Green Asia

Strategy for Sustainable Food Systems, MIDORI
Technology Catalog for the Asia-Monsoon Region

Technology Catalog Contributing to Production Potential and Sustainability in the Asia-Monsoon Region

Ver. 3.1

The International Center for Strategy "MIDORI" (2025), *Technology Catalog Contributing to Production Potential and Sustainability in the Asia-Monsoon Region*, Ver. 3.1, Japan International Research Center for Agricultural Sciences

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Preface

In May 2021, Japan formulated the Strategy for Sustainable Food Systems, "MIDORI", which aims to enhance agricultural productivity potential and sustainability through innovation as a new approach for sustainable food systems. Among the technologies developed to transform the food systems in Japan, there are technologies applicable to the Asia-Monsoon region, where we share similar features such as high temperature and humidity, paddy-rice based agriculture, and a high proportion of small and medium-sized farmers.

To accelerate testing and disseminating technologies applicable to the region, the Ministry of Agriculture, Forestry and Fisheries (MAFF) assigned the Japan International Research Center for Agricultural Sciences (JIRCAS) to conduct the project "Accelerating application of agricultural technologies which enhance production potentials and ensure sustainable food systems in the Asia-Monsoon region" from 2022. It is currently being implemented at JIRCAS under the project name of "Green Asia".

As part of the activities of Green Asia and in cooperation with other research institutes concerned, we have developed the "Technology Catalog Contributing to Production Potential and Sustainability in the Asia-Monsoon Region", a compilation of applicable technologies which were developed in Japan or through international collaboration over the past 10 years and are expected to contribute to the establishment of sustainable food systems in the region.

We hope that this catalog will serve as a reference to various stakeholders in the Asia-Monsoon region, including government officials, researchers, extension officers, producers, and the private sectors. We also hope that the technologies in this catalog will be demonstrated and implemented on the ground through optimization and coordination in various regions, thereby helping in transformation of the food systems among countries in the Asia-Monsoon region.

About the Contents of Technology Catalog

The configuration of this catalog is as follows.

Title indicating the name and potential use of the technology

Area of contribution to the sustainable food systems

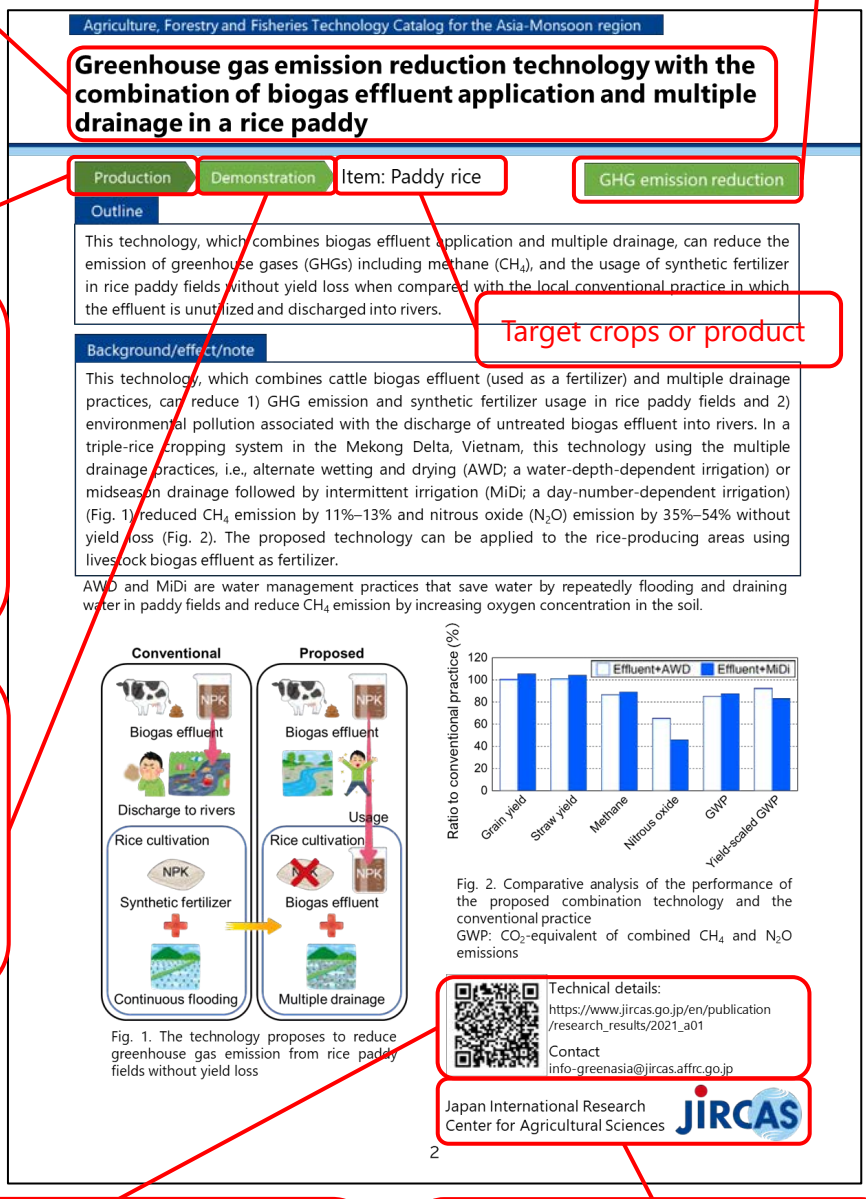
Target process within the supply chain (Production, Input, Processing and Distribution, or Consumption) for utilization of the technology

Present status of achievement in the development of the technology (Demonstration or Implementation)

Target crops or product

Link for details on the technology and information on institute(s) involved in the research.
Contact e-mail address for inquiry about technology

Representative institute in Japan involved in the development of the technology



Agriculture, Forestry and Fisheries Technology Catalog for the Asia-Monsoon region

Greenhouse gas emission reduction technology with the combination of biogas effluent application and multiple drainage in a rice paddy

Production | Demonstration | Item: Paddy rice | GHG emission reduction

Outline

This technology, which combines biogas effluent application and multiple drainage, can reduce the emission of greenhouse gases (GHGs) including methane (CH_4), and the usage of synthetic fertilizer in rice paddy fields without yield loss when compared with the local conventional practice in which the effluent is unutilized and discharged into rivers.

Background/effect/note

This technology, which combines cattle biogas effluent (used as a fertilizer) and multiple drainage practices, can reduce 1) GHG emission and synthetic fertilizer usage in rice paddy fields and 2) environmental pollution associated with the discharge of untreated biogas effluent into rivers. In a triple-rice cropping system in the Mekong Delta, Vietnam, this technology using the multiple drainage practices, i.e., alternate wetting and drying (AWD; a water-depth-dependent irrigation) or midseason drainage followed by intermittent irrigation (MiDi; a day-number-dependent irrigation) (Fig. 1) reduced CH_4 emission by 11%–13% and nitrous oxide (N_2O) emission by 35%–54% without yield loss (Fig. 2). The proposed technology can be applied to the rice-producing areas using livestock biogas effluent as fertilizer.

AWD and MiDi are water management practices that save water by repeatedly flooding and draining water in paddy fields and reduce CH_4 emission by increasing oxygen concentration in the soil.

Fig. 1. The technology proposes to reduce greenhouse gas emission from rice paddy fields without yield loss

Fig. 2. Comparative analysis of the performance of the proposed combination technology and the conventional practice
GWP: CO_2-equivalent of combined CH_4 and N_2O emissions

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2021_a01

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Japan International Research Center for Agricultural Sciences

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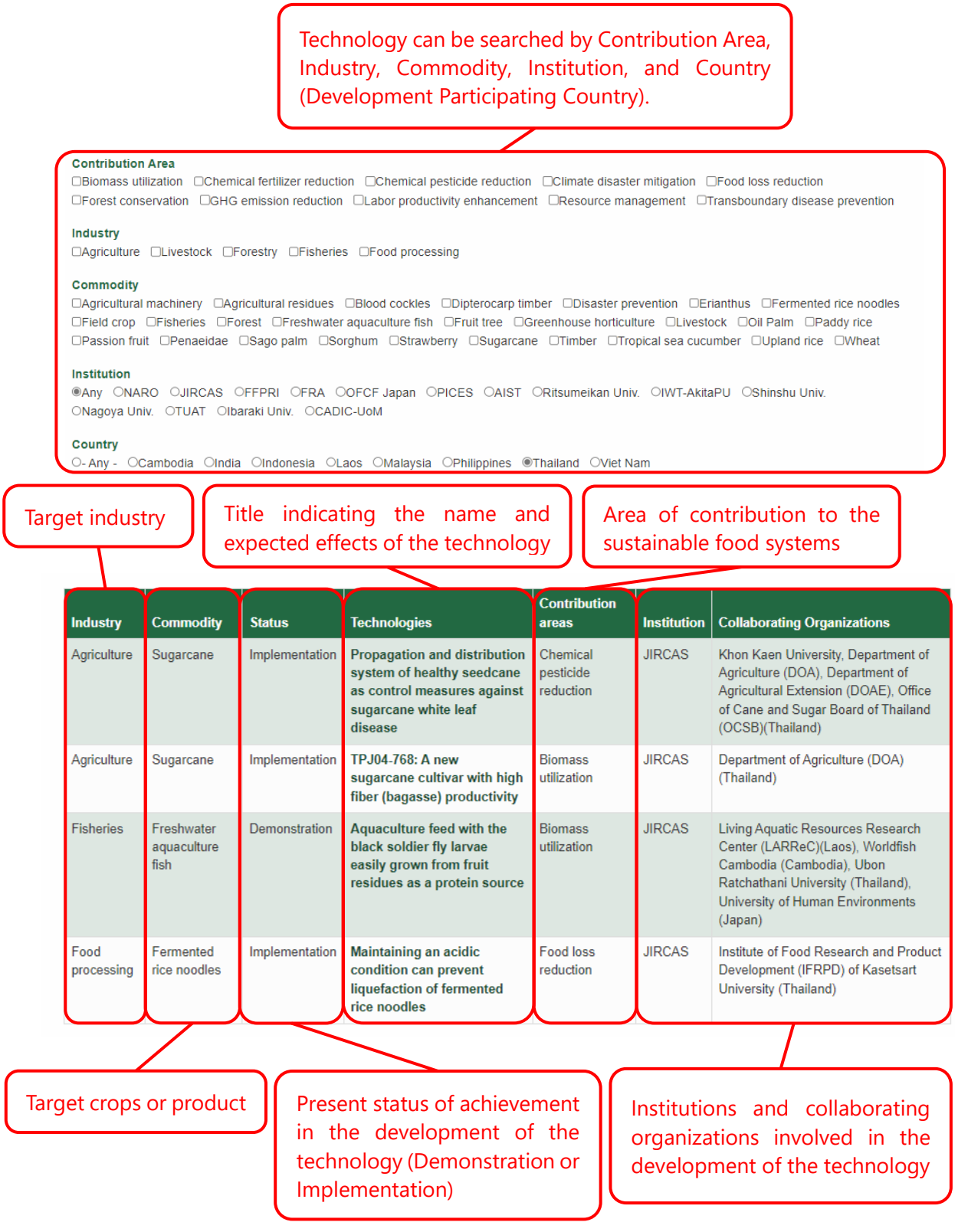
About the Database of Technology Catalog

The Technology Catalog database is available on the following website. It enables users to easily identify the technologies they are looking for and the institutions that developed them.
https://www.jircas.go.jp/en/greenasia/techcatalog

The configuration of the database is as follows.



Industry	Commodity	Status	Technologies	Contribution areas	Institution	Collaborating Organizations
Agriculture	Sugarcane	Implementation	**Propagation and distribution system of healthy seedcane as control measures against sugarcane white leaf disease**	Chemical pesticide reduction	JIRCAS	Khon Kaen University, Department of Agriculture (DOA), Department of Agricultural Extension (DOAE), Office of Cane and Sugar Board of Thailand (OCSB)(Thailand)
Agriculture	Sugarcane	Implementation	**TPJ04-768: A new sugarcane cultivar with high fiber (bagasse) productivity**	Biomass utilization	JIRCAS	Department of Agriculture (DOA) (Thailand)
Fisheries	Freshwater aquaculture fish	Demonstration	**Aquaculture feed with the black soldier fly larvae easily grown from fruit residues as a protein source**	Biomass utilization	JIRCAS	Living Aquatic Resources Research Center (LARReC)(Laos), Worldfish Cambodia (Cambodia), Ubon Ratchathani University (Thailand), University of Human Environments (Japan)
Food processing	Fermented rice noodles	Implementation	**Maintaining an acidic condition can prevent liquefaction of fermented rice noodles**	Food loss reduction	JIRCAS	Institute of Food Research and Product Development (IFRPD) of Kasetsart University (Thailand)

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"Prolonged midseason drainage" in paddy fields for maintaining agricultural production and decreasing greenhouse gas emissions

Production | Implementation | Item: Paddy rice | GHG emission reduction

Outline

Prolonging midseason drainage* (Fig. 1) of paddy fields by a week longer than usual reduces methane (CH_4) emissions by approximately 30% on average without negatively impacting rice yield and quality.

*Midseason drainage around the peak of the rice tillering stage generally for 1-2 weeks to improve rice yield and quality.

Background/effect/note

Methane is a greenhouse gas with the second-largest impact on global warming after carbon dioxide. Methane emissions from paddy soils account for approximately 10% of the global anthropogenic methane emissions. Thus, the reduction of methane emissions is an urgent issue.

The effect of reducing methane emissions from paddy fields by prolonging the midseason drainage period was verified with the cooperation of the agricultural experimental institutes in the eight prefectures at nine locations nationwide in Japan (Fig. 2). Prolonging the midseason drainage by one week reduced average methane emissions from paddy fields by approximately 30% without impacting the yield and protein content of rice (Fig. 3).

Note: As the amount of cadmium absorbed by rice plants may increase in areas with high concentrations of cadmium in the paddy soil, this method is not recommended for such areas. For arsenic in the paddy soil, prolonging mid-season drainage is expected to decrease the absorption of arsenic by rice.

Fig. 1. Paddy field under midseason drainage

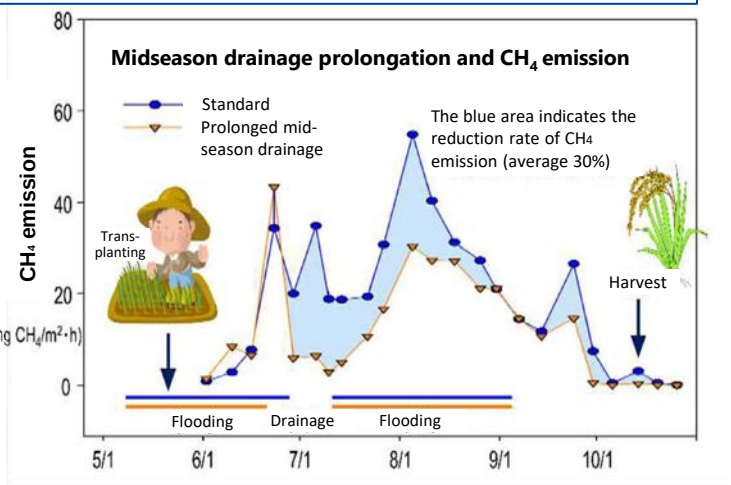

Fig. 2. CH_4 emissions and the effect of prolonged midseason drainage in Fukushima prefecture (example)

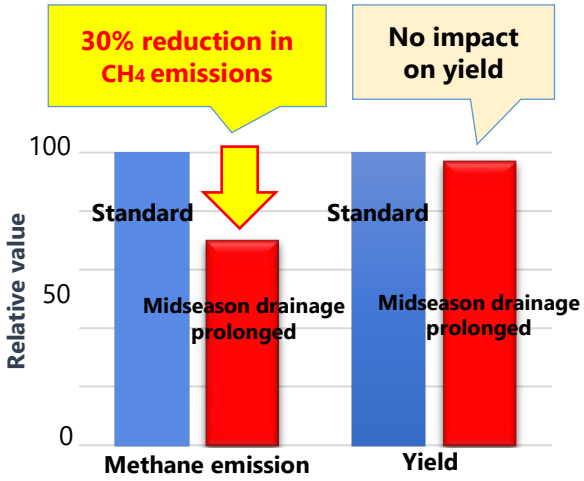

Fig. 3. CH_4 emissions and impacts on rice yield

Technical Details:

https://www.naro.affrc.go.jp/archive/niaes/sinfo/result/result29/result29_02.html (Japanese)

https://www.naro.go.jp/english/laboratory/niaes/files/fftc-marco_book2019_107.pdf (English)

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Greenhouse gas emission reduction technology with the combination of biogas effluent application and multiple drainage in a rice paddy

Production | Demonstration | Item: Paddy rice | GHG emission reduction

Outline

This technology, which combines biogas effluent application and multiple drainage, can reduce the emission of greenhouse gases (GHGs) including methane (CH_4), and the usage of synthetic fertilizer in rice paddy fields without yield loss when compared with the local conventional practice in which the effluent is unutilized and discharged into rivers.

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AWD and MiDi are water management practices that save water by repeatedly flooding and draining water in paddy fields and reduce CH_4 emission by increasing oxygen concentration in the soil.

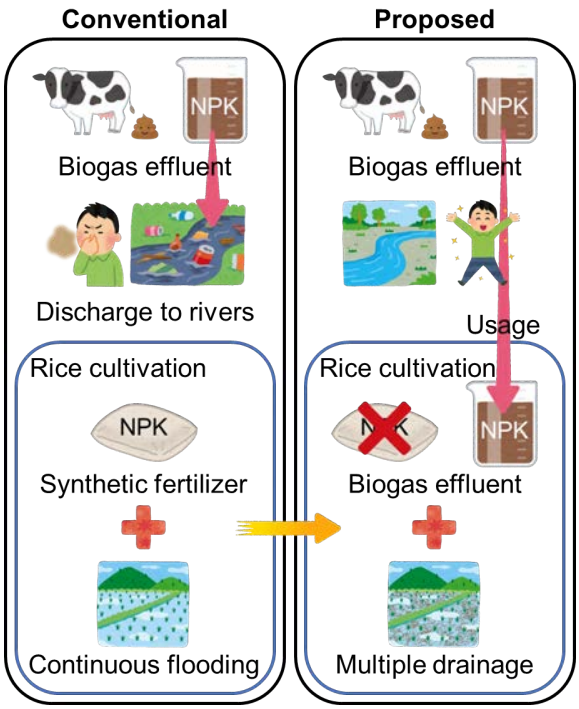

Fig. 1. The technology proposes to reduce greenhouse gas emission from rice paddy fields without yield loss

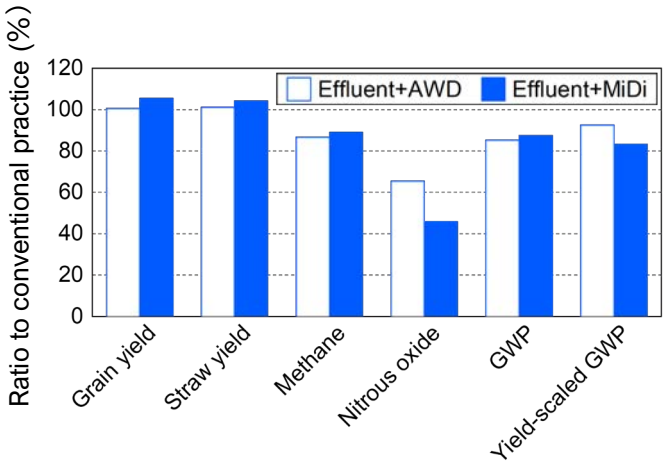

Fig. 2. Comparative analysis of the performance of the proposed combination technology and the conventional practice
GWP: CO_2-equivalent of combined CH_4 and N_2O emissions

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2021_a01

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Japan International Research Center for Agricultural Sciences

A method to estimate the reduction in life cycle greenhouse gas emissions from rice cultivation caused by the use of alternate wetting and drying

Production | Demonstration | Item: Paddy rice | GHG emission reduction

Outline

A life cycle assessment (LCA) method was developed to estimate greenhouse gas (GHG) emissions from farmers during the life cycle‡ of rice cultivation using alternate wetting and drying (AWD).

‡Life cycle: The developed method includes every stage from the production of material and machinery for rice cultivation to harvesting/rice straw management.

Background/effect/note

Alternate wetting and drying (AWD) saves water and mitigates GHG emissions from paddy field when compared with continuous flooding. In AWD, paddy soil is repeatedly re-flooded after several days of drying (Fig. 1). The LCA method that we developed calculates the life cycle greenhouse gas (LC-GHG) emission by summing up emissions from agricultural material production to rice cultivation stages (Fig. 2). This method allows the evaluation of the impact of AWD, considering potential trade-offs (e.g. decrease in soil CH_4 emissions and increase in N_2O emissions). Additionally, this method can be used in the Asia-Monsoon region for policy-making and further dissemination of AWD. For example, estimations from the LCA method indicated AWD reduces LC-GHG emission by 41% (Fig. 3). However, this method partly used Intergovernmental Panel on Climate Change (IPCC) guidelines that enable easy calculation but does not reflect country or site differences. The use of field data (CH_4 and N_2O emissions from soils) at each site (if available) is more desirable than the estimates based on IPCC guidelines.

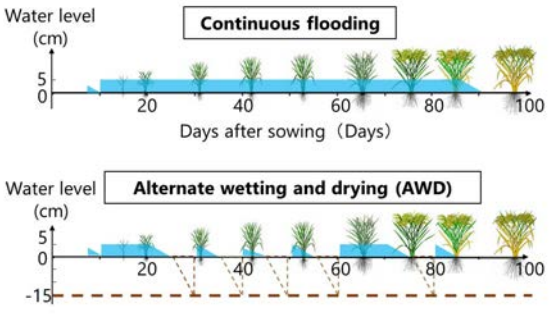

Fig. 1. An example of conventional water management (continuous flooding) and alternate wetting and drying (AWD) during a cropping season

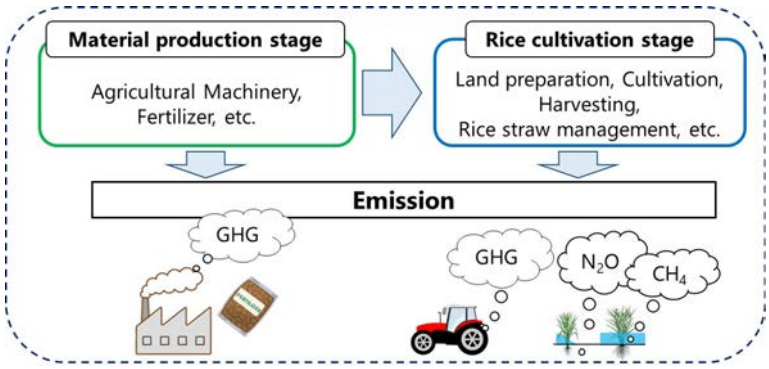

Fig. 2. Life cycle greenhouse gas (LC-GHG) emissions from rice cultivation

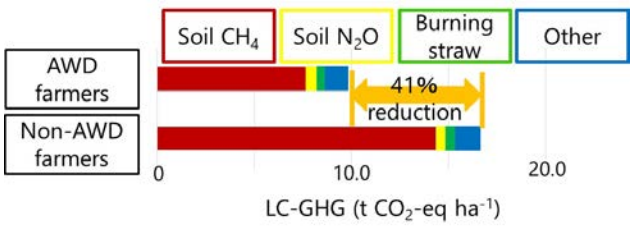

Fig. 3. Comparing greenhouse gas (GHG) emissions between alternate wetting and drying (AWD) farmers and non-AWD farmers

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_a02

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Japan International Research Center for Agricultural Sciences

Energy-saving low-carbon technology in greenhouse horticulture utilizing thermal energy in irrigation canals

Production | Demonstration | Item: Greenhouse horticulture | GHG emission reduction

Outline

We developed a technology for collecting and utilizing heat by installing a sheet-type heat exchanger in flowing water, such as an irrigation canal. Energy consumption and greenhouse gas (GHG) emissions from heating/cooling of agricultural greenhouses can be reduced by collecting and utilizing heat from flowing water.

Background/effect/note

Heavy fuel oil is commonly used for heating agricultural greenhouses and is one of the sources of GHG emissions. On the other hand, heat pumps have become popular for cooling in addition to heating. Recently, heat pumps have been used in order to produce high-quality crops. However, air-source heat pumps are used in most cases. Water has higher thermal conductivity and specific heat than air. The heat exchange efficiency is further improved by the flow. Thus, flowing water is the most suitable heat source for heat pumps. Laboratory experiments determined that the installation of a sheet-type heat exchanger (Figs. 1 and 2) in flowing water improved heat exchange efficiency by approximately 15 and 2.5 times when compared with that in underground and stagnant water, respectively (Fig. 3). Furthermore, construction costs can be reduced as digging boreholes is not necessary during the installation of the heat exchanger in irrigation canals. Additionally, protective materials can be attached on the heat exchanger to reduce damages caused by debris in water.

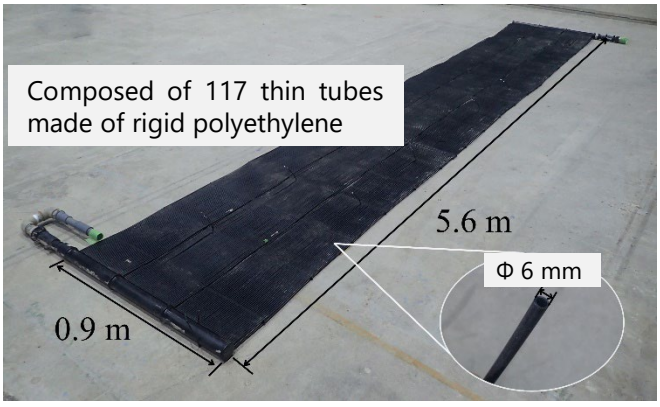

Fig. 1. Sheet-type heat exchanger

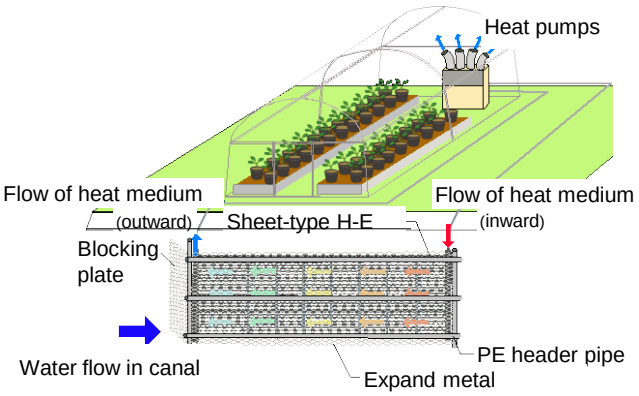

Fig. 2. Schematic view of heat utilization in greenhouse (cooling)

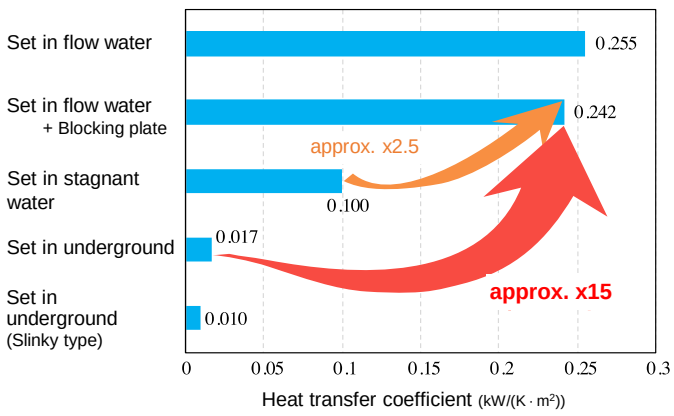

Fig. 3. Comparison of heat exchange efficiency

Technical details:

https://www.naro.go.jp/english/laboratory/nkk/press_release/sheetheatexchanger/index.html

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農研機構 NARO

Improved CO_2 recovery and application equipment to reduce greenhouse gas emissions and increase productivity in greenhouse horticulture by utilizing exhaust gases from heating and cooling equipment

Production | Demonstration | Item: Greenhouse horticulture

GHG emission reduction
Labor productivity enhancement

Outline

Carbon dioxide (CO_2) is applied in greenhouses to increase productivity. We developed equipment that can capture and store CO_2 from exhaust gases generated by nighttime heating and apply it to greenhouses. This method promotes photosynthesis, thereby increasing the yield of horticultural crops such as roses by 30–45%, while reducing greenhouse gas emissions.

Background/effect/note

Typically, fossil fuels are burned to generate CO_2 for application in greenhouses. The use of CO_2 recovery and application equipment to collect and store CO_2 from the exhaust gases generated during heating and apply it in greenhouses reduces both fuel costs and CO_2 emissions (Fig. 1).

Existing CO_2 recovery methods generally involve adjusting the gas pressure or temperature. However, the energy-saving CO_2 recovery and application equipment we developed uses the concentration difference method to recover CO_2 from exhaust gases at a low cost. To apply the captured CO_2 in greenhouses, outside air is input into the device to release the CO_2, which contains few impurities such as nitrogen oxides (Fig. 2). This device can also capture and use exhaust gases from cooling.

The application of CO_2 using this system in the cultivation of roses shortened the time to flowering by 2–6 days, increased the yield by 30–45%, and increased the length and weight of cut flowers (Fig. 3). Effects such as increased yield, have also been observed in other flowering plants.

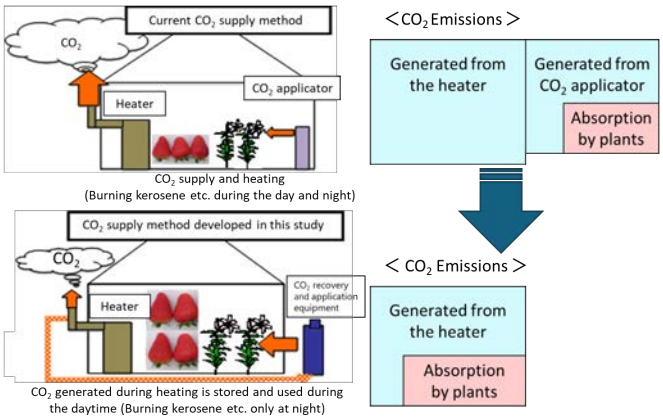

Fig. 1. Conceptual diagram

Fig. 2. The CO_2 recovery and application equipment

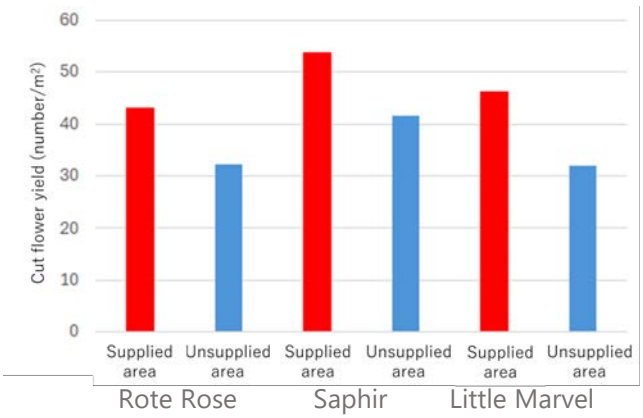

Fig. 3. Effect of CO_2 application on cut flower yield

Technical details:

https://www.j-platpat.inpit.go.jp/c1801/PU/JP-6179915/15/ja

https://www.naro.affrc.go.jp/org/warc/research_results/h24/pdf/08_kaki/46-0802.pdf

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AIST

Technologies for reducing greenhouse gas emissions from livestock waste

Production | Demonstration and implementation | Item: Livestock | GHG emission reduction

Outline

Technologies enable the effective reduction of greenhouse gas (GHG) emissions during wastewater treatment and livestock manure composting by improving feed composition and utilizing microorganisms.

Background/effect/note

GHG emissions from the process of livestock manure composting and wastewater treatment account for 10~15% of GHG emissions derived from the agricultural sector. The GHG emissions in the process can be effectively reduced by using these technologies.

① Feeding fattening pigs with a low-protein diet supplemented with amino acids reduces GHG emissions from the manure management process by 40% when compared with a conventional diet without affecting rearing performance. - Implementation

② The GHG emissions can be significantly reduced by introducing a carbon fiber reactor to a swine wastewater treatment facility and maintaining an organic matter treatment capacity equivalent to that of the conventional activated sludge treatment method (Fig. 1). - Demonstration

③ During the composting of livestock manure, nitrite accumulation can be eliminated by adding mature compost containing nitrite-oxidizing bacteria to suppress the emission of nitrous oxide as a potent GHG (Fig. 2). - Demonstration

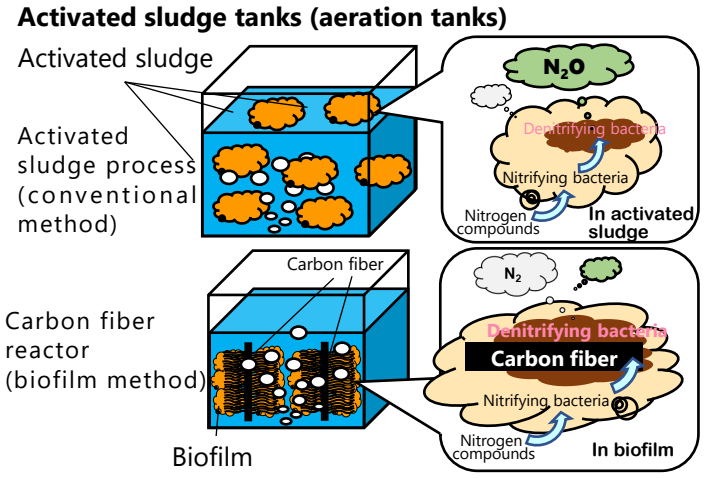

Fig. 1. Differences between the conventional activated sludge method and the carbon fiber reactor (biofilm method) [conceptual diagram]

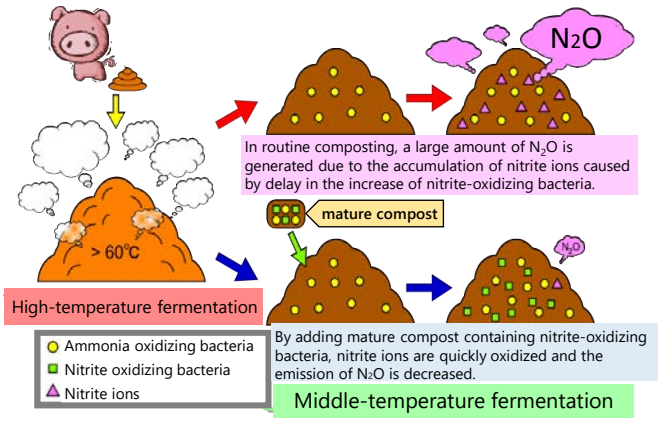

Fig. 2. Effect of mature compost addition on the reduction of greenhouse gas emissions [conceptual diagram]

Technical details:

①
https://www.naro.go.jp/publicity_report/press/laboratory/nilgs/073580.html [Japanese]

②
https://www.naro.go.jp/english/laboratory/nilgs/press-release/CFreactor/index.html [English]

③
https://www.naro.go.jp/english/laboratory/niaes/files/fftc-marco_book2019_067.pdf [English]

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National Agriculture and Food Research Organization

Mitigation of methane emissions from local cattle using cashew nut shell liquid feeding

Production | Implementation | Item: Livestock | GHG emission reduction

Outline

Cashew nut shell liquid (CNSL) feeding can decrease the enteric CH_4 emission from Vietnamese local cattle (Lai Sind, Fig. 1) by 20% by inhibiting the methanogen activity in the rumen.

Background/effect/note

Livestock production, especially ruminant production, is reported to be one of the major sources of greenhouse gas (GHG) emissions in Southeast Asian countries.

Here, we demonstrated that the average enteric methane emission per kg dry matter intake from Vietnamese local cattle (Lai Sind) decreased by 20.2~23.4% with CNSL feeding (Fig. 2). Additionally, CNSL feeding decreased the abundance of methanogens and increased the abundance of propionate-producing bacteria in the rumen, which can improve the production of the cattle (Fig. 3).

This technology can be widely applied for zebu cattle (*Bos indicus*), which are common in the tropical region.

Fig. 1. Vietnamese local cattle (Lai Sind) and methane emission measurement

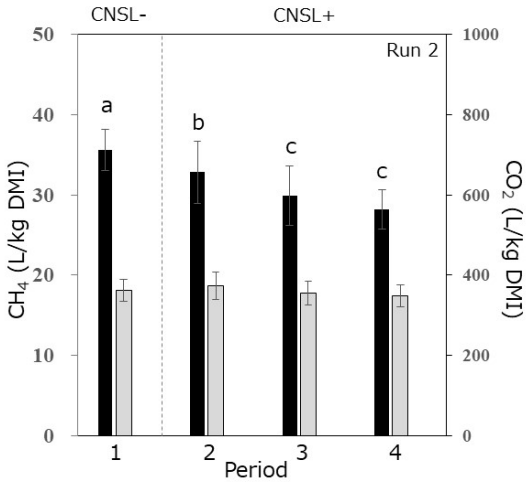

Fig. 2. Enteric methane (CH_4, black) and carbon dioxide (CO_2, grey) emissions per kg dry matter intake (DMI) from Lai Sind cattle with continuous CNSL feeding (4 periods of 5 days/period)

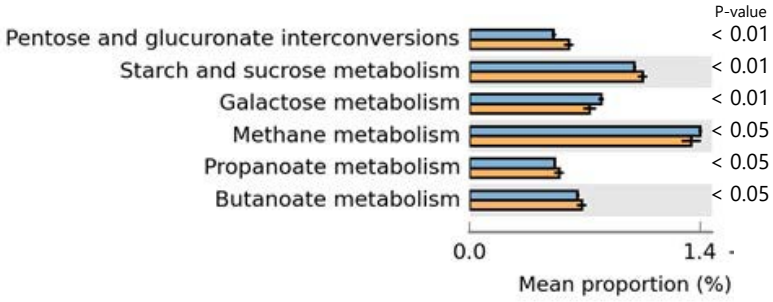

Fig. 3. Effect of cashew nut shell liquid (CNSL) feeding on the function of the rumen microbiome
Orange: CNSL+, Blue: CNSL-
Propanoate metabolism is significantly stimulated due to CNSL feeding.

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_a01

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Japan International Research Center for Agricultural Sciences

A simple and accurate method for estimating soil carbon sequestration using biochar based on proximate analysis

Procurement | Demonstration | Item: Bamboo

GHG emission reduction
Biomass utilization

Outline

Biochar has gained increasing attention due to its potential mitigating climate change and improving soil quality, and it is also being used to generate carbon credits. Estimating soil carbon sequestration with biochar typically requires time-consuming and costly methods, such as elemental analysis. However, our newly developed method simplifies this process by applying proximate analysis based on the Japanese Industrial Standard (JIS) M 8812, which is commonly used in coal quality assessment. This approach allows for more straightforward and accurate estimation of soil carbon sequestration using biochar.

Background/effect/note

Biochar is produced from biomass through pyrolysis at temperatures in excess of 350˚C under low-oxygen conditions (Fig. 1, left). When applied to agricultural land (Fig. 1, right), biochar improves the physical, chemical, and biological properties of soil, thereby fostering an improved soil environment. Globally, biochar is recognized as an effective and low-cost solution for carbon dioxide removal (CDR) and soil carbon sequestration. Estimating soil carbon sequestration according to the IPCC 2019 Refinement involves determining the organic carbon content (F_c) and the carbon remaining after 100 years (F_{perm}). However, this process typically requires time-consuming and costly elemental analysis and other measurements, imposing a burden on biochar carbon credit project developers. To address this issue, we developed a new method that uses proximate analysis instead of elemental analysis. This method estimates the pyrolysis temperature and soil carbon sequestration based on biochar's volatile matter (VM) and fixed carbon (FC) contents. Using this method illustrated here by the example of bamboo, research institutions can develop and share estimation formulas tailored to different feedstocks, thereby enhancing the efficiency of quality assessment processes. In countries with existing proximate analysis standards for charcoal, this method allows the back-calculation of biochar's pyrolysis temperature (Fig. 2), F_c (Fig. 3a), and F_{perm} (Fig. 3b) from standard proximate analysis data. In countries without such standards, adopting this method based on JIS M 8812 provides simplified yet reasonably accurate quality verification, facilitating the broader use of biochar for CDR with the co-benefit of soil improvement.

Fig. 1. Biochar (bamboo) produced using a flame-curtain kiln (left), and biochar mixed with manure for application to farmland (right).

Technical details:

https://www.jstage.jst.go.jp/article/wcr/16/1/16_3/_article/-char/en

https://www.jstage.jst.go.jp/article/wcr/16/2/16_67/_article/-char/en

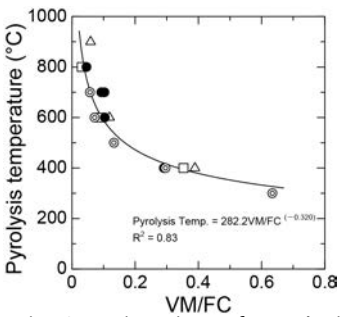

Fig. 2. Estimation of pyrolysis temperature from JIS M 8812 data on bamboo biochar.

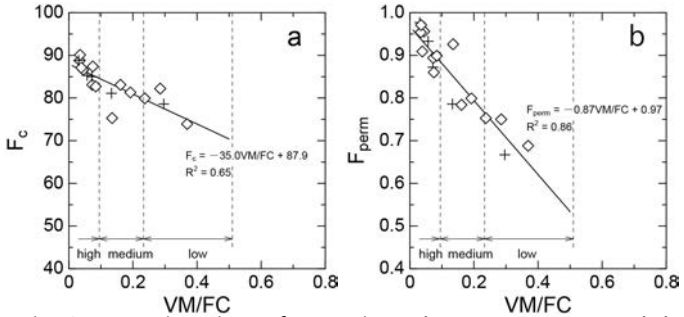

Fig. 3. (a) Estimation of organic carbon content F_c and (b) carbon remaining after 100 years F_{perm} from JIS M 8812 data on bamboo biochar.

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RITSUMEIKAN UNIVERSITY

Institute of Wood Technology, Akita Prefectural University

Utilization by “Multi-Biomass Treatment Process” of unused biomass discharged from the palm oil industry

Procurement | Demonstration | Item: Oil palm

GHG emission reduction
Biomass utilization

Outline

A multi-biomass treatment process that can treat various types of biomasses in the same process, for the production of sustainable fuel pellets and wood substitutes (Fig. 1) from unused biomass (oil palm trunks, empty fruit bunches, and fronds) discharged from the oil palm industry has been developed.

Background/effect/note

To promote the sustainable utilization of diverse and enormous amounts of unused biomass discharged from the oil palm industry, we have developed a manufacturing technology called “Multi-Biomass Treatment Process” that facilitates the conversion of oil palm trunks, empty fruit bunches, fronds, and fibers into energy and wood substitutes (Fig. 2). The technology has been demonstrated at a full-scale level at a pilot plant in Johor, Malaysia (Fig. 3). Currently, we have started a procurement test for sustainable fuel pellets and furniture materials from oil palm trunks and empty fruit bunches with the cooperation of a palm oil mill in Sarawak.

Fig. 1. Furniture pellets made from oil palm trunks

Characterization of each pellets made by Multi-Biomass Treatment Process using oil palm biomass

Properties	OPT pellet	EFB pellet	OPF pellet	MCF pellet
Bulk specific gravity	720 kg/m³	850 kg/m³	800 kg/m³	795 kg/m³
Lower heating value	17,470 J/g	17,920 J/g	17,940 J/g	18,750 J/g
Potassium	＜500ppm	1400ppm	900ppm	900ppm
Moisture	8.8%	7.4%	9.4%	4.4%
Mechanical durability	97.1%	98.9%	98.9%	92.6%

Fig. 2. Biomass pellets are produced by the Multi-Biomass Treatment Process. Sustainable and high-quality pellets can be produced in the same process.

Fig. 3. Demonstration pilot plant in Kluang, Johor, Malaysia

Technical details:

https://www.jircas.go.jp/en/publication/research_results/2019_c03
https://www.jircas.go.jp/en/publication/research_results/2015_c07

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Japan International Research Center for Agricultural Sciences

Low-cost, high-efficiency production of CH_4 and H_2 from agricultural residues through microbial saccharification and bio-methanation

Procurement | Demonstration | Item: Agricultural residues | GHG emission reduction Biomass utilization

Outline

Microbial saccharification technology enables the efficient production of biogas and biohydrogen from agricultural residues. CO_2 and H_2 generated from microbial saccharification by saccharifying bacteria (Fig. 1) and methane fermentation can facilitate energy recycling of unused agricultural residues without greenhouse gas (GHG) emissions.

Background/effect/note

Agricultural waste generated from food and agricultural industries is difficult to decompose and is a source of GHG emissions. Microbial saccharification (Fig. 2) is a novel enzyme-free saccharification method that can saccharify and solubilize agricultural residues using only microorganisms without cellulolytic enzymes. In this method, agricultural residues are efficiently decomposed into sugars and organic acids and can be converted into CH_4 and H_2. Additionally, CO_2 and H_2 generated through microbial saccharification and methane fermentation can produce methane again through the bio-methanation process to facilitate energy recycling of unused agricultural residues without GHG emissions.

Fig. 1. Electron micrograph of saccharifying bacteria

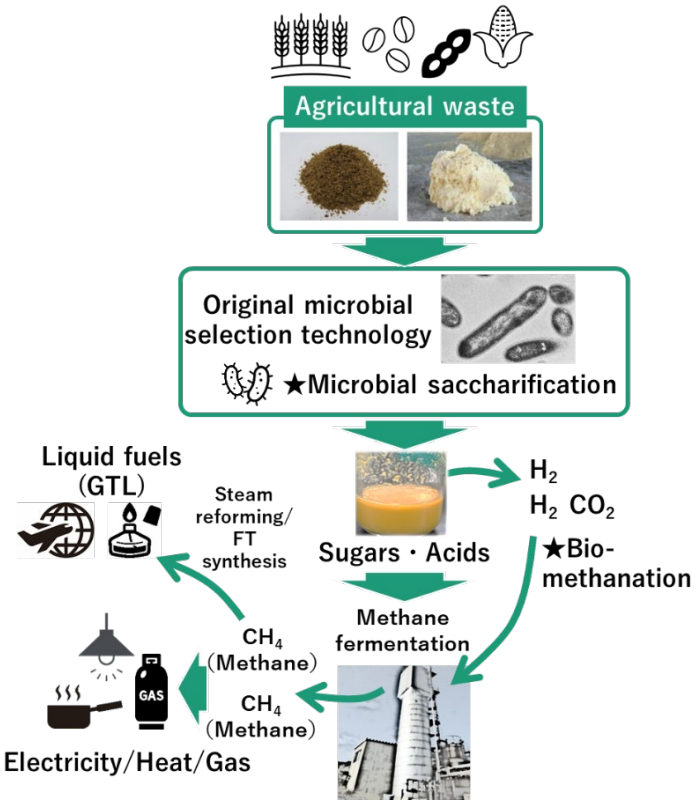

Fig. 2. Overview of low-cost, high-efficiency CH_4 and H_2 production technology through microbial saccharification and bio-methanation
GTL: Gas to Liquid

Technical details:

https://www.jircas.go.jp/en/publication/research_results/2020_c03

https://www.jircas.go.jp/en/publication/research_results/2014_c05

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Japan International Research Center for Agricultural Sciences

A new F_1 high-sugar, high-biomass sorghum variety "ENRYU" supports decarbonization efforts

Production | Implementation | Item: Sorghum | GHG emission reduction, Biomass utilization

Outline

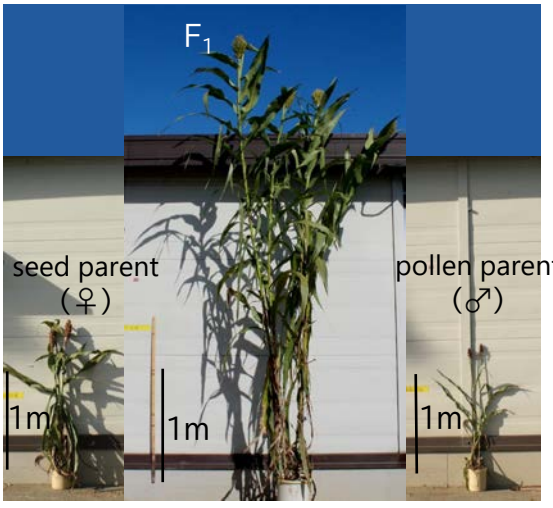
We elucidated the principle of heterosis* by genetically analyzing sorghum heterosis, an agriculturally important phenomenon, and identifying the genes sufficient for high-biomass sorghum. The new F_1 sorghum variety "ENRYU," which has a high sugar content and high biomass, is the first example of the principle application. For the decarbonized society, it proposes a new concept of cascade use† of the extracted syrup as an energy source and the residues as animal feed.

* Heterosis: The phenomenon in which the first filial exhibits a trait superior to that of its parents.
† Cascade use: A multi-stage use of materials where a residue from one process is used in another process.

Background/effect/note

The principle of heterosis in high biomass sorghum was elucidated through genetic analysis of the hybrid progeny generation (Fig. 1). The variety "ENRYU" (Fig. 2) was created by utilizing this principle, and it has a quantitative trait locus (QTL) (*qBRX-6*) derived from sweet sorghum, in addition to five genes sufficient for the culm length heterosis. Thus, the distinctive traits of high sugar content and high biomass were realized. Cultivation in temperate and tropical zones will enable the cascade use of extracted syrup and residues. The new variety "ENRYU" supports efforts toward developing a decarbonized society with a new carbon value chain linking agriculture, distribution, and consumption.

(a)



(b)

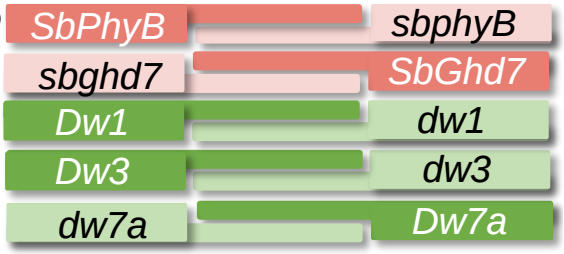


Fig. 1. Heterosis of a high biomass sorghum F_1 variety and five genes supporting the principle.
(a) Left: seed parent, right: pollen parent, center (Ref. 2): F_1.
(b) Five genes controlling hybrid vigor.

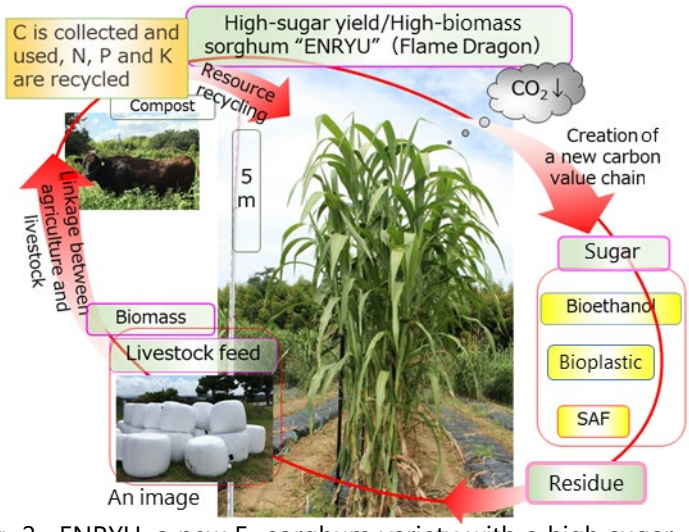


Fig. 2. ENRYU, a new F_1 sorghum variety with a high sugar yield and high biomass. It shows potential for cascade use, where the extracted sugar is used for energy and the residue for livestock feed.

Technical Details:

1) https://www.jst.go.jp/pr/jst-news/backnumber/2023/202305/pdf/2023_5_p8-11.pdf
2) (License: CC BY 4.0) https://www.nature.com/articles/s41598-021-84020-3

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SHINSHU UNIVERSITY
NAGOYA UNIVERSITY

Biological nitrification inhibition maintains wheat yield with reduced nitrogen fertilizer application

Production | Demonstration | Item: Wheat

GHG emission reduction
Chemical fertilizer reduction

Outline

Biological nitrification inhibition (BNI)-enabled wheat, in which BNI capacity was introduced from wild wheat by intergeneric crossing, suppresses soil nitrification, maintains high productivity under reduced nitrogen (N) application, and consequently reduces environmental loads, such as nitrous oxide (N_2O) emissions and aquatic pollution in wheat cultivation.

Background/effect/note

BNI is the mechanism that inhibits soil nitrification and reduces the conversion of ammonium from fertilizer to nitrate by releasing substances from crops. BNI-enabled wheat (Fig. 1) exhibited improved nitrogen use efficiency with enhanced BNI (introduced from wild wheat by intergeneric crossing) capacity. As the productivity under low N conditions is improved, grain yield and quality were not significantly different with a 60% reduction in N fertilizer application (Fig. 2). BNI-enabled wheat can reduce lifecycle GHG emissions (Fig. 3) and aquatic pollution from nitrate, which is easily leached from the soil, due to the decreased N application and the suppression of soil-nitrifying activity. The expression of BNI capacity is dependent on soil conditions (pH etc.).

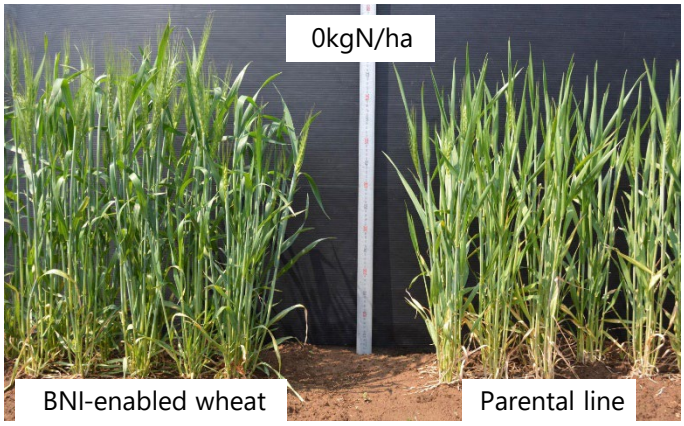

Fig. 1. Biological nitrification inhibition (BNI)-enabled wheat exhibits improved productivity under low nitrogen conditions in the field.

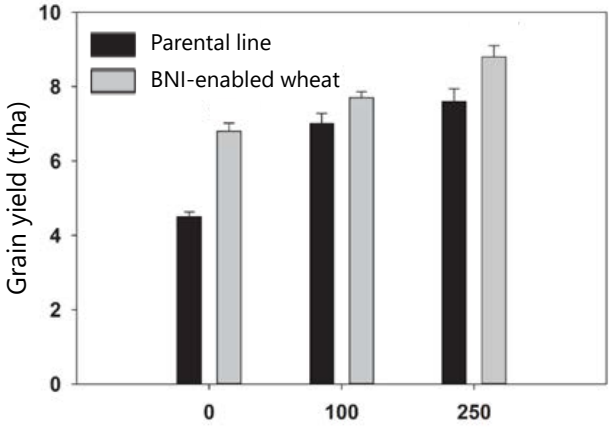

Fig. 2. Grain yield with different nitrogen application amounts

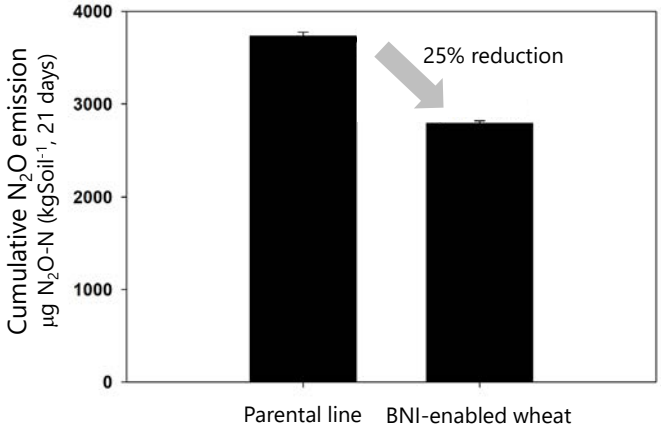

Fig. 3. N_2O emissions from rhizosphere soil

Technical details:

JIRCAS research highlights (FY2021)

https://www.jircas.go.jp/en/publication/research_results/2021_a04

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Japan International Research Center for Agricultural Sciences

"Paddy Field Dam" that reduces flood damage downstream while maintaining agricultural production

Production | Implementation | Item: Paddy rice | Climate disaster mitigation

Outline

We developed a simple device (a weir plate "Damkeeper") for controlling the water level of paddy fields to easily suppress paddy water runoff without negative impacts on rice growth and yield. "Paddy Field Dam" is expected to alleviate flood damage in the downstream area by temporarily storing stormwater during heavy rainfall.

Background/effect/note

"Paddy Field Dam" that temporarily impounds stormwater in paddy fields has received attention as a countermeasure against flood damage, which has increased in recent years. As the "Paddy Field Dam" uses farmers' land to store water, the anxiety of farmers must be addressed and their understanding of the device is essential. We found out the characteristics of inundation damage to paddy rice (Fig. 1), which proved you can use "Paddy Field Dam" to reduce flood damage even during the rice growing period. We also developed a weir plate-type device that can be easily placed for controlling the water level of the paddy fields as one of the variations of "Paddy Field Dam" devices (Fig. 2). A local demonstration in paddy fields revealed that this device enhances the water storage capacity of the paddy fields during heavy rain (Fig. 3). The "Paddy Field Dam" is expected to have larger effects with larger application areas.

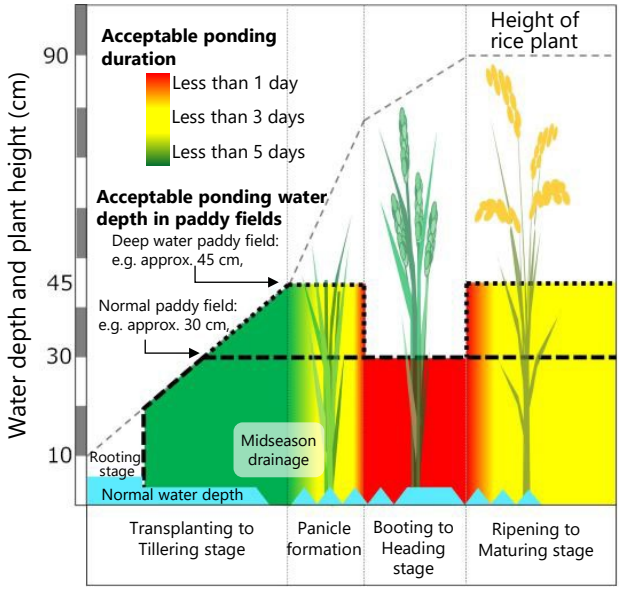

Fig. 1. Growth stages of rice and threshold of ponding water depth that rice plants tolerate

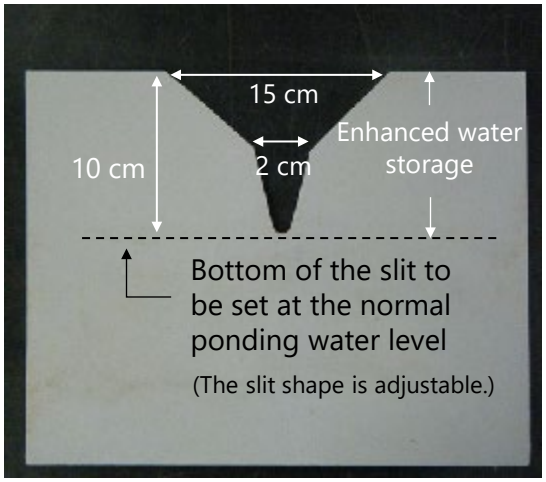

Fig. 2. Structure of the weir plate "Damkeeper" (water level control device)

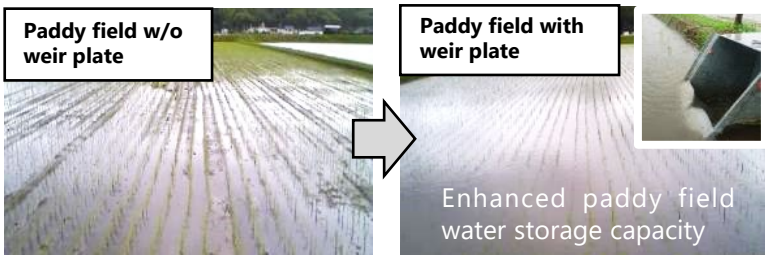

Fig. 3. Demonstration of "Paddy Field Dam" (immediately after heavy rain)

Technical Details:
https://www.naro.go.jp/english/topics/laboratory/nkk/136445.html

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National Agriculture and Food Research Organization

Monitoring saline intrusion in rivers near paddy fields using satellite data

Production | Demonstration | Item: Paddy rice | Climate disaster mitigation

Outline

Salinity cannot be directly estimated from satellite imagery. However, the strong correlation between electrical conductivity and river turbidity can be used to indirectly estimate seasonal changes in river salinity. This technology enables the implementation of proactive measures to prevent saltwater intrusion into rice paddies.

Background/effect/note

River turbidity is high in upstream areas near the ocean (Fig. 1). Freshwater from river water becomes turbid due to the strong repulsion between negatively charged suspended particles. The mixing of cations with the entry of seawater suppresses the repulsion between particles, and the suspended particles agglomerate (flocculate). Based on this correlation between electrical conductivity and turbidity (Fig. 2(a)), the electrical conductivity of river water can be indirectly estimated from the green band reflectance of Sentinel-2 satellite data (Fig. 2(b)). The use of satellite imagery is an effective method in understanding the spatial and temporal changes in saline intrusion, which will facilitate the implementation of proactive measures to prevent saltwater intrusion into rice paddies (Fig. 3).

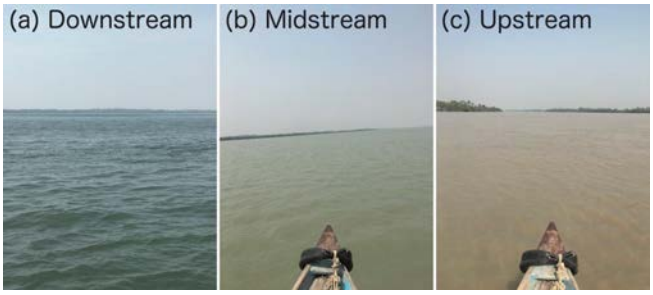

Fig. 1. Photographs of river water conditions in the (a) downstream, (b) midstream, and (c) upstream reaches of Ywe River on 9 March 2018

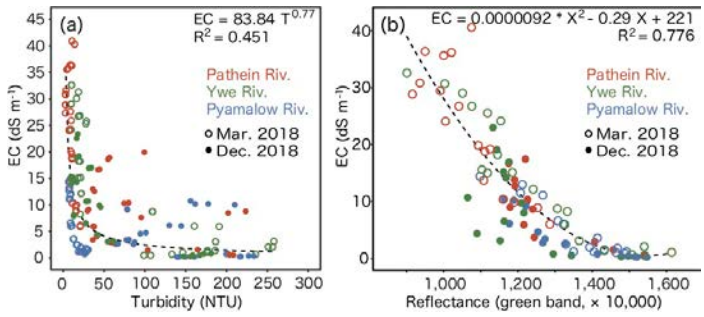

Fig. 2. Correlation between (a) turbidity and electrical conductivity (EC), and (b) EC and green band reflectance retrieved from Sentinel-2

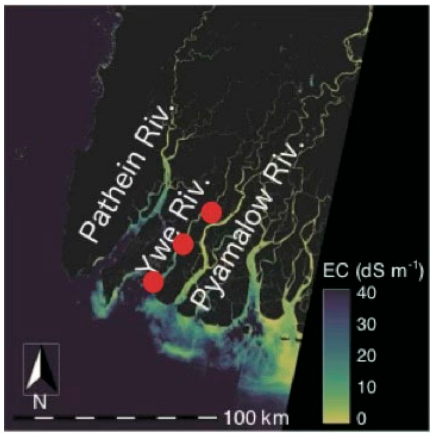

Fig. 3. Electrical conductivity (EC) map derived from the reflectance of the green band in the satellite image (March 12, 2018)
The red dots are locations where the images shown in Fig. 1 were captured.

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_a03

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Japan International Research Center for Agricultural Sciences

“Disaster prevention support system for irrigation pond” to predict flood risk and share disaster information

Production | Implementation | Item: Disaster prevention | Climate disaster mitigation

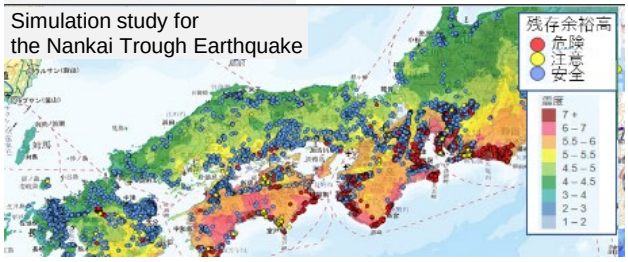
Outline

We developed a system that visualizes the risk of irrigation pond failure in the event of an earthquake or heavy rain and enables sharing of the state of pond damage for people involved in disaster prevention. This system enables alleviation of human damage caused by irrigation pond failure and ensures the reach of rapid support to the disaster responders.

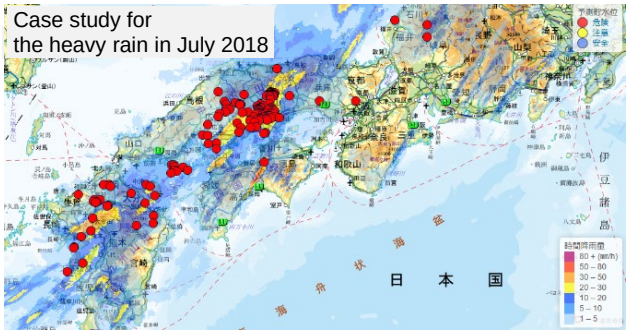
Background/effect/note

During the Great East Japan Earthquake in March 2011 and the heavy rainfall in July 2018, several irrigation ponds collapsed, resulting in severe secondary disaster in the downstream areas. To prevent secondary disaster, the measures to predict the pond failure and communicate the hazard information was needed.

The “Disaster prevention support system for irrigation pond” (Fig. 1) is useful for predicting the real-time risk of pond damage during disasters and sharing information and photographs of the damage with personnel involved in disaster prevention, such as national and municipal governments (Fig. 2). This enables the implementation of rapid emergency measures and disaster response.



Hazard prediction in the event of an earthquake



Hazard prediction in the event of heavy rain

Irrigation pond hazards labeled "Dangerous (red)," " Alert (yellow)", and "Safe (blue)"

Fig. 1. Disaster prevention support system for irrigation pond

Fig. 2. Irrigation Pond Management App

Technical Details:

https://www.naro.go.jp/english/laboratory/nkk/press_release/smartphone/index.html

https://www.naro.go.jp/english/laboratory/nkk/press_release/pondapp/index.html

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National Agriculture and Food Research Organization
農研機構 NARO

Underdrain-drilling machine “Cut Drain”: Easy construction of subsurface drainage without additional materials

Production | Implementation | Item: Field crop | Climate disaster mitigation

Outline

Deep drainage cavities can be constructed continuously by towing the “Cut Drain” with a tractor without using additional materials, such as pipes. In Japan, drilling unit developed and practically applied for this purpose is sold by a domestic tractor manufacturer and is used and popularized for drainage improvement in flat and clayish agricultural lands.

Background/effect/note

The “Cut Drain” constructs cavities underground by towing the drilling unit with a tractor to resolve the poor drainage in the farmland (Figs. 1–3). Additionally, the “Cut Drain” eliminates salt through underground infiltration in semi-arid lands and has been demonstrated as a simple and low-cost technology to reduce salt hazard in Uzbekistan. The technology is also useful for subdrainage in low-level wetlands and salt-damaged areas in Asia, Africa, and other regions.

However, the application of “Cut Drain” is limited to the clay soil type. The development of inexpensive grade units is currently under consideration for overseas countries.

Fig. 1. Drilling unit of “Cut Drain”

Fig. 2. Drilling unit in operation

Fig. 3. How to create a water conduction hollow without pipes

Technical details:

https://www.jircas.go.jp/sites/default/files/publication/manual_guideline/manual_guideline-_-_55.pdf (JIRCAS)

https://www.jircas.go.jp/en/publication/research_results/2017_a03 (JIRCAS)

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National Agriculture and Food Research Organization
農研機構 NARO

The “Cut-Soiler” tractor attachment easily constructs shallow subsurface drainage systems using agricultural residues such as rice and wheat straw

Production | Demonstration | Item: Field crop, Agricultural residue | Climate disaster mitigation, Biomass utilization

Outline

Using the “Cut-Soiler” tractor attachment, developed in Japan, is an inexpensive and easy method for constructing shallow subsurface drainage* systems. In this method, drainage systems are constructed using agricultural residue by simply pulling the attachment while driving a tractor. This method contributes to improving drainage, mitigating salinization, and processing agricultural residues.

* Shallow subsurface drainage: a drainage hole constructed at 40–60 cm depth without excavation in the farm field.

Background/effect/note

Conventionally, when constructing material-filled subsurface drainage systems, it is necessary to prepare the hydrophobic material to be buried in the soil and load it into the construction machine. Cut-Soiler (Fig. 1) does not require these tasks; instead, harvested residues such as rice and wheat straw can be scattered in the field and buried simply by running a tractor equipped with Cut-Soiler. Therefore, shallow subsurface drainage systems can be constructed inexpensively and easily (Fig. 2).

Salinization is a serious issue in the Indo-Gangetic Plain owing to tube well irrigation‡. Considering the high-salinity irrigation water and poor drainage in the region, Cut-Soiler to construct shallow subsurface drainage systems has been shown to reduce soil salinity and improve yields.

Cut-Soiler does not have wheels for long-distance transport; therefore, it must be loaded onto a truck for transportation. The estimated useful life of Cut-Soiler is approximately 7 years when covering 30–50 ha per year. If there are no problems with the frame, it can be used continuously by simply replacing the consumables. In paddy fields, the water requirement rate may increase. Construction is difficult when there is a gravel layer**, stone, or wood (more than 5 cm thick).

‡ Tube well irrigation: an iron pipe (10–20 cm in diameter) is driven into the groundwater layer, and groundwater is pumped up for irrigation.

** Gravel layer: a layer formed of sand and pebbles.

Fig. 1. Cut-Soiler

①The shredded residue (straw, stems, and leaves) and compost are scattered on the field after harvesting.

②Driven by a tractor, the Cut-Soiler cuts the soil into an inverted triangular (V) shape and lifts the soil to open a trench. Simultaneously, the surface materials are collected and pushed toward the narrow groove formed during trench opening.

③The lifted soil is backfilled over the filling material, creating a groove-shaped, shallow subsurface drainage system.
As the ground is raised after construction, the field should be leveled using a rotary, leveler, or disc harrow.

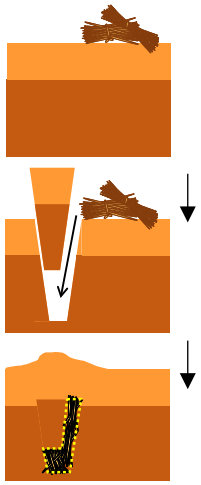

Fig. 2. Method of constructing a shallow subsurface drainage system using Cut-Soiler

Technical details:
JIRCAS Research Highlights(2022)
https://www.jircas.go.jp/en/publication/research_results/2022_a11

Cut-Soiler User’s guide
https://www.jircas.go.jp/ja/publication/manual_guideline/jircas-2022-001

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Japan International Research Center for Agricultural Sciences
National Agriculture and Food Research Organization

International differential system to protect the rice production against rice blast diseases

Production | Demonstration | Item: Rice | Chemical pesticide reduction

Outline

An international differential system for rice blast control was developed by combining "standard differential strains" and "standard differential rice cultivars" collected and cultivated in collaboration with research institutes in Asia and Africa. By using this system, it is possible to identify the distribution of rice blast strains that are prevalent in a target area and rice cultivars with appropriate resistance, leading to a reduction in the amount of agricultural chemicals used.

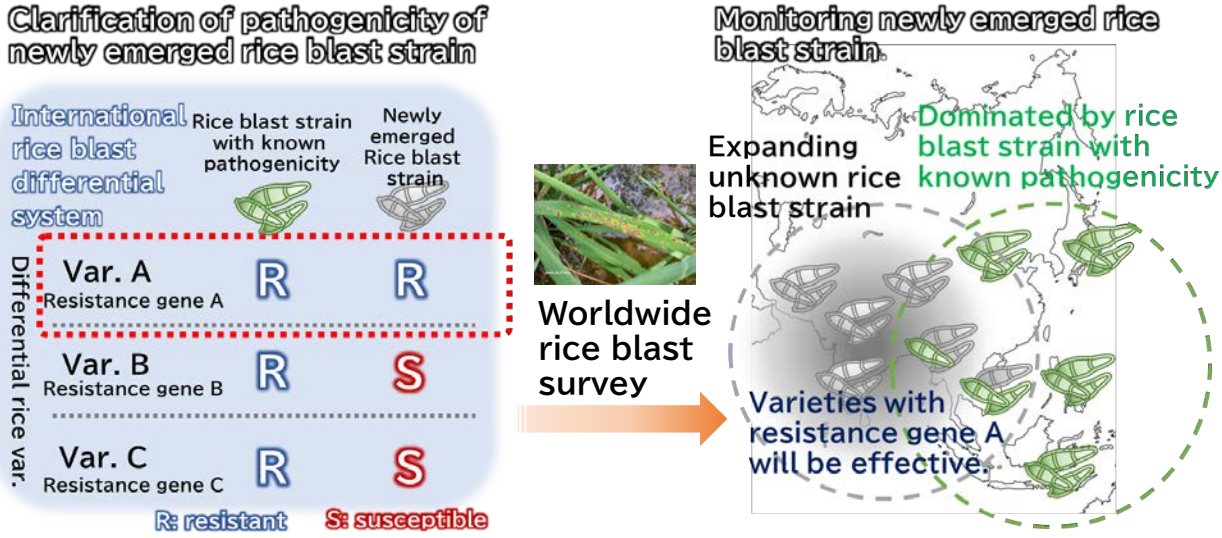
Background/effect/note

Rice blast is a serious disease that reduces rice production by 30-60% without proper control. For rice blast control, we collected and selected standard strains of rice blast in Asia and Africa. We also developed 23 standard rice cultivars with resistance genes in collaboration with the International Rice Research Institute (IRRI). The international rice blast differential system combines the standard strains and the standard cultivars.

The system can ascertain pathogenicity of a newly emerged rice blast (Fig. 1). It can also clarify effective resistance genes, which can be used for breeding resistant cultivars.

Though each country restricts imports of rice blast fungi across borders in terms of plant protection, the standard differential rice cultivars can be shared.

In Indonesia, Vietnam, Laos, and Bangladesh, "rice blast differential strains" have been selected and the system is available.



The differential system identifies an effective resistance gene. For a known rice blast strain, resistance gene A, B, and C are effective. For a newly emerged rice blast strain, only gene A is effective.

Based on the information from the differential system, distribution of a newly emerged rice blast strain can be grasped, which will enable proactive measures against rice blast.

Fig. 1. An example of effective utilization of the international rice blast differential system

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_b11

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Japan International Research Center for Agricultural Sciences

Controlling disease in paddy rice seeds using hot water disinfection combined with pre-drying

Production | Implementation | Item: Paddy rice | Chemical pesticide reduction

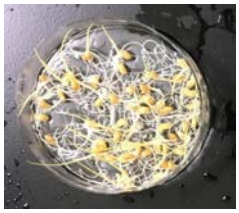
Outline

The heat stress tolerance of rice seeds improved when their water content was reduced to less than 10% before disinfection with hot water (Fig. 1). Based on this finding, a new high-temperature hot water disinfection method that incorporates a pre-drying step was established and adopted into practical use. This technique enables disinfection at a higher temperature (65˚C) than that used in the conventional method. Therefore, it can be effective in controlling "Bakanae disease," for which conventional methods have not been sufficient.

Background/effect/note

The hot water disinfection method, in which rice seeds are immersed in water at 60˚C for 10 minutes, is a clean technology without pesticides. However, some diseases, such as "Bakanae disease" are not sufficiently controlled by this treatment. Therefore, we developed an improved method that incorporates a pre-drying step. Experimental results using rice cultivars from Thailand (Fig. 3) and Malaysia showed that pre-drying was effective in improving the heat tolerance of rice seeds. This method enables disinfection at a high temperature of 65˚C and was shown to be as effective as chemical pesticides in controlling "Bakanae disease" (Fig. 2). Furthermore, pre-drying followed by disinfection at 65˚C for 10 minutes was effective in controlling blast as well as bacterial diseases, such as bacterial seedling rot and bacterial seedling blight, which are increasing due to global warming. This method does not require special equipment to dry the seeds or boil the water. Practical applications of this disinfection method in rice-planting areas in Southeast Asia are also expected.

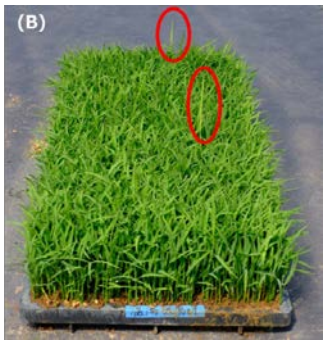
Without pre-drying
(14.0% water content)



With pre-drying
(8.9% water content)

Fig. 1. Germination of "Nipponbare" seeds treated with hot water at 65˚C for 10 minutes.
Pre-drying was performed at 50˚C for 24 hours. The seeds were soaked in water at 28˚C for 10 days under dark conditions.

New technology
(pre-drying +65˚C for 10 minutes)



Conventional method
(60˚C for 10 minutes)

Fig. 2. Efficacy of high-temperature hot water disinfection (new technology) for control of Bakanae disease.
Seedlings circled in red are infected with Bakanae disease (conducted at Akita Prefectural University).

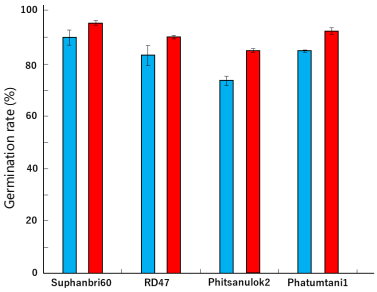


Fig. 3. Pre-drying treatment improves heat stress tolerance of rice seeds in Thailand.
Blue: without pre-drying Red: with pre-drying
The seeds were treated with water at 65˚C for 10 minutes.

Technical details:
https://www.jstage.jst.go.jp/article/plantbiotechnology/30/2/30_13.0207a/_article/-char/ja

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Tokyo University of Agriculture and Technology

Propagation and distribution system of healthy seedcane as control measures against sugarcane white leaf disease

Production | Implementation | Item: Sugarcane | Chemical pesticide reduction

Outline

We developed a system and manual on field management techniques for propagation of healthy seedcane to control sugarcane white leaf disease (SCWLD) (Fig. 1), distribution methods for the production, procedures to detect pathogens using the loop-mediated isothermal amplification (LAMP) method, and procedures to produce disease-free seedlings using the growth point culture method.

Background/effect/note

SCWLD is one of the most devastating insect-borne diseases affecting sugarcane production in Asia. We considered that the use of healthy seedcane is highly effective in controlling SCWLD. Hence, a manual for the propagation and distribution of healthy seedcane was developed for sugar mills and institutions that produce and distribute seedcane to farmers (Fig. 2). Verification test demonstrated sufficiently low rate of healthy seedcane even though the number of diseased plants increased up to 10-fold in the third generation (Fig. 3). The insecticides that can be used to control the vector are based on information available in Thailand. Users are advised to check and confirm current pesticide treatment regulations in their respective countries.

Fig. 1. A field abandoned due to widespread sugarcane white leaf disease (SCWLD)

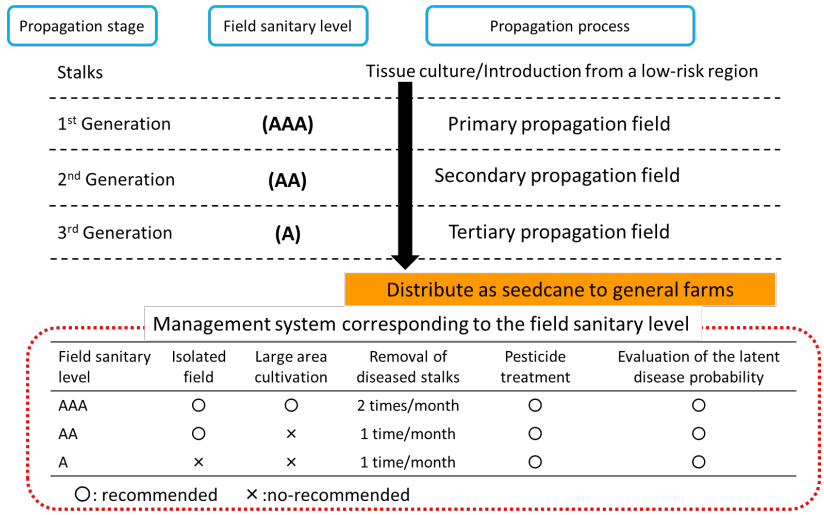

Fig. 2. Overview of the healthy seedcane propagation system

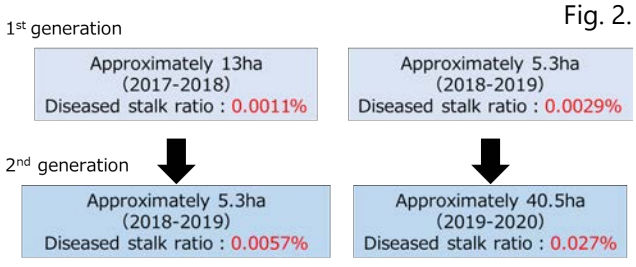

Fig. 3. Results of the healthy seedcane propagation verification test
Observations for two generations showed lower disease prevalence (0-20%, mean 5.8%, median 5%) as compared to newly planted fields.

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_b10

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Japan International Research Center for Agricultural Sciences

Strawberry disease control with heat shock treatment

Production | Demonstration | Item: Strawberry | Chemical pesticide reduction

Outline

Spraying strawberries with hot water (heat shock treatment) once a week during cultivation induces systemic disease resistance in the plant body and suppresses the occurrence of powdery mildew, including fungicide-resistant strains, at a level similar to suppression using agricultural chemicals. Heat is expected to have a direct suppressive effect on other pests and diseases as well.

Background/effect/note

Strawberry cultivation in the main field lasts for more than six months for June-bearing varieties* and for multiple years for everbearing varieties‡. Despite long cultivation periods, the use of agricultural chemicals on strawberries is limited to registered formulations, and the application frequency is restricted. In particular, the chemical control of powdery mildew has become difficult because of the emergence of an ergosterol biosynthetic inhibitor (DMI) resistant strain. Heat shock treatment applied by spraying hot water once a week (Fig. 1) can suppress DMI-resistant powdery mildew by inducing systemic resistance, as well as through the direct effect of heat. To obtain the best effect, the strawberry leaves closest to the spray nozzle are treated at 50˚C for 20 seconds (Figs. 2, 3). This treatment also has a direct suppressive effect on thrips and aphids. There is no damage to yield or quality if the treatment is applied properly; however, it should be noted that the expected effect is preventive and not curative. In addition, to prevent gray mold due to increased humidity in the greenhouse, the treatment should be applied in the morning on sunny days, and the plants should be dried using ventilation immediately after spraying.

* June-bearing varieties: flower sprouts in short-day conditions and fruiting only in winter and spring.
‡ Everbearing varieties: fruiting not only in winter and spring, but also in summer and fall.

Fig. 1. Hot water spraying device (Rikuzentakata City, Iwate Prefecture)

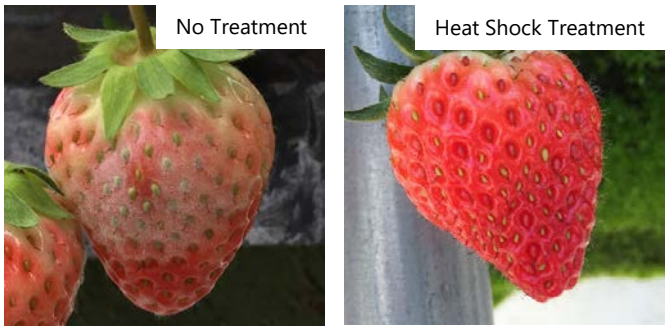

Fig. 2. Effect of heat shock treatment on powdery mildew

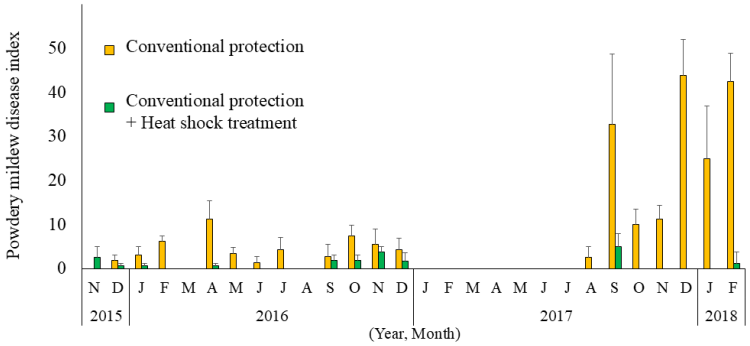

Fig. 3. Effects of heat shock treatment on resistant strain of powdery mildew

Technical details:

http://protech.agr.ibaraki.ac.jp/sub25.html

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茨城大学 Ibaraki University

Smart production systems contributing to productivity improvement in paddy rice cultivation

Production | Demonstration and implementation | Item: Paddy rice | Labor productivity enhancement

Outline

Smart agricultural technologies, such as automated rice transplanters, multi-robot work systems*, and yield-monitoring combine harvesters** have been developed. These technologies contribute to significant improvements in the productivity of paddy rice cultivation.

* A system with which an operator can drive multiple agricultural machines at the same time
** A combine harvester with functions of weighing unhulled rice and determining water content of the grains

Background/effect/note

Automation technologies for agricultural machines have been developed to achieve efficient production (Fig. 1). They are especially important because the number of farmers has decreased. Smart agricultural machines reduce the workload of operators, improve work efficiency, and decrease the number of farm workers. Additionally, smart agricultural machines enable variable rate fertilizer application in fields with uneven fertility and crop growth. Furthermore, performing tasks, such as record and data aggregation management of farms, crops, and work history become easy by linking with the agricultural management system. Consequently, the efficiency of farm management can be improved.

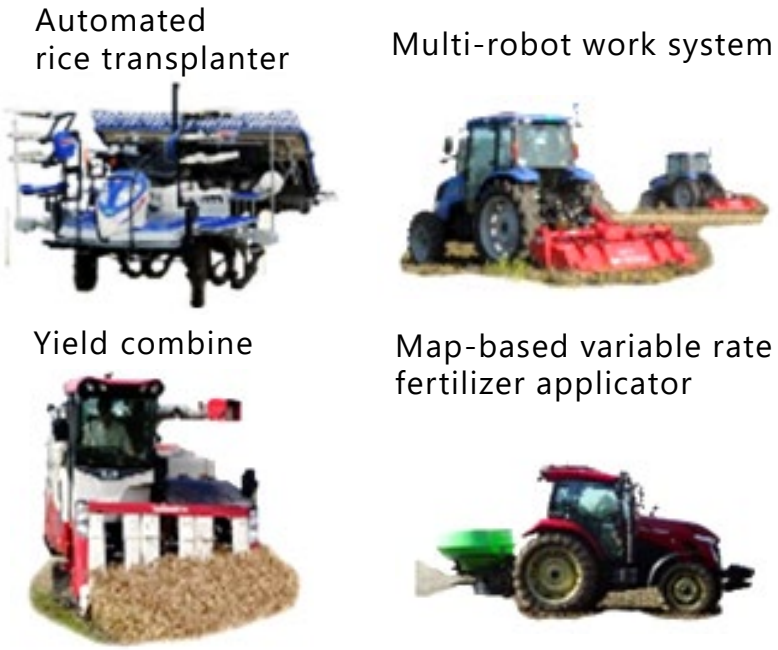

Fig. 1. Examples of smart agricultural production systems

Technical Details: [Japanese]
https://www.naro.go.jp/publicity_report/press/laboratory/iam/075850.html
https://www.naro.go.jp/project/results/4th_laboratory/tarc/2017/17_003.html

Movie: [English]
https://www.youtube.com/watch?v=yGizlqBcL80&list=PLW99yTRNzVkPpBMyGubqVY3TeqSurjusE&index=3
https://www.youtube.com/watch?v=-ZxVm6QgLc8&list=PLW99yTRNzVkPpBMyGubqVY3TeqSurjusE&index=19

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National Agriculture and Food Research Organization

Smart agricultural machinery in compliance with the Common Communications Standard (ISOBUS)

Production | Demonstration and implementation | Item: Agricultural machinery | Labor productivity enhancement

Outline

ISOBUS realizes electronic inter-operability beyond the frames of agricultural machinery manufacturers. Digital transformation (DX) of agricultural operations, such as variable fertilizing and spot chemical application are likely to be promoted through the practical use of agricultural machines compliant with ISOBUS.

Background/effect/note

In Europe and the United States, tractors and working machines compliant with ISOBUS have become standards (Fig. 1). The compliant working machines can electronically connect and exchange various data with each other beyond the frames of the manufacturers (Fig. 2). This will enable agricultural operations, such as variable fertilizing and spot application of chemicals based on image data acquired by drones, operation log acquisition, etc. DX of agricultural operations will also be promoted through data linkage with the cloud platform.

NARO developed the first domestic product of Electronic Control Unit (ECU) for working machines which acquired ISOBUS certification. This technology was transferred to a Japanese agricultural machinery manufacturer who developed a general-purpose ECU (Fig. 3) applicable to various types of agricultural machines and 3 types of ISOBUS-compliant agricultural machines. The general-purpose ECU has been commercially available since April 2022.

Fig. 1. ISOBUS certification marks

Fig. 3. Commercially available general-purpose electronic control unit (ECU)

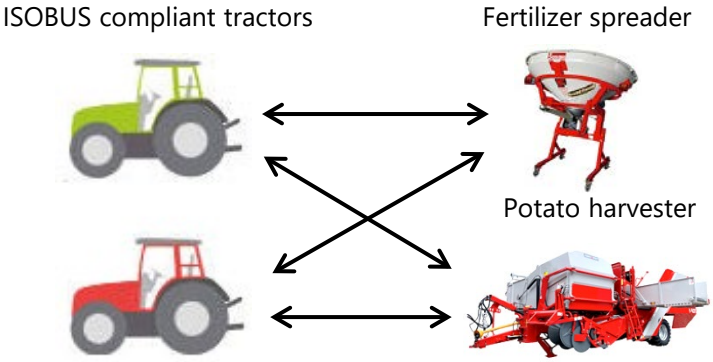

Fig. 2. Image of data exchange through electronical connections between the tractors and the other machines

Technical details:

https://www.naro.go.jp/publicity_report/press/laboratory/iam/152162.html (Japanese)
https://www.naro.go.jp/english/laboratory/iam/press_release/19july/index.html (English)

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National Agriculture and Food Research Organization
農研機構 NARO

A simple shoot-tip grafting practical method for virus-free passion fruit propagation at the farm level

Production | Implementation | Item: Passion fruit | Labor productivity enhancement

Outline

A practical technology for virus-free propagation of passion fruit seedlings at the farm level has been developed using a simple shoot-tip grafting.

Background/effect/note

In Asia, passion fruit (*Passiflora edulis*) is produced mainly in Indonesia, India, and Vietnam. Recently, passion fruit production is gaining attention as an alternative crop to tackle climate change in Japan. However, the occurrence of Passiflora latent virus (PLV) diseases is a major problem concern (Fig. 1). Virus infection can spread easily due to vegetative propagation via cuttings. Thus, securing virus-free plants is difficult due to infection of the mother stock used for propagation. We established a method for virus-free propagation of passion fruit from PLV-infected plants using a simple shoot-tip grafting method that can be easily introduced into the field without any aseptic technique and facility (Fig. 2). This method may be effective against other viruses and viral infection related symptoms of unknown cause in the production countries for the propagation of healthy seedlings.

Fig. 1. Viral infection-like symptoms observed in the leaves and fruits of passion fruit

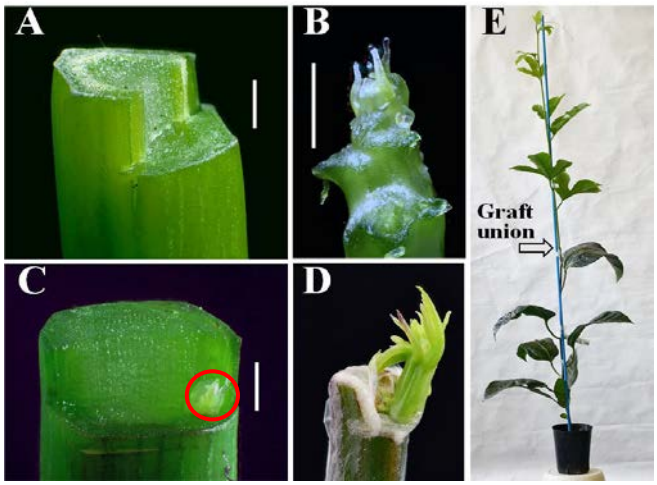

Fig. 2. In vivo shoot-tip grafting of passion fruit (bar = 1 mm)

A: Preparation of a rootstock.
B: The shoot-tip is used as a scion (0.2–1.0 mm)
C: The excised shoot-tip attached on the cambium of the rootstock and covered with laboratory film to prevent drying.
D: Sprouting of the scion in approximately one month.
E: After approximately two months, the growing scion is ready for virus detection.

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2021_c02

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Japan International Research Center for Agricultural Sciences

Removing seed coat tissues improves the germination rate, enabling seedling propagation to achieve the planned management of sago palms

Production | Implementation | Item: Sago palm | Labor productivity enhancement Resource management

Outline

Applying a simple physical treatment to remove the seed coat tissues from sago palm seeds, dramatically increases the germination rate, enabling seedling propagation. This method can increase the survival rate in the field by more than 30% compared with that of the conventional method of transplanting suckers*, enabling planned resource management.

* Sucker: part of the young shoot where a portion of the rhizome appears above ground.

Background/effect/note

The sago palm grows in Southeast Asia and accumulates more than 200 kg of starch (dry weight) in its trunk. It is a resilient plant capable of adapting to problematic soils such as saline and acidic soils. Sago palm starch is used as an ingredient in allergy-preventive foods and meals for older adults. Traditionally, it has been harvested from natural forests; however, in recent years, resource management has become necessary to meet increasing demand. Challenges have emerged, including the low survival rate in the field (~60%) with vegetative propagation (sucker transplanting) and the low seed germination rate (~20%). Therefore, we developed a method to remove seed coat tissues (pericarp and sarcotesta) that contain germination inhibitors (Fig. 1) prior to sowing. This method increases the germination rate to over 90% (Fig. 2), and few seedling deaths are observed after transplantation. The same effect is achieved by excising the seed coat tissues above the embryo (Fig. 3). A field demonstration was conducted at a university in Indonesia using this method (Fig. 4), and the application of this technology is expected in Malaysia, Thailand, the Philippines, and Brunei. This technology was adopted by the FAO Technical Corporation Program (TCP) in Papua New Guinea, with a sago nursery established in East Sepik Province in May 2023 (Fig. 5) and a new planting field of 1 hectare opened in August of the same year.

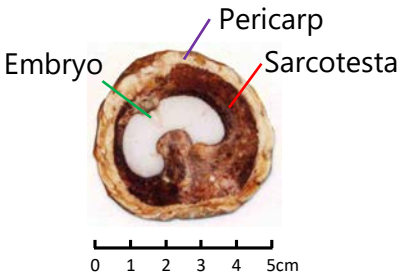

Fig. 1. Transverse section of sago palm fruit

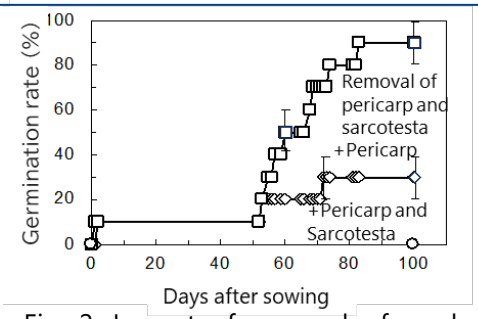

Fig. 2. Impact of removal of seed coat tissues on germination rate

Fig. 3. Pericarp and sarcotesta above embryo removed

Fig. 4. Seedlings planted in a field (Southeast Sulawesi, Indonesia)

Fig. 5. Sago Nursery of FAO TCP

Technical details:
https://icrea95.wixsite.com/labo/sago-palm-studies

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NAGOYA UNIVERSITY

Information and communication technology-based water management system for reducing agricultural water usage, agricultural labor, and electricity

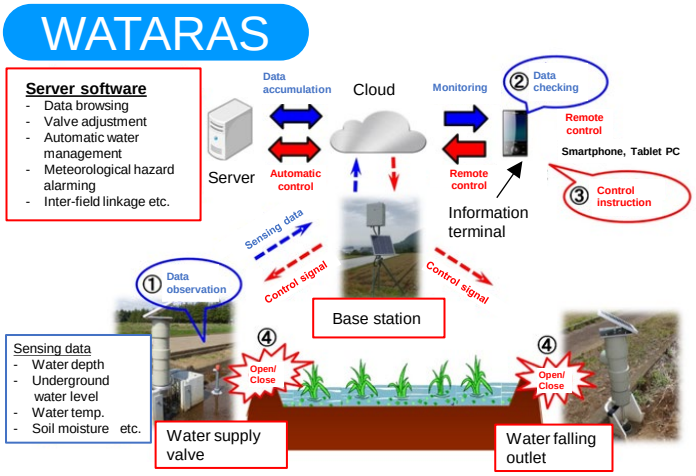
Production | Implementation | Item: Paddy rice | Resource management / Labor productivity enhancement

Outline

We developed the following two information and communication technology (ICT)-based systems: Water for Agricultural Remote Actuated System (WATARAS), for remote automated water supply and drainage management of paddy fields; Irrigation and Drainage Automation System (iDAS), for optimizing regional agricultural water allocation. The effective introduction of both systems enables optimum water supply and significant savings in labor costs and energy consumption.

Background/effect/note

The depopulation and the aging population of rural areas and the decline in the number of farmers have contributed to the insufficient management efforts of paddy fields and irrigation facilities and the wastage of water and power. The ICT-based water management from irrigation facility to paddy field enables the reduction of ① water management labor for paddy fields by approximately 80%, ② regional water consumption, and ③ the power consumption of pumps required for water use (Fig. 1). It is noted that those systems should be constructed to match existing infrastructure (e.g. paddy fields, water channels, information and communication) and cost-effectiveness that may vary depending on the country.



Outline of field water management system using information and communication technology.

iDAS **Data linkage**

Simulation of the optimum valve opening in the field.

Automatic control of water distribution facilities.

Communication Communication

Fig. 1. Management system for efficient agricultural water supply from irrigation facility to paddy field

Technical Details:

<<Episode 22>> Easy Water Management of Paddy Fields with Smartphones
https://www.naro.go.jp/laboratory/brain/english/press/stories/155708.html

(Research results) Development of an efficient water distribution management control system through field-water utilization facility cooperation using ICT.
https://www.naro.go.jp/english/laboratory/nkk/press_release/idas/index.html

(Video) Easy Water Management of Paddy Fields with Smartphones [Japanese]
https://www.youtube.com/watch?v=tdwMKx-a2hs&list=PLW99yTRNzVkNDB0HaClwbaqGa-m4ikBF2&index=13

(Video) Automated Water Management and Control System with ICT from irrigation facility to paddy field [Japanese]
https://www.youtube.com/watch?v=j1mrcuGSV1Y

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National Agriculture and Food Research Organization

Identification of wood species and provenance of timber to promote trade of legal timber

Production | Demonstration and implementation | Item: Timber | Resource management

Outline

We improved the identification technology for the timber produced in the Southeast Asian region (Fig. 1) to prevent illegal logging. Identification technology is based on the database and the combination of microscopic observation, DNA analysis, chemical analysis, and tree ring analysis.

Background/effect/note

Timber produced in Southeast Asia is estimated to consist of hundreds types of species, and contains wood with a high possibility of illegality during the process of production. The Forestry and Forest Products Research Institute established a comprehensive database comprising approximately 180 types of commercially traded tree species groups originating from Southeast Asia. This database is based on wood samples obtained from around 30,000 specimens representing approximately 8,000 species worldwide[1]. Leveraging this database, the identification of wood species (primarily at the genus level) and estimation of their origin are accomplished through microscopic observation[2]. To enhance the accuracy of identification, we developed a DNA analysis for meranti (*Shorea* spp.)[3], a chemical composition analysis for ramin (*Gonystylus* spp.) (Fig. 2), and a country-of-origin discrimination method based on tree ring analysis for teak (*Tectona grandis*). Since applicable identification methods vary by tree species, careful selection of analysis methods based on microscopic estimation results is necessary.

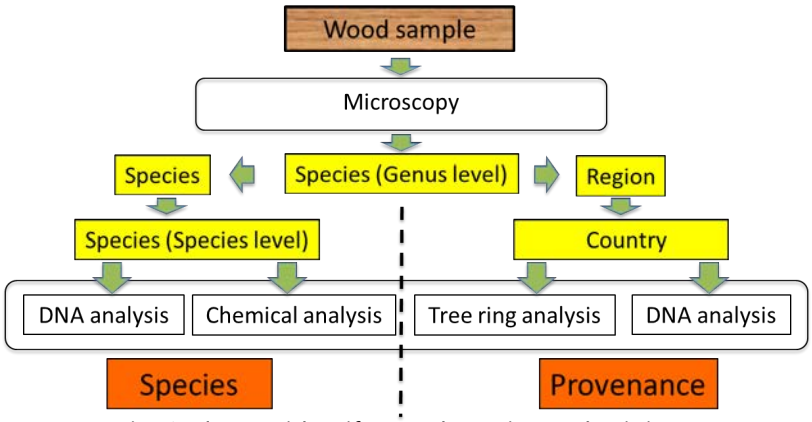

Fig. 1. Flow to identify wood species and origins

1-6 : Wood species similar to ramin
7-9 : Ramin (*Gonystylus banacanus*)
10 : Standard sakuranetin
Ramin can be identified by sakuranetin.

Fig. 2. Identification of ramin wood by thin layer chromatography (TLC)

Technical details:

1) https://db.ffpri.go.jp/WoodDB/index-E.html
2) https://www.kaiseisha-press.ne.jp/ISBN9784860992446.html
3) https://doi.org/10.1007/s10265-010-0348-z

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Forestry and
Forest Products Research Institute

A simple calculation method of biological indices for blood cockle resource management through aquaculture fishing ground selection and harvest time determination

Production | Demonstration | Item: Blood cockles | Resource management

Outline

To properly conduct blood cockles resource management in Southeast Asia, where its production has been drastically decreasing, we improved the calculation method of indicators of bivalve growth conditions, including the sharpness index and condition factor. This facilitates the identification of optimal aquaculture fishing grounds that can ensure a high survival rate of spat, determine appropriate harvest time when production can be increased, ultimately enhancing the utilization efficiency of natural spat.

Background/effect/note

The blood cockle, *Tegillarca granosa* (Fig. 1), is rich in minerals and vitamins and is an indispensable ingredient to the local people. Presently, the production of blood cockle in Southeast Asia is alarmingly decreasing because of environmental deterioration. Therefore, appropriate resource management and technical measures to recover the resource are required. We developed simple biological indices that can easily evaluate the fishing ground environment and growth condition of the blood cockle by improving the sharpness index and the condition factor (Fig. 2). These indices can be calculated by simply measuring three variables: shell length, shell width, and total weight, facilitating ease of monitoring of the environmental and growth conditions, enabling selection of optimal aquaculture fishing grounds (Fig. 3) and identification of appropriate harvest times.

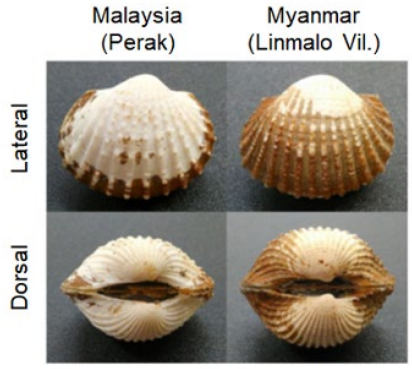


Fig. 1. Blood cockle (*Tegillarca granosa*)

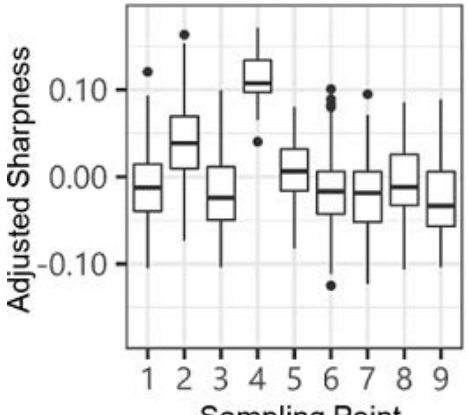
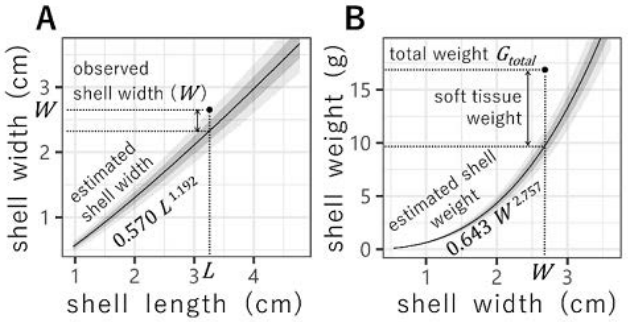


Fig. 3. Comparison of adjusted sharpness indices
Smaller values indicate a more suitable environment for cultivation of blood cockles.



$$SI_{adj} = \frac{W - 0.570L^{1.192}}{L} \quad \cdots\cdot \text{(Eq. A)}$$

$$CF = \frac{G_{total} - 0.643W^{2.757}}{G_{total}} \quad \cdots\cdot \text{(Eq. B)}$$

SI_{adj}: Adjusted sharpness index, W: Shell width (cm),
L: Shell length (cm), CF: Condition factor, G_{total}: Total wet weight (g)

Fig. 2. Derivation of estimate equations for the adjusted sharpness index (A) and the condition factor (B)
Each plot was superimposed with the allometry curve (black line) and 68% (light grey) and 95% (grey) prediction intervals.

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_c10
https://www.jstage.jst.go.jp/article/jarq/57/2/57_165/_article/-char/ja/

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Japan International Research Center for Agricultural Sciences

Utilizing coconut fiber for the recovery of tropical sea cucumber resources

Production | Demonstration | Item: Tropical sea cucumber | Resource management

Outline

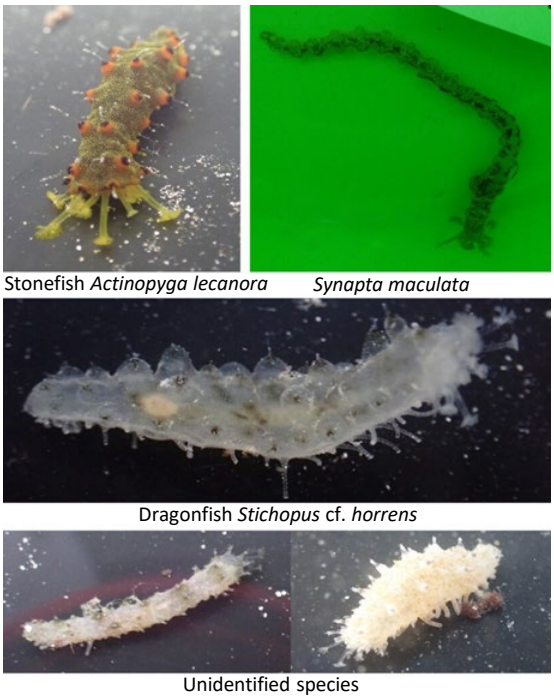
In tropical waters, sea cucumber resources are overexploited, and the release of seedlings (juveniles) has not been extended enough to recover the resources. We conducted experiments in Solomon Islands and demonstrated the technical feasibility of collecting wild seedlings of tropical sea cucumbers. Moreover, we found that coconut fiber is an efficient material for collecting the seedlings.

Background/effect/note

Wild seedling collection is a method of naturally attaching juveniles of invertebrates to materials moored in the sea. Examples of wild seedling collection have been reported for two *Apostichopus* species of temperate sea cucumbers, but not for tropical sea cucumbers. A tank experiment using hatchery-produced juveniles of the tropical sea cucumber, *Stichopus horrens*, showed that seedling collection efficiency of coconut fiber and mesh fabric was higher than that of oyster shells. Subsequently, simple seedling collectors filled with coconut fiber (Fig. 1) were moored in the sea for three months (Fig. 2), and multiple species of juvenile sea cucumbers were collected (Fig. 3). The collectors can be made cheaply using husks of commonly consumed coconuts and can be easily installed. Thus, we anticipate widespread adoption among the local fishing community to replenish the sea cucumber resources.

Fig. 1. Removing coconut fiber from the husk

Fig. 2. Deploying wild seedling collectors by snorkeling



Stonefish *Actinopyga lecanora* *Synapta maculata*

Dragonfish *Stichopus* cf. *horrens*

Unidentified species

Fig. 3. Juvenile sea cucumbers attached onto the wild seedling collectors

Technical details:

https://www.fra.go.jp/home/kenkyushokai/ronbun/2022/20221216.html (Japanese)

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Japan Fisheries Research and Education Agency

Overseas Fishery Cooperation Foundation of Japan

Smartphone application to collect coastal fisheries and environmental information for adaptation to changes in the marine environment (FishGIS)

Production | Demonstration | Item: Fisheries | Resource management

Outline

Local fishers can quickly share information on changes in the marine environment and catches due to climate change among stakeholders through reporting of images such as catches and ocean colours, and the location where they were taken, using their smartphones.

Background/effect/note

The marine environment has considerably changed worldwide in recent years, and the species composition of catches is also changing. To adapt to changes in the marine environment and achieve sustainable fisheries, it is important to detect changes in the marine ecosystem and immediately share this information with stakeholders. Therefore, as part of the PICES/MAFF project "Building Local Warning Networks for the Detection and Human Dimension of Ciguatera Fish Poisoning in Indonesian Communities", funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan through the Fisheries Agency of Japan (JFA) from the Official Development Assistance (ODA) Fund, a research team consisting of researchers from the Japan Fisheries Research and Education Agency (Japan), Canada, China, South Korea, Russia and the USA developed a smartphone application for collecting coastal fisheries and environmental information (Fig. 1). With this application, local fishers can collect fish size distribution data from catch images (Fig. 1, left) and water quality parameters from ocean colour images (Fig. 1, right), as well as share the reported results with local stakeholders (e.g., fishers' groups, government officials). Thus, this application is a useful tool to facilitate fisheries resource assessment and management in Southeast Asia.

Fig.1. Examples of coastal fisheries and environmental information collected by FishGIS

Technical details:

https://meetings.pices.int/projects/FishGIS
https://meetings.pices.int/projects/Ciguatera
https://apps.apple.com/jp/app/fishgis/id1550904014
https://play.google.com/store/apps/details?id=com.gfken.fishgis

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Japan Fisheries Research and Education Agency
North Pacific Marine Science Organization

ToroCam: A smartphone application for rapid collection of total length data required for fish stock assessment

Production | Demonstration | Item: Fisheries | Resource management

Outline

An application called ToroCam was developed to record the total length (TL) of fish by capturing images on a smartphone. The app allows users to collect TL data without manually measuring fish, leading to a substantial reduction in labor time.

Background/effect/note

To enhance the accuracy of stock assessments and reduce the workload of surveyors, we developed an application called ToroCam, which allows users to collect TL data by photographing fish catches using a smartphone (Reference 1). ToroCam is freely available on Google Play. To use ToroCam, the user aligns a fish box within the frame displayed on the screen (Fig. 1) and captures a photo. The image is transferred to a PC, where the number of pixels representing the fish's body area (Fig. 2) is automatically calculated using deep learning model. The frame in the image serves as a reference scale, enabling the extraction of the TL (cm) (Fig. 3). ToroCam can be used in ports and fishing villages where power and secure conditions may not be guaranteed, as long as a smartphone is available. Only one PC is required at a central location where the images are aggregated. Compared with similar technologies, this app does not require expensive equipment, making it a useful tool for efficiently collecting data for stock assessments, even in small-scale ports and villages.

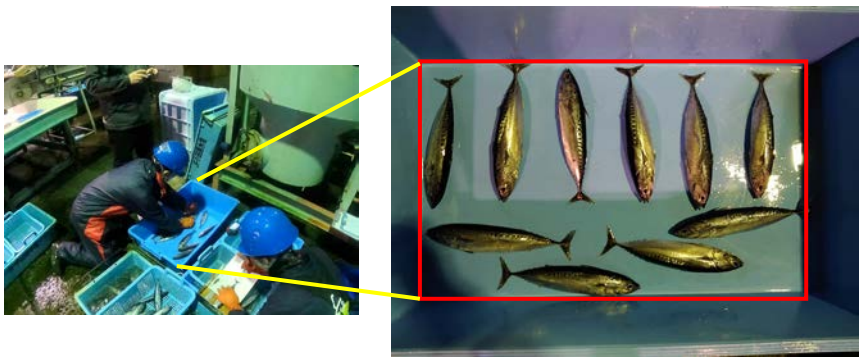

Fig. 1. A capture scene using ToroCam

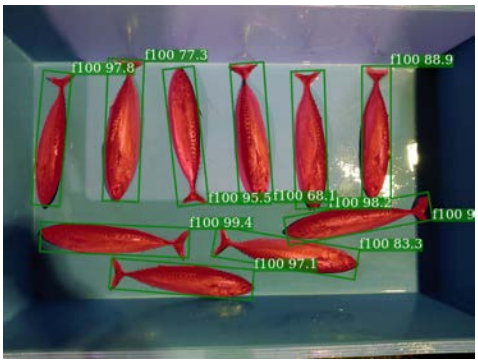

Fig. 2. Detection of the fish body area. The label 'f100' indicates that the fish is not overlapped by other fish, and the numbers represent the confidence level of the label

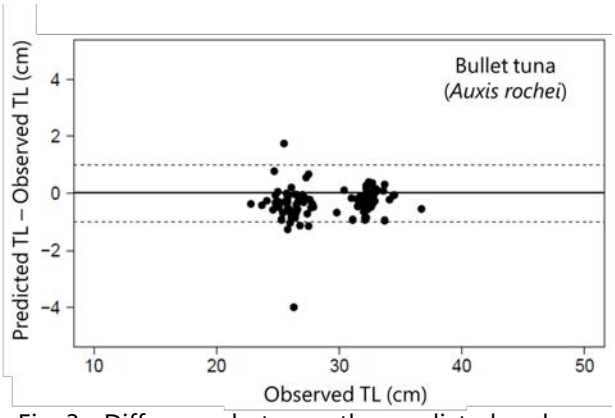

Fig. 3. Difference between the predicted and observed total length (Adapted and reproduced from Shibata et al., 2024)

Technical details:

Reference 1
https://www.sciencedirect.com/science/article/abs/pii/S0165783624000341

A smartphone application: ToroCam
https://play.google.com/store/apps/details?id=jp.co.compmind.fiasd.torocam

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Japan Fisheries Research and Education Agency

An improvement method of selective logging criteria for dipterocarp timber species to maintain healthy tropical rainforests

Production | Demonstration | Item: Dipterocarp timber | Resource management Forest conservation

Outline

To maintain healthy tropical rainforests (Fig. 1), it is necessary to set appropriate selective logging criteria‡ to maintain healthy seed production through outcrossing pollination*. A method based on tree diameter was developed to estimate the ratio of outcrossing pollen of four timber species in Dipterocarpaceae. This method enables desirable selective logging criteria for each timber species, and thus promoting sustainable forest management.

‡Selective logging criteria: Criteria for tree diameter, etc., to determine whether or not trees can be felled.
*Outcrossing pollination: Pollination by pollen from the same species but different individual.

Background/effect/note

The minimum cutting size of the selective logging criteria for dipterocarp timbers in Malaysia is 50 cm in diameter; however, it remains unknown whether healthy seed production occurs in secondary forests after harvesting according to this criterion. Therefore, we have developed a method to estimate the ratio of outcrossing pollen after selective logging using simulation with pollen dispersal pattern and the amount of flowering of the four timber species as parameters. The current minimum cutting size maintains approximately 30–80% of outcrossing pollen ratios in fast-growing species, while that in slow-growing species is reduced to < 20% (Fig. 2, Table 1). Thus, it is necessary to establish a more stringent selection criterion for the slow-growing species.

Fig. 1. Malaysian lowland dipterocarp tropical rainforest

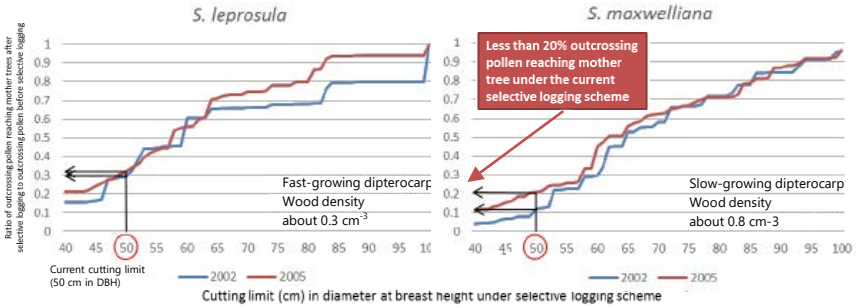

Fig. 2. Simulating the ratio of outcrossing pollen reaching mother trees after selective logging to outcrossing pollen without selective logging for four dipterocarp timber species. The simulation was conducted using the selective logging criteria (tree diameter cutting limit) of 40 cm and at every 1-cm increment thereafter.

Table 1. Ecological difference between the experimental timber species and improvement plan in response to the simulation results

Timber species		Ecological feature		Healthy seed production		Simulation results
Classification	Example	Wood density	Longevity	Current criteria	Improvement plan	Percentage of outcrossing pollination
Fast-growing sp.	*S. leprosula*, *S. parvifolia*	Low	Short	Healthy mating	Current criteria	Approx. 30% Approx. 80%
Slow-growing sp.	*S. curtisii*, *S. maxwelliana*	High	Long	Reducing healthy mating	More strict criteria	Less than 20% Less than 20%

Technical details:

https://www.jircas.go.jp/en/publication/research_results/2016_c04

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Japan International Research Center for Agricultural Sciences

Easy-to-do monitoring method for soil erosion risk to maintain high productivity and water and soil conservation functions of forests

Production | Implementation | Item: Forest | Forest conservation

Outline

We have developed a method for visually assessing soil erosion risk in forests in 10% increments based on forest floor cover percentage (the proportion of the forest floor covered by understory vegetation or litter), which is strongly correlated with soil erosion (sediment transport, Fig. 1). By utilizing this indicator, we can effectively implement sustainable forest management to maintain high productivity.

Background/effect/note

Good soil conservation is essential for the fulfillment and maintenance of the multifunctional role of the forests. However, owing to the time-consuming and costly nature of observing soil erosion, monitoring surveys could not be conducted at many sites. In Japan, this method has been incorporated into the soil erosion survey of the Forestry Agency's Forest Resource Monitoring Survey (National Forest Inventory) and is being conducted every five years at more than 13,000 monitoring points. Moreover, the Food and Agriculture Organization (FAO) has verified this method in Vietnam and publicized and promoted it as a low-cost forest conservation survey method.

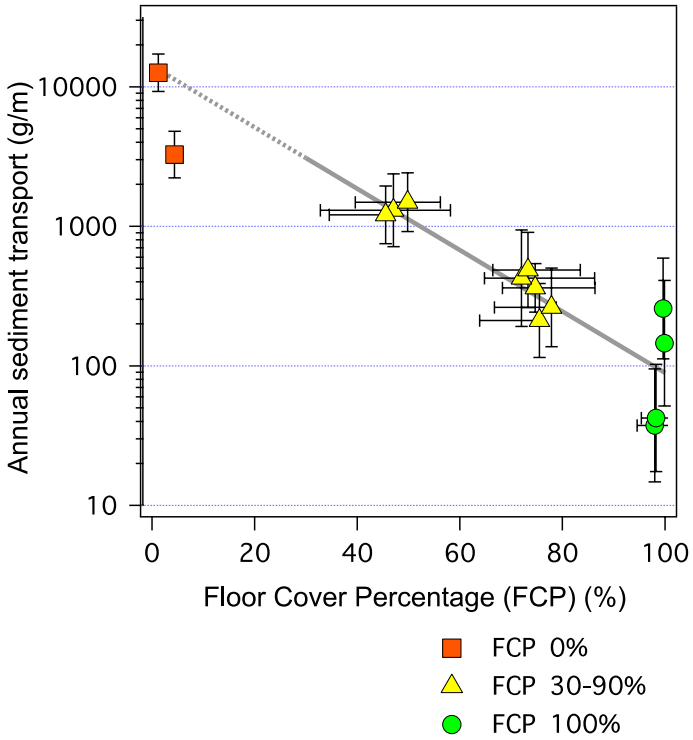

Fig. 1. Relationship between forest floor coverage percentage (FCP) and sediment transport
Error bars indicate standard deviations.

A 10% decrease in forest floor cover results in a 66% increase in fine-grained sediment transport. With minimal experience, it is possible to master the technique of visually determining floor coverage percentage in 10% increments. (Compiled from Miura et al. 2015)

Technical details:

https://www.rinya.maff.go.jp/j/keikaku/tayouseichousa/ (Forestry Agency)
https://www.fao.org/3/i4509e/i4509e.pdf (FAO)
https://www.fao.org/3/i4498e/i4498e.pdf (FAO)

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Forestry and
Forest Products Research Institute

TPJ04-768: A new sugarcane cultivar with high fiber (bagasse) productivity

Production | Implementation | Item: Sugarcane | Biomass utilization

Procurement | Implementation

Outline

A new sugarcane cultivar with high fiber production and the same amount of sugar production as conventional cultivars was developed in Thailand. The use of this cultivar is expected to increase the production of bioenergy and other products using fiber.

Background/effect/note

In the sugarcane industry, electricity generation using fiber is increasing along with sugar production. To expand the utilization of fiber, a new cultivar (TPJ04-768) was developed in Thailand using an interspecific crossing between sugarcane and its wild species (*Saccharum spontaneum*) (new cultivar number 0317/2558, Department of Agriculture, Thailand). The sugar yield of this cultivar was comparable to that of the conventional cultivar KK3 although the sugar content was slightly lower. Moreover, the production of fiber (bagasse*) in this cultivar is approximately 1.5 times higher than that in KK3 in Northeast Thailand (Figs. 1 and 2). Thus, TPJ04-768 is a suitable raw material for biofuel and other biomass applications. TPJ04-768 is more suitable than KK3 for multiple ratoon cultivation based on its decreased yield reductions in ratoon cropping. Machine harvesting may be required due to the thin and large number of stalks of the cultivar (Table 1). Breeding of similar cultivars can be applied to other Asian countries to promote fiber utilization in the sugar industry.

* Bagasse is the fibrous material that remains after crushing sugarcane stalks to extract the juice. This material is used as a raw material for electricity production.

Fig. 1. The growth at second ratooning in Kosum Phisai of Northeast Thailand (December 2014)
Left: TPJ04-768, Right: KK3

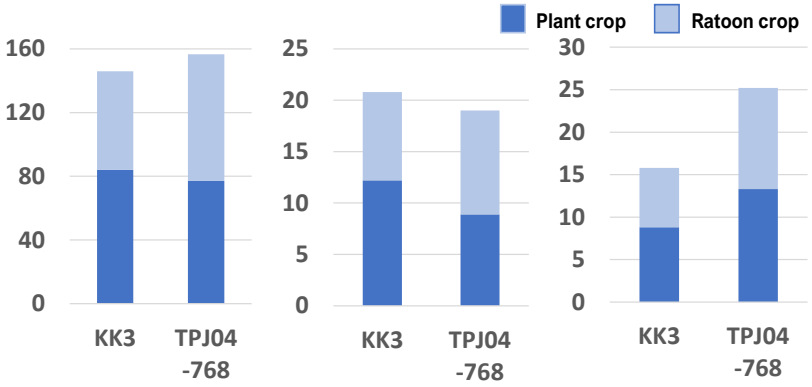

Fig. 2. Yield of TPJ04-768 at plant and ratoon crop (t/ha) in Khon Kaen of Northeast Thailand
Left: Cane yield, Middle: Sugar yield, Right: Fiber yield

Table 1. Characteristics of the yield components of TPJ04-768 (at harvesting of ratoon crop of Fig. 2)

Variety	Stalk no. (no. /ha)	Diameter (cm)	CCS (%)	Fiber (%)
KK3	42468	2.84	14.0	11.3
TPJ04-768	51282	2.22	12.7	15.0

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2015_b10

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Japan International Research Center for Agricultural Sciences

JES1: A new *Erianthus* cultivar for biomass production

Production Implementation Item: *Erianthus* Biomass utilization

Procurement Implementation

Outline

A new *Erianthus* cultivar (JES1) has been developed for biomass production in Japan. This cultivar can be cultivated perennially with ratoon cultivation. The harvested biomass of this cultivar can be used as a raw material for the production of biomass pellet fuel and other products.

Background/effect/note

Erianthus arundinaceus, a perennial grass that is widely distributed in Asian regions, can be used as a new biomass crop owing to its high biomass productivity. The novel *Erianthus* cultivar JES1 was registered in Japan in 2019 (Fig. 1). This cultivar can be grown in the Kanto region (37°N) and southward in Japan and produce an annual dry matter yield of more than 20 t/ha (Fig. 2). After planting, the cultivar can be grown continuously for ratoon cultivation for more than five years, allowing low-cost cultivation. Practical cultivation of JES1 has been implemented in Sakura City, Tochigi Pref. (Figs. 3 and 4). The biomass has been converted into pellets (Fig. 5) used for bioenergy production. The use of *Erianthus* as breeding or material resources can be applied to other Asian regions that are considering the use of biomass crops.

Fig. 1. Plant: Growth habitat of JES1 (Kumamoto Pref., Japan)

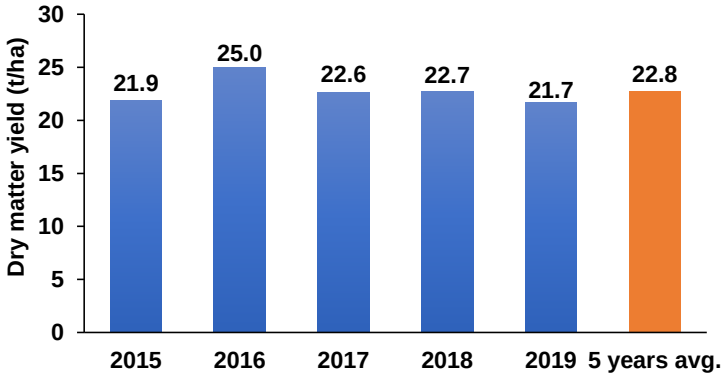

Fig. 2. Dry matter yield of JES1 in a practical field in Sakura City, Tochigi Pref., Japan

Fig. 3. Practical cultivation of JES1 in Sakura City, Tochigi Pref., Japan

Fig. 4. Harvesting via forage harvester

Fig. 5. Pellets produced from dry matter of JES1

Technical details:

https://www.jircas.go.jp/en/publication/research_results/2015_b07

https://www.naro.go.jp/english/topics/laboratory/nilgs/077373.html

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Japan International Research Center for Agricultural Sciences

National Agriculture and Food Research Organization

Aquaculture feed with the black soldier fly larvae easily grown from fruit residues as a protein source

Procurement | Demonstration | Item: Freshwater aquaculture fish | Biomass utilization

Outline

Protein-rich and low-cost feeds from black soldier fly (BSF: *Hermetia illucens*) larvae (Fig. 1(a)), easily grown from fruit residues, have better protein assimilation efficiency than conventional fishmeal (FM) feeds for the climbing perch (*Anabas testudineus*) that is one of main targets for aquaculture in Laos (Fig. 1(b)). In the current situation of FM price hike, the feed from BSF is expected to reduce cost.

Background/effect/note

In Laos, aquaculture promotion is required to increase protein supply to the public. However, the high cost of imported aquaculture feeds hinders the dissemination. Therefore, we incorporated the BSF larvae into feeds with/without FM for the climbing perch (Table 1) and evaluated fish growth (Table 2) and protein assimilation (Table 3). Results showed that fish growth by BSF feed was similar to that by FM feed, and that protein assimilation was better in BSF feed than in FM feed. These observations indicate that BSF larvae can be a practical substitute for FM, agricultural residues can be efficiently utilized to breed BSF larvae, and the feed cost can be reduced by incorporating BSF. As both the climbing perch and the black soldier fly are widely distributed in Southeast to West Asia, it is expected that BSF feed will be utilized as aquaculture feed in other areas.

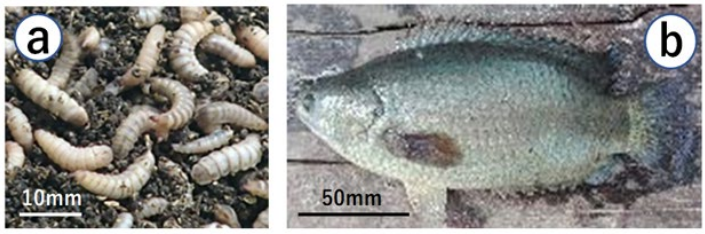

Fig. 1. Black soldier fly larvae (a) and the climbing perch (b)

Table 1. Proximate contents of the experimental feeds (% dry matter)

Feed	Fishmeal	Mixed meal	Black soldier fly
Crude protein	32.5	30.0	25.0
Crude fat	6.7	7.6	8.9
Crude ash	11.1	9.5	7.3
Crude starch	22.8	28.0	27.7

Fishmeal：fishmeal only, Mixed meal：fishmeal and black soldier fly mixed meal, Black soldier fly：black soldier fly only

Table 2. Growth performance of the climbing perch given the experimental feeds

Growth index	Fishmeal	Mixed meal	Black soldier fly
Total length at stocking (mm) *	46.3 ± 7.4	46.3 ± 7.4	46.3 ± 7.4
Total length at harvest (mm) **	159.9 ± 13.6	164.1 ± 11.7	160.9 ± 12.8
Body weight at stocking (g) *	2.2 ± 1.2	2.2 ± 1.2	2.2 ± 1.2
Body weight at harvest (g) **	85.1 ± 25.5	92.0 ± 22.3	83.5 ± 22.2
Feed Conversion Ratio ***	3.4 ± 0.2	3.2 ± 0.4	3.2 ± 0.1

Values are the mean ± standard deviation, *n = 180, **n = 60, ***n = 3.

Table 3. Body composition (moisture, crude protein, crude fat, crude ash) (% dry weight) and protein assimilation (protein efficiency ratio, protein retention) at stocking and harvest of the study

Contents	At stocking	At harvest		
		Fishmeal	Mixed meal	Black soldier fly
Moisture	77.6 ± 0.2 (6)	63.4 ± 1.5 (18)	62.8 ± 1.0 (18)	63.1 ± 0.8 (18)
Crude protein	14.9 ± 0.3 (6)	18.1 ± 0.3 (6)	17.8 ± 0.8 (6)	17.2 ± 0.6 (6)
Crude fat	2.8 ± 0.1 (6)	12.0 ± 0.9 ^{a} (12)	12.3 ± 1.7 ^{a} (12)	14.4 ± 2.2 ^{b} (12)
Crude ash	3.8 ± 0.6 (6)	5.4 ± 1.0 ^{a} (18)	5.7 ± 0.7 ^{a} (18)	4.1 ± 0.8 ^{b} (18)
Protein assimilation indices		Fishmeal	Mixed meal	Black soldier fly
Protein efficiency ratio		0.9 ± 0.1 ^{a} (3)	1.1 ± 0.1 ^{a} (3)	1.3 ± 0.1 ^{b} (3)
Protein retention		16.4 ± 0.7 ^{a} (3)	18.8 ± 2.3 ^{a,b} (3)	21.9 ± 0.8 ^{b} (3)

*Values are the mean ± standard deviation, *numbers in parentheses are the number of samples.
** Different capital letters indicate significant difference (Tukey's HSD test, $p < 0.05$).

Technical details:

https://www.jircas.go.jp/en/publication/research_results/2019_c05

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Japan International Research Center for Agricultural Sciences

A new aquaculture method of giant tiger prawn to improve profitability by utilizing unused biological resources as supplementary live feeds

Production | Demonstration | Item: Penaeidae | Biomass utilization

Outline

A new method to use filamentous green alga (*Chaetomorpha* sp.) and microsnail (*Stenothyra* sp.) as supplementary live feed for giant tiger prawns in the early stages of aquaculture was developed. The weight of giant tiger prawns cultured by this method increased significantly and the profit was approximately 1.5 times higher than conventional methods. *Chaetomorpha* sp. and *Stenothyra* sp. are expected to be utilized in shrimp aquaculture due to their availability as untapped biological resources, and their suitability for cultivation in intensive shrimp ponds.

Background/effect/note

Penaeidae shrimp production in intensive aquaculture systems contribute to the economic development of developing tropical countries. However, decreasing shrimp productivity and profitability have been reported owing to deterioration in artificial feed quality and the soaring prices of artificial feed. We examined the profitability of giant tiger prawns produced with *Chaetomorpha* sp. and *Stenothyra* sp. as supplemental live feeds in 9m x 9m experimental ponds (Fig. 1). Giant tiger prawns were fed with 8% *Chaetomorpha* sp. and 2% *Stenothyra* sp. to total feed consumption in the early stage of cultivation, and we observed the differences in their growth from the fourth week (Fig. 2), and the production and profit were increased by about 1.3 and 1.5 times, respectively (Table 1). These untapped biological resources could be utilized for intensive aquaculture of other Penaeidae species and could improve the profitability of tropical Penaeidae farmers.

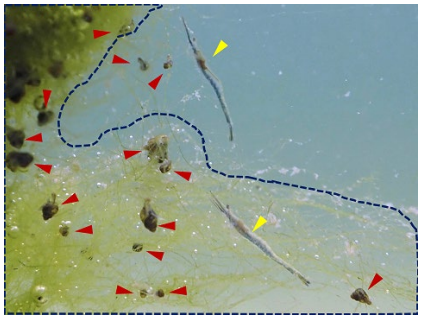

Fig. 1. Post-larvae (Total length: ~9 mm, △), *Chaetomorpha* sp. (area within dark blue broken line) and *Stenothyra* sp. (▲)

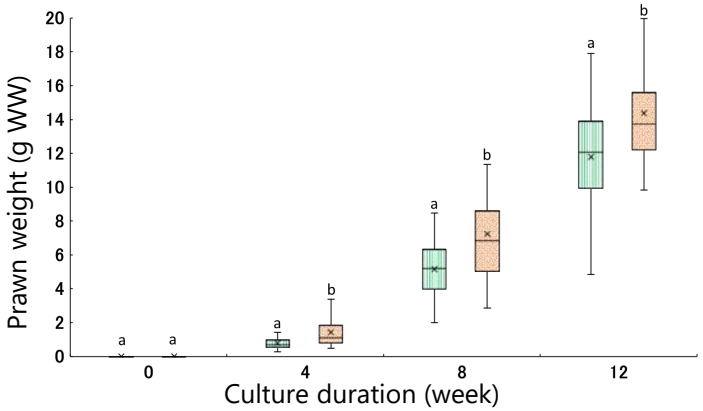

Fig. 2. Changes in wet weight of giant tiger prawn under control (▥) and treatment (▩) conditions
Control: Artificial feed only
Experiment: Artificial feed + *Chaetomorpha* sp. + *Stenothyra* sp.
Different lowercase letters within the same sampling week indicate a significant difference between treatments at a significance level of 0.05 adjusted for multiplicity.

Table 1. Results of giant tiger prawn aquaculture experiments in concrete aquaculture ponds

	Control area	Experimental area
Total prawn production (kg WW)	33.0	43.9 *
Artificial prawn feed cost (USD) (a)	83.55	98.59 *
Feed efficiency (%)	54.1	61.1 *
Miscellaneous costs (USD) (b)	—	12.11
Prawn Sales (USD) (c)	155.73	215.97 *
Profit (prawn sales minus costs) (USD) (c-a-b)	72.18	105.27 *

* in the same column indicate significant differences between control and experimental area (n=3) (t-test, $p<0.05$). Miscellaneous costs are the costs spent on the propagation of supplementary live feed organisms. The Increase in artificial feed cost is due to the increase in feed consumption.
WW: wet weight.

Technical details:
https://www.jircas.go.jp/en/publication/research_results/2020_c09

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Japan International Research Center for Agricultural Sciences

Simple and highly sensitive detection kits for foot-and-mouth disease virus that can be used in the Asia-Monsoon region

Production | Implementation | Item: Livestock | Transboundary disease prevention

Outline

The foot-and-mouth disease virus (FMDV) antigen detection kit can be used in the field without the need for any special equipment to rapidly detect FMDV antigens in the lesions of the tongue and oral cavities of cattle, pigs, goats, and sheep with foot-and-mouth disease (FMD) with high sensitivity.

Background/effect/note

Considering the importance of initial disease control during FMD outbreaks, rapid first-line on-site testing is useful for preventing highly contagious FMD (Fig. 1).

The detection kit is expected to prevail not only in Japan but also in countries with insufficient social infrastructure and large areas of national land.

Additionally, a monoclonal antibody-based typing kit that can be used to detect and distinguish all seven serologically different types of FMDV has already been developed. If implemented, this kit would enable simple and quick serotyping. Detailed information on the FMD epidemic situation in neighboring countries will be available through a survey using the detection kit.

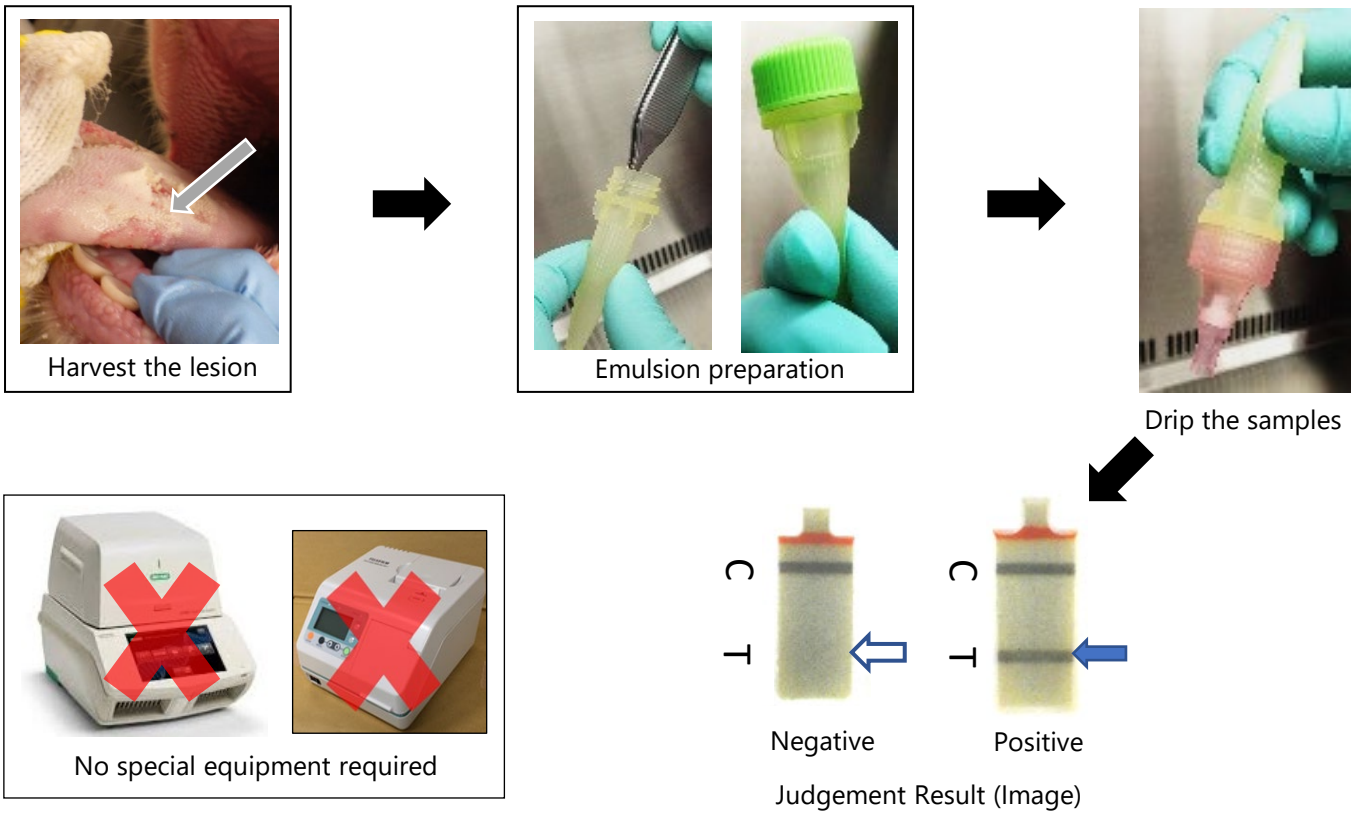

Fig. 1. Flow of detecting foot-and-mouth disease virus using the kit

Technical details:
https://www.naro.go.jp/project/results/4th_laboratory/niah/2019/19_051.html [Japanese]

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National Agriculture and Food Research Organization

Simple and rapid diagnostic technology that can be used in the field to enable early quarantine measures for foot-and-mouth disease

Production | Demonstration | Item: Livestock | Transboundary disease prevention

Outline

Using a portable gene amplification device , we developed a technology that can detect foot-and-mouth disease (FMD) viruses with high sensitivity within 20 minutes from tissues collected at farms. This technology enables the early detection of infected animals on farms and rapid quarantine measures after the occurrence of infectious diseases.

Background/effect/note

Foot-and-mouth disease (FMD) is a highly contagious transboundary infectious disease that affects cattle and swine. In countries where FMD has occurred, economic losses have been enormous due to the reduced productivity of livestock and restrictions on the export of livestock products. We developed a simple, rapid genetic diagnosis method for FMD using a portable device (Fig. 1). The device can be powered by a portable smartphone battery, which allows diagnosis on site (Fig. 2). Using this portable gene amplification device, FMD can be diagnosed with high sensitivity within 20 minutes using tissues collected from animals with suspected infections on the farm (Fig. 3). Furthermore, the system can be applied to diagnostic methods using dried reagents that do not require refrigeration, even under hot and humid climatic conditions. Compared with conventional FMD viral antigen detection kits, this technology can detect the virus with high sensitivity, and this diagnostic method will enable rapid identification of FMD-positive farms and highly effective quarantine measures. Currently, operational procedures and manuals are being developed and preparations for implementation are underway in Thailand.

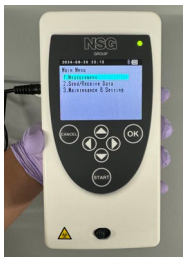


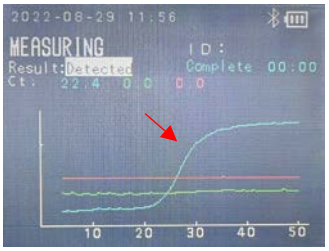
Fig. 1. Portable gene amplification device PicoGene® PCR1100

Fig. 2. A rapid diagnosis is conducted by carrying a portable set of necessary items to the farm.

Collecting lesion tissue on the farm

Mash the lesion tissue.

Mix the mashed lesion tissue with the reaction reagent and load it into the measuring chip.



Positive response for FMD virus (red arrow).

Fig. 3. Procedures for rapid diagnosis of foot-and-mouth disease on farms

Technical details:

https://dx.doi.org/10.1016/j.jviromet.2023.114753
https://www.nature.com/articles/d42473-023-00311-5

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Maintaining an acidic condition can prevent liquefaction of fermented rice noodles

Processing and distribution | Implementation | Item: Fermented rice noodles | Food loss reduction

Outline

Maintenance of acidic condition (approximately pH 4) of fermented rice noodles can suppress the growth of amylase-producing bacteria, which cause liquefaction of the product under the post-manufacturing ambient storage conditions. This technique is effective for reducing food loss and waste.

Background/effect/note

Fermented rice noodles are traditional foods widely produced and consumed in Thailand. Similar products are common in Laos, Vietnam, Cambodia, Myanmar, and China. These noodles are prepared from fermented rice flour containing lactate and retain quality without rotting for a few days at ambient temperature. However, these noodles may occasionally undergo severe liquefaction, causing economic and food losses (Fig. 1).

This is attributed to bacterial amylolytic enzymes (α-amylase) that are activated when the pH of the noodles increases to ≥ 6.0. However, liquefaction can be prevented by maintaining the product under an acidic condition (approximately pH 4) (Fig. 2).

In addition to the technology to control liquefaction of the product, the use of a booklet (Fig. 3) that explains the production process and cooking method in simple local language will improve the profitability of producers, reduce food loss, and promote dietary education.

Fig.1. Fermented rice noodles recalled from the market before selling due to the liquefaction

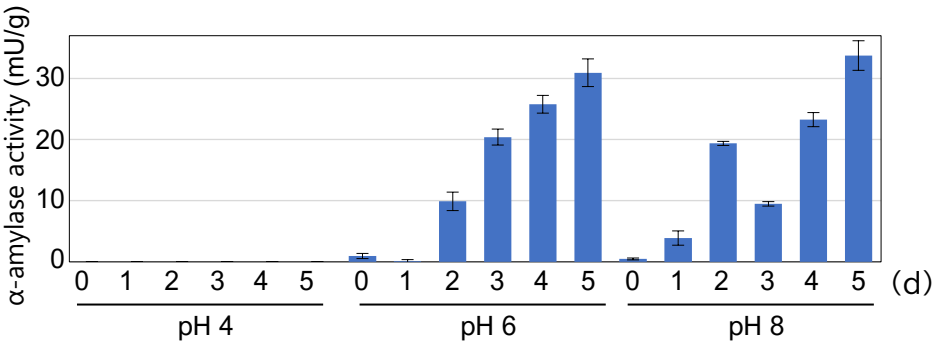

Fig. 2. Time-dependent change in α-amylase activity (cause for the liquefaction) in fermented rice noodles treated with buffers at pH 4.0, 6.0, and 8.0

Technical details:

https://www.jircas.go.jp/en/publication/research_results/2019_c01

https://www.jircas.go.jp/ja/publication/kanomjeen

Fig. 3. Introduction of pH monitoring methods for fermented rice noodles in the form of a booklet written in Thai

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For inquiries concerning each technology, please contact the e-mail address in each catalog sheet.

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PDF and database versions of the catalog are available at the following URL:

https://www.jircas.go.jp/en/greenasia/techcatalog

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