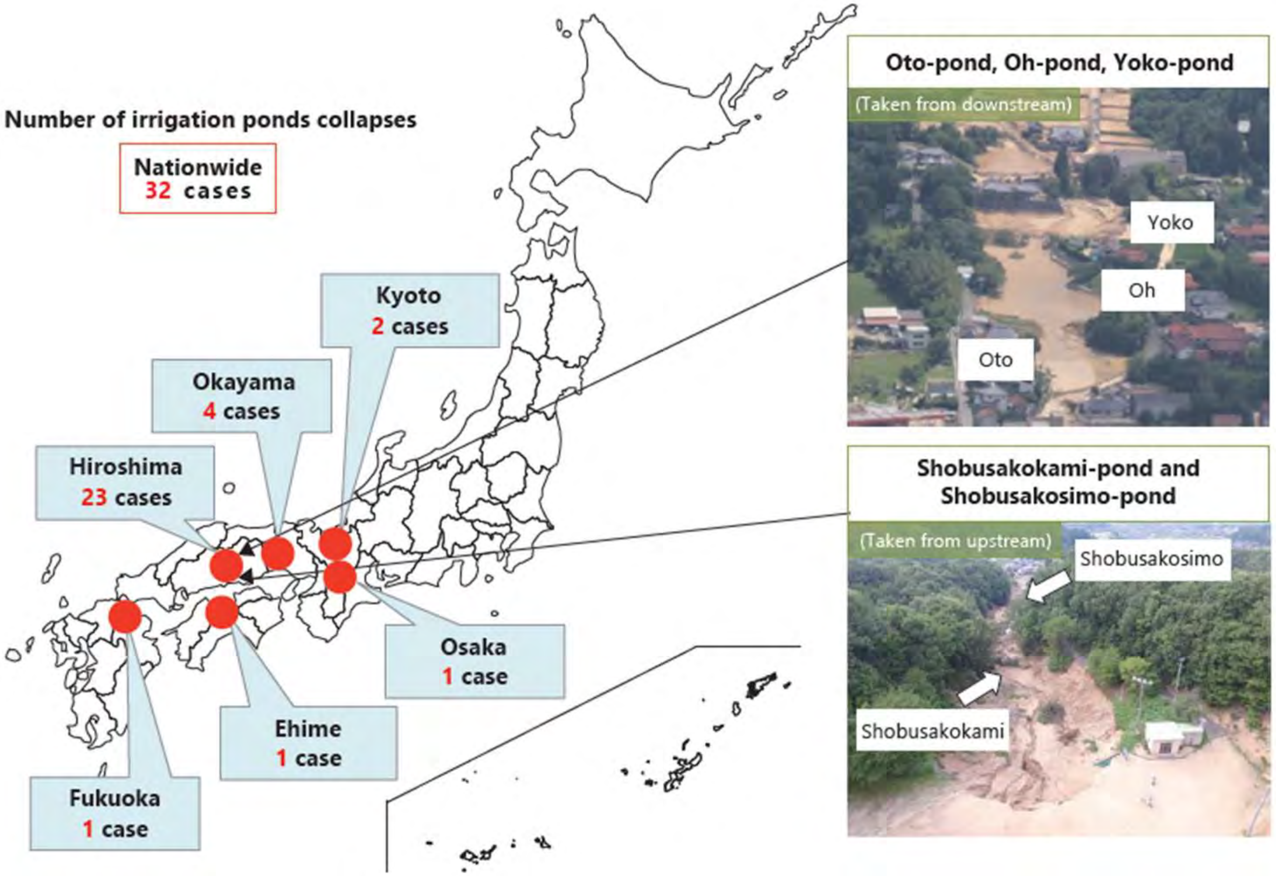
Irrigation ponds maintenance triggered by a torrential rainfall disaster

Many irrigation ponds were constructed before the Edo period, making them vulnerable to heavy rainfall and earthquakes.

- In June 28 to July 8, 2018, heavy rainfall occurred throughout Japan, several irrigation ponds collapsed, mainly in the Hiroshima Prefecture, causing extensive downstream damage.
- Since the irrigation ponds that caused human casualties had not been selected as priority irrigation ponds for disaster prevention*.
- By the end of August, 88,133 irrigation ponds were inspected at which problems were found in 1,540 irrigation ponds, and emergency measures taken.

*Reservoirs with a benefiting area of 0.5 ha or more, or reservoirs that have the potential to cause damage to people's homes or public facilities downstream in the event of a collapse.

Irrigation ponds maintenance triggered by a torrential rainfall disaster



The current disaster prevention measures for irrigation ponds are;

- Hazard maps were prepared for major irrigation ponds, which included information on the extent of inundation, evacuation directions, etc.
- Capacity of flood discharges is being improved and levees are being raised

3. Social impact of irrigation systems

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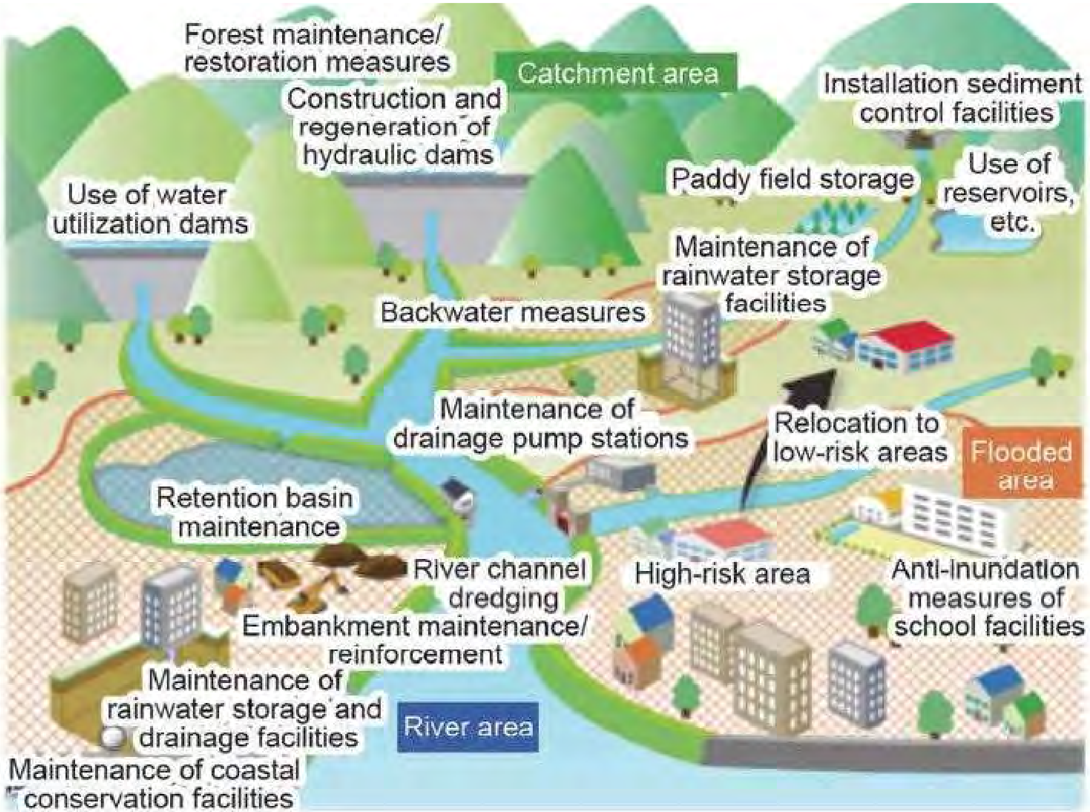
Promotion of river basin disaster resilience and sustainability

All parties involved in the watershed (national government, prefectures, municipalities, companies, residents, etc.) are working together to promote “River Basin Disaster Resilience and Sustainability by All” to control flooding in the entire watershed

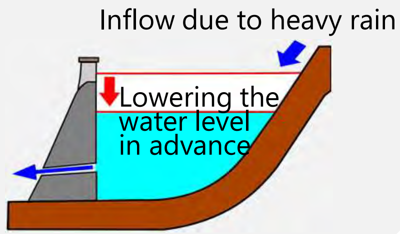


Promotion of river basin disaster resilience and sustainability

MAFF is strengthening its efforts in the event of anticipated flood damage in cooperation with relevant ministries and agencies, local governments, and agricultural officials.

1. Lowering the water level of agricultural dams and reservoirs in advance to store rainwater.
2. Installing boards with small holes at drop-off points in rice paddy to temporarily store rainwater to prevent a sudden rise in the water level.
3. Properly draining internal water into rivers with maintained drainage pumps to reduce waterlogging damage to crops and settlements.

Utilization of agricultural dams



Utilization of paddy fields (rice paddy dams)

Utilization of drainage facilities

4. Introduction of research results
Fruit tree cultivation in rice paddy fields using drip irrigation

Rationale for using rice paddy water for fruit tree cultivation

Drip irrigation is introduced into a soil mound rhizosphere restricted culture system for high-quality fruit tree production.

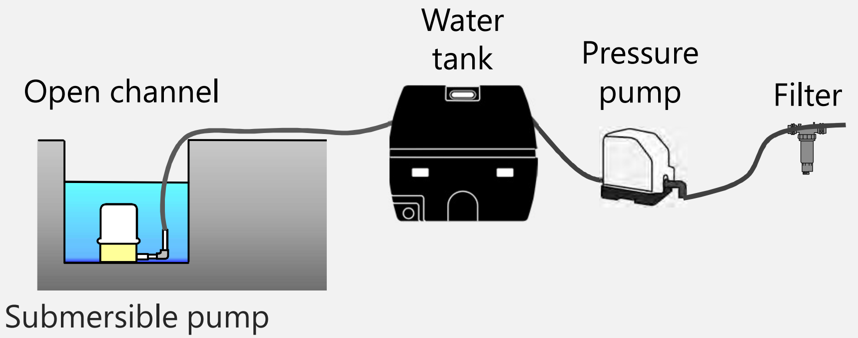
Many fruit tree farmers experiencing difficulties in securing a water source.

➡ The use of paddy water is effective in solving this issue

Problems with using paddy water

- Algae and sediment contained in paddy water cause clogging in drip irrigation equipment.
- Leading to stoppage in irrigation that results in yield reduction.

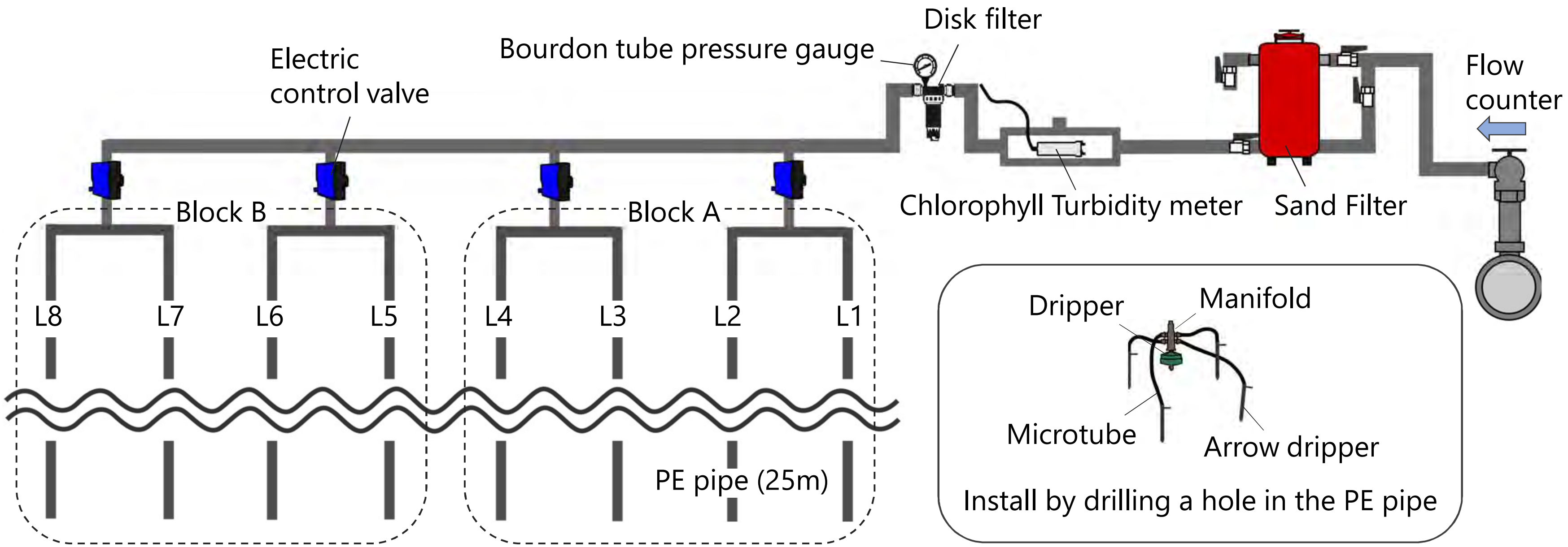
Examples from the field



- ✓ Algae adhering to submersible pump and filter, causing frequent clogging.
- ✓ Pump and filter cleaned once a week

Progress of paddy field water clogging in drip irrigation is examined by a field test.

The outline of the field



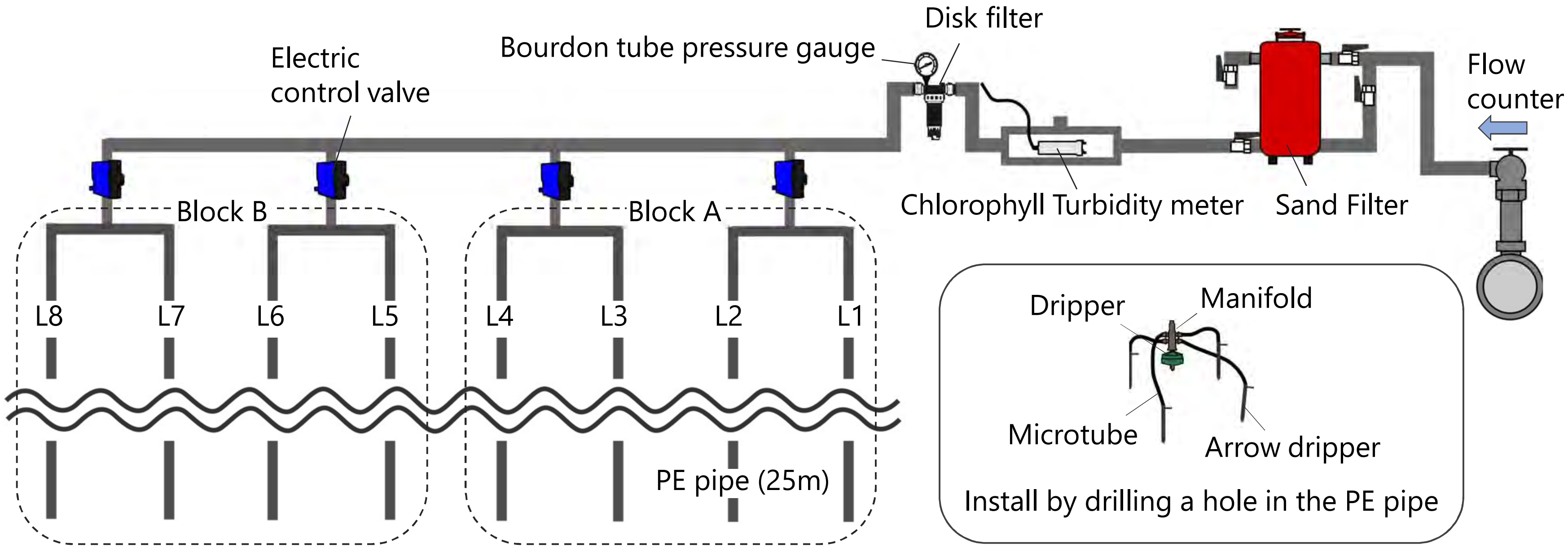
- Water for paddy fields is stored in a water supply tank and then pumped to the test fields by pipeline.
- Water supply tank is open, algae are generated
- The sand filter, the disc filter and the electric control valves were connected using a VP pipe.
- PE pipe was equipped with 40 drippers

Method of measuring clogging

1. Quantify the amount of algae and sediment in the paddy water
   - ➡ Chlorophyll turbidity meter was installed upstream of the disk filter

2. Current clogging index
   - ➡ Water pressure at the outlet of the disc filter "P_o" which is used by fruit tree farmers as an indicator of clogging

3. Determine the progression of clogging by linking the results of measurement 1 to 2 measurement



Setting up rotation blocks and irrigation schedule

- The field was irrigated in rotation in Blocks A and B due to low water pressure in the low-pressure pipeline.
- The drop flow rate of the drippers was set to 7.8 L/h
- Irrigation time is set to meet the highest water requirement of 50 L/tree/day in soil mound rhizosphere restricted culture system of Shine Muscat.

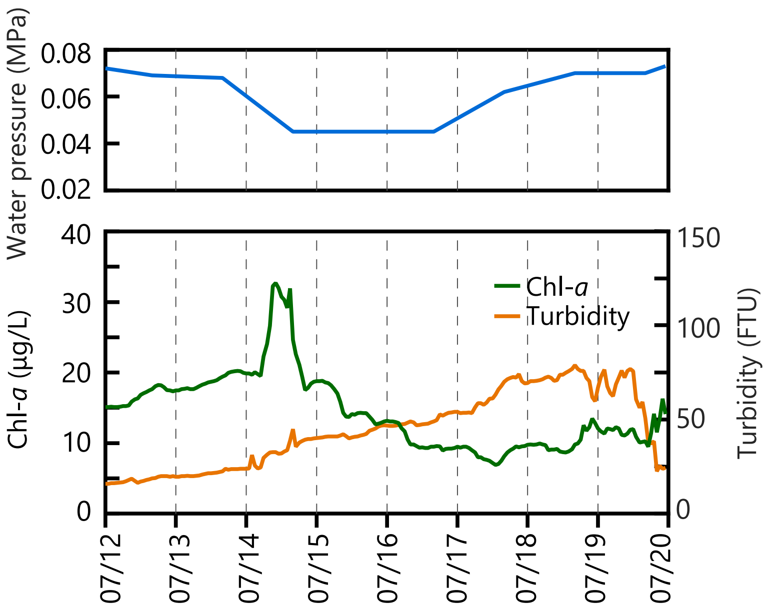
Block	A		
Irrigation time	9:30-10:20	11:20-13:00	14:50-15:40
Irrigation water (m^3)	1.04	2.08	1.04

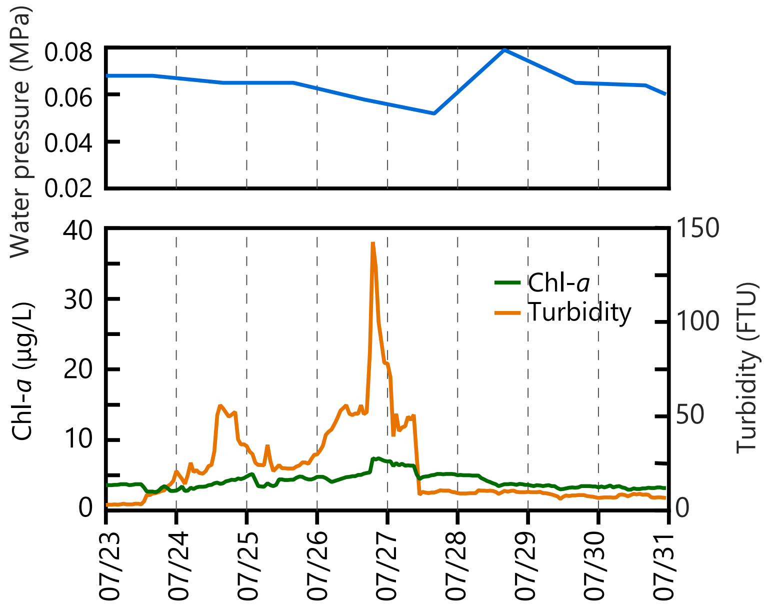
Block	B		
Irrigation time	10:25-11:15	13:05-14:45	15:45-16:35
Irrigation water (m^3)	1.04	2.08	1.04

Progression of clogging in the first 1–2 months after the start of the test (July)

- Chl-*a* concentration recorded several high values.
  ➡ P_o didn't decreased, or temporarily decreased but recovered to pre-decline value a few days later

- Turbidity also recorded high values several times.
  ➡ P_o didn't decreased, or temporarily decreased but recovered to the value at the beginning of the test a few days later

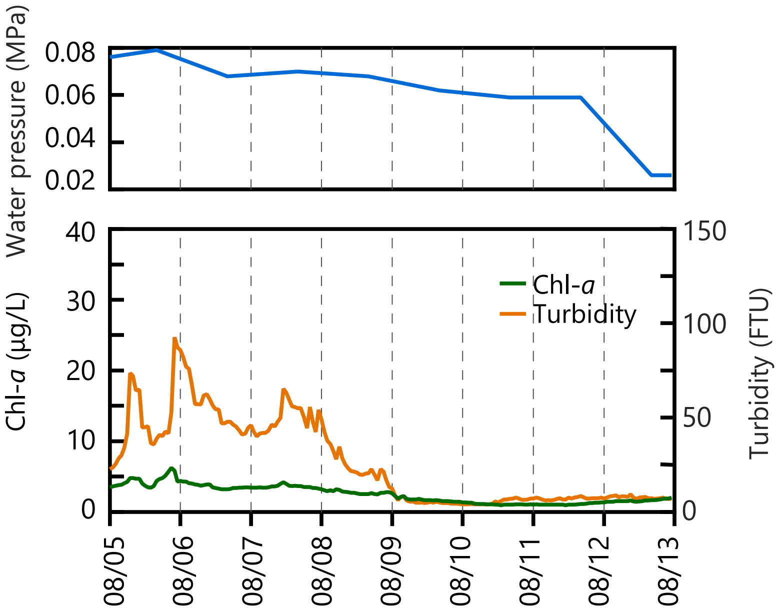




Irrigation shutdown due to a sudden drop in water pressure (August)

- Turbidity was again high, but P_o did not change and remained approximately 0.06 MPa

➡ P_o sudden drop to 0.03 MPa and irrigation was stopped



Irrigation shutdown due to a sudden drop in water pressure (August)

- In August, filter clogging did not occur as a decrease in P_o in spite of the time when the irrigation quantity is most required.

- It is important to include Chl-*a* concentration and turbidity as indicators of clogging and to estimate the quantity of algae and sediment trapped in the filter by monitoring increases in these values.

  ➡ If the quantity of algae and sediment can be estimated, irrigation stoppages can be prevented by pre-cleaning the filter media.

Conclusions

Regarding the economic impact of an irrigation system, we provided **profit-enabling measures for commercial farmers**.

- The consolidation of large paddy plots, which allow for farmers to secure large areas of land and improve their farm work efficiency.
- Creating multipurposed rice paddy fields, which improve drainage and allow for the cultivation of highly profitable crops, such as vegetables and fruit trees instead of rice.
- The introduction of smart agriculture, which reduces labor needed for farm work.

Conclusions

Regarding the social impact of irrigation systems, we reported **how irrigation systems guarantee the safety and security of people**.

- The proper repair and renewal of outdated dams, waterways, reservoirs, and drainage pump stations to ensure that they are operative when disasters occur
- Storage of rainwater in dams, irrigation ponds, and rice paddies when flooding occurs (to control the rapid rise in water levels in waterways and rivers)
- The proper operation of pumps at drainage pump stations to drain rainwater from farmlands to rivers to avoid flooding damage to farmlands and urban areas.

Thank you for your kind attention