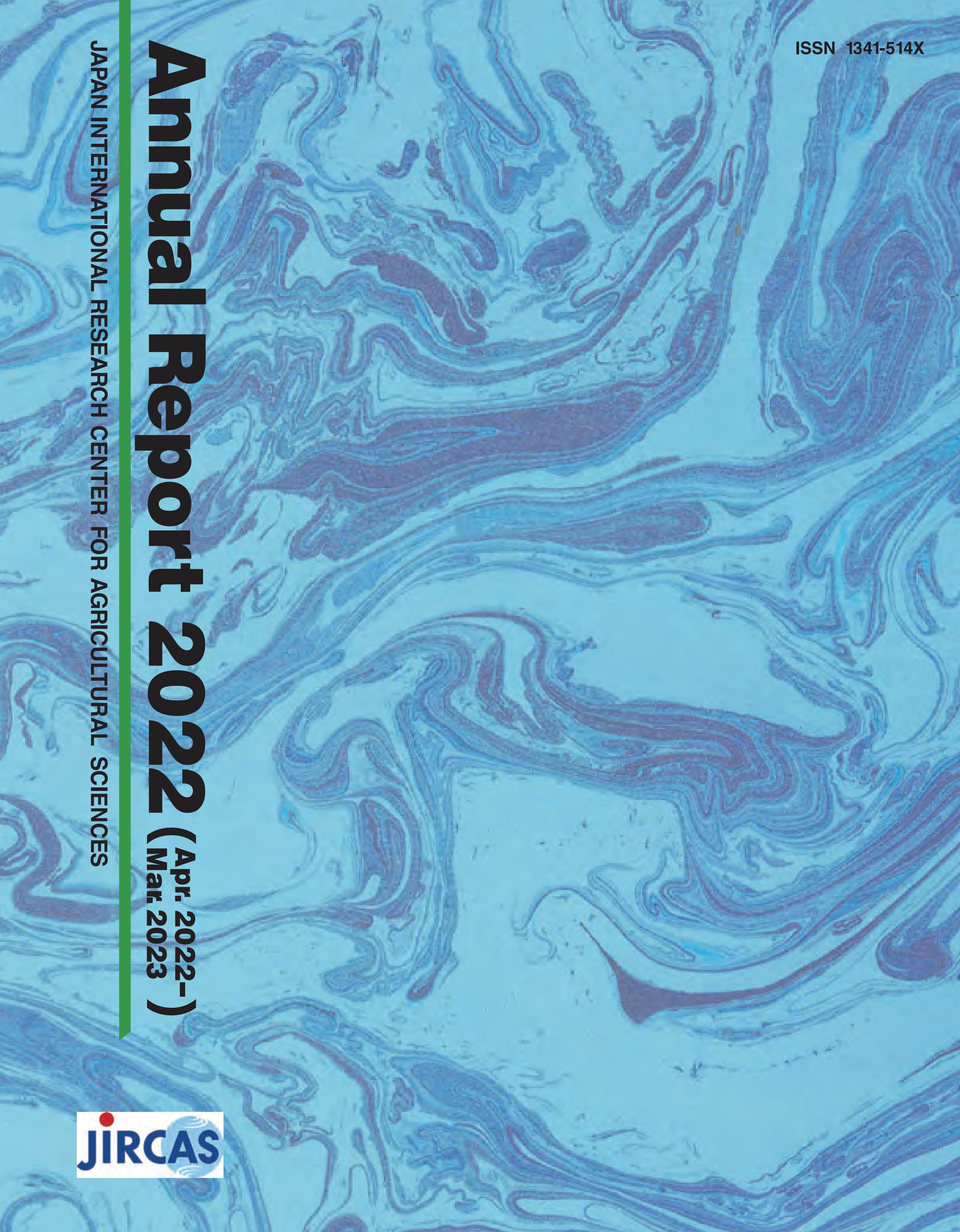

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Annual Report 2022 (Apr. 2022–Mar. 2023)

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

JIRCAS

Japan International Research Center for Agricultural Sciences

Annual Report 2022

(April 2022-March 2023)

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Contents

JIRCAS Annual Report 2022

Research Overview

Training and Invitation Programs / Information Events

Appendix

Message from the President

President
Osamu Koyama
(FY2021-)

Pushing ahead towards sustainable agri-food systems transformation

The Japan International Research Center for Agricultural Sciences (JIRCAS), including its predecessor organization, has been conducting international joint research with local research institutes and universities in the tropics and subtropics as well as in developing regions for over 50 years. It is a unique Japanese national research and development agency that contributes to the improvement of agriculture, forestry, and fisheries technologies overseas, and eventually to the development of the world's agriculture, forestry, and fisheries industries.

The situation surrounding the world's agriculture, forestry, and fisheries has changed significantly with the times. Expectations for novel technology development in each era, such as the era of large production increase led by the Green Revolution, the era of export competition between developed countries, the era of deepening awareness of global environmental problems, and the era of volatile food prices due to the economic crisis, have also changed. In particular, in the tropics/subtropics and developing regions targeted by our Center, the need for new technologies is changing drastically due to economic globalization, urbanization, and rapid economic growth.

As global issues such as climate change became more apparent, the United Nations adopted a set of common goals for humankind, better known as the SDGs, to overcome various issues and form a sustainable society by 2030. In order to achieve the goals, many activities are being developed. In September 2021, the United Nations Food Systems Summit was held, confirming that a series of activities related to food production, processing, transportation, and consumption will be transformed into a sustainable system. Japan also declared that it would aim to be carbon neutral by 2050, and so in May 2021, it issued a policy called the "Strategy for Sustainable Food Systems, MIDORI." It aims to both enhance productivity potentials and ensure the sustainability of agriculture, forestry, fisheries, and food industries through innovation.

In parallel with the above, JIRCAS has maintained a solid and long-term corporate philosophy (JIRCAS Vision), and it has consistently endeavored to solve food and environmental problems through research and development and contributed internationally through science and technology. In March 2021, JIRCAS was instructed about the 5th Medium to Long-Term Target based on the recent changes in the situation surrounding international agriculture, forestry, and fisheries research as described above, and a new five-year term was started. The new medium to long-term goal redefines the superb mission of JIRCAS. JIRCAS is mandated to improve agriculture, forestry, and fisheries technologies around the world, including Japan, toward the realization of government policies such as "The Basic Plan for Food, Agriculture and Rural Areas," representing Japan as a core national institute in the field of international agriculture, forestry, and fisheries research.

For the five years of the 5th term, we have set up a system that enables simple and effective business operations by arranging four business segments: Planning, Environment, Food, and Information. We are also working to improve the matrix system, a unique research promotion method of JIRCAS, in which research staff from different academic disciplines and belonging to specialized Divisions participate in multiple research projects set in the research activity segments and engage in interdisciplinary research activities that solve complex problems. In addition, we have assigned the Information and Public Relations Office directly under my supervision so it can promote institution-wide public relations and collaborative works. With this new administrative system, we have started activities to achieve our medium to long-term goals.

Following a difficult first year in the implementation of the Fifth Medium to Long-Term Plan, which was heavily influenced by the continuing COVID-19 pandemic, research activities at local sites in foreign countries gradually recovered in the second year, FY 2022, thanks to the easing of the pandemic. However, the global food and agriculture situation, including the sourcing, affordability, and availability of critical inputs such as fertilizers, continued to deteriorate due to the consequences of COVID-19, climate change events, and conflicts in Ukraine and other regions. Under these circumstances, global food security concerns have been raised in various international fora. As an institution representing Japan, which depends on the international market for about 60% of its food on a calorie basis, JIRCAS had its role defined, and its mission of making an international contribution through science and technology innovation was highlighted further.

In FY 2022, a new project named "Green Asia" was initiated. Together with the Ministry of Agriculture, Forestry and Fisheries of Japan, JIRCAS aims to promote the transformation towards sustainable food systems in the region by sharing Japanese experience and technologies with areas in the region that have similar climatic and farming conditions to Japan. Many technologies have been catalogued as usable and scalable, and some promising technologies that could achieve both productivity gains and environmental benefits are being tested in these target areas, which we have defined as the "Asia-Monsoon" region. Meanwhile, in Africa, various research results achieved through continuing collaborations and can contribute to food security as well as to sustainable and resilient food systems have been recognized by local governments and awarded by prestigious agencies in FY 2022.

With a history of international joint research spanning more than 50 years, our strength exists in our working method where we tackle global food and environmental problems, which are sometimes in conflict with each other, with an interdisciplinary approach and present solutions with local partners hand in hand. JIRCAS will never forget its mission as a public institution that provides global public goods, and all staff members will collaborate to create new value common to all humankind, "together for our food and planetary health." We hope that you will read this Annual Report, which introduces a part of our activities for one year, and that you will continue to understand, support, and cooperate with the activities of JIRCAS. We also welcome your frank advice and questions.

September 2023

Osamu Koyama, President

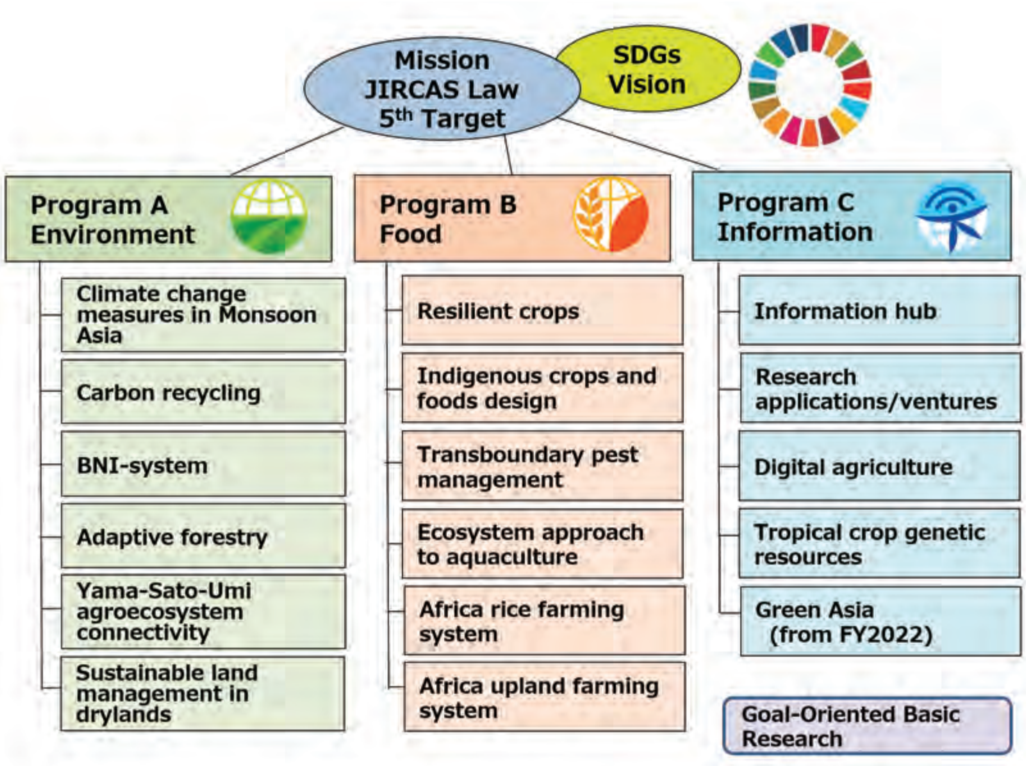


Fig. 1. Program-Project Research Framework (FY2021-2025)

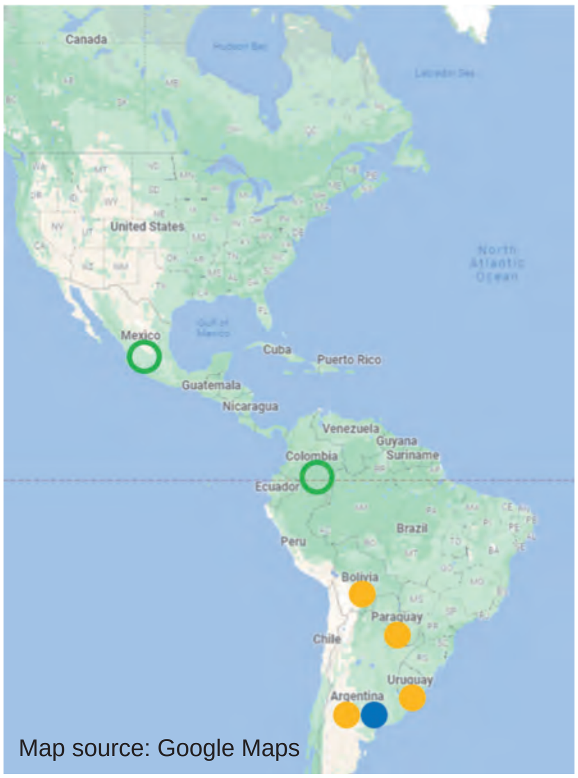


Fig. 2. Locations of activities in the 5th Medium to Long-Term Plan

Highlights from 2022

JIRCAS International Symposium 2022 Report

JIRCAS International Symposium 2022, titled "Artisanal Fisheries and Aquaculture in the Sustainable Food Systems," was held in hybrid format at Hitotsubashi Hall, Hitotsubashi University and online on November 22, 2022, under the auspices of the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Japan Fisheries Research and Education Agency (FRA).

Against the background of discussions at the 2021 UN Food Systems Summit and the 2022 International Year of Artisanal Fisheries and Aquaculture (IYAFA), this symposium focused on the importance of artisanal fisheries and aquaculture in a sustainable food system and in promoting sustainability and increased productivity. In particular, it was held with the aim of forming a common understanding of the current status and issues in the implementation of science and technology innovation that is compatible with both, and providing an opportunity to exchange opinions on the direction of international joint research.

In the opening session, Mr. Osamu Koyama, President of JIRCAS, stated that the symposium aims to provide a forum for domestic and international researchers and the academic community to discuss opportunities and challenges for resilient, efficient, and sustainable fisheries and aquaculture. Mr. Takashi Koya, Director-General of the Fisheries Agency of Japan, then gave a welcome address, expressing his hope that the active exchange of views at this symposium would deepen understanding of the importance of sustainable food production systems and the compatibility between sustainability and productivity improvement.

The keynote speeches were given by Dr. Nobuyuki Yagi, Professor at the Graduate School of Agricultural and Life Sciences, University of Tokyo, on the role of fisheries and aquaculture in sustainable food systems, and Dr. Shakuntala Haraksingh Thilsted, Global Lead for Nutrition and Public Health, WorldFish, and winner of the 2021 World Food Prize, on the development of holistic and nutrition-sensitive approaches in aquatic food systems.

Session 1 on "The Challenges of Artisanal Fisheries and Aquaculture in the Sustainable Food Systems" was chaired by Dr. Kazuo Nakashima, Director of JIRCAS Food Program, and featured presentations by Dr. Tsutom Miyata, Director of JIRCAS Fisheries Division, and Dr. Kazutaka Sakiyama, Director of Aquaculture Research Department, Production Engineering Division, Fisheries Technology Institute, FRA, on the challenges of small-scale fishery and aquaculture in Southeast Asia and Japan, respectively, in achieving sustainable food systems. Dr. Jeffrey T. Wright, Associate Professor at the Institute for Marine and Antarctic Studies, University of Tasmania, then gave a lecture on the potential of seaweeds for reducing greenhouse gas emissions and combating climate change.

Session 2 on "Research and Application to Enhance Sustainability and Productivity of Artisanal Fisheries and Aquaculture" was chaired by Dr. Norihito Kanamori, Project Leader at JIRCAS, and featured presentations by Dr. Tatsuya Yurimoto, Senior Researcher at JIRCAS Fisheries Division, Dr. Shinsuke Morioka, Professor at the Faculty of Environmental Science, University of the Human Environments, and Dr. Jon P. Altamirano, Head of Farming Systems and Ecology Section, the Southeast Asian Fisheries Development Center / Aquaculture Department (SEAFDEC/AQD), on case studies on the development and utilization of propagation and aquaculture technologies for bivalves, small indigenous fish species, and black tiger prawns, respectively. It was confirmed that research is important to address the empowerment of local communities and environmental sustainability, and at the same time, that local environments are very different and innovation must be tailored to the specific needs of each region.

The panel discussion was moderated by Dr. Marcy N. Wilder, Project Leader at JIRCAS Fisheries Division, who posed questions to each panelist. Professor Yagi was asked about the overseas application of cases, and Dr. Thilsted was asked about how to enable more women and young people to have career and job opportunities related to the seafood and food systems. Next, questions that had been received in advance (e.g., what the future balance of production between fisheries and aquaculture will be like, and what the future impact on marine plants and animals will be if the abnormal rise in seawater temperature due to global warming continues for a long time) were addressed by the panelists. Finally, a Q&A segment was held to field questions from the audience (e.g., query regarding access to seafood products in inland areas that are inaccessible from production areas).

In her closing remarks, Dr. Yukiyo Yamamoto, Vice-President of JIRCAS, thanked the speakers and participants, and summarized the following points.

1. We have greatly benefited from the leading experts who shared their experiences on how best to address the challenges in artisanal fisheries and aquaculture.
2. While no single solution exists, a multi-disciplinary approach can be key to addressing not only the technical challenges faced by small-scale operators in locally specific contexts, but also to identifying support areas to overcome socio-economic constraints, including regulations and institutions.
3. Accelerating innovations in artisanal fisheries and aquaculture requires not only local action but also the commitment of all stakeholders, including local communities, research institutions, the private sector, and policymakers.

We would like to thank everyone who attended this symposium in person and those who viewed it online. We hope that this symposium contributed to the promotion of scientific and technological innovation to achieve food and nutrition security and the development of a robust and sustainable fisheries and aquaculture industry that leaves no one behind. JIRCAS will continue to contribute to the development and dissemination of sustainable aquaculture technologies in the tropics based on ecosystem approaches in cooperation with domestic and international partners.

The event was attended by 55 participants on-site and 198 online viewers from 16 countries around the world, including Japan and Southeast Asian nations, demonstrating the high level of interest in the role of smallholder fisheries and aquaculture in sustainable food systems.

For those of you who were unable to attend the event, we have posted a video of the event on the JIRCAS YouTube channel. (In the original language only, no Japanese-English interpretation is provided.)

Part1: https://youtu.be/wfs-l5xoIsQ
Part2: https://youtu.be/rs_P-n-gQJc
Part3: https://youtu.be/zz9OdVf8xfE
Part4: https://youtu.be/wnAbjK4EKZw

Commemorative photo

2022 (The 16th) Japan International Award for Young Agricultural Researchers (Japan Award) and Commendation Ceremony

About the Japan Award

The Japan International Award for Young Agricultural Researchers (Japan Award), which began in 2007, is organized and presented by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan to honor young foreign researchers whose outstanding achievements promote research and development of agricultural, forestry, fishery and other related industries in developing regions.

Up to three young researchers under age 40 (as of January 1st, award year) who have shown

(1) outstanding performance in research and development in agriculture, forestry, fisheries, or related industries in developing regions and

(2) outstanding achievements in research and development that will lead to future technological innovation in agriculture, forestry, fisheries or related industries in developing regions

are invited yearly to Japan to receive certificates of commendation from the Chairman of the Agriculture, Forestry and Fisheries Research Council.

The 2022 (The 16th) Japan Award Ceremony Report

The 2022 (16th) Japan Award commendation ceremony was held on November 22nd (Tuesday) in a hybrid format (in-person at Hitotsubashi Hall, Hitotsubashi University, and online).

On behalf of the organizers, Mr. Yoshio Kobayashi, Chairman of the Agriculture, Forestry and Fisheries Research Council (AFFRC) of the Ministry of Agriculture, Forestry and Fisheries, greeted the participants. This was followed by congratulatory remarks, an introduction of the guests, and a report on the screening process by Dr. Mutsuo Iwamoto, Chair of the Selection Committee. The certificates of commendation (Chairman's Award) were presented by AFFRC Chairman Kobayashi, and the cash incentives (Motai-JIRCAS Award) were given by Mr. Osamu Koyama, President of JIRCAS. The 2020 (The 14th) Japan Award winners, who were not able to personally receive their prizes due to the COVID-19 pandemic, were in attendance at this year's ceremony.

There was a brief photo session after the award ceremony, followed by commemorative lectures of their research achievements by the 2022 winners and a welcome lunch reception to celebrate the event.

The 2022 (The 16th) Japan Award Winners (Honorific titles omitted; ages as of January 1, 2022)

Tovohery RAKOTOSON
(39 years old, Male, Malagasy)
Professional Affiliation: University of Antananarivo

Research Achievement: Addressing phosphorus deficiency in rice in Sub-Saharan Africa

Reason for the Award: The awardee quantified the amount of solubilized phosphorus in the soil when compost is applied in various soils, showing that application of compost to phosphorus-deficient paddy fields can greatly increase the phosphorus uptake of paddy rice and its yield. This study is highly evaluated as a problem-solving study based on the needs of the field in Africa. The results of this research could reduce the amount of purchased fertilizer while maintaining the yield.

Leonardo CRESPO HERRERA
(39 years old, Male, Mexican)
Professional Affiliation: International Maize and Wheat Improvement Center (CIMMYT)

Research Achievement: Genetic improvement of global wheat, including progress for enhancing insect resistance

Reason for the Award: The awardee developed an efficient method of breeding wheat lines with aphid resistance through the identification of insect resistance genes in wheat and the development of genetic markers. This study has been highly evaluated for developing lineages that have been distributed worldwide for use in wheat breeding, and the methods of this study have been applied to develop varieties with resistance mechanisms against various kinds of insects, not only aphids.

Athanasia Amanda SEPTEVANI
(37 years old, Female, Indonesian)
Professional Affiliation: National Research and Innovation Agency (BRIN)

Research Achievement: The value of agricultural waste: Cellulose as a building block for materials

Reason for the Award: The awardee established a simple, low-cost, and environmentally friendly process for producing high-purity cellulose from empty fruit bunches of discarded oil palm. Since the oil palm industry plays an important role in the Indonesian economy, the prevalence and practical application of the processing method developed in this study will lead to the effective use of oil palm waste in the future. This research is highly recognized for its potential to reduce the environmental impact and improve the management of producers.

NEW RESEARCH COLLABORATION

JIRCAS promotes its research network with international as well as national agricultural research institutions, extension systems, universities, and the private sector, through information and personnel exchange programs. Memorandums of Understanding (MOUs) have been signed between JIRCAS and its research partners, both domestic and abroad, to implement long-term research collaborations. In FY 2022, JIRCAS implemented considerably more joint research activities than in FY 2021. For example, JIRCAS renewed an MOU with the Royal University of Agriculture (RUA), a major research institution for agriculture, forestry and fisheries in Cambodia. JIRCAS and RUA also signed a work plan to implement the JIRCAS research project "Development of comprehensive agricultural technologies for climate change mitigation and adaptation in Monsoon Asia." In addition, JIRCAS has started joint research with many research institutes in Monsoon Asia and other regions.

As of March 2023, the number of active MOUs was 130. Based on the work plans elaborated in the respective MOUs, JIRCAS carried out joint research projects with 68 research institutions in 32 countries.

Together with domestic partners, JIRCAS carried out 101 joint research activities in total: 12 with national research and development agencies under the Ministry of Agriculture, Forestry and Fisheries, 9 with independent entities, 8 with public research institutions, 54 with universities, and 17 with private companies. Some of the private companies contributed to the financing of research activities implemented by JIRCAS (worth 14 million JPY).

TROPICAL AGRICULTURE RESEARCH FRONT

The Tropical Agriculture Research Front (TARF), a substation of JIRCAS, is located at the southwestern edge of Ryukyu archipelago in Ishigaki, Okinawa, Japan. Geographically, TARF is closer to Taiwan (280 km to the west) than Tokyo (2,000 km to the northeast). The climate is subtropical, with an average temperature of 24.3°C and annual rainfall of 2,107 mm. TARF's facilities include 21 hectares of experimental fields, several types of greenhouses, and lysimeters. With its geographical advantages and facilities, TARF implements basic and fundamental researches and creates improved agricultural technologies that can be applied in developing and/or island countries of the tropics/subtropics.

Research and development of agricultural production technologies

The following projects and related research activities have been implemented at TARF since FY 2021 under the 5th Medium to Long-Term Plan: (1) Island agriculture with environmental conservation, (2) Collection, evaluation, and utilization of tropical crop genetic resources, and (3) Development of a year-round vegetable production system for the Asia-Monsoon region.

The "Yama-Sato-Umi agroecosystem connectivity" project is designed to develop and evaluate environmental conservation technologies for tropical islands through an approach emphasizing Ridge-to-Reef (Yama-Sato-Umi) agroecosystem connectivity. This project aims to establish healthy material cycles among the connected ecosystems through development of technologies to reduce environmental loads in the areas, and resource circulation targeting the Philippines and Ishigaki, Okinawa, Japan. For this purpose, we are conducting research under the following themes.

- Development of technologies for reducing environmental loads and circulating natural resources based at TARF
- Elucidation of soil and nutrient loads from river basins and the conditions for implementing developed technologies in tropical islands

The Optimized Subsurface Irrigation System (OPSIS) is a water-saving irrigation system developed by the National Agriculture and Food Research Organization (NARO). By installing a trapezoidal impervious sheet at the bottom of the water supply pipe, water loss due to downward infiltration is suppressed. OPSIS showed that soil moisture during the dry season was maintained above the soil water content of the primary wilting point by a lower irrigation water supply than the recommended rate provided by sprinklers on Ishigaki Island. The sugarcane yields were also higher than the average yield on Ishigaki Island.

Applying biochar to soil is a promising technology both for carbon sequestration and reduction of fertilizer-derived nitrate nitrogen. We conducted an indoor pipe experiment to clarify the effect of biochar application depth on nitrate leaching. The results showed that biochar application to surface soil layer can reduce nitrate leaching while maintaining crop growth. We searched for alternatives to chemical fertilizers by determining the effects of applying filter cake and conducting pot experiments to test bagasse ash generated in sugar industries. Filter cake application maintained and improved the dry matter weight of sugarcane even with reduced chemical fertilizer application. In October 2022, we held a symposium titled "The forefront of agricultural research to promote resource recycling on a semi-tropical island, Ishigaki, Japan" to strengthen collaboration among producers, governments, academia, and civil society toward promoting resource-recycling technology for agriculture (Photo 1).

The "Tropical crop genetic resources" project is designed to strategically develop and promote research on tropical crops based on domestic and international issues and research needs for each crop, taking advantage of such diverse and abundant tropical crop genetic resources and geographical location in TARF. Furthermore, by sharing and providing this information and technology, we aim to strengthen collaboration that will lead to the formation of networks with domestic and overseas research institutions for the advancement of tropical crop genetic resource utilization. For this purpose, we are conducting research under the following themes across several crops such as rice, sugarcane, and tropical fruits.

- Information and networking of genetic resources
- Evaluation of genetic resources and development tools
- Utilization of genetic resources for new breeding materials and cultivation technologies
- Domestic research collaboration through utilization of genetic resources

We have been conducting genetic and breeding studies to improve rice varieties in tropical countries. One of our main objectives is to enhance rice productivity under unfavorable conditions such as less fertile soils. We have also been developing breeding materials resistant to rice blast disease to reduce pesticide application. Breeding lines with durable blast resistance have been developed through DNA marker selection. These developed breeding lines are shared with national agricultural research institutes in tropical Asian countries such as Bangladesh, Philippines, Vietnam, and Indonesia through international collaborations. We are also working to improve rice varieties by applying genome editing technologies that can introduce genetic mutations accurately.

Sugarcane research at TARF enables the establishment of essential information and technologies for the effective use of sugarcane-related genetic resources in breeding to improve sugarcane's productivity and adaptability to adverse environments and reduce its environmental load. We are focusing on wild sugarcane (*Saccharum spontaneum*) and *Erianthus* as important genetic resources for sugarcane improvement. A database consisting of 150 accessions of *Erianthus* genetic resources native to Thailand was developed (https://www.jircas.go.jp/ja/database/erianthus), and agronomic data were collected from the first ratoon crop of about 500 accessions of Japanese *S. spontaneum* (Photo 2).

In addition, a method to evaluate acid tolerance in genetic resources using root electrolyte leakage assay was developed to select breeding materials for improving sugarcane stress tolerance. In order to develop new sugarcane varieties with higher sugar and fiber productivity to promote sugar and fiber utilization in sugarcane industries in Japan and Southeast Asian countries, evaluation and selection of promising sugarcane clones were conducted in Japan and Thailand. Furthermore, research was initiated to develop genomic prediction models for the effective use of intergeneric hybrids in sugarcane breeding.

Tropical fruit research for utilization of genetic resources has been conducted to contribute to the promotion of tropical fruit production and sharing of information through research networking in Japan and main production areas in Southeast Asia. Tropical fruits are gaining attention as alternative crops that can be grown to cope with climate change in Japan. Also, the introduction of diverse tropical fruit species will contribute to the diversification of food and nutrient sources. In this project, we focus mainly on mango and passion fruit research, with the aim of achieving effective flowering and fruit setting for stable production through evaluation of genetic resources and development of new breeding materials and cultural technologies. Regarding the practical implementation of such knowledge in passion fruit production, a virus-free propagation technique has been developed for the viral disease, which has been spreading in recent years. The manual and video explaining this virus-free technology were also developed and published (Photo 3).

Several integrated research activities focusing on a plant factory are being conducted at TARF. The aim of the research activities is to develop technologies for stable year-round production of tomatoes and strawberries in tropical/subtropical regions through collaboration with private companies and NARO. Research studies are being conducted in collaboration with private companies to boost tomato cultivation in summer and increase strawberry production in subtropical regions. Another activity is the cross-sectoral collaboration among the private sector, NARO, and JIRCAS, supported by project grants from the Bio-oriented Technology Research Advancement Institution (BRAIN) Research Program on Development of Innovative Technology, to develop a strawberry cultivation system that is adapted to tropical/subtropical regions.

Contribution to domestic agriculture

TARF contributes to domestic agriculture through the following activities:

1) *Generation advancement*

Early generations of rice population consisting of 60 accessions from NARO breeding stations all over Japan are grown twice a year.

2) *Conservation of genetic resources*

Through the NARO Genebank project, TARF, as a sub-bank for tropical and subtropical crop genetic resources, maintains 570 accessions of sugarcane and its relatives, 150 of tropical fruit trees, and 125 of pineapple vegetatively in fields and greenhouses.

3) *Development of varieties for Nansei Islands*

TARF-JIRCAS contributes to domestic sugarcane breeding by taking advantage of the optimum environmental conditions for sugarcane crossing in Ishigaki Island. In collaboration with NARO and the Okinawa Prefectural Agricultural Research Center, 158 crossing fuzz with 79 combinations were obtained and provided to the domestic breeding program. Furthermore, promising clones showing vigorous ratooning ability and root growth were selected from the backcrossing populations of intergeneric hybrids between sugarcane and *Erianthus*, and provided to the 3rd and 4th selections in the domestic sugarcane breeding programs of NARO and the Okinawa Prefectural Agricultural Research Center.

Photo 1. Participants at the symposium titled "The forefront of agricultural research to promote resource recycling on a semi-tropical island, Ishigaki, Japan"

Photo 2. Evaluation of the Japanese *S. spontaneum* was carried out in this field at TARF.

Photo 3. The practical manual (left) and tutorial video (right) explaining the virus-free propagation technique for healthy passion fruit seedlings

Academic Prizes and Awards

BNI-enhanced wheat research awarded the Cozzarelli Prize for Best Paper in 2021 by PNAS

In March 2022, the joint research collaboration of JIRCAS, the International Maize and Wheat Improvement Center (CIMMYT) and others on BNI-enhanced wheat was awarded the Cozzarelli Prize for Best Paper in 2021 by the *Proceedings of the National Academy of Sciences of the United States of America* (PNAS).

The Cozzarelli Prize is awarded to a paper in each of the six categories among 3,476 papers published in PNAS in 2021, and the winning research paper, titled “Enlisting wild grass genes to combat nitrification in wheat farming: A nature-based solution,” was awarded in the Applied Biological, Agricultural and Environmental Sciences category.

This Cozzarelli Prize was awarded in recognition of the identification of a chromosomal region that regulates biological nitrogen inhibition (BNI) ability of wheat grass (*Leymus racemosus*), a wild relative of wheat, and the development of the world’s first BNI-enabled wheat through intergeneric crossing with a high-yielding wheat cultivar. The results of this research are expected to contribute to the prevention of nitrogen pollution, which leads to water pollution and greenhouse gas emissions, while maintaining productivity with less nitrogen fertilizer. An introductory video highlighting the results of this work is now available on the PNAS YouTube channel.

In addition, JIRCAS has been working toward social implementation of BNI-enhanced wheat in India, the world’s second largest wheat producing country, in conjunction with “The Project for Establishment of Nitrogen-efficient Wheat Production Systems in Indo-Gangetic Plains by the Deployment of BNI-technology” under the Science and Technology Research Partnership for Sustainable Development (SATREPS) program.

The BNI research has been positioned in the “Strategy for Sustainable Food Systems, MIDORI” of the Ministry of Agriculture, Forestry and Fisheries (MAFF) formulated in May 2021, and was also selected by MAFF as one of the “Top 10 Agricultural Technology News for 2021.”

JIRCAS will contribute to the international society by solving global-scale issues with BNI technology as one of the platforms for international joint research.

National Academy of Sciences Press Release: PNAS Announces Six 2021 Cozzarelli Prize Recipients
https://www.jircas.go.jp/ja/release/2021/press202127

Cozzarelli Prize Video
PNAS 2021 Cozzarelli Prize Winner for Class VI: Applied Biological, Agricultural, and Environmental Sciences
https://www.youtube.com/watch?v=Q_Bj38PsQxg

Publication
Enlisting wild grass genes to combat nitrification in wheat farming: A nature-based solution
https://doi.org/10.1073/pnas.2106595118

Cozzarelli Prize commemorative photo
L-R: Masahiro Kishii, Guntur Subbarao, JIRCAS President Koyama, Former President Iwanaga, Satoshi Tobita, and Tadashi Yoshihashi

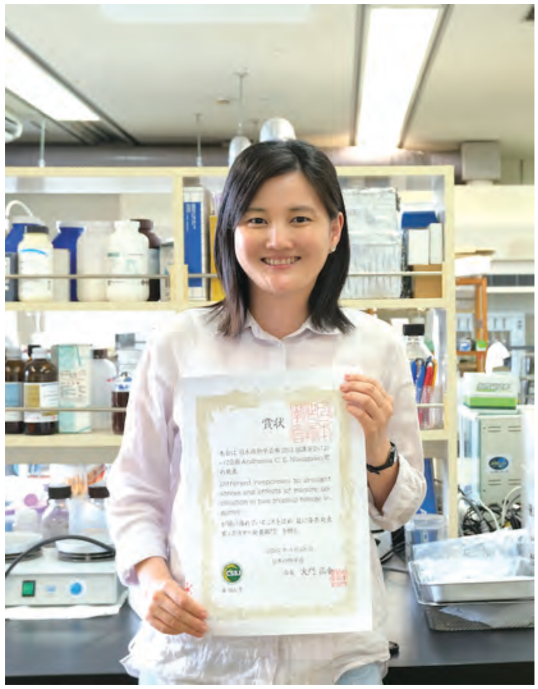

The Proceedings of the National Academy of Sciences
confers upon
Guntur V. Subbarao Xiang Gao Carmen González-Murua
Masahiro Kishii Maria Itria Ibba Tadashi Yoshihashi
Adrian Bozal-Leorri Hannes Karwat Satoshi Tobita
Ivan Ortiz-Monasterio M. B. Gonzalez-Moro Victor Kommerell
Hans-Joachim Braun Masa Iwanaga
THE COZZARELLI PRIZE
for their outstanding article
Enlisting wild grass genes to combat nitrification in wheat farming: A nature-based solution
Published in PNAS on August 23, 2021

Cozzarelli Prize certificate

Dr. Andressa Nakagawa wins Best Poster Presentation Award at the 253rd Annual Meeting of the Crop Science Society of Japan

Dr. Andressa Nakagawa (Researcher, Crop, Livestock and Environment Division) received the Best Poster Presentation Award for her research titled “Different responses to drought stress and effects of manure application in two tropical forage legumes,” presented at the 253rd Annual Meeting of the Crop Science Society of Japan (CSSJ) held online on March 27-28, 2022.

In her award-winning research, Dr. Nakagawa showed that there are interspecific differences in the response to drought of two tropical forage legumes, glycine (*Neonotonia wightii*) and siratro (*Macroptilium atropurpureum*). Siratro plants responded to drought with early stomatal closure and a decrease in the percentage of aboveground leaves, whereas glycine plants maintained a nearly constant percentage of leaves and a constant nitrogen concentration in the plant body even under drought conditions. Cattle manure application also reduced the extent to which drought reduced dry matter production in both grass species. The results of this study suggest that the selection of grasses that respond similar to glycine, while actively utilizing compost, may be useful for the production of high-quality forage for small-scale farmers in Mozambique, where forage is in short supply during the dry season.



Dr. Nakagawa with the CSSJ Best Poster Award certificate

AfricaRice Principal Scientist Kazuki Saito wins the 7th Niigata International Food Award 21st Century Hope Prize

Dr. Kazuki Saito, Principal Scientist at Africa Rice Center (AfricaRice), was selected as the winner of the 21st Century Hope Prize of the 7th Niigata International Food Award. The winners were announced on July while the award ceremony was held in November 2022. Dr. Saito has also been pursuing research at JIRCAS as an affiliated researcher since 2017.

The Niigata International Food Award honors individuals or organizations that have made significant contributions to the welfare, health, and peace of humankind by enhancing the quality and quantity of food in the world and creatively developing food culture and the food industry. The “21st Century Hope Prize” is given to individuals or organizations that have made significant contributions in joint research, development, experiments in practical application, and activities that are expected to develop in the future, with the aim of realizing the potential and feasibility of future contributions to society.

Dr. Saito has made significant contributions to rice breeding projects in Africa by discovering new breeding materials, developing selection methods, and conducting other research to improve food self-sufficiency in Africa. He was also recognized for his significant achievements in improving and consolidating rice farming systems for small-scale farmers and improving farmers’ livelihoods and nutrition.

The Niigata International Food Award laureates from JIRCAS include Dr. Masaru Iwanaga (former President of JIRCAS), winner of the 4th Niigata International Food Award Grand Prix (2016); Dr. Marcy Nicole Wilder (Project Leader, Fisheries Division), winner of the 4th Niigata International Food Award Sano Touzaburo Special Prize (2016); and Dr. Kotaro Maeno (Senior Researcher, Crop, Livestock and Environment Division), who received the 5th Niigata International Food Award 21st Century Hope Prize (2018).

Links:
Announcement of winners (The 7th Niigata International Food Award)

http://www.niigata-award.jp/en/contents/news/220728/index.html

About the Niigata International Food Award
http://www.niigata-award.jp/en/contents/about/index.html

JIRCAS receives Recognition Award at the Thailand National Science and Technology Fair 2022

The annual Thailand National Science and Technology Fair is Thailand's largest science and technology exhibition. This year, it was held for nine days from August 13 to 21 at the Impact Exhibition and Conference Center in Nonthaburi Province.

The JIRCAS Southeast Asia Liaison Office, based in Bangkok, has participated in this exhibition every year since 2007, but due to the new coronavirus pandemic, this was the first time in three years that JIRCAS participated in this exhibition. In addition to JIRCAS, the Japan Pavilion, organized by the Embassy of Japan in Thailand, also featured exhibits from the Japan Society for the Promotion of Science (JSPS), Japan Aerospace Exploration Agency (JAXA), Tokyo Institute of Technology, Kyoto University, National Institute of Information and Communications Technology (NICT), Space Policy Secretariat of the Cabinet Office, Ministry of Internal Affairs and Communications (MIC) INNO-vation Program, and Japan Science and Technology Agency (JST).

The JIRCAS exhibit featured the new *Brachiaria* variety "Issan" developed through international joint research with the Department of Livestock Development of Thailand. "Issan" is the first grass variety developed for the Asian market, and following its registration in Japan, an application for variety registration is currently being processed in Thailand.

The opening ceremony was attended by Deputy Prime Minister and Minister of Foreign Affairs Don Pramudwinai and Minister of Higher Education, Science, Research and Innovation Anek Laothamatas. At the award ceremony, Mr. Sirirurg Songsivilai, Permanent Secretary, Ministry of Higher Education, Science, Research and Innovation, presented a trophy of recognition to JIRCAS for its contribution to science and technology education in Thailand.

During the fair, many visitors, including local elementary, junior high, and high school students, came to see various exhibits.

Overview of AfricaRice
AfricaRice was established in 1970 as West Africa Rice Development Association (WARDA) to improve rice productivity and quality in West Africa. As of 2022, there are 28 member countries. The headquarters is located in Cote d'Ivoire, with branch offices in Senegal, Nigeria, Madagascar, Liberia, and Uganda.

Thai language poster and potted *Brachiaria* variety "Issan" on display

Deputy Prime Minister and Minister of Foreign Affairs Don Pramudwinai at the Japan booth

Mr. Shotaro Ando, representative of JIRCAS Southeast Asia Office, receiving the award

Julio César García-Rodríguez, Yamanaka Naoki, and colleagues receive Honorable Mention for the *PhytoFrontiers* Best Student Paper Award 2021

JIRCAS and the National Institute for Forestry, Agriculture and Livestock Research (INIFAP) in Mexico have been conducting joint research on Asian soybean rust, and part of the results has been published in *PhytoFrontiers*, a journal of the American Phytopathological Society (APS), as Virulence Diversity of *Phakopsora pachyrhizi* in Mexico. The authors, Julio César García-Rodríguez of INIFAP and Naoki Yamanaka of JIRCAS, and their colleagues, received honorable mention for the *PhytoFrontiers* Best Student Paper Award 2021.

This award recognizes the work of early-career scientists and honors outstanding papers by a student first author published in the journals of the American Phytopathological Society such as *Phytopathology*, *Plant Disease*, *Molecular Plant-Microbe Interactions*, *Plant Health Progress*, *Phytobiomes* and *PhytoFrontiers*.

This paper describes the Asian soybean rust (ASR), which has become a problem due the recent increase in soybean cultivation in Mexico, and shows that ASR pathogenic samples collected from two major Mexican production states had very different virulence characteristics, indicating distinct geographical differences in the virulence of the ASR pathogens in close soybean cultivation regions. This is a rare case in the world. The content of this paper is also presented in the JIRCAS Research Highlights 2021, The pathogenicity of Asian soybean rust pathogen in Mexico can be grouped into two broad trends.

The paper was also selected for the Editor's Picks in *PhytoFrontiers*.

Julio César García-Rodríguez, Zeferino Vicente-Hernández, Manuel Grajales-Solís, Naoki Yamanaka (2022) Virulence diversity of *Phakopsora pachyrhizi* in Mexico. *PhytoFrontiers* 2 (1): 52-59. https://doi.org/10.1094/PHYTOFR-06-21-0044-R

Asian soybean rust in a soybean field in Tamaulipas State

Naoki Yamanaka (left) and Julio César García-Rodríguez (right)

Senior Researcher Junji Koide receives the 18th Young Agriculture, Forestry and Fisheries Researcher Award for 2022

Dr. Junji Koide (Senior Researcher, Social Sciences Division) received the 18th Young Agriculture, Forestry and Fisheries Researcher Award for 2022 in a ceremony held at the Agribusiness Creation Fair (Tokyo Big Sight) on October 27, 2022.

Dr. Koide was awarded for his achievement in the development of a versatile agricultural management planning model for small-scale farmers. The model has been used to support decision-making by small-scale farmers in a wide range of regions, including Africa, and has enabled many small-scale farmers to improve their management and incomes. The model, which was also used in various technology development projects to develop optimal adoption plans that maximize farmers' ability to generate income and adapt to climate change, was highly evaluated as a promising contribution to future support for African agriculture.

This award is a commendation of the Chairman of the Agriculture, Forestry and Fisheries Research Council to young researchers (under 40 years old) with outstanding research achievements in agriculture, forestry, fisheries and related industries, and are highly expected to make further contributions in the future. It is aimed at increasing the motivation among young researchers engaged in research and development.

This year, 19 researchers from all over Japan applied for the award, and as a result of the selection process, five researchers including Dr. Koide were selected to receive the award. He is the third recipient of this award at JIRCAS, following Dr. Takehiro Ikezaki (2009 awardee) and Dr. Yasuhiro Tsujimoto (2020 awardee) who are both senior researchers in the Crop, Livestock and Environment Division.

Related URL: https://www.affrc.maff.go.jp/docs/press/221014.html

Senior Researcher Koide (left) and AFFRC Chairman Kobayashi (right)

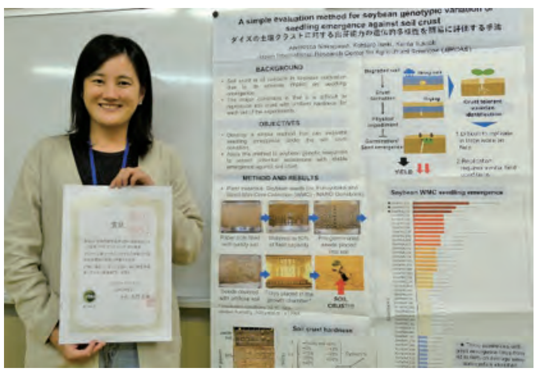
Commemorative photo with awardees (Dr. Koide is in front row, far right.)

Researcher Andressa Nakagawa wins Best Poster Presentation Award at the 254th Annual Meeting of the Crop Science Society of Japan

Dr. Andressa Nakagawa (Researcher, Crop, Livestock and Environment Division) received the Best Poster Presentation Award for her research achievement, titled “A simple evaluation method for soybean genotypic variation of seedling emergence against soil crust” (Andressa Nakagawa, Kohtaro Iseki, Kenta Ikazaki) and presented at the 254th Annual Meeting of the Crop Science Society of Japan (CSSJ) held at Fukushima University on September 20-21, 2022.

In this award-winning research, Dr. Nakagawa developed a simple method to evaluate seedling emergence of soybean after adjusting the hardness of the soil crust to a uniform level. She also applied this method to soybean genetic resources to screen potential accessions with stable emergence against soil crust. The results of this research are expected to contribute to the identification of soybean varieties and lines with high germination rate against soil crust in order to increase soybean cultivation in regions where soil crust occurs, such as West Africa.

http://www.cropscience.jp/award/award_08.html



Researcher Nakagawa with the CSSJ Best Presentation Award (Poster)

Senior Researcher Kotaro Maeno receives the 19th JSPS Prize at the award ceremony

Dr. Kotaro Maeno, Senior Researcher in the Crop, Livestock and Environment Division, received the 19th (FY2022) Japan Society for the Promotion of Science (JSPS) Prize at the award ceremony held at the Japan Academy in Tokyo on February 7, 2023.

The research achievement for which the prize was awarded is "Development of Control Techniques for the Desert Locust in Africa." Dr. Maeno's comprehensive research has led to the development of control techniques that dramatically reduce the amount of pesticides used to control the desert locust. The award also cited the fact that this series of research was carried out through nine years of field surveys and experiments in the Sahara Desert.

The JSPS Prize is awarded to young researchers with creativity and outstanding research ability to honor them from the early stages of their careers and to motivate and support their research development, in order to raise the level of scientific research in Japan to the world's highest standard.

Their Imperial Highnesses Crown Prince and Crown Princess Akishino, Mr. Yosei Ide, Vice Minister of Education, Culture, Sports, Science and Technology (MEXT), Mr. Tsuyoshi Sugino, President of the Japan Society for the Promotion of Science, Dr. Makoto Kobayashi, Chairman of the Selection Committee, and others were in attendance to offer words of congratulations.

During the reception, there was an exchange of words with Their Imperial Highnesses Crown Prince and Crown Princess Akishino, and the awardees received words of appreciation and encouragement for their efforts.

URL: https://www.jsps.go.jp/jsps-prize/kettei.html (In Japanese)

Senior Researcher Maeno receiving the award
Note: Provided by JSPS for use in reporting the award on the website and public relations magazine of the recipient's institution. Posting on SNS is not permitted.

Medal and Certificate

Senior Researcher Maeno

Research Overview

Overview of JIRCAS's Research Structure

1. History

The Japan International Research Center for Agricultural Sciences (JIRCAS) was first established in 1970 as the Tropical Agriculture Research Center (TARC), one of the research institutes of the Ministry of Agriculture and Forestry of Japan. TARC was reorganized into JIRCAS in 1993.

On April 1, 2001, JIRCAS became an Incorporated Administrative Agency (IAA) under the jurisdiction of the Ministry of Agriculture, Forestry and Fisheries (MAFF), in accordance with the administrative reforms of the Government of Japan to facilitate the reorganization of national government-affiliated research organizations.

2. Mission

Through research and development (R&D) and dissemination of information related to agriculture, forestry and fisheries in developing regions, JIRCAS contributes to the improvement of the international presence of Japan and towards a secure and stable supply of food worldwide including Japan.

3. The IAA System

An IAA is an organization responsible for key public services that the government is not required to provide, but which the private sector is likely to neglect for various reasons. The IAA system was introduced in 2001, as part of central government reforms based on the scheme that the planning sectors and the implementing sectors should be separated. Under the IAA system, MAFF defined JIRCAS's Fifth Medium to Long-Term Goals in FY 2021, including that JIRCAS will focus on research areas that address growing expectations for the development of technologies in the agriculture, forestry, and fisheries sectors to achieve the Sustainable Development Goals (SDGs). Based on the Fifth Medium to Long-Term Goals, JIRCAS drafted and began to implement a detailed five-year plan, the Fifth Medium to Long-Term Plan (FY 2021 - FY 2025).

4. Evaluation

The performance and budgeting management of research activities conducted by JIRCAS undergo regular evaluation by the National Research and Development Agency Council established within MAFF. As for the activities of each fiscal year, the Council investigates and analyzes the progress towards achieving the Medium to Long-Term Plan, and the results of this evaluation shall be applied as deemed necessary to the modifications of the operational and financing systems for subsequent fiscal years. To meet the requirements of the general guideline concerning the evaluation of national research and development (a decision of the Prime Minister in 2016) which requires efficient evaluation, JIRCAS carried out the in-house evaluation in FY 2022 as follows:

1) Research activities for each Research Project were reported in January 2023.
2) Summary reports of research activities for each Research Program were prepared. In addition, summary reports of the management of research and development activities were also prepared. These reports were collectively evaluated by the President, Vice-President, Auditor, and Program Directors at the in-house evaluation meeting held in mid- February 2023.
3) A meeting to promote research cooperation in international agriculture, forestry and fisheries was held in late February 2023. The research activities of JIRCAS were reported to government officials from MAFF and specialists from other research institutes under MAFF and from Japan International Cooperation Agency, and there was an exchange of ideas on how to promote cooperation with JIRCAS.
4) The JIRCAS External Evaluation Committee performed a comprehensive evaluation of all JIRCAS activities, which also include administrative operations, in a meeting held in March 2023.

The members of the evaluation committee are listed in the Appendix. The results of the in-house evaluation and a summary of all activities were submitted to MAFF in June 2023.

5. Medium to Long-Term Plan

JIRCAS implements three programs for research activities under the Medium to Long-Term Plan. Each program consists of several projects. Major accomplishments and research highlights of the programs in FY 2022 are described in the following sections. The contents of the Medium to Long-Term Plan are also described in the Appendix.

Table 1. Number of Projects in the Fifth Medium to Long-Term Plan (FY 2021 - FY 2025)

Program	Projects
A (Environment)	6
B (Food)	6
C (Information)	5

Fifth Medium to Long-Term Plan (FY 2021 - FY 2025)

■Program A

Development of agricultural technologies for climate change, resource recycling and environmental conservation

Projects:

1. Development of comprehensive agricultural technologies for climate change mitigation and adaptation in Monsoon Asia
2. Development of carbon recycling technologies to address global issues caused by agricultural waste
3. Development of planet-friendly agricultural production systems using biological nitrification inhibition (BNI) technology
4. Evaluation of genetic resources for strengthening productivity and adaptability of tropical forests
5. Development and evaluation of environmental conservation technologies for tropical islands through an approach emphasizing Yama-Sato-Umi (Ridge-to-reef agroecosystem) connectivity
6. Development of sustainable land management technologies under extreme weather conditions in drylands

■Program B

Technology development towards building a new food system with improved productivity, sustainability and resilience

Projects:

1. Development of resilient crops and production technologies
2. Design of crop breeding and food processing of indigenous resources to create new and diversified demands
3. Development of environment-friendly management systems against transboundary plant pests based on ecological characteristics
4. Development and dissemination of sustainable aquaculture technologies in the tropical area based on the eco-system approach
5. Development of sustainable rice cultivation and food production systems in Africa
6. Development of soil and crop management technologies to stabilize upland farming systems of African smallholder farmers

■Program C

Strengthening function as an international hub for providing strategic information on agriculture, forestry and fisheries, and mobilizing new research partnerships

Projects:

1. Strategic information hub for international agricultural research
2. Practical application of global research results and establishment of a model platform for promoting private-sector research collaboration and creating new business ventures
3. Towards the development of digital agriculture technologies in Sub-Saharan Africa
4. Advancement of tropical crop genetic resources utilization through the development of database, technologies and research networking
5. Accelerating application of agricultural technologies which enhance production potentials and ensure sustainable food systems in the Asia-Monsoon region

6. Collaborative Research

JIRCAS is required to cover a wide range of research fields. Human resources at JIRCAS, however, are limited. This makes collaborative research with other institutes or universities necessary towards achieving JIRCAS's project objectives. Whenever JIRCAS and its collaborators reach an agreement on the commencement of collaborative research after exchanging ideas and opinions, a Memorandum of Understanding (MOU) or a Joint Research Agreement (JRA) is usually concluded. JIRCAS developed the concept of JRAs in 2006. A JRA is a contract for collaborative research with a particular research subject and with a fixed term. A total of 130 MOUs and JRAs remained in force at the end of FY 2022.

In 2004, JIRCAS was given a Certificate of Recognition by CGIAR as a key partner and as the CGIAR focal point institution in Japan. JIRCAS has been playing an important role in promoting mutual understanding and collaboration between CGIAR and the Japanese government. It has also been intensively implementing collaborative research with several CGIAR research centers.

JIRCAS has been regularly dispatching researchers and research managers to promote research in the developing regions. Likewise, we have been dispatching researchers from other institutes and universities to promote the effective implementation of JIRCAS's projects with the cooperation of such organizations. JIRCAS has also implemented several invitation programs for overseas researchers and administrators at counterpart organizations. These programs facilitate not only the promotion of international collaborative research but also related exchanges of information and opinions.

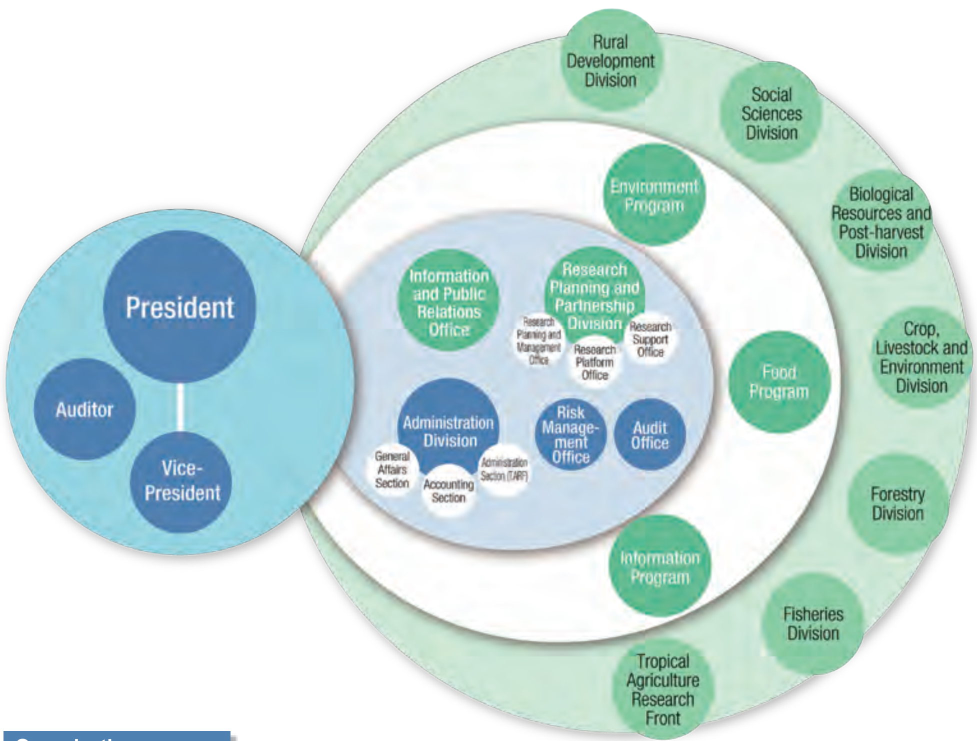
7. Organization of JIRCAS

The organizational structure of JIRCAS for the Fifth Medium to Long-Term Plan period is summarized in the figure below.

Three Program Directors are responsible for the implementation of individual programs during the Fifth Medium to Long-Term Plan period.

The directors of divisions and the Tropical Agriculture Research Front (TARF) are responsible for managing staff and enhancing the capabilities of researchers.

TARF (formerly the Okinawa Subtropical Station), located in Ishigaki Island in the southernmost part of Japan, is JIRCAS's sole substation. It focuses on agricultural, forestry, and fisheries research being carried out in overseas regions with highly similar climatic and geographic conditions as Okinawa, taking full advantage of its subtropical weather and geographic location.



Organization

Main Research Programs

Program A
Environment

“Development of agricultural technologies for climate change, resource recycling and environmental conservation”

A significant rise in greenhouse gas (GHG) emissions through crop cultivation, livestock production, and extractive forest resource use has amplified the burden on people’s lives and the environment. The ‘Environment Program’ aims to ensure sustainability in the agriculture, forestry, and fisheries sectors and establish appropriate resource management by maximizing resource use efficiency, especially in developing countries and regions that are vulnerable to the adverse impacts of climate change.

[Climate change measures in Monsoon Asia]

We began measuring the rice growth and yield and GHG emissions under conventional agronomic practices at our study site in Cambodia. In Vietnam, we identified a water management practice for paddy fields that both increased rice yield and decreased CH_4 emissions. Through cultivation experiments in Japan, we found that the degree of soil drying during intermittent irrigation affected GHG emissions and rice yield. Furthermore, we simulated irrigation and reservoir management to introduce ratoon rice cropping system in the study area. We also conducted a study on the rooting ability of ratoon rice crops under hydroponic conditions. We analyzed the resource utilization rules of a water users’ group in Bali and clarified the relationship between changes in social conditions and resource allocation. We also demonstrated the effectiveness of Japan’s circular irrigation system in reducing water consumption and preventing the eutrophication of water sources. In addition, we conducted a flood survey in Cambodia using satellite altimetry and revealed that the damage to rice cultivation was extensive throughout the Tonle Sap Lake area.

Based on the results of a long-term field experiment for over 40 years in Northeast and Eastern Thailand, the rate of soil carbon sequestration by organic matter application was calculated. Additionally, it was revealed that in sandy soils, the carbon sequestration effect is not limited to the surface soil but can also be observed in the subsoil. We estimated the carbon storage potential by the physicochemical properties of soils collected from sugarcane fields, forests, and home gardens in Negros Island, Philippines, and data from peer-reviewed papers. We clarified that the carbon storage potential is regulated by land use.

We developed the GHG emission factor value from the Vietnamese beef cattle manure sun-drying system. We also found that a significant shift in the manure microbiome and the suppression of methanogen activity occur at the beginning of sun-drying. In Thailand, we tested the effect of rice straw mixing on GHG emissions from beef cattle manure storage and found that it significantly reduces methanogen activity in the manure while methane emission reduction was not statistically significant. We conducted gene expression analysis of several kinds of cytokines involved in immune responses using bovine peripheral blood mononuclear cells, and we showed that non-conventional yeast cell wall from cultivation in cassava pulp induced gene expression of both proinflammatory and anti-inflammatory cytokines.

We selected target plots as a model site for water management in a large paddy area in Cambodia, installed observation devices, and collected information from target farmers and a water users’ group. We also introduced biogas digesters to target farmer households to study Life Cycle Assessment (LCA) in Vietnam. To contribute to the Nationally Determined Contribution (NDC) of Thailand on GHG emission reduction based on the results of the long-term experiment conducted in Thailand, we worked on the preparation of papers. We exchanged views with relevant organizations and collected related information on the dissemination method utilizing the carbon market mechanism being discussed at the Conference of the Parties (COP).

[Carbon recycling]

The establishment of technologies and social systems that promote agricultural waste recycling will help address issues related to the treatment and disposal of farm waste. This project will develop a microbial saccharification-gasification bioreactor to generate biogas and hydrogen from agricultural waste with high efficiency at a larger scale. A transformation system for the saccharification bacterium *Paenibacillus macerans* (NITE-P) has been established by electroporation. We also presented a microbial saccharification technology by co-culturing thermophilic anaerobic bacteria without using cellulolytic enzymes. An automated open/closed chamber system was installed in a palm plantation in Malaysia and measurements of the CO_2/CH_4 flux in the soil were initiated. JIRCAS Dream Biomass Solutions, the second venture company of JIRCAS, was established and the social implementation of the technology developed was started.

[BNI-system]

Field trials were conducted at the JIRCAS Tsukuba field in the third cropping season, and the results confirmed that the Biological Nitrification Inhibition (BNI)-enabled wheat line consistently produced higher yields than the parental lines in all cropping seasons up to this year, and the effect was visibly evident under low fertilizer application conditions. We monitored the dynamics of nitrous oxide and nitrate in the rhizosphere soil of BNI-enabled wheat, confirming that less nitrous oxide was generated after rainfall following fertilizer application and that soil nitrate was reduced during the cropping season. A SATREPS (Science and Technology Research Partnership for Sustainable Development) project was initiated with Indian partners and multi-location trials were initiated using BNI-isogenic lines in different elite wheat backgrounds (at least 3 pairs namely Munal vs BNI-Munal, Roelf vs BNI-Roelf, Borlaug vs BNI-Borlaug) in Punjab, Madhya Pradesh, and Bihar. In addition, backcrosses were initiated to introduce *Leymus racemosus* N chromosome short-arm (Lr#N-SA) from BNI-Munal into several elite Indian wheat varieties.

The contribution of maize BNI compounds to the hydrophilic and hydrophobic fractions was determined. A hydrophilic BNI compound was found to contribute 69% of the hydrophilic fraction and 50% of the total BNI activity. Development of doubled haploid line (DHL) populations is nearing completion at the International Maize and Wheat Improvement Center (CIMMYT). Phenotyping for hydrophobic-BNI capacity of DHL populations will be initiated.

Two sorghum lines with high sorgoleone content were selected from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) African panel, and field trials were conducted at the JIRCAS Tsukuba field. The results showed a significant decrease in nitrate in the rhizosphere soil, confirming that high-sorgoleone producing lines have strong BNI-function and thus reduce soil nitrate formation more effectively than low-sorgoleone producing lines in the field.

To construct a denitrification-decomposition (DNDC) model for *Brachiaria*-maize crop rotation, five *Brachiaria* lines were monitored at the JIRCAS Ishigaki field using the minirhizotron. The effect of BNI on maize production in the post-*Brachiaria* crop was also confirmed at the International Center for Tropical Agriculture (CIAT) field, and it was confirmed that BNI was effective on maize up to the sixth crop after *Brachiaria*.

Ex-ante analysis of BNI-enabled sorghum under development showed that adopting a nitrification inhibition rate of 30% can reduce nitrogen fertilizer application by 11.7% and LC-GHG emissions by 20.8%.

The 4th BNI International Consortium Meeting was held in Tsukuba, Japan, bringing together about 80 new and former members from around the world, as well as representatives from domestic institutions, for a three-day meeting to exchange information and discuss ways to deepen research on BNI-enabled wheat and strengthen the collaboration for the development of BNI research.

[Adaptive forestry]

Tropical forests are rich in diversity and contain trees with a variety of excellent timber properties, but there are challenges to the sustainable use of such resources. This project aims to clarify the characteristics, functions, and adaptability to environmental changes of the indigenous genetic resources of tropical forests in Southeast Asia and other regions, and to develop silviculture technologies to enhance forest productivity and environmental adaptability to climate change based on the results. In this project, we clarified the following six subjects. 1) A whole-genome transcriptome analysis was conducted using a dipterocarp species, *Neobalanocarpus heimii*. As a result, we obtained 434 and 531 candidate genes that promote and repress leaf flushing under higher and lower temperature conditions, respectively. 2) In 13 species of seasonal forests in northeastern Thailand, we examined the degree of cavitation and the amount of soluble sugars in the xylem, which are indicators of tree drought tolerance. These characteristics showed significant correlations with wood density, and species with high wood density were suggested to have a higher risk of dying from drought. 3) Double digest restriction-site associated sequencing (ddRADseq) identified single-nucleotide polymorphism (SNP) genotypes with broad genomic coverage, and high genomic heritability was calculated for growth-related phenotypes:

tree height and breast height diameter in the seventh year. In addition, a small number of significant SNPs were detected in these phenotypes as a result of genome-wide association study (GWAS). Furthermore, we selected modeling methods to predict phenotypes from genotypes by using linear models such as the genomic best linear unbiased prediction (GBLUP) and nonlinear models such as convolutional neural networks (CNNs). 4) Based on literature and existing data on leaf and wood traits of 16 species in Dipterocarpaceae, we found that there were differences of about 2 times in wood density, and about 1.5 times in leaf dry weight per unit area among the species. 5) To clarify the restoration of biodiversity and its functions in response to natural regeneration of forest, monitoring of soil carbon flux and evaluation of soil microbial flora using portable chambers and genetic analyses were started in primary and secondary forests in Pasoh Forest Reserve, Peninsular Malaysia. In secondary forests, the amount of soil microbes was lower than that in primary forests. In particular, it was found that aerobic methanotrophs, which contribute to methane uptake in the soil, was also decreased in secondary forest due to the low levels of rhizosphere development. 6) In a mangrove forest dominated by *Bruguiera gymnorhiza* on Ishigaki Island, we measured methane emission rates from stems and buttress roots of *B. gymnorhiza* and from sediments, and clarified the variability of methane emission rates in mangrove forests.

[Yama-Sato-Umi agroecosystem connectivity]

The development of carpophores from mushroom beds (*Auricularia* sp.) was observed under assumed field conditions such as different rates of sunlight and direct cultivation on the ground. Suitable environments for healthy rooting were identified for the cutting propagation of the tropical fruit trees acerola and jaboticaba. The effectiveness of improved saplings made by the “soil briquette” method was suggested in higher growth and deeper root systems compared to conventional pot saplings. The water-saving effect of irrigation was clarified through water balance observations. Bagasse biochar applied to the soil surface layer reduced nitrate nitrogen leaching the most and improved crop yield. Filter cake application maintained and improved the dry matter weight of sugarcane even with reduced fertilizer application. The fertilizer use efficiency of nitrogen applied at the time of planting pineapple on Ishigaki Island was estimated to be nearly 0% at the time of planting, and 3%–5% during the first year of planting pineapple at Ishigaki Island. Regarding sugarcane biomass use in the Philippines, sugarcane plants that were planted and harvested at different times were investigated, and it was found that sugar + fiber yields were maximized at 10-month harvest in dry-season planting (externally funded research - “Sugarcane Cultivation Systems”). Compared to conventional planting (10 cm depth), deep planting (30 cm depth) decreased lodging by typhoons and increased cane yield by about 6%. Haruno-Ogi, developed through interspecific hybridization with wild sugarcane, has high leaf area index (LAI) due to early growth and vigorous tillering, resulting in high soil runoff suppression even in the plant crop. We identified the variations in the components of sugar mill wastewater, and obtained vitamin-producing, acidophilic microalgae from outdoors in Japan for treatment of sugar mill wastewater. Seasonal changes in the green algae, *Ulva* sp., on the coast of Ishigaki Island were examined, and their nitrogen content was determined. A model was developed to relate the growth of mangroves to their nutrient absorption function. The relationship between soil carbon and nitrogen sequestration in mangrove forests and microtopography was clarified. A mangrove growth simulation model was developed for mangroves on Ishigaki Island in different salinity environments and published as an academic paper (externally funded by “SATREPS”). The carbon accumulation process of planted mangroves was clarified by chrono-sequential analysis and published as an academic paper (externally funded by “SATREPS”). The response of nitrogen concentration in river water to agricultural management in the watershed was predicted using a machine learning model that was created based on the result of river water quality monitoring in Ishigaki Island. The relationship between the concentration and composition of riverine dissolved organic matter and watershed characteristics was also evaluated. A preliminary hydrologic and water quality survey was conducted in the rivers of Negros Island, Philippines, to select the target rivers and locations for monitoring. Refinement of the nitrogen footprint and scenario analysis suggested that a 30% reduction of chemical fertilizers could be achieved by returning about 60% of cattle manure to agricultural land in Ishigaki Island. A questionnaire survey of farmers and non-farmers in Ishigaki City indicated that soil runoff from farmland is perceived as damaging to farm management.

[Sustainable land management in drylands]

Desertification, or land degradation in dry areas, is one of the most serious global environmental issues. Irrigation is essential for agricultural production in drylands with low precipitation and high evaporation. However, excessive irrigation and poor drainage have led to soil salinization. In soil-degraded areas, the decline in yield during extreme weather events such as droughts and heavy rains is more pronounced than in other areas, and this synergistic damage also threatens food and nutrition security. To achieve sustainable agriculture and food security in drylands, it is crucial to develop a sustainable land management (SLM) strategy that consists of mitigating the damage from soil salinization and extreme weather events and maximizing water use efficiency. This project is focused on the northern part of India.

From groundwater table observation data, it was confirmed that the construction of shallow sub-surface drainage with Cut-soiler lowers the groundwater table and drains saline groundwater. As a result of the analysis focusing on "swelling" and "dispersion," it was confirmed that the higher the Na content, the higher the risk of dispersion causing drainage deterioration. We confirmed that shallow sub-surface drainage (60 cm depth) constructed with the Cut-soiler reduced soil salinity by 8% and 32% (P=0.047) at 4 and 16 months after construction, respectively. In addition, yield improvements of 4% and 23% (P=0.048) were confirmed in the dry and rainy season crops, respectively.

Based on groundwater database across India, we analyzed the groundwater table fluctuations from 2015 to 2020, and confirmed that the groundwater table is declining. We started a farmer survey targeting 70 to 80 farmers, then selected 9 fields from 7 villages with severe soil salinization and water logging problems as areas where we will next construct shallow sub-surface drainage systems using the Cut-soiler.

TOPIC 1

Greenhouse gas emission factor value from Vietnamese beef cattle manure sun-drying process

Livestock manure and its management process are known to be a major source of greenhouse gas (GHG) emissions. Developing countries, including some SE Asian countries, sometimes do not have their own emission factor (EF) values, which forces them to use the Tier 1 approach with the default EF values provided by the IPCC to estimate their GHG inventory. Therefore, some GHG emission measurement dataset is needed to develop the independent EF values for higher Tiers estimation. Here, we conducted a farm survey in southern Vietnam to identify the major manure management system in the region. Moreover, we measured the GHG emission from the sun-drying system, estimated the EF value for this specific management, and focused on the manure microbiome to analyze its relationship with GHG emissions.

A questionnaire-based farm survey was conducted among 20 beef cattle farmers in Ben Tre province, which has a high cattle population in the Mekong Delta region, to identify the major manure management system in the region. We found that most farmers sun-dry the manure in their backyards (Fig. 1). We carried out the sun-drying experiment of beef cattle manure by mimicking the local practice and found that significant fresh weight loss occurs within 3-4 days (Fig. 2A). We measured the GHG emissions and found that CH_4 emission occurs only at the beginning, while N_2O emission was negligible (Figs. 2B and 2C). The potential EF values from this management category were estimated as CH_4:

Fig. 1. Sun-drying of beef cattle manure in Ben Tre province

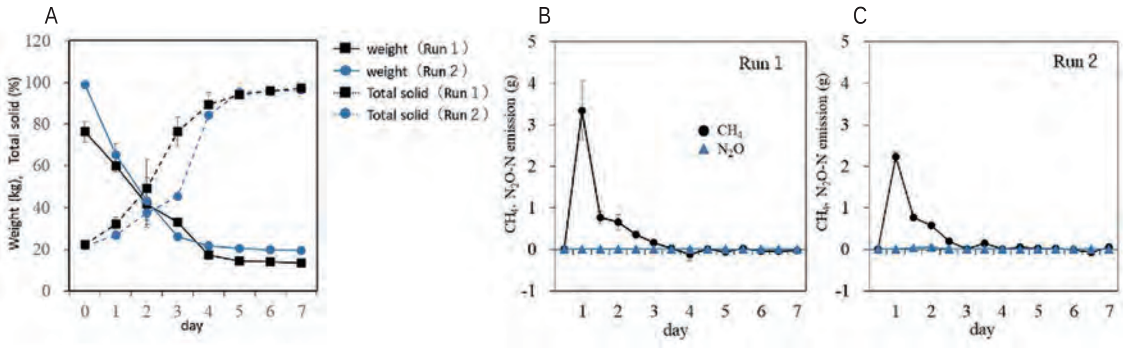


Fig. 2. Change in fresh weight, total solids, and GHG emissions from manure sun-drying

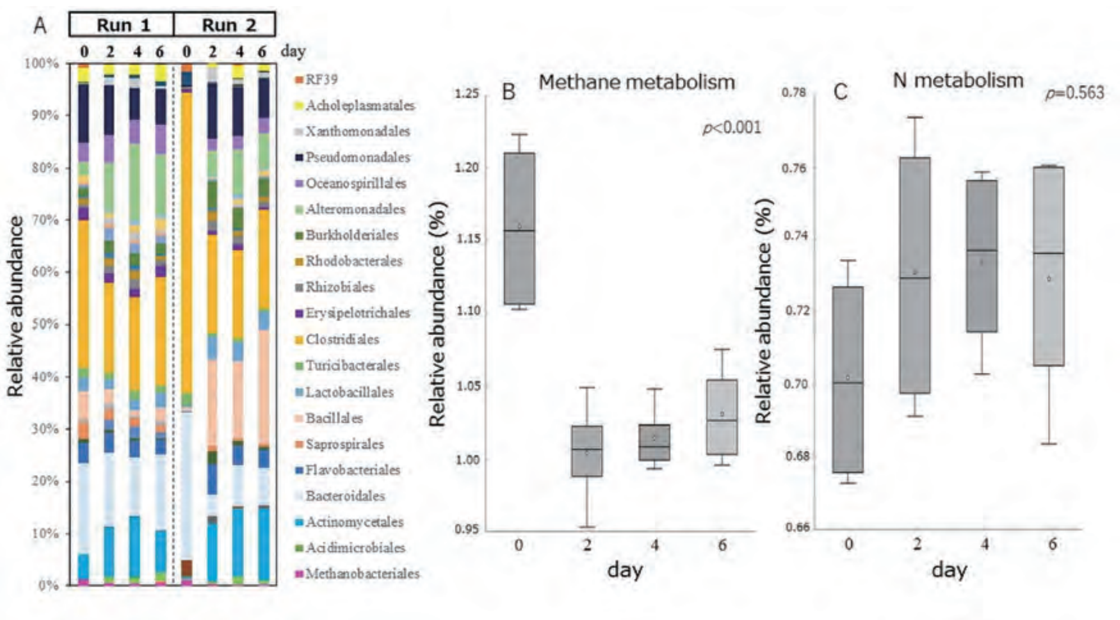


Fig. 3. Change in the manure microbiome and its functions during sun-drying

0.295 ± 0.078 g kg^{-1}VS and N_2O: 0.132 ± 0.136 g N_2O-N kg^{-1} $N_{initial}$, respectively. We estimated the function of the microbiome and elucidated that sun-drying treatment significantly reduces the activity of methane-related metabolism at the beginning stage ($p<0.001$), which is reflected by the significant reduction in the relative abundance of the methanogens (Fig. 3B), and this agrees well with the significant reduction in methane emission at the beginning of drying (Figs. 2B and 2C). On the other hand, the effect of sun-drying on N conversion activity, which includes nitrification or denitrification, was not statistically significant ($p=0.563$, Fig. 3C).

This information can be utilized as the EF value for the Vietnamese national GHG inventory. Sun-drying systems can be said to be very effective in manure management from the point of view of CH_4 emission mitigation. Other agricultural practices that produce GHGs, such as dried manure application to coffee/pepper farmlands, should be further investigated.

Reference

Nguyen et al. (2022) *PLoS ONE* 17(3): e0264228. Figures reprinted/modified with permission.

(K. Maeda,
T.V. Nguyen [Institute of Agricultural Science for Southern Viet Nam (IASVN)],
T.H.T. Nguyen [IASVN], V.N. La [IASVN],
T. Suzuki [National Agriculture and Food Research Organization (NARO)], D.D. Nguyen [Tay Nguyen University, Vietnam])

A comprehensive assessment of greenhouse gas emissions from Thai beef cattle production

Livestock is known to be a major source of greenhouse gases (GHGs). However, a GHG emission dataset from livestock production in Southeast Asian countries is still lacking. There is a strong need for a CH_4 conversion factor (*Ym* value) dataset or emission factor (EF) value for each manure management category. Moreover, some developed countries have independent datasets, while no dataset covers both. Here, we provide the dataset that covers both enteric CH_4 and GHG emissions during manure storage from a Thai native beef cattle production system. In addition, we assess the effect of mixing rice straw (RS), which is an abundant and ready-to-use resource.

Four Thai native cattle were fed a restricted amount (2% of BW) of a diet comprised of 70% Pangola grass and 30% commercial concentrate to meet their digestible energy requirements. The emission of enteric CH_4 was measured by the head-hood system for 6 days in three periods, and the manure was accumulated in the dynamic chamber system coupled with GC-FID and ECD. Five hundred kg of manure with and without 25 kg of rice straw mixture were put in the chamber for 12 weeks and mixed every 2 weeks. Dry matter (DM) intake for runs 1 and 2 was 5.4 and 5.6 kg/d, while DM digestibility was 53.68 and 55.42%, respectively. Digestibility of organic matter, crude protein, and ether extract was also in the range of typical values for the region. The *Ym* value was 6.87%GEI (gross energy intake) and CH_4 emission from manure storage was 0.68% GEI (Table 1). Mixing of RS significantly affected manure temperature, reaching 65.1℃–66.2℃ in the RS mixed pile while that of the control pile ranged between 43.8℃ and 47.4℃ (Fig. 1). There was a high variation in the gas emission; the CH_4 emission from the RS mixed pile showed a lower tendency while there was no significant effect on the total CH_4 emission (Fig. 2A). The same trend was observed for N_2O emission (Fig. 2B). An analysis of the relationship between the estimated function of manure microbiome and GHG emission shows that a significant treatment effect was obtained on methane metabolism at the beginning (Fig. 3), and it agrees well with the mitigation of the peak CH_4 emission in the RS mixed manure.

This information can be utilized as the EF value for Thailand's national GHG inventory. The use of rice straw as a bulking agent can enhance OM degradation in the manure and suppress the activity of methanogens, but it should be noted that its effect may be limited for small-scale farmers with small amounts of manure.

Table 1. Fate of the energy contained in the feedstuff (kJ/head/day)

	Run 1	Run 2	%
Gross Energy Intake	90,754.4	99,609.8	100.00
Retained energy	20,166.6	16,614.9	19.32
Heat production	24,407.6	29,588.3	28.36
Enteric CH_4	6161.2	6918.6	6.87
Urine	1197.0	1785.0	1.57
Manure (excluding CH_4 emission during storage)	38032.4	44201.0	43.20
CH_4 during manure storage	789.6	501.9	0.68

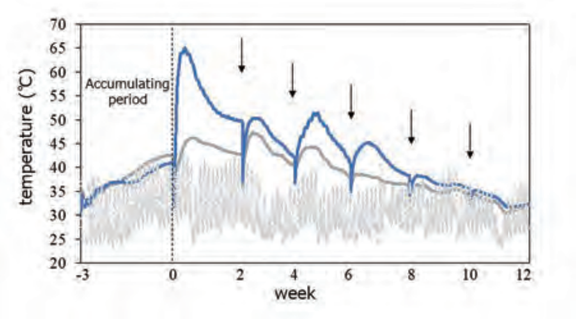
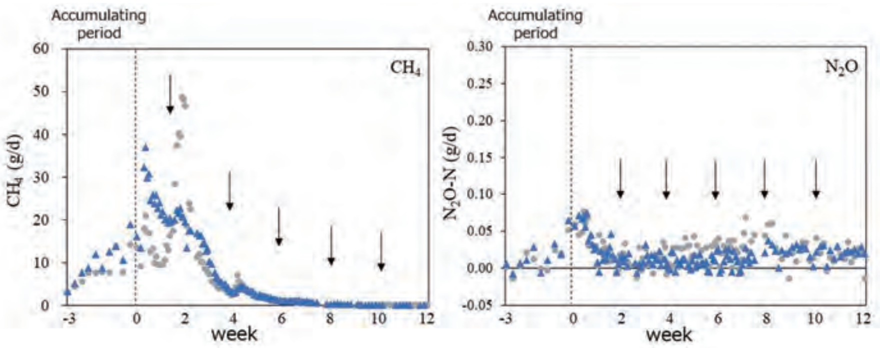
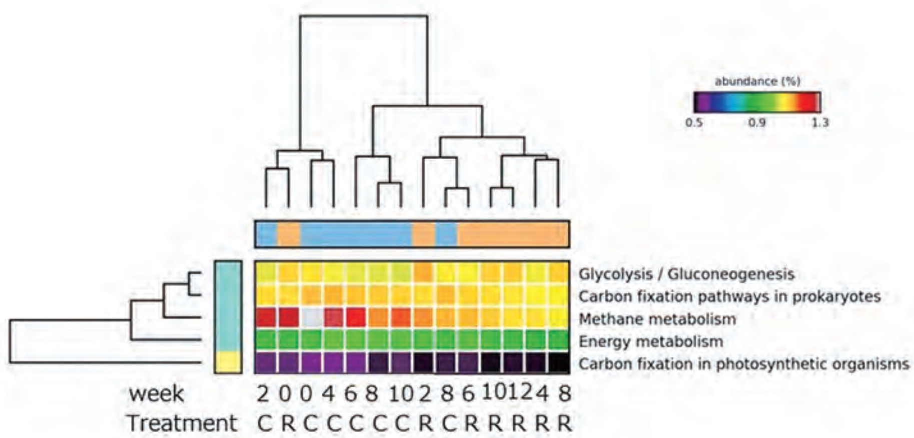


Fig. 1. Temperature profiles during manure storage
Blue: rice straw mixed
Grey: control
Light grey: ambient temperature



Blue: rice straw mixed
Grey: control
Arrows: turnings

Fig. 2. CH_4 and N_2O emissions during manure storage



R: rice straw mixed
C: control

Fig. 3. Effect of rice straw mixing on functions of manure microbiome

Reference

Angthong et al. (2022) *Front. Environ. Sci.* 10: 872911.

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(K. Maeda, Y. Cai, W. Angthong [Ruminants Feeding Standard Research and Development Center (RFSDC), Thailand], O. Kaeokliang [RFSDC], S. Kamphayae [RFSDC] T. Suzuki [NARO], A. Mori [NARO], H. Kitwetchroen [Khon Kaen University, Thailand])

TOPIC 3

Enteric methane emission models for beef cattle in Southeast Asia

Ruminants are one of the major sources of greenhouse gas emissions. Therefore, a precise estimation of this category is needed. Since direct precise measurement from each cattle is labor-consuming and requires a specific expensive measurement facility, an alternative approach that enables indirect estimation with available data, such as the feed intake or its quality, is needed.

Currently, methane emissions from ruminants in each country are estimated using the methane conversion value (Y_m), which utilizes the gross energy intake (GEI) data. In this study, the model is composed of datasets from Western cattle breeds and feed composition; however, it is very different from the situation in Southeast Asian countries, and it makes the precision of the estimation poor. Therefore, a better estimation equation model that reflects the specific production condition in Southeast Asian countries is needed. Here, we revised the current methane emission equation model by collecting the available methane emission data and feed intake or its composition data across Southeast Asian countries.

We conducted a survey on methane emission data and feed intake or composition data from 8 Southeast Asian countries as part of the GRA-LRG global network project, and found that only 3 countries (Thailand, Vietnam, and Indonesia) possess methane emission data using the standard chamber method. After quality filtering, 398 data points were used for developing the methane emission estimation equation model. First, we developed the model based on dry matter intake data (Table 1, ①). The RMSPE value is lower compared to current IPCC Tier 2 (2019) or Global Network Tier 2 equation models, indicating that our model has higher precision compared to these existing models (Fig. 1). The RMSPE value could be further lowered by including NDF or body weight as additional parameters (Table 1, ②③, Fig. 1). Furthermore, the dataset was divided into 3 categories according to the roughage/concentrate ratio (all forage: 119, high forage: 163, low forage: 116), and they were used for developing higher precision equation models (Table 2). The RMSPE value was lowest for the high forage (50%–85%) category, which is the most widespread feed composition in the region.

These estimation equations can be utilized as a better and alternative approach compared to the existing estimation equations for inventory data development in each country. However, we need to keep in mind that the dataset used for the methane emission estimation equation model is derived from only a few countries (Thailand, Vietnam, and Indonesia).

Table 1. Estimation equation and prediction error of methane emission from the rumen all data (n=398)

Model		RMSPE (%)
① DMI	20.15 (4.42) + 19.59 (0.90) × DMI	16.9
② DMI, NDF	36.03 (4.91) + 18.77 (0.86) × DMI – 0.34 (0.05) × NDF	15.2
③ DMI, NDF, BW	26.63 (4.82) + 15.20 (1.04) × DMI – 0.29 (0.05) × NDF + 0.08 (0.015) × BW	14.2
Global Network Tier 2	[0.061 × GEI] ÷ 0.05565	27.4
IPCC (2019) Tier 2	[0.07 × GEI] ÷ 0.05565	19.9
Suzuki et al. (2018)	8.91 + 22.71 × DMI	16.8
van Lingen et al. (2019)	54.2 + 12.6 × DMI	19.0

DMI: dry matter intake, NDF: neutral detergent fiber, CP: crude protein, EE: ether extract, BW: body weight, GEI: gross energy intake, RMSPE: root mean square prediction error, values in the parenthesis: standard error

Table 2. Estimation equation and prediction error of methane emission from the rumen, high forage content (50% – 85%, n=163)

Model		RMSPE (%)
① DMI	14.27 (6.00) + 19.75 (1.27) × DMI	15.1
② DMI, NDF	34.32 (6.78) + 19.81 (1.14) × DMI – 0.43 (0.09) × NDF	13.0
③ CP, EE, NDF, BW	63.33 (9.89) – 2.19 (0.54) × CP + 2.74(0.86) × EE – 0.36 (0.11) × NDF + 0.28(0.02) × BW	13.2
Global Network Tier 2	[0.061 × GEI] ÷ 0.05565	21.5
IPCC (2019) Tier 2	[0.07 × GEI] ÷ 0.05565	15.1
Suzuki et al. (2018)	8.91 + 22.71 × DMI	16.5
van Lingen et al. (2019)	54.2 + 12.6 × DMI	17.4

DMI: dry matter intake, NDF: neutral detergent fiber, CP: crude protein, EE: ether extract, BW: body weight, GEI: gross energy intake, RMSPE: root mean square prediction error, values in the parenthesis: standard error

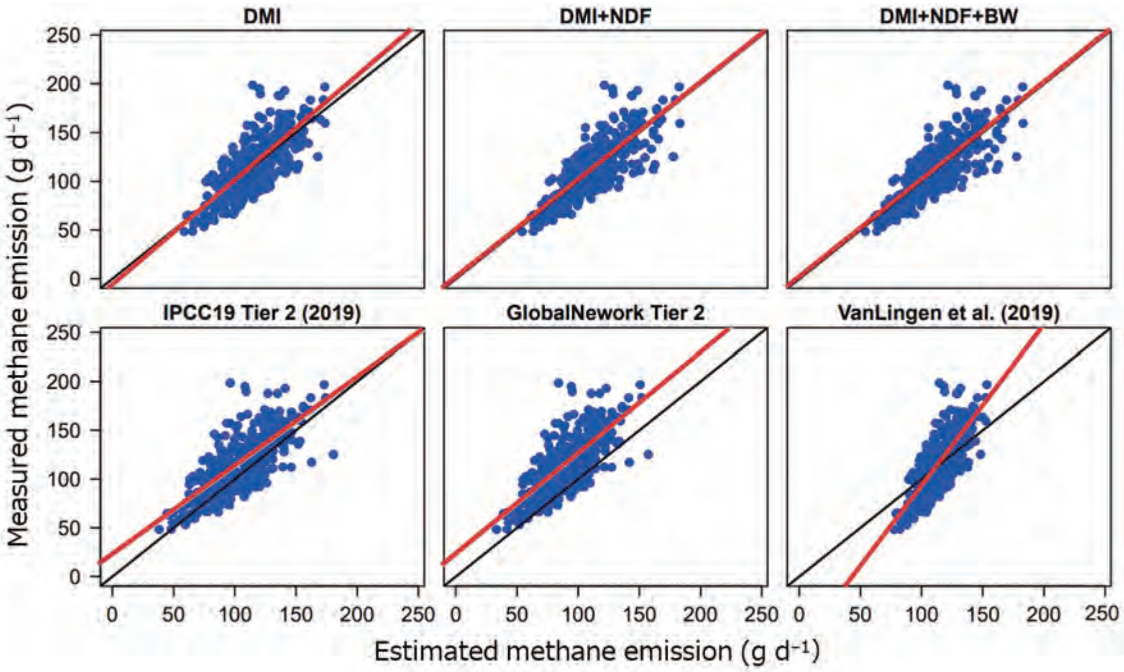

Fig. 1. Observed vs. predicted plots for methane emission (g $d^{-1}animal^{-1}$) prediction equations

Reference

Tee et al. (2022) *Anim. Feed Sci. Technol.* 294: 115474.

Figure and tables reprinted/modified with permission.

(K. Maeda, T. Suzuki [National Agriculture and Food Research Organization (NARO)], Tee T.P. [University of Putra-Malaysia (UPM)], Liang J.B. [UPM], and 37 others

TOPIC 4

Year-round implementation of alternate wetting and drying across three cropping seasons improves farmers' benefits and reduces greenhouse gas emissions

The Mekong Delta, located in southern Vietnam, is the country's largest paddy rice cropping region. Recently, the area planted with rice has been expanding due to the cultivation of three-season crops. Increasing rice acreage is an effective means of meeting food demand and maintaining or improving farmers' incomes. However, intensive rice cropping system is increasing water demand and greenhouse gas (GHG) emissions.

In rice paddies, the soil becomes anaerobic (without oxygen) and the anaerobic microorganisms produce methane (CH_4), which exacerbates climate change. An irrigation technique called alternate wetting and drying (AWD) is one of the promising technologies that have been developed to reduce irrigation water consumption. This technique supplies oxygen to the soil and reduces CH_4 emissions.

Based on the MeaDRI Strategy and the Global Methane Pledge, JIRCAS is carrying out research about the impact of AWD in the Asia-Monsoon region to facilitate further dissemination. A comprehensive evaluation on the impact of AWD on farmer benefits and GHG emissions, and the merits of year-round implementation across three cropping seasons, has not been done. Therefore, the main objective of this study is to evaluate the impact of year-round AWD implementation on life cycle greenhouse gas (LC-GHG) emissions and farmers' benefits using survey data in 2019-2020 from An Giang Province in the Mekong Delta region of Vietnam. Using the life cycle assessment method, LC-GHG emissions were calculated by summing up emissions from agricultural material production, rice cultivation, harvesting, and rice straw management (Fig. 2).

The results of this study showed that farmers who implemented AWD for three cropping seasons increased their annual financial benefits by 6% compared to farmers who did not implement AWD (Fig. 3). It also revealed that farmers who implement AWD could reduce annual LC-GHG emissions by 38% for the entire year (Fig. 4). Based on these results, this study recommends implementing AWD throughout the year in An Giang Province if irrigation and drainage systems are available.

The implementation of year-round AWD is a co-benefit agricultural system that both increases farmers' benefits and reduces environmental impacts from agriculture, and is expected to be a

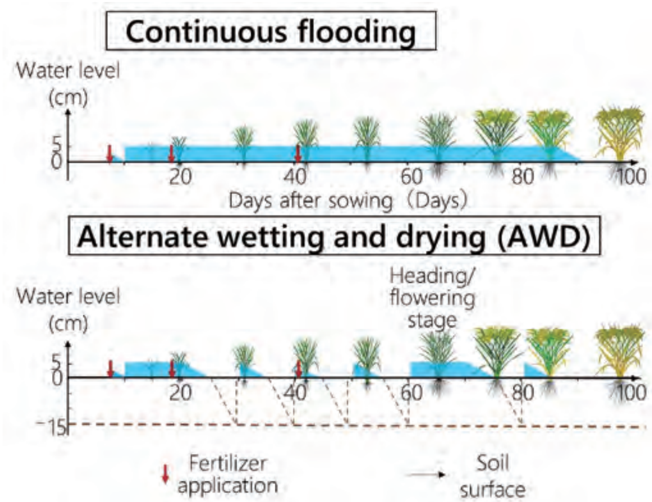

Fig. 1. An example of conventional water management (continuous flooding) and alternate wetting and drying (AWD) during a cropping season
Under AWD, the paddy soil is reflooded to a depth of 5 cm after several days of drying when the water table reaches approximately 15 cm below the soil surface, except for ten days from 10 to 20 days after seeding and during the fertilizer application period and flowering period.

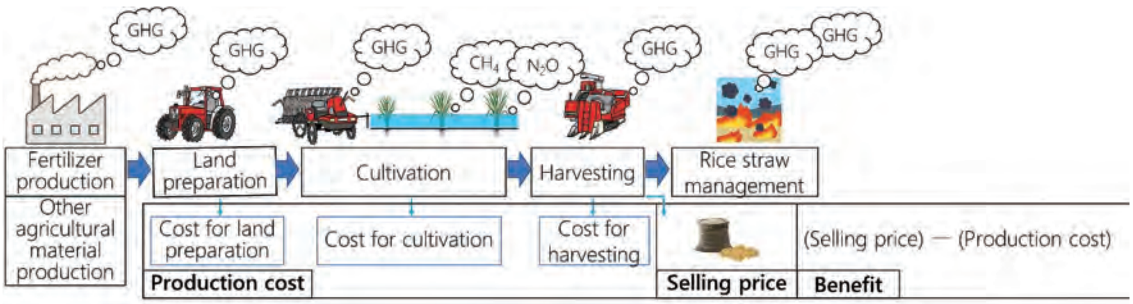

Fig. 2. Life cycle greenhouse gas (LC-GHG) emissions and benefits
LC-GHG is the sum of emissions from agricultural material production to harvesting/rice straw management.

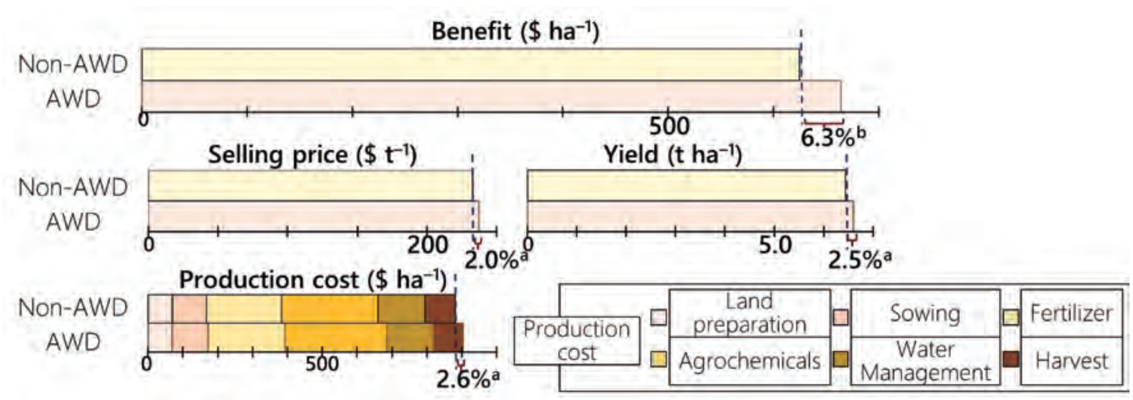

Fig. 3. Benefit, selling price, yield, and production cost of non-AWD and AWD farmers
a: $p<0.05$, b: $p<0.056$; n: Number of fields analyzed (501 non-AWD farmers, 535 AWD farmers)

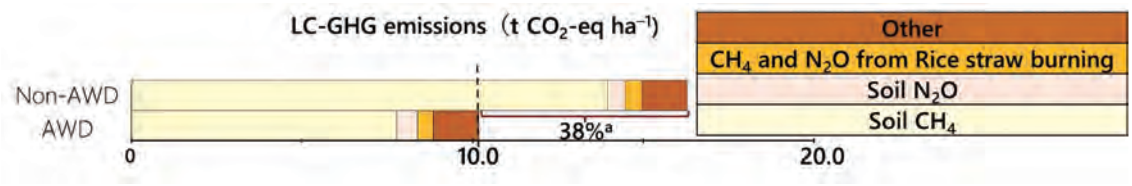

Fig. 4. Life cycle greenhouse gas (LC-GHG) emissions of non-AWD and AWD farmers
a: *p*<0.05; n: Number of fields analyzed (470 non-AWD farmers, 515 AWD farmers)

promising mitigation and adaptation measure for climate change in the Asia-Monsoon region. The results obtained in this study can be used as supporting data for the effectiveness of year-round AWD implementation.

Reference

Leon and Izumi (2022) *Journal of Cleaner Production* 354: 131621.
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(A. Leon, T. Izumi)

TOPIC 5

Game theory predicts changes in community values regarding resource allocation held by Subaks in Bali

In the irrigation sector, Water Users Associations (WUAs) play an essential role in ensuring sustainable and efficient resource use while adapting to changes such as climate change and a declining agricultural population. To effectively involve WUAs in sustainable resource management, it is important to lay out the rules in use and the community values of resource use in WUAs, as well as understand the structure of water conflicts. *Subaks*, the traditional WUAs in Bali, Indonesia, are known for their cooperative water management. However, as social structures in Bali are changing, harvesting labor resources are also declining, affecting the water management of subak systems. Using a subak system as a case study, this study proposes a method for analyzing resource allocation conflicts using agent-based modeling and the noncooperative game theory.

An agent-based model was developed to replicate the water allocation system of the target area. In the model, agents representing WUAs with various attributes attempt to maximize annual rice production by following the rules of resource use (Fig. 1). The model's inputs are water and harvesting labor resources, and its outputs are a cropping schedule, seasonal yields, and the annual production of each agent. To assess the strategy combinations of the agents regarding

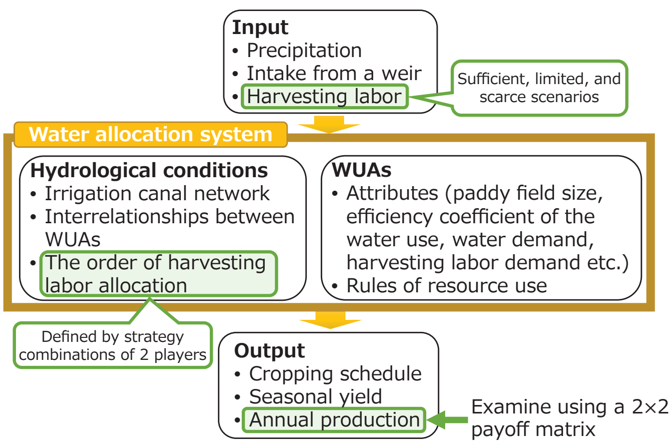

Fig. 1. The model outline
The water allocation system is developed using an agent-based model. Green boxes indicate relation to the application of the noncooperative game theory.

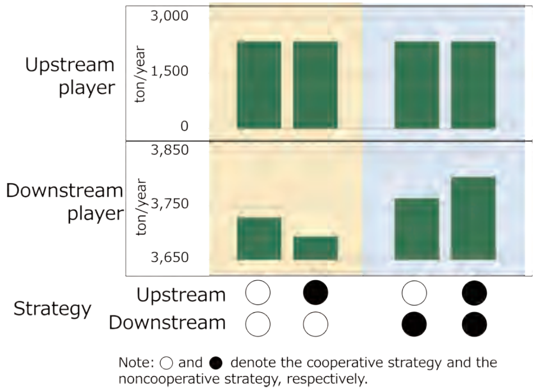

Fig. 2. The total annual production in the sufficient scenario
In the sufficient scenario, the total annual production of the upstream player was the same in any strategy combinations, whereas that of the downstream player was higher when the player chose the noncooperative strategy.

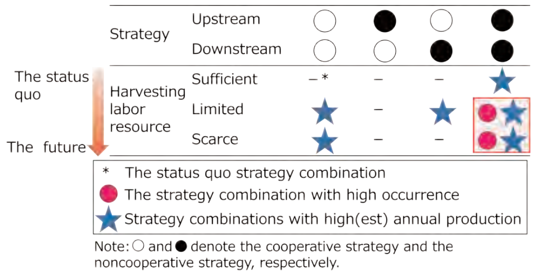

Fig. 3. Results of the noncooperative game in the three scenarios
In the limited and the scarce scenarios, when both the upstream and the downstream players had the noncooperative strategy, the strategy combination became Pareto-optimal and reached the Nash equilibrium.

the order of harvesting labor allocation, the noncooperative game was formulated. The strategies of the agents are the cooperative strategy (Cs) and the noncooperative strategy (Ns). If an agent chooses Cs, it prioritizes upstream agents, whereas if it chooses Ns, it prioritizes agents with larger paddy fields. The agents are categorized into 2 players: the upstream and the downstream players, and the total annual productions of the 2 players were examined using a 2 × 2 payoff matrix. To analyze the influence of harvesting labor shortage, three scenarios of different harvesting labor were generated: sufficient, limited, and scarce scenarios. In the sufficient scenario, the total annual production of the downstream player was higher when it chose Ns, contrary to its status quo strategy combination, i.e., when both players chose Cs. This suggests that maintaining cooperative relationships between subaks is outweighed by maximizing individual production (Fig. 2). The results of the limited and the scarce scenarios suggest that as harvesting labor shortage progresses, the value of noncooperative labor resource use increases (Fig. 3), which could affect any allocation of other limited resources.

The results show that the model is useful for analyzing resource allocation conflicts. Additionally, it can potentially evaluate, for example, a countermeasure against harvesting labor shortage before its implementation. As a support tool, this model can help revise resource use rules to adapt to environmental and social changes.

Reference

Okura et al. (2022) *Agricultural Water Management* 274: 107951.

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(F. Okura,
I. W. Budiasa [Udayana University],
T. Kato [Tokyo University of Agriculture and Technology])

TOPIC 6

Technology development to saccharify cellulose “only by cultivating microorganisms” without using cellulase enzymes

Cellulosic biomass, such as fiber and wastepaper discarded from our daily lives, is difficult to decompose in nature, and greenhouse gas emissions from the disposal and incineration of such cellulosic biomass are estimated to exceed 300 million metric tons worldwide. On the other hand, cellulosic biomass is the most abundant resource on earth, hence its effective utilization is required. Until now, its decomposition and saccharification have required large amounts of cellulase enzymes produced by fungi. However, cellulase enzymes are difficult to recycle and expensive to purchase, so there has been a need to reduce the cost of cellulase enzymes.

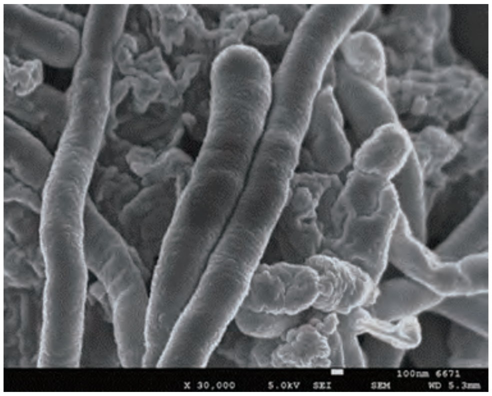

Fig. 1. Electron micrograph of *Thermobrachium celere* A9, which produces the highly active extracellular β-glucosidase

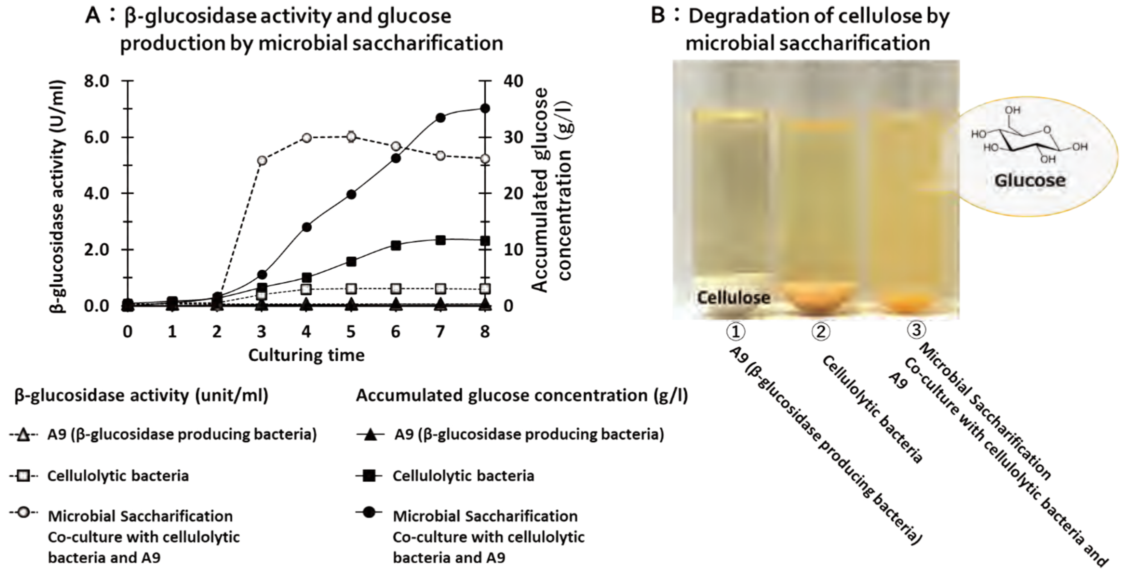

Fig. 2. Glucose production from cellulose by "microbial saccharification" (A) and cellulose saccharification (B)

(A) A9 cannot saccharify cellulose (▲ and △; △ overlaps ▲). The cellulolytic bacteria (□) can degrade cellulose, but produce only a small amount of glucose (■).

On the other hand, in the co-culture of cellulose-poor bacteria and A9 (microbial saccharification method), cellobiose produced by cellulose saccharification is converted to glucose by the extracellular β-glucosidase of A9 bacteria (○) (●).

(B) Accumulation of glucose by the microbial saccharification method (③).

This report introduces the development of "microbial saccharification," an innovative saccharification technology that can produce glucose directly from cellulose using only microbial cultivation, by co-culturing the thermophilic anaerobic cellulolytic bacterium *Clostridium thermocellum* (hereinafter referred to as "cellulolytic bacteria") with bacteria that produce β-glucosidase, an enzyme that hydrolyzes cellobiose, the result of cellulose saccharification.

By screening with exelin, an artificial substrate, thermophilic anaerobic *Thermobrachium celere* A9 bacteria (NITE P-03454) (hereafter "A9"), which produce "β-glucosidase" outside the bacteria, are isolated from sewage sludge (Fig. 1). Cellulolytic bacteria use the cellobiose produced by cellulose saccharification, and since there is no β-glucosidase activity outside the bacteria, the cellobiose remains in the culture medium as cellobiose. On the other hand, the newly identified A9 cannot saccharify cellulose (Fig. 2A △ and ▲). A9 is a very rare bacterium that produces a potent extracellular β-glucosidase (Fig. 2A ○). The β-glucosidase produced by A9 converts cellobiose into glucose (Fig. 2A ●). As a result, cellulose is degraded with high efficiency, while glucose accumulates in the culture medium (Fig. 2B). This microbial saccharification method is thus an innovative technology that converts cellulose to glucose using only microbial culture without the use of cellulase enzymes.

Reference

Nhim, et al. (2022) *Applied Microbiology and Biotechnology* 106: 2133–2145.

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(A. Kosugi, A. Uke)

TOPIC 7

Regional population differences in growth characteristics of the Dipterocarpaceae tree species *Shorea leprosula*

Excessive logging has led to the degradation and deforestation of tropical forests dominated by Dipterocarpaceae species in Southeast Asian regions. Furthermore, as the effects of climate change on tropical forests are becoming more apparent, there is an urgent need to establish sustainable afforestation techniques for Dipterocarpaceae species. One of the Dipterocarpaceae species, *Shorea leprosula*, is widely distributed in Peninsular Malaysia and is considered to be one of the most important timber species. On the other hand, there is a concern about an increasing risk of scale insect infestation due to climate change, and the collection of detailed data is becoming urgently important.

Therefore, this study aims to detect differences in growth characteristics among genetically distinct populations and to evaluate tolerance against scale insect infestation in a common garden experiment using *S. leprosula* seedlings from different forest reserves in the Malay Peninsula.

A common garden was established at the Forest Research Institute Malaysia (FRIM) to elucidate the genetic basis of the complex quantitative traits of dipterocarp through genome-wide association studies (Fig. 1A). In this common garden, *S. leprosula* seedlings (Fig. 1B) from nine populations were grown in 40 replications using the random block design (Fig. 1C). We found that the relative growth rate of tree height was highest in population P7 and significantly different from populations P2, P4, and P9 (Fig. 2, $p < 0.05$) and insignificantly different from P1, P3, P5, P6, and

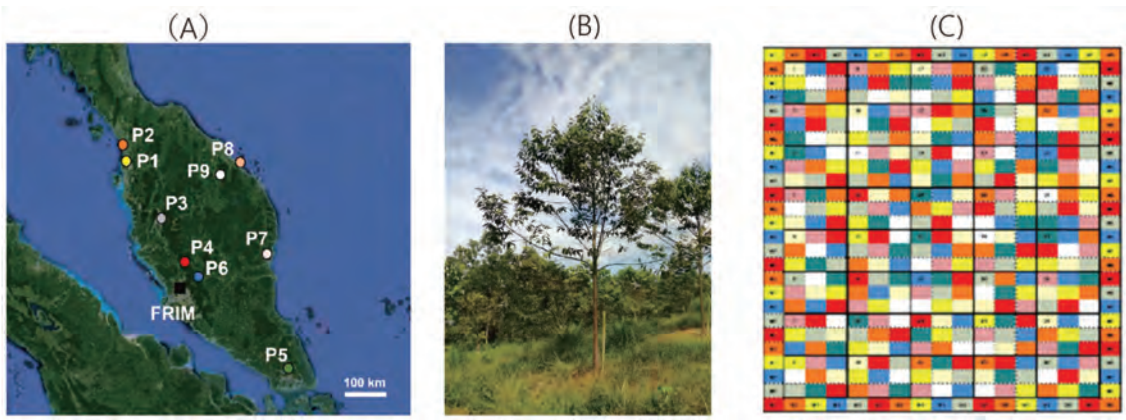

Fig. 1. (A) Sampling sites of seedlings in the Malay Peninsula and Forest Research Institute Malaysia (FRIM), (B) *S. leprosula* planted in the common garden, and (C) the random block design in the common garden
(A) The circles indicate the sampling sites, and the square indicates the location of FRIM where the common garden was established. The numbers indicate the population ID of each sampling site. (B) *S. leprosula* individuals 3 years after planting. (C) Different colors indicate different populations of the planted seedlings.

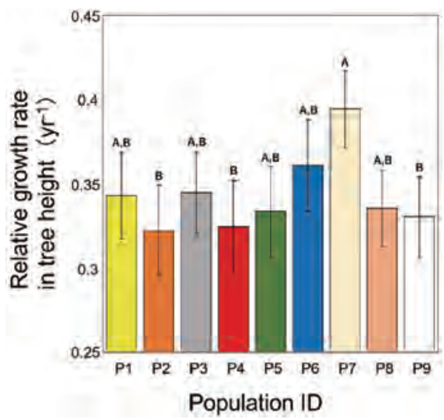

Fig. 2. Relative growth rate of tree height by population
Different letters indicate significant differences ($p < 0.05$).

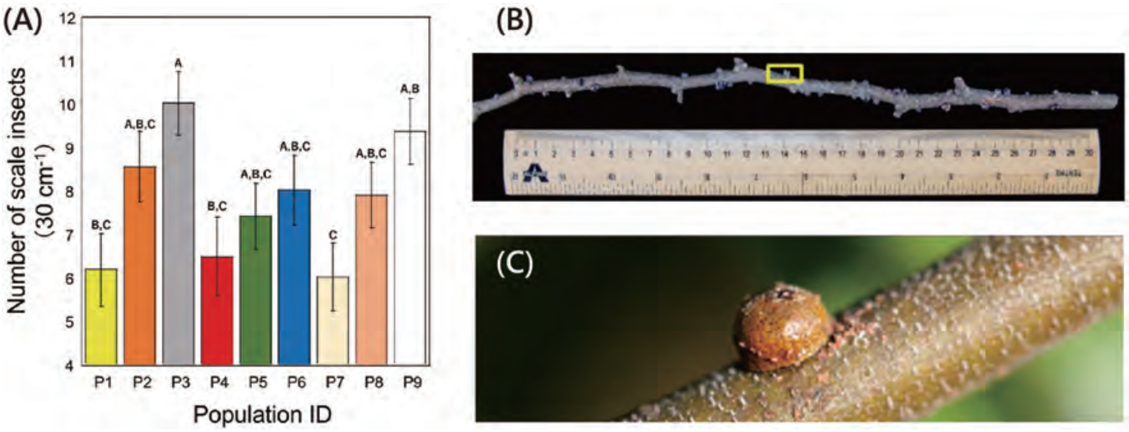

Fig. 3. (A) Number of scale insects on branches in each population, (B) a branch with scale insects, and (C) an enlarged view of a scale insect
(A) Three 30-cm branches were sampled for each individual. The number of scale insects was counted, and the average value is shown. (B) A branch with scale insects, where the yellow box indicates the location of a scale insect (*Pedroniopsis* sp.).

P8 ($p > 0.05$). Also, the number of scale insects (*Pedroniopsis* sp.) was the lowest in P7, with significant differences ($p < 0.05$) from P3 and P9 and insignificant from P1, P2, P4, P5, P6, and P8 ($p < 0.05$) (Fig. 3A). In the future, the common garden is expected to be used as a platform for genome-wide association studies, and it will be necessary to investigate the correspondence between genetic differences and phenotypes at the individual level of *S. leprosula*.

Reference

Ng et al. (2022) *Journal of Forestry Research*. https://doi.org/10.1007/s11676-022-01510-4

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TOPIC 8

Vein structure is related to leaf toughness and photosynthetic capacity in tropical forest trees

Tropical rainforests in Southeast Asia absorb carbon dioxide through high photosynthetic activity and are essential for mitigating climate change. However, they have been degraded by excessive logging, and thus there is a need to restore forest resources through tree planting. In order to ensure successful planting, it is necessary to select tree species suitable for planting environment of the degraded forest through understanding of tree ecological traits such as stress tolerance.

To understand tree ecological traits, we focus on leaf vein structure, which is easy to observe, and develop a method to easily identify tree traits based on leaf morphology in Malaysian tropical rainforest. Tree leaves can be classified into two types of vein structure: leaves with a clearly visible vein network are called heterobaric leaf, while leaves with an indistinct vein network are called homobaric leaf. The former has a transparent fibrous tissue around the veins, which allows light to penetrate, while the latter lacks this tissue (Fig. 1). Leaf toughness and photosynthesis increase with height regardless of species and are related to vein structure (Fig. 2). In taller and brighter environments, heterobaric leaves are more robust and have high photosynthetic ability compared with homobaric leaves. Taller tree species have a higher proportion of heterobaric leaves, while shrubby species tend to have homobaric leaves. Heterobaric leaves are stronger

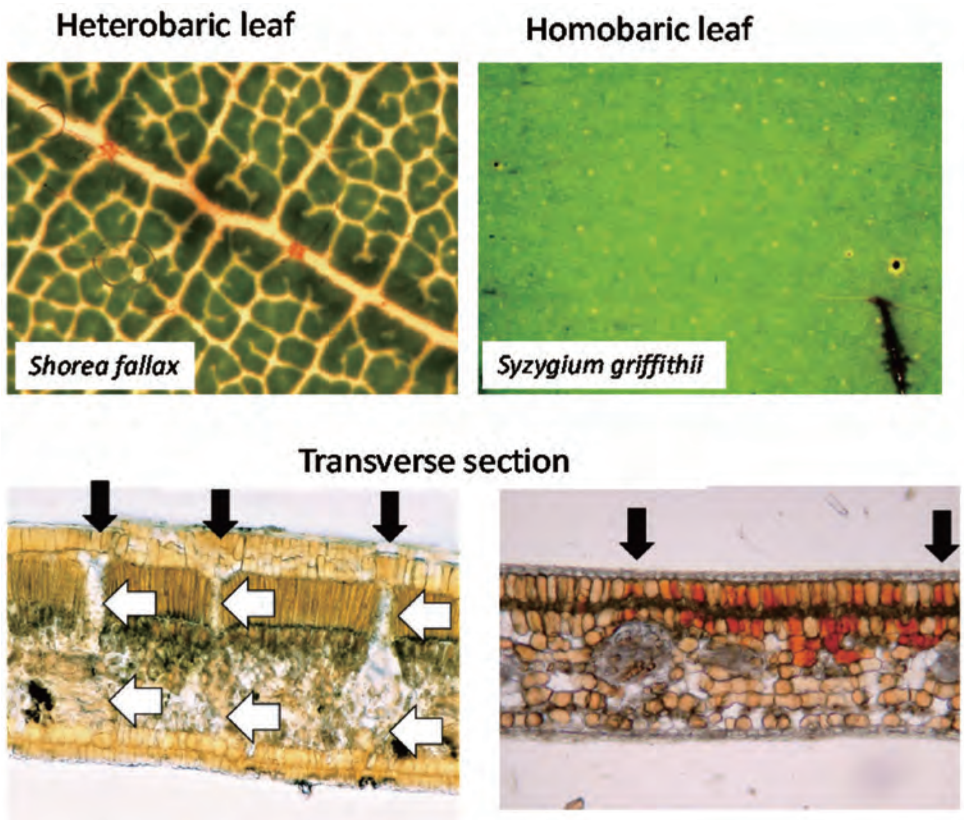

Fig. 1. Different structure of veins between heterobaric and homobaric leaves
Tree leaves can be divided into two groups: those with clear veins when exposed to light (heterobaric leaf, left) and those with indistinct veins (homobaric leaf, right). Heterobaric leaves have bundle sheath extensions (white arrows) by fibrous tissue around vascular bundles (black arrows).

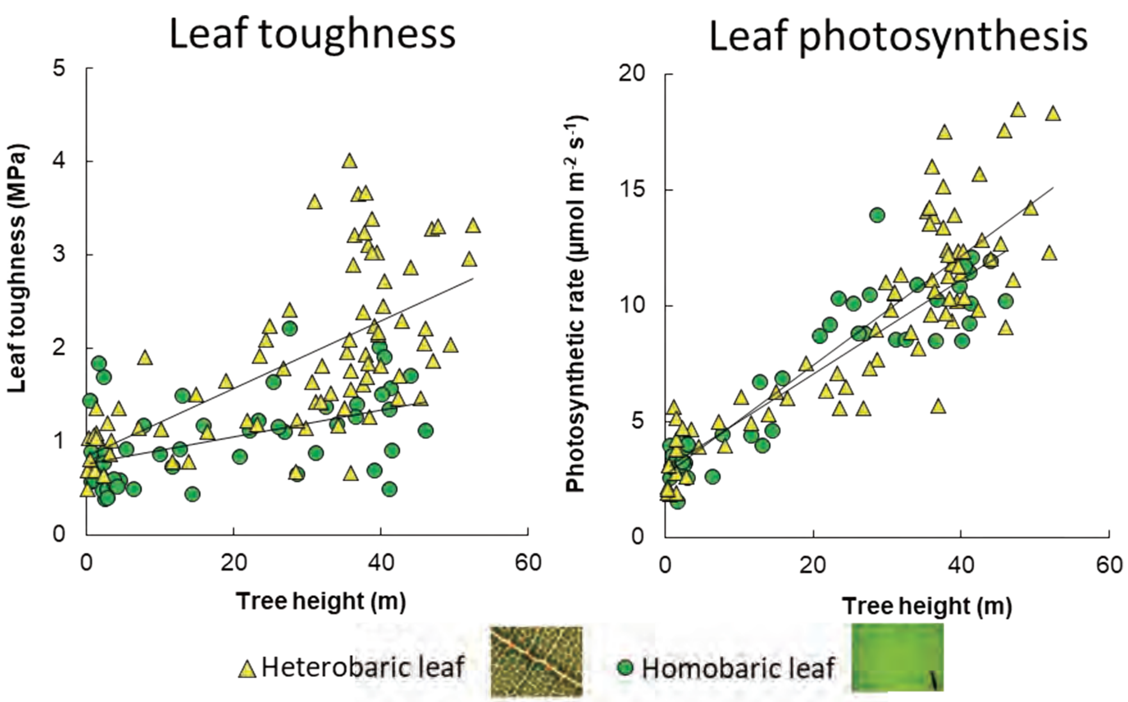

Fig. 2. Variation in leaf toughness (left) and photosynthesis (right) with tree height
Leaf toughness and photosynthesis increase with tree height. In tall trees (around 40 m), which are exposed to strong light and strong winds, heterobaric leaf species tend to have more robust leaves and higher photosynthesis than homobaric leaf species.

due to their fibrous tissue and higher photosynthesis making them advantageous in environments where leaf defense is required. Homobaric leaves, on the other hand, have much amount of photosynthetic cells instead of fibrous tissue, which allows them to utilize weak light more efficiently, thus favoring photosynthesis in dark environments.

Overall, the leaf vein structure can be used as a convenient indicator for selecting herbivore-tolerant and shade-tolerant tree species from diverse tropical rainforest species. However, it should be noted that a tree's ability to adapt to its environment is not determined solely by the vein structure. For example, tolerance to cold and drought is likely to be related to other traits such as wood density, and thus it is necessary to improve the indicator such as combination with vein structure.

Reference

Kenzo et al. (2022) *Frontiers Forest Global Change* 5: 1002472.

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TOPIC 9

Intergeneric hybrid between sugarcane and *Erianthus* exhibits superior nitrogen use efficiency than sugarcane

Nitrate-nitrogen leaching from farmland has adverse effects on drinking water and environmental conservation in tropical and subtropical island regions such as the Southwest Islands of Japan. Sugarcane is widely grown in these areas, and it is necessary to increase the nitrogen use efficiency of this crop to reduce nitrogen leaching. Studies on nitrogen utilization in this species have focused on yield potential and fertilizer management; however, there have been only a few breeding attempts. The relationship between root system characteristics and nitrogen utilization is also unclear, while improvement of nitrogen utilization using *Erianthus arundinaceus* can be expected because of its unique root system characteristics. In the present study, nitrogen leaching and root system characteristics of sugarcane × *Erianthus* intergeneric hybrid and parental genotypes were investigated using a lysimeter to verify the possibility of improving nitrogen utilization characteristics (Figs. 1 and 2).

Nitrogen leaching was significantly lower under the parental *Erianthus* from the early growth stage, while it was significantly lower in the intergeneric hybrid in the mid-growth stage than that in the parental sugarcane (Fig. 3). The

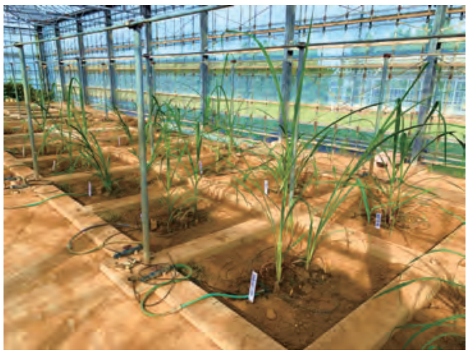

Fig. 1. Outline of lysimeter study
Sugarcane (NiF8), *Erianthus* (JIRCAS1), and intergeneric hybrid F_1 (J08-12) were grown under lysimeter conditions (n=4 plots) from Sept. 2020 to May 2021.

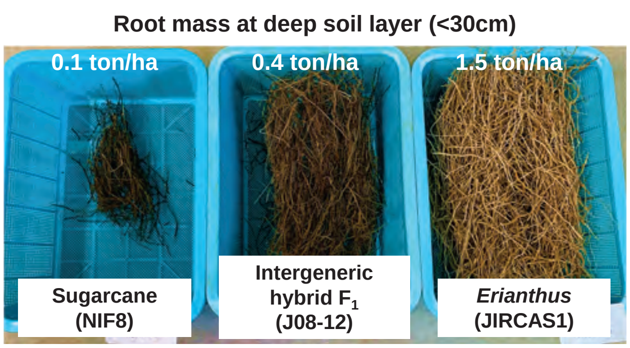

Fig. 2. Root mass of each genotype
Values indicate root mass at deep soil layer with significant genotypic differences.

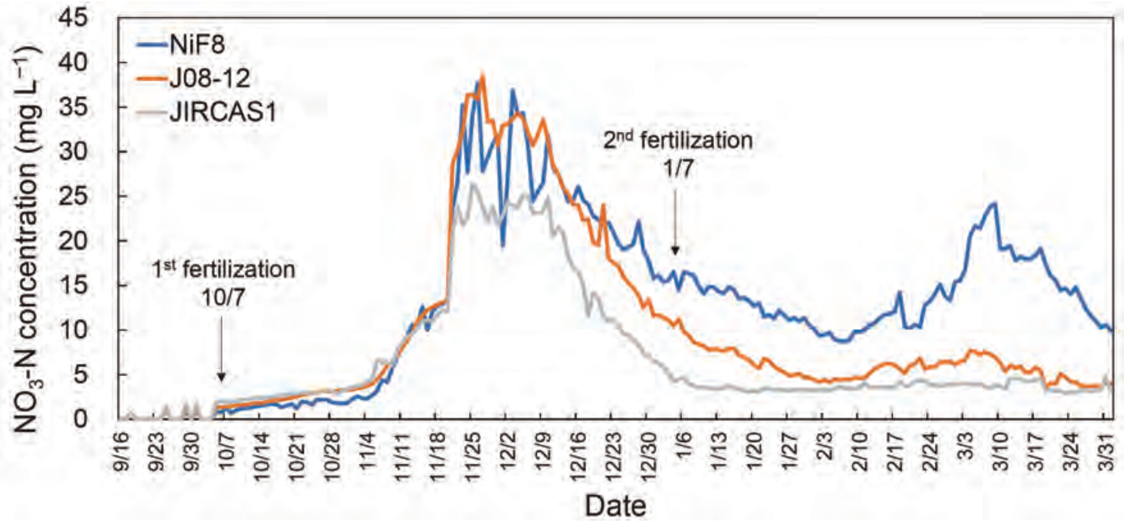

Fig. 3. Changes in nitrate-nitrogen concentration in drainage water during the growth period
Survey was conducted from September 2020 to March 2021. Arrows indicate fertilization dates.

Table 1. Characteristics of nitrogen use and biomass partition

Genotype	Drainage NO3-N (kg ha-1)	Total dry mass (ton ha-1)	Shoot mass/ Root mass ratio	Root depth index (cm)	Total N uptake (kg ha-1)	N use efficiency (g gN-1)
Sugarcane (NiF8)	42.6 b	17.0 a	30.7 c	24.8 a	104.5 a	163.5 a
Intergeneric hybrid F_1 (J08-12)	32.4 b	27.6 b	24.8 b	31.6 b	136.3 b	202.4 b
Erianthus (JIRCAS1)	17.8 a	26.4 b	6.4 a	35.7 b	128.3 ab	206.7 b

Higher root depth index indicates deeper root system. Nitrogen use efficiency is calculated by dividing total biomass by total nitrogen uptake. Different alphabet means significant differences among genotypes at $P < 0.05$ (Tukey, n=4).

nitrogen use efficiencies of *Erianthus* and the intergeneric hybrid were significantly greater than that of sugarcane (Table 1). *Erianthus* and the intergeneric hybrid exhibited lower shoot/root ratio and deeper rooting than sugarcane and consumed significant amounts of soil moisture in the deeper layers, suggesting that root mass and deeper rooting may be factors in reducing nitrogen leaching. These results indicate the possibility of improving the nitrogen utilization characteristics of sugarcane by improving its root system characteristics using *Erianthus*.

The intergeneric hybrid F_1 can be used to breed sugarcane varieties that contribute to reductions of nitrogen leaching and fertilization. However, it is necessary to improve the sugar content of the F_1 line through backcrossing with sugarcane varieties in order to utilize it as a variety for sugar production because the F_1 line has low sugar content at harvest season. In addition to root elongation characteristics, nitrate preference may also be related to greater nitrogen use efficiency, which should be investigated in future studies using the N^{15} tracer method.

Reference

Takaragawa et al. (2022) *Plant Production Science* 25: 298–310.

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(H. Takaragawa, K. Okamoto, Y. Terajima, T. Anzai)

Predicting riverine nutrient concentrations from catchment characteristics using a machine learning method

Excessive loadings of terrestrial nitrogen and phosphorus, and their imbalances with silicon have been recognized as one of the major causes of water quality and ecosystem deterioration in receiving coastal waters around tropical islands. In this study, water quality was monitored every two months for one year in the rivers and streams of Ishigaki Island, a tropical island in Japan (Fig. 1), to analyze how the catchment characteristics (e.g., land use, geology) influence the concentrations of dissolved inorganic nitrogen (DIN), total phosphorus (TP) and dissolved silicon (DSi).

Based on the monitoring results, predictive models for nutrient concentrations from the catchment properties were created using Random Forest (RF) machine learning algorithm. Coefficient of determination (R^2) between the observed and predicted values were 0.87 ~ 0.96 and 0.69 ~ 0.88 for training and testing data sets, respectively, and the percent bias (PBIAS) values were –0.33 ~ 0.36% and –1.30 ~ 0.06%, demonstrating that the created models can predict nutrient concentrations with sufficient accuracy (Fig. 2). Contributions of the catchment properties to nutrient concentrations can be also evaluated from their importance in the RF models in combination with the correlation coefficients with

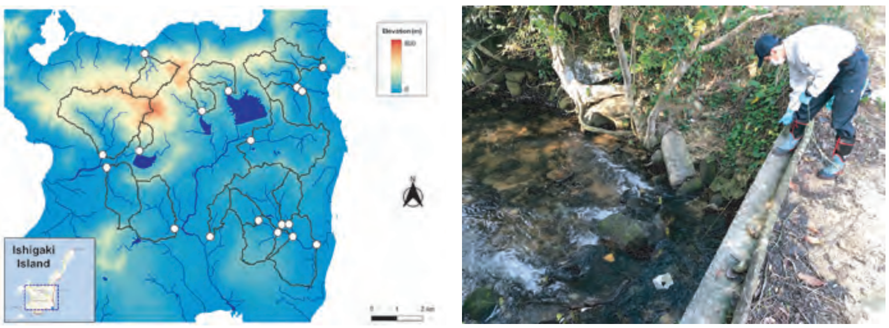
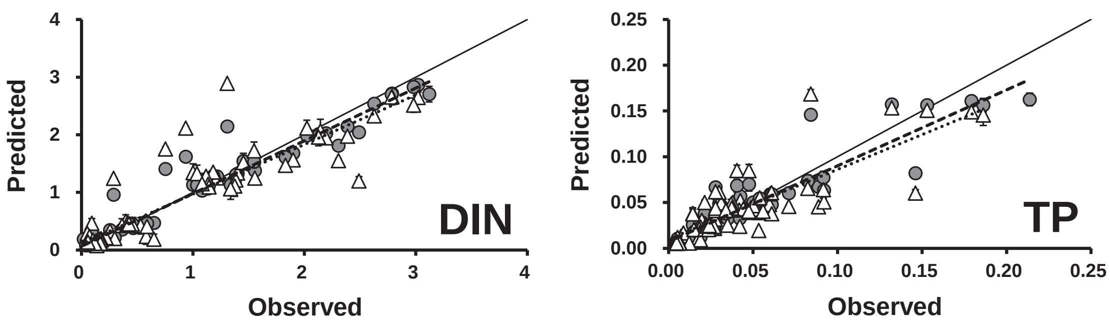


Fig. 1. Study site (left); river water sampling (right)
White circles and black lines in the left panel represent the sampling stations and catchment boundaries, respectively.



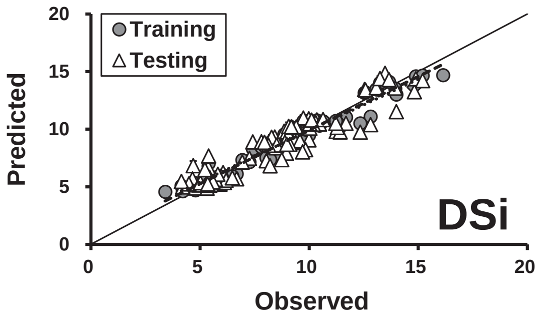


Fig. 2. Observed (x-axis) versus predicted (y-axis) nutrient concentrations (in mg/L)
Solid, dashed, and dotted lines represent the 1-to-1 line, linear regression line for training data and that for testing data, respectively.

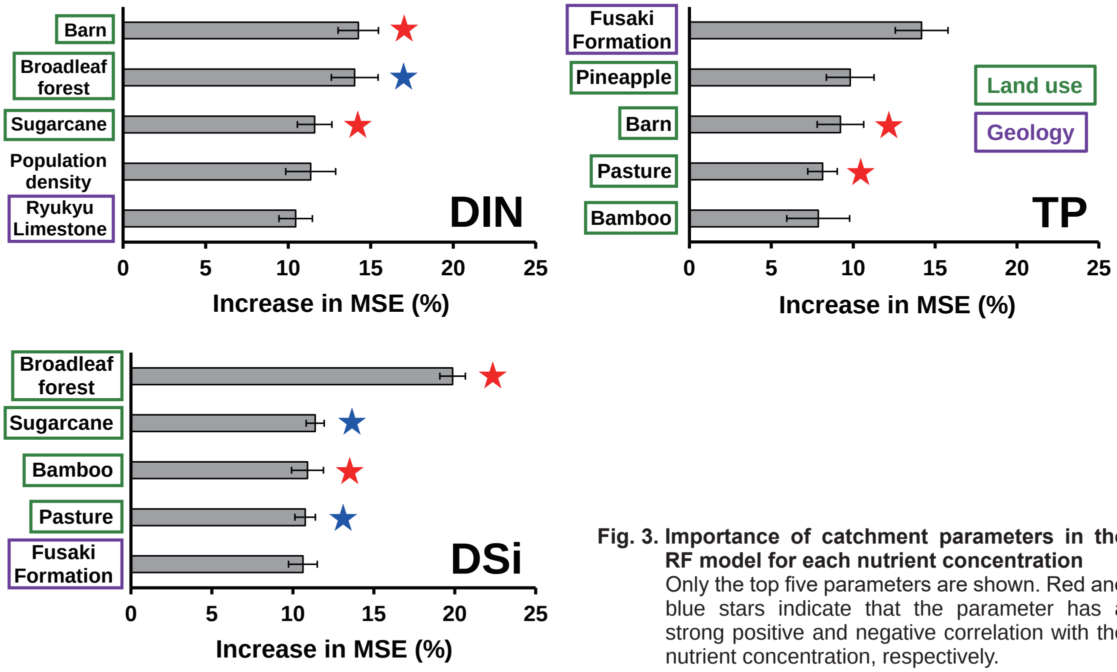


Fig. 3. Importance of catchment parameters in the RF model for each nutrient concentration
Only the top five parameters are shown. Red and blue stars indicate that the parameter has a strong positive and negative correlation with the nutrient concentration, respectively.

nutrient concentrations. Agricultural land uses (e.g., livestock barn, sugarcane field) were ranked as the most important parameters in the RF models for DIN and TP, and they also had strong positive correlations (Spearman's rank correlation coefficients being more than 0.7) with these nutrients (Fig. 3). Considering the fact that sugarcane cultivation and beef calf raising are active in Ishigaki Island, these results suggest that these agricultural activities have strong influences on riverine nitrogen and phosphorus concentrations. On the other hand, forest was not only the most important parameter in the RF model for DSi but also strongly positively correlated with DSi concentration (Fig. 3), suggesting that forest serves as a dominant source of riverine Si.

As the RF models can be operated in a relatively easy way, they can be utilized for formulating action plans toward conservation of coastal water quality and ecosystems (e.g., identification of rivers that need to be monitored with respect to nutrient loading to coastal water). These models would also be applicable for predicting the variations in riverine nutrient concentrations due to the change in catchment land use and management, while the predictions need to be validated through comparison with those of process-based hydrologic models.

Reference

Kikuchi et al. (2023) *Environ. Pollut.* 316: 120599.

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(T. Kikuchi, T. Anzai)

TOPIC 11

Shallow sub-surface drainage constructed with "Cut-soiler" mitigates soil salinity

In the Indo-Gangetic Plain, groundwater irrigation dramatically improved agricultural production. However, salinization has become a serious issue due to the high salinity of irrigation water and poor drainage. Construction of open and/or sub-surface drainage is effective at mitigating salinization, but it is difficult for farmers to implement due to the high cost. Therefore, towards developing sustainable drainage measures that farmers can practice, we conducted research and created a low-cost method of constructing shallow sub-surface drainage using a Japan-built tractor attachment called the "Cut-soiler."

Conventionally, when constructing a material-filled sub-surface drainage, it is necessary to prepare the hydrophobic material to be buried in the soil and load it into the construction machine. This method does not require these works, and harvested residues such as rice and wheat straw scattered on the field can be buried underground simply by running a tractor equipped with the Cut-soiler. The method involves cutting the soil into an inverted trapezoid, then lifting it up to make space from the ground surface to a depth of 40 to 60 cm. The crop residue, spread to a width of 120 cm, is then pushed into this space to make a shallow sub-surface drainage (Fig. 1). Shallow sub-surface drainage (60-cm depth) constructed with the Cut-soiler reduced soil salinity (ECe: electrical conductivity of the solution extracted from the saturated soil) by 8% (no significant difference) and 32% (P=0.047) at 4 and 16 months after construction, respectively (Fig. 2). Meanwhile, the yield improved by 4% (no significant difference) and 23% (P=0.048) in the dry season crop (November to March: mustard) and in the rainy season crop (June to September: pearl millet), respectively (Fig. 3).

The construction method has been compiled into a manual, titled "Cut-soiler constructed Preferential Shallow sub-surface drainage for mitigating salinization User's Guide," and is now available on the JIRCAS website for its further extension. It is expected to be used for salinization countermeasures by the Central Saline Soil Research Institute (CSSRI) in India. Regarding the method and equipment, the following should be noted. The drainage condition should be checked in advance as this method depends on the drainage condition around the field. Then, a suitable construction method should be chosen. The Cut-soiler does not have wheels, so it must be loaded onto a truck when transporting long distances. The estimated useful life of the Cut-soiler is around 7 years covering 30–50 ha of construction area per year. If there is no problem with the frame, it can be used continuously by simply replacing consumables.

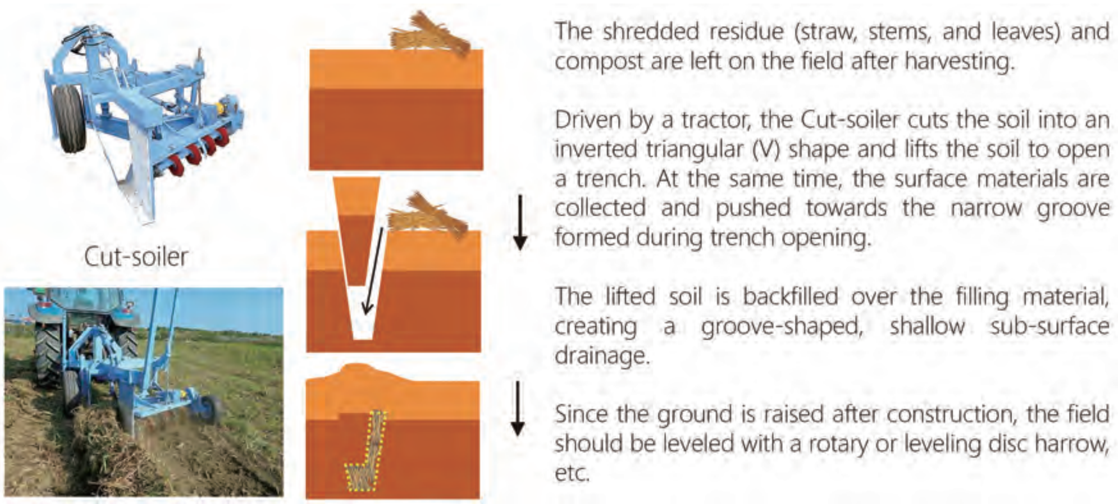

Fig. 1. Method of constructing a shallow sub-surface drainage with the Cut-soiler

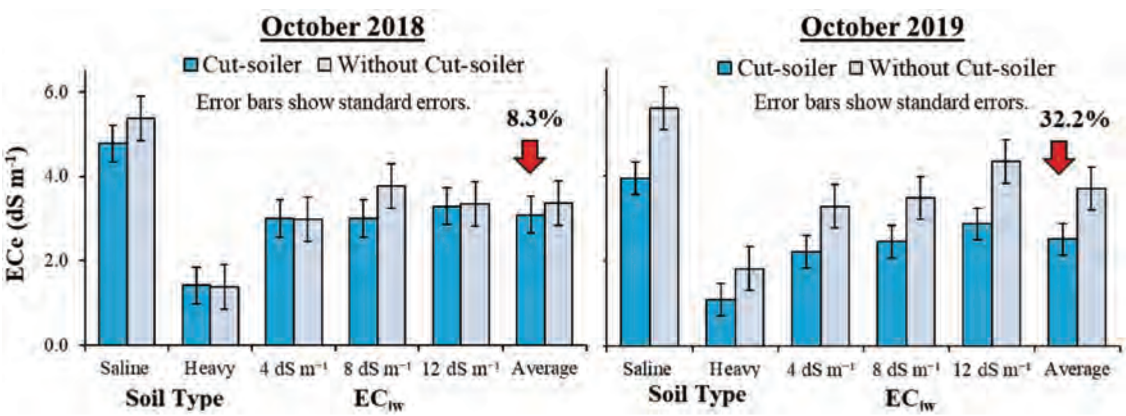

Fig. 2. Changes in soil salinity

EC_{iw} is the electrical conductivity of irrigation water.

Average is the average of 12 plots with and without Cut-soiler construction.

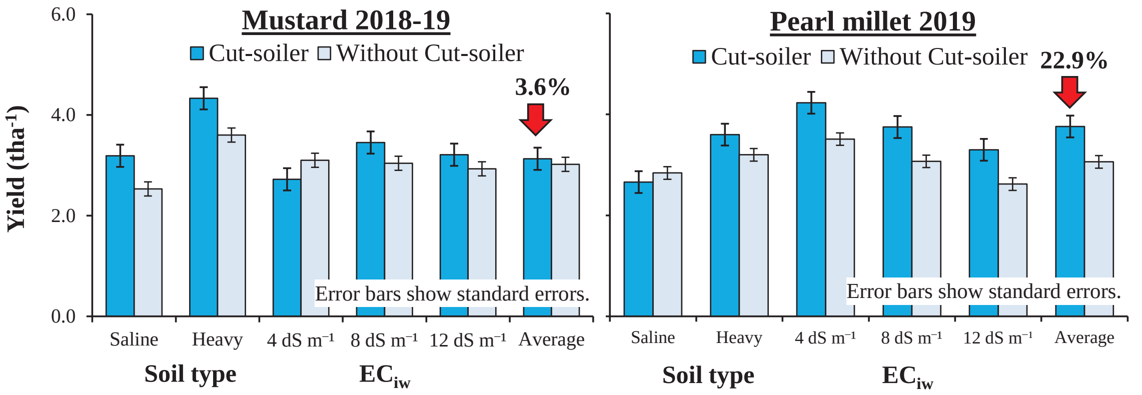

Fig. 3. Yield of dry season crop (mustard) and rainy season crop (pearl millet)
EC_{iw} is the electrical conductivity of irrigation water.
Average is the average of 12 plots with and without Cut-soiler construction.

References

Fig. 1. NARO Research Highlight (2015); Figs. 2 and 3, Neha et al. (2022)
Journal of Arid Land Studies 32(S): 117–122. https://doi.org/10.14976/jals.32.S_117
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(J. Onishi, K. Koda, K. Matsui, T. Anzai, K. Okamoto, G. Lee, T. Watanabe, K. Omori, I. Kitagawa [National Agriculture and Food Research Organization], Chaudhari S.K. [Indian Council of Agricultural Research], Yadav R.K. [ICAR-Central Saline Soil Research Institute], Yadav G. [ICAR-CSSRI], Neha [ICAR-CSSRI], Rai A.K. [ICAR-CSSRI], Kumar S. [ICAR-CSSRI], Narjary B. [ICAR-CSSRI], Sharma P.C. [ICAR-CSSRI])

Program B
Food

“Technology development towards building a new food system with improved productivity, sustainability and resilience”

Economic disparities within developing regions are widening and needs are diversifying, including responses to increasingly complex food and nutrition issues. In the agriculture and fisheries sectors, solving food and nutritional deficiencies remains an important issue. At the same time, there are growing expectations for new initiatives, such as qualitative improvement of nutrition, higher value-added products, and transformation to a new food system utilizing ICT and IoT. In order to contribute to the stable production of food and improved nutrition to meet new needs in developing regions such as Asia and Africa while also taking domestic benefits into consideration, the ‘Food Program’ aims to develop crops and food processing technologies by utilizing the various characteristics of indigenous crops and advanced methods such as ICT and IoT. To maintain and strengthen the food production base, we are also working on control technologies for transboundary pests and diseases that are expanding beyond national borders, and revitalizing the fisheries industry through appropriate management of aquaculture and fishing grounds. Furthermore, for the African region, which is facing serious food and nutrition problems, we are contributing to rice production and the Coalition for African Rice Development (CARD), and developing technologies to improve agricultural productivity, sustainability, and resilience, including field crops and livestock production. To achieve our goals, we conduct the following six research projects.

[Resilient crops]

For the development of resilient crops and production technologies, we focused on the following research in FY 2022. We have identified the locus locations of *qRL4.1* and *qRL8.1* in the rice locus for increasing root length and have shown that the efficiency of nitrogen utilization is promoted by larger rice hull size. Furthermore, we showed that nitrate utilization promotes phosphorus utilization among the major nitrogen sources utilized by plants. We identified novel salt-tolerant Quantitative trait locus (QTL) and candidate genes in soybean that function under high-salt conditions. We performed a comprehensive gene expression analysis in quinoa under high salt stress and identified a set of genes involved in cell growth promotion and Na^+ transport regulation as a set of salt stress-inducible genes involved in the temporal increase in aboveground Na^+ accumulation. We isolated a microbial strain (*Pantoea* sp.) from quinoa that promotes plant growth under high salt stress. We developed a generation promotion technique based on compact cultivation of quinoa, allowing promotion of four generations per year. We crossed southern upland quinoa lines with early maturing lines to produce recombinant inbred lines (RILs) necessary for efficient identification of resilience-enhancing genes and to obtain phenotypic data for (QTL) analysis. We also selected useful candidate lines from the RIL population (F_6 generation) that exhibited shorter growing season than the southern upland lines and larger grain size traits than the early maturing lines. Furthermore, we showed that the pathogenicity of the Asian soybean rust fungus in Bangladesh has changed to diverse and highly virulent. We also showed that the yield performance of two new rust-resistant soybean cultivars from Paraguay increased 1.7-fold and 1.4-fold, respectively, from the pre-improved cultivars under the influence of rust. In addition, a high-yielding, disease-resistant, salt-tolerant soybean variety that we developed by utilizing the salt-tolerant gene *Ncl* has been registered in China.

[Indigenous crops and foods design]

For design-oriented crop breeding and food processing of indigenous resources to create new and diversified demands, we focused on the following research in FY 2022. We produced mutants by genome editing using Lao black rice (H50) and analyzed the accumulation of functional components, taxifolin and isoquercitrin, in the brown rice. The results showed that the accumulation of taxifolin and isoquercitrin was 10–100 and 3–70 times higher, respectively, than that of H50, suggesting that functional rice can be produced by genome editing. To investigate the appropriate phosphorus fertilization level, we conducted a comparative analysis of the relationship between phosphorus fertilization level, yield, and anthocyanin accumulation in black rice. The results suggested that excessive phosphorus fertilization did not increase yield and decreased anthocyanin accumulation. We produced brown rice amazake (fermented Japanese rice drink) by examining the ratio of yellow and white yeast rice malt. As a result, we clarified the blending ratio that decomposes phytic acid and promotes the formation of inositol, which has high nutritional value. In Southeast Asian countries such as Laos, it is desirable to produce lactic acid fermented amazake under high temperature and acidic conditions where food poisoning bacteria are unlikely to proliferate. Therefore, we selected two species of lactic acid bacteria resistant to high temperature (45°C) from a total of 264 species of lactic acid bacteria isolated in Japan, Thailand, and Myanmar. In addition, we developed an estimation model using spectral information to rapidly estimate the content of gingerols, which are the main pungent component in ginger and have anti-inflammatory and other effects. We also found that the yield of yam, a major crop in West Africa, is strongly influenced by individual sex and flowering date.

[Transboundary pest management]

For the development of an environment-friendly management system against transboundary plant pests based on ecological characteristics, we focused on the following research in FY 2022. We found that nymphs in the gregarious phase of the desert locust migrate in groups and are suitable for control, while individuals just before molting remain on the plant and the group is divided. During molting, locusts are immobile and at risk of cannibalism. Other individuals with a strong appetite move in groups, and only those immediately before molting are isolated, thus decreasing the risk of cannibalism. From a pest control perspective, our results suggest the need to search the area around large plants if pesticide application is conducted during the daytime. We have established a method for evaluating the impact of insecticides that also focuses on sublethal toxicity to *Cyrtorhinus lividipennis*, an important predatory bug of rice planthoppers. We also established a method to evaluate the impact of insecticides on natural enemies of the fall armyworm. We collected and organized data on maize supply and demand in various countries located in the Lower Mekong River Basin, and clarified geographical and time-series characteristics, such as particularly high production in Shan State, Myanmar. In addition, we conducted an insecticide susceptibility test against fall armyworm in Thailand. We obtained data suggesting that susceptibility to some insecticides may be declining. We also transferred insecticide susceptibility testing technology for fall armyworm to prepare for international comparisons.

[Ecosystem approach to aquaculture]

For the development and dissemination of sustainable aquaculture technologies in the tropical area based on the eco-system approach, we focused on the following research in FY 2022. In Malaysia, we installed WiFi-capable meteorological instruments, cameras, and other equipment in oyster farms to enable real-time observation of the fishing grounds via a network. Problems identified included the need for maintenance of underwater equipment and the difficulty of installing salinity measurement equipment. In northeastern Thailand, we investigated the life history characteristics of the high-value freshwater shrimp, and found that females carrying fertilized eggs were more likely to appear during the rainy season from June to August. We found that dried seaweed feed can be used as an alternative to fresh seaweed without inhibiting shrimp growth. Regarding the intermediate rearing of juvenile sea cucumbers *Holothuria scabra*, we have clarified the relationship among growth rate, survival rate, environmental factors and sea cucumber growth in floating hapa net and bottom pen. Based on these results, we predicted the growth process of the juvenile sea cucumbers in the floating and bottom rearing methods, and found that the results were almost the same as the measured ones. We have developed a basic model of the system dynamics model, a tool for the community to discuss and agree on countermeasures to problems and anxieties arising from the introduction of new technologies, by incorporating various variables into the model based on theories of the physiology, ecology, socioeconomics, and management of sea cucumbers, and by changing conditions and simulating the results. In addition, we isolated diatoms of the genus *Cylindrotheca* (needle diatoms) as a suitable food source for donkey's ear abalone and sea cucumbers, and established a passaging culture strain. We also fed needle diatoms to donkey's ear abalones and sea cucumbers and observed their feces, indicating that needle diatoms may be more easily digested than the currently fed *Navicula* diatoms. Furthermore, we developed a prototype artificial mucus to induce the settlement of planktonic abalone larvae. We observed the settlement of abalone larvae using the artificial mucus made with carrageenan, and found that the artificial mucus was able to induce the larvae to settle on the bottom material.

[Africa rice farming system]

For the development of sustainable rice cultivation and food production system in Africa, we focused on the following research in FY 2022. We developed a topographic and watershed map of a paddy field area in Tanzania using satellite data and GIS. We then developed a model to estimate waterlogging in rainfed paddy fields by calculating runoff from the watershed using the curve number method. We also designed a schematic of development techniques that reinforce rice paddies and improve water use efficiency in the area. We evaluated the sustainability of channel surface coverings and improved a manual on water use efficiency measures. We found two QTLs on chromosome 9 that have effects on early root and above-ground growth in a cross population between NERICA4 and *Aus* rice DJ123. We found that lines carrying these QTLs have high dry matter productivity in farmers' fields in Madagascar. We have completed the breeding of near isogenic lines (NILs) carrying the *MP3* locus on the genetic background of X265, a major rice variety in Madagascar, and confirmed that the number of spikelets in the bred lines was significantly higher than in the parental lines. We selected three promising paddy rice lines with superior iron toxicity tolerance. We cultivated 95 *Amaranthus tricolor* lines and selected nine lines with a high content of betalains, pigments with antioxidant activity. In Madagascar, we developed a manual for the effective application of farmyard manure (FYM) to paddy rice and confirmed its effectiveness and high acceptance by farmers through farmer participatory trials. We found that there are large variations among varieties in growth retardation caused by phosphorus deficiency, and that *Hd3a*, one of the major flowering-related genes, may be involved in regulating growth retardation. The rhizosphere soils of leguminous grass *Stylosanthes* sp., which has an excellent dry matter production capacity even in phosphorus-deficient fields in Madagascar, showed high levels of gene expression of phosphorus-solubilizing bacteria that possess genes involved in the secretion of organic acids and enzymes that solubilize insoluble phosphorus. We showed that inoculation of the filamentous fungus *Colletotrichum tofildiae* (*Ct* fungus) after mycelial culture significantly increased dry matter production of Japanese mustard spinach, and that this effect was particularly high under phosphorus-deficient conditions, and that *Ct* inoculation increased the abundance of fungi and bacteria in the rhizosphere soil. Early harvesting of paddy rice with P-dipping treatment significantly increased the yield of post-crop cruciferous leafy vegetables, indicating that the economic benefits of P-dipping treatment may be greater when paddy rice is combined with post-crop vegetable production. In addition, we have elucidated the genetic diversity of *A. tricolor* and generated single nucleotide polymorphism markers and core collections useful for breeding. We have shown that *Aus* rice IRIS313-9368, selected using a genomic prediction model, has stable and high zinc content in diverse production environments in Madagascar. We discovered a Koshihikari-derived gene *MP3* (*MORE PANICLES 3*) that increases rice yield in high CO_2 environments. We have disseminated the P-dipping technology to 3,305 farmers in five major rice-producing regions of Madagascar, and demonstrated that the technology can increase yields in farmers' practices. We have completed the foundation seed production of the new lowland rice varieties FyVary32 and FyVary85 under the JICA technical cooperation project Papriz, and have started certified seed production by 23 seed farmers and exhibition plots by 55 farmers in 11 regions of Madagascar. We found that increased paddy yields not only increased rice consumption, but also increased purchases of nutritious food groups and improved energy and intake of micronutrients such as vitamin A, iron, and zinc.

[Africa upland farming system]

For technology development towards supporting farmers' decision-making to boost sustainable upland farming system in Africa, we focused on the following research in FY 2022. We continued cropping trials on experimental fields in northern Ghana and found that both relay and intercropping of maize and cowpea increased the yield of the subsequent year's single cropping maize yield by about 1 t ha^{-1}. We also found that incorporating leguminous green manure crops into the soils significantly increased maize yields in two out of nine crops compared to the one after fallow as the control. We found that six green manure crops gave comparable maize yields with chemical fertilizer application. A survey of livestock feeding management in smallholder farms identified low levels of crop residue utilization. We then assessed the irrigation situation in the dry-season vegetable growing areas. We selected three villages for on-farm trials to be conducted in the coming year and conducted a pre-survey in preparation for a rural household survey in northern Ghana to be conducted in the coming year. We have continued testing improved soil conservation technologies in Burkina Faso, where two years of field trials have shown that the Fallow Band System (FBS) can increase crop yields by 160% compared to the control, and that further yield increases can be expected by combining FBS with a minimum application of chemical fertilizer and compost, which can also be implemented by local farmers. We have obtained first-year data on the relationship between cumulative soil erosion, sorghum yield, and fertilizer efficacy in three dominant soil types through a topsoil removal experiment. We have obtained the data necessary to adjust the parameters of the yield prediction model and to determine the soil moisture response of the main local field crops (*Poaceae* and *Leguminosae*) in different climatic zones and soil types from cropping trials at three sites in Burkina Faso. We confirmed that the soil moisture estimated from satellite observations is accurate enough to be used in drought estimation for different climatic zones in West Africa. In addition, we elucidated the genetic variation in the germinability of soybean genetic resources under soil crust conditions and identified cultivars with good germination ability under soil crust conditions. We found that composting of low-grade phosphate rock from Burkina Faso with rhizosphere soils increased sorghum yields as much as chemical fertilizers. We analyzed the results of an earlier application trial of a farm management planning model in Mozambique in order to understand the expected benefits and possible challenges of the future application of the model in Ghana. We found that farmers in Mozambique nearly doubled their incomes by referring to cropping plans created by the model. However, since less than a majority of farmers referred to the created cropping plan, it is necessary to increase the number of farmers who refer to the plan.

TOPIC 1

Novel genetic loci that elongate rice roots under different nitrogen conditions

To reduce the impact of nitrogen on the environment, it is expected that varieties with improved nitrogen utilization will be developed. One strategy to promote nitrogen utilization (uptake) is to improve the elongation of rice roots and increase the size of the root system. Therefore, identifying the loci involved in rice root length and develop DNA markers for line selection is crucial. The nitrogen available to rice varies with the growing environment. Under reducing waterlogged conditions (irrigated paddy fields), where irrigation water is available, ammonia-form is the main source of nitrogen supply. On the other hand, in rain-fed paddy fields and upland rice cultivation, which are prone to dry conditions and oxidative conditions, nitrate-form nitrogen may be the source of nitrogen supply. Therefore, to estimate the available cultivation conditions, it is necessary to set up experimental conditions in which ammonia-form nitrogen and nitrate-form nitrogen are the sole sources of nitrogen supply.

We set up four hydroponic conditions adjusted to 5 µM or 500 µM of NH_4Cl as ammonia-form nitrogen and KNO_3 as nitrate-form nitrogen. Line YTH187, which contains chromosomal fragments derived from IR69093-41-2-3-2 (YP5) in the genetic background of IR64, has a significantly longer root length than IR64 under all conditions (Figs. 1 and 2). Among the genetic loci that increase root length in YTH187, *qRL4.1-YP5* is located between the molecular markers RM3534 and RM6909 on chromosome 4 and elongates roots only in the 5 µM nitrate-nitrogen condition (Fig. 3). These results suggest that it is effective in a nitrate-nitrogen-specific manner and may be effective in oxidative, low-fertility rainfed and upland rice fields. *qRL8.1-YP5* (R^2=0.09–0.16), located between RM8271 and RM3395 on chromosome 8, elongates roots under growing conditions with 500µM NH_4Cl or KNO_3. This result may be effective in irrigated and rainfed/

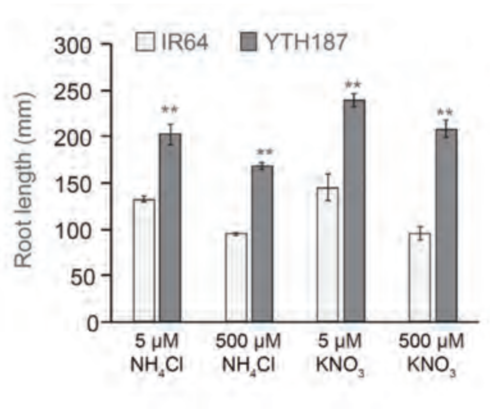

Fig. 1. Root length of YTH187 and IR64 grown for 8 days in each treatment
**: *t*-test indicates significant difference at 1% level (n=4).

Fig. 2. Root length of YTH187 and IR64 in the presence of 500 μM nitrate nitrogen
IR64 (top) and YTH187 (bottom) grown for 8 days

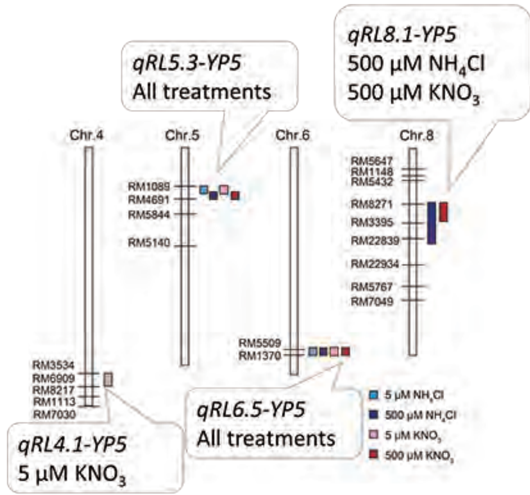

Fig. 3. Location and condition of detected genetic loci
The region where each gene is located and the nitrogen condition under which it was detected. The bar range indicates the locus region.

upland rice cultivation with high nitrogen fertilization levels. *qRL5.3-YP5* (R^2=0.10–0.11) is located between RM1089 and RM4691 on chromosome 5 and elongates roots under all growing conditions. *qRL6.5-YP5* (R^2=0.12–0.22) is located between RM5509 and RM1370 on chromosome 6 and elongates roots under both low- and high-concentration root elongation under both nitrogen conditions. These results suggest that the two loci may be effective under a wide range of growing conditions.

The DNA marker information of *qRL4.1-YP5*, *qRL5.3-YP5*, *qRL6.5-YP5*, and *qRL8.1-YP5* can be used for marker selection to improve the efficiency of nitrogen absorption through root morphology improvement. The effect was observed in the genetic background of IR64, which can contribute to the improvement of Indian-type cultivars grown in many tropical regions. The effects on root mass, nitrogen uptake, and productivity in the field need to be verified by growing near-isogenic lines carrying each locus alone.

Reference

Sasaki and Obara (2022) *Soil Science and Plant Nutrition* 68(4): 454–462.

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(K. Sasaki, M. Obara)

TOPIC 2

Enlargement of grain size improves nitrogen utilization efficiency in rice

The Green Revolution made it possible to increase crop yields through the application of large amounts of nitrogen (N) fertilizers, but it also resulted in serious environmental pollution. In addition, such production systems are vulnerable to high N fertilizer prices. Therefore, toward sustainable production and supply of rice, increasing the crop grain yield must be achieved without such a considerable input of N fertilization. Our previous studies demonstrated that a large-grain *japonica* rice cultivar, Akita 63, has high nitrogen utilization efficiency per unit of absorbed nitrogen (PNUE) and a large-grain allele of the *GS3* gene. To examine the positive effect of the large-grain allele of *GS3* on rice yields, PNUE, and nitrogen utilization efficiency per unit of fed nitrogen fertilizer (NUE), a near-isogenic line of the large-grain allele of *GS3* originated from Akita 63 was developed in the genetic background of a *japonica* cultivar, Notohikari, with a large grain (LG-Notohikari).

LG-Notohikari always showed longer and wider grains compared to Notohikari in any fertilizer conditions (Fig. 1). Significant grain yield increases for LG-Notohikari were observed in two fertilized plots, with application rates equal to 4.8 and 9.6 g N/m^2, but not observed in the unfertilized plot (Table 1). Among yield components, thousand-grain weight showed significant increases in all conditions tested. Also, grain yield of the LG-Notohikari grown in the 4.8 g N/m^2 plot was similar to that of the Notohikari grown in the 9.6 g N/m^2 plot. NUEs of the LG-Notohikari were significantly higher than those of

Fig. 1. Typical phenotypes of Notohikari and LG-Notohikari grains
Ten grains each of the Notohikari and LG-Notohikari were prepared, and plants were grown in a field in Aobayama, Miyagi, Japan, without N fertilizer application. The scale bar indicates 1 cm.

Table 1. Grain yield and yield components of Notohikari and LG-Notohikari grown with different amounts of N fertilizer

N fertilization (g N/m^2)	Line	Paddy yield (g/m^2)	Total spikelet number (103/m^2)	Seed fertility (%)	1,000-grain weight (g)
0	Notohikari	269±4 a	15.0±0.2 a	76.2±1.4 a	24.6±0.5 a
	LG-Notohikari	287±9 a	15.0±0.2 a	74.4±1.8 a	31.0±1.5 b
4.8	Notohikari	338±17 a	21.0±0.6 a	80.3±1.4 a	25.6±0.4 a
	LG-Notohikari	456±26 b	22.0±0.8 a	79.8±1.1 a	29.3±0.6 b
9.6	Notohikari	450±31 a	30.1±0.8 a	76.7±1.4 a	23.1±0.6 a
	LG-Notohikari	535±21 b	28.3±0.8 a	81.8±1.9 a	28.6±0.5 b

Plants were grown at a JIRCAS paddy field in Tsukuba, Ibaraki, Japan. The mean values and standard errors are indicated. Different letters indicate significant differences (*P* value less than 0.05) between Notohikari and LG-Notohikari in each condition (n=10).

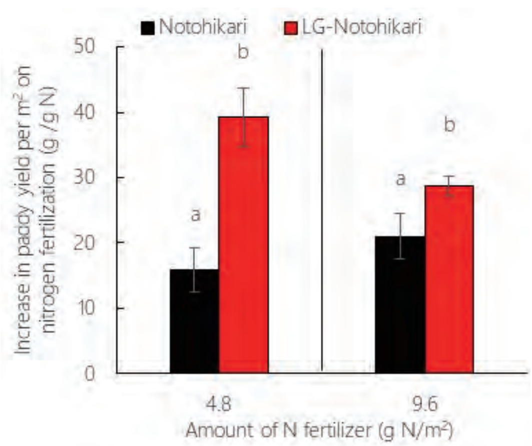

Fig. 2. NUEs of the Notohikari and LG-Notohikari
Plants were grown at a JIRCAS paddy field in Tsukuba, Ibaraki, Japan. The mean values and standard errors are indicated. Different letters indicate significant differences (*P* value less than 0.05) between Notohikari and LG-Notohikari in each condition (n=10).

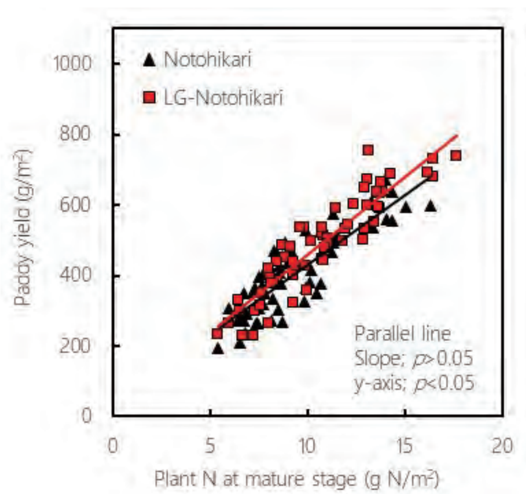

Fig. 3. PNUEs of the Notohikari and LG-Notohikari
Relationship between plant N at mature stage and paddy yield of plants grown at a Kawatabi paddy field in Osaki, Miyagi, Japan

the Notohikari in both N applications (Fig. 2). Likewise, PNUE of the LG-Notohikari was higher than that of the Notohikari (Fig. 3).

Enlargement of grain size using the large allele of *GS3* improves nitrogen utilization efficiency in rice and can be used in a rice breeding program for reduced amounts of N fertilizer. It should be noted that the effect of improving NUE and grain quality by the enlargement of grain size depends on original varieties, growth conditions, environments, and other factors.

Reference

Yoon et al. (2022) *Plant Direct* 6(7): e417. https://doi.org/10.1002/pld3.417
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Development of the new soybean variety "Sudou 27"

Saline soils cover approximately 830 million hectares globally (FAO), with around 53% of this area located in Asia. Salinity problems lead to reduced crop productivity in these regions. Therefore, the development of crop varieties with high salt tolerance is necessary to adapt to saline soils. Previously, we identified the salt-tolerant gene *Ncl* from a Brazilian soybean variety and demonstrated that soybean lines carrying *Ncl* can maintain high seed yields in saline fields. *Ncl* is now being used in soybean breeding practices in China, Vietnam, and India. "Sudou 27," a new soybean variety, was developed in collaboration between the Jiangsu Academy of Agricultural Sciences, China, and the Japan International Research Center for Agricultural Sciences, Japan.

"Sudou 27" (Fig. 1) was selected from the progenies of a cross between soybean lines 1138-2 and NILs72-T. NILs72-T harbors the salt tolerance gene *Ncl*. Based on three-year field evaluation results, "Sudou 27" was recognized for its excellent traits by the Crop New Variety Inquiry Committee of Jiangsu Province, China, and was registered as a new soybean variety in China on August 29, 2022. "Sudou 27" showed high seed yield and high seed quality characteristics, with a 6.9% higher seed yield (3.14 t/ha) and 1.4% higher seed oil content (22.4%) than the leading soybean cultivar in the northern region of Jiangsu Province, "Xudou 13," which was used as control variety in the new variety test and productivity test experiments (Table 1). In a salt tolerance evaluation test conducted by treating the seedlings with 120 mM

Fig. 1. "Sudou 27" seeds (left, scale bar = 1 cm) and mature plants (right, scale bar = 10 cm)

Table 1. Characteristics of "Sudou 27"

	New variety test experiment [a] (2019～2020, 6 test sites)							Productivity test [b] (2021, 7 test sites)
	Grain yield (t/ha)	Growth period (day)	100-seed weight (g)	Seed quality		Resistance level to SMV [c]		Grain yield (t/ha)
				Oil content (%)	Protein content (%)	Race SC-3	Race SC-7	
Sudou 27	3.27	104.5	17.0	22.4	38.7	Moderate resistance	Moderate resistance	3.14
Xudou 13 [d]	3.14	101.0	25.6	21.0	40.3	Moderate susceptibility	Moderate susceptibility	2.94

[a] New variety test experiment: The experiment was conducted for 2 years at 6 test sites. The plot area for each line (variety) was 9.6 m^2 with 3 replicates. [b] Productivity test: Productivity test was conducted for the new variety candidate lines that passed the new variety test experiment. It was conducted for 1 year at 7 test sites. The plot area for each line (variety) was 150 m^2 with 2 replicates. [c] SMV: Soybean mosaic disease. [d] Xudou 13: A leading soybean cultivar in the northern region of Jiangsu Province, China. It was used as control variety in the new variety test experiment and the productivity test experiment.

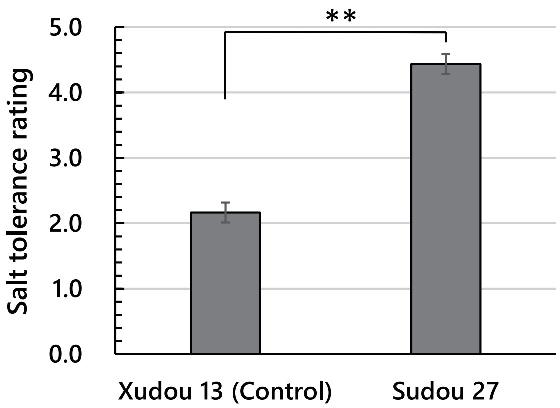

Fig. 2. Salt tolerance evaluation of "Sudou 27"
Left: Soybean plants treated with 120 mM NaCl solution for 3 weeks in seedling stage.
Right: Results of salt tolerance rating. The salt tolerance rating was classified into 5 grades, ranging from 1 (plants completely dead) to 5 (plants with normal health leaves). **: $P < 1\%$.

NaCl solution for three weeks, "Sudou 27" showed higher salt tolerance than "Xudou 13" (Fig. 2). In addition, "Sudou 27" exhibited moderate resistance to soybean mosaic disease caused by the soybean mosaic virus (SMV) (Table 1).

"Sudou 27" is expected to become one of the leading soybean varieties in the northern area of Jiangsu Province, China, replacing the former leading variety "Xudou 13." The successful development of this new variety using the salt tolerance gene *Ncl* has paved the way for breeding salt-tolerant varieties that are expected to contribute to the sustainability of soybean production in areas with salinity problems.

Reference

JIRCAS Press Release (2022-09-08) *Development of New Salt Tolerant Soybean Variety with High Yield and Disease Resistance—Contributing to Stable Soybean Production in Salt-affected Agricultural Areas—* https://www.jircas.go.jp/en/release/2022/press202207

(D. Xu, H. Chen [Jiangsu Academy of Agricultural Sciences (JAAS), P.R. China], X. Cui [JAAS], H. Zhang [JAAS], X. Liu [JAAS], Q. Wang [JAAS], X. Chen [JAAS], H. Gu [JAAS])

TOPIC 4

Nitrate uptake positively correlates with phosphorus use efficiency in rice

Phosphorus (P) is one of the essential elements for plants but is frequently deficient in agricultural fields. P fertilizer is expected to be depleted in the future, and in light of the soaring cost of fertilizers, farmers cannot apply sufficient P fertilizers in many developing countries where food security is particularly threatening. Thus, for the production of rice, which is the major agricultural crop in many of these developing countries lacking ample supply of P, developing P-efficient rice varieties that efficiently absorb P and/or efficiently produce biomass with limited amount of P is a promising approach. However, previous investigations suggest that P use efficiency in rice is controlled by many small-effect genetic factors, thus rendering a conventional breeding approach of limited use. Our previous metabolomics study showed that several amino acids and nitrogen (N)-containing metabolites serve as markers for P use efficiency, suggesting that N utilization might be a key for efficient use of P. Therefore, in the current study, we examined the effect of different N sources on P use efficiency.

Addition of nitrate lowered root P concentration under low P supply compared with the condition when the same amount of N was applied solely as ammonium (Fig. 1A). This resulted in higher P use efficiency in nitrate-treated plants (Fig. 1B). Comparison of gene expression patterns in 5 rice accessions that differ in P use efficiency showed that, compared with P-inefficient genotypes such

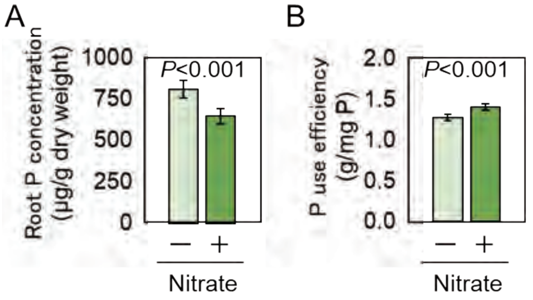

Fig. 1. Effects of nitrate on root P concentration and P use efficiency
Root P concentration (A) and P use efficiency (defined as the biomass produced per unit P) (B) of plants (cultivar: Taichung) with (+) or without (-) nitrate ion in culture solution. Mean values and standard deviations (n=4) are shown. Two-tailed Student's *t*-test was performed, and the resultant *P* value is indicated.

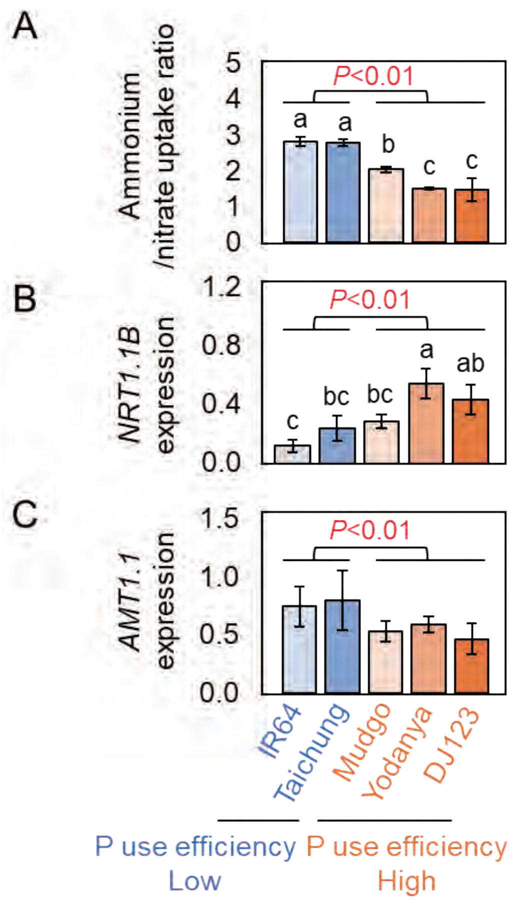

Fig. 2. N use patterns in rice accessions contrasting in P use efficiency
(A) Ratio of ammonium and nitrate uptake in roots. (B,C) The expression of *NRT1.1B* (B) and *AMT1.1* (C) in root. Mean values and standard deviations (n=4) are shown. One-way analysis of variance was performed, and the values among different genotypes were compared by Tukey-Kramer *post-hoc* test. Different alphabets indicate that the values are different at the significance level of *P*=0.05. Wilcoxon's rank sum test was further performed to further compare the values obtained from the groups with high or low P use efficiency, and the resultant *P* value is indicated.

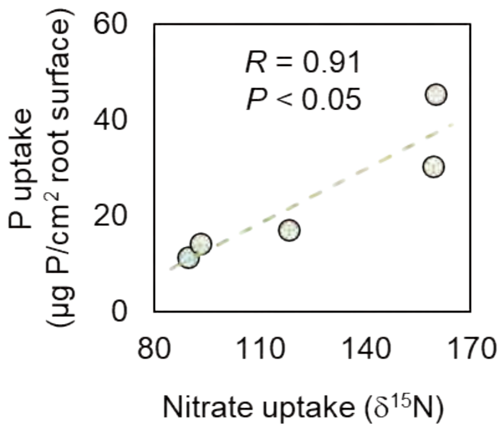

Fig. 3. Relationship between the uptake efficiency of nitrate and P
Nitrate uptake efficiency in P-limiting hydroponic condition (horizontal axis) and P uptake efficiency in P-limiting upland field (vertical axis) were compared in 5 genotypes that differ in P use efficiency. Pearson's correlation coefficient and the significance level of the correlation are indicated.

as IR64 and Taichung, P-efficient genotypes such as DJ123, Mudgo, and Yodanya had lower uptake ratio of ammonium to nitrate (Fig. 2A). Accordingly, the expression of *NRT1.1B*, which encodes a nitrate transporter that likely highly contributes to nitrate uptake, was higher in P-efficient genotypes than P-inefficient genotypes (Fig. 2B). On the other hand, the expression of *AMT1.1* that encodes one of the major ammonium transporters tended to be lower in P-efficient genotypes (Fig. 2C).

A strong positive correlation was observed between the uptake efficiency of nitrate examined under the hydroponic condition and P uptake efficiency previously examined in a low P field (Fig. 3). These observations suggest that utilization of nitrate and P are interconnected, and improvement of nitrate use may increase P use efficiency. This is in accordance with a previous hypothesis that nitrate uptake increases P solubilization in the rhizosphere and contributes to increased P uptake. Further studies are necessary to confirm if altered N fertilization scheme affects P use efficiency of rice in the field and to discover the causal gene for such genotypic differences.

Reference

Ueda and Wissuwa (2022) *Plant and Soil* 481: 547–561.

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(Y. Ueda, M. Wissuwa)

TOPIC 5

Plant sex and flowering date are strong determinants of tuber yield in white Guinea yam

White Guinea yam (*Dioscorea rotundata* Poir.) is a tuber crop widely cultivated in West Africa, accounting for more than 90% of global yam production. The average annual yield of yam has been stagnant for decades and varies from year to year. Variability in tuber yield and yield-related traits has been observed even among plants of the same variety grown in the same environment. This study focused on the sex of yam flowers as one of the causes of unstable tuber yield, as flower sex has been known to interact with tuber yield. Yams are a dioecious species, with male and female flowers on different plants (Fig. 1). Moreover, plant-to-plant variability in flower sex expression is common in yam fields. A better understanding of the relationship between flower sex and tuber yield could be crucial for genetic improvement in yam breeding.

This study used F_1-derived clonal progenies from a bi-parental cross to minimize the impact of basal genetic differences between the sex phenotypes. The impact of plant sex on agronomic traits, specifically tuber yield, was evaluated through field trials conducted for four years. The results showed that only plants with a female genotype exhibited diverse sex phenotypes (Fig. 2). Inter-plant variation in tuber yield was affected by both sex phenotype and sex genotype, but greater contribution to tuber yield was observed in the former than the latter (Table 1). Our results revealed that plants with female phenotypes had higher tuber yield than those with male phenotypes (Fig. 3). This result can be attributed to the fact that, compared to male plants, the low flowering intensity in female plants increases the availability of carbon resources for leaf development. The sexual differences in tuber yield were evident when comparing plants with similar flowering dates. Significant difference was observed for plants flowering in late July, but the difference became small for late flowering plants. This is because early flowering can avoid resource competition with tuber enlargement, which starts from mid-August.

Since sex phenotype varies with the surrounding environment in plants with the female genotype, artificial control of sex phenotype would be possible for yield improvement of female-genotyped varieties and could be achieved by appropriate field management, such as soil water control and arrangement of plant light interception, to maintain good culture conditions. The identification of the genetic factors and environmental conditions that determine flowering is currently underway, and it is expected to lead to new cultivation methods that improve tuber yield by successfully controlling flowering phenotype and flowering period, as well as the development of new varieties genetically modified for these traits.

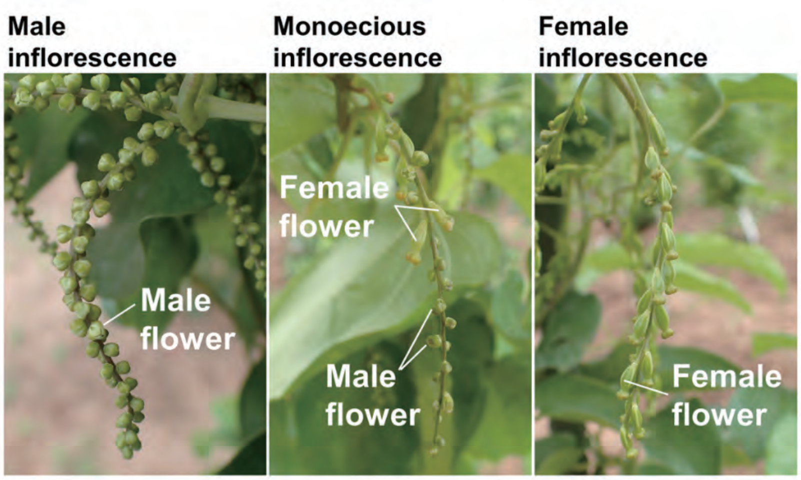

Fig. 1. Sex phenotypes in yam
Male inflorescence of male plant (left) and female inflorescence of female plant (right). Inflorescence of monoecious plant has both male flower and female flower (center).

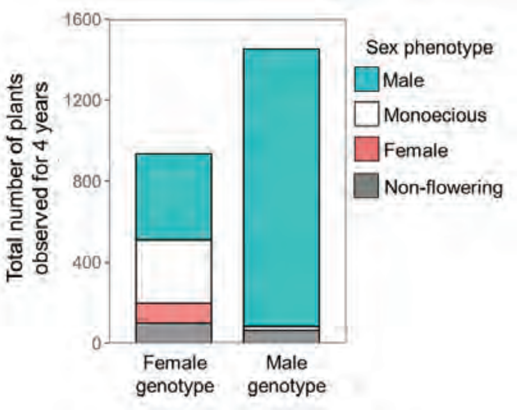

Fig. 2. Observed sex phenotype in plants with male and female genotypes
Distribution of sex phenotypes from a total of 2,400 plants, consisting of 200 accessions with 3 replications over a 4-year period. Approximately half of the plants with a female genotype showed a male phenotype.

Table 1. Effect of sex phenotype and sex genotype on tuber yield

Factor	Contribution (%)
Sex genotype	0.1 *
Sex genotype × Sex phenotype	3.2 **

The results of nested analysis of variance (ANOVA) using sex genotype as the hierarchical factor. Values indicate the contribution ratio of each factor on the total yield variation. ** and * indicate that the contribution is statistically significant at $P<0.01$ and $P<0.05$ levels, respectively.

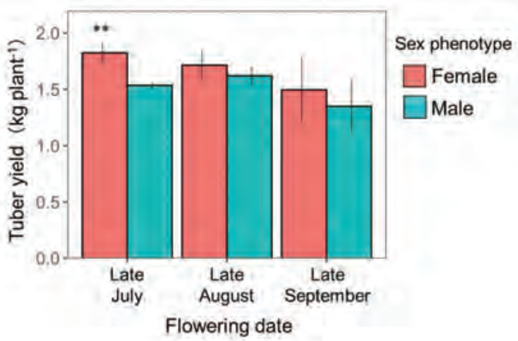

Fig. 3. Relationship between flowering date and tuber yield in plants with male and female phenotypes
Female plants had higher tuber yield than male plants when comparing plants with similar flowering dates. Significant difference at $P<0.01$ level was obtained for plants with early flowering in late July.

Reference

Iseki et al. (2022) *Frontiers in Plant Science* 13: 837951. https://doi.org/10.3389/fpls.2022.837951

(K. Iseki, R. Matsumoto [International Institute of Tropical Agriculture (IITA)], O. Olaleye [IITA], A. Asfaw [IITA])

TOPIC 6

Spawning season of the edible tropical oyster *Crassostrea belcheri* in the coastal area of Myeik, southern Myanmar

Oyster aquaculture research in Myanmar started in the 1970s, but commercial oyster farming techniques have not yet been established. The availability of seed oysters for oyster farming depends on the natural occurrence of juvenile oysters in coastal areas in the case of natural seedling collection. Therefore, the relationship between the environment of the target area and the spawning period of the target species needs to be clarified. In temperate regions, where water temperatures vary greatly between winter and summer, many species spawn once a year in the summer when water temperatures rise, whereas in tropical regions, where water temperatures are high all year round, they often spawn year-round. However, there is seasonal variation in the proportion of spawning individuals. The main spawning seasons have been reported as once, twice, or three times a year, and the timing may vary from region to region, even for the same species. This study aims to reveal the reproductive cycle of the edible tropical oyster (*Crassostrea belcheri*) from the waters near Myeik (Fig. 1) in southern Myanmar and to identify suitable periods for natural seedling collection of the species. From September 2017 to October 2018, 12–20 edible tropical oysters were obtained monthly from markets in Myeik (Fig. 2). Gonadal tissue sections were examined under an optical microscope, and maturity stages were determined.

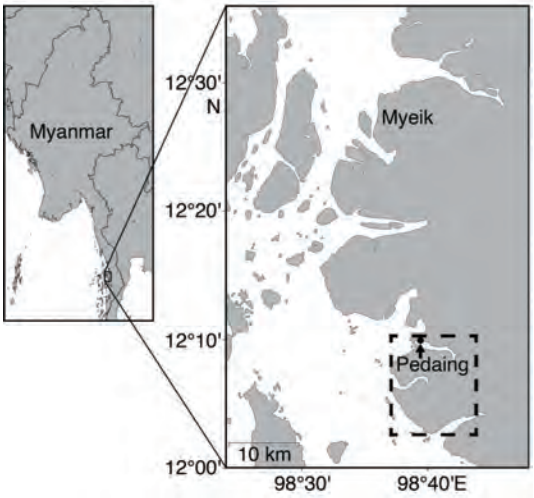

Fig. 1. Study area
The study area is located on the southernmost coast of Myanmar. Edible tropical oysters are harvested from the nearby mangrove creeks of Pedaing Village (generally within the area enclosed by the dotted line) and sold in Myeik City all year round.

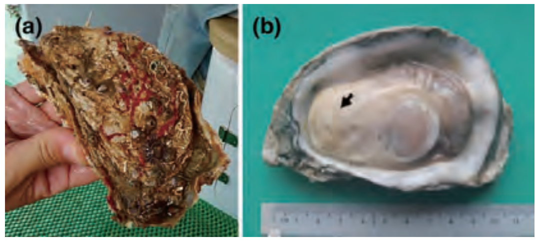

Fig. 2. Exterior of edible tropical oyster (a) and inside the shell (b)
The arrow indicates the location of the gonads.

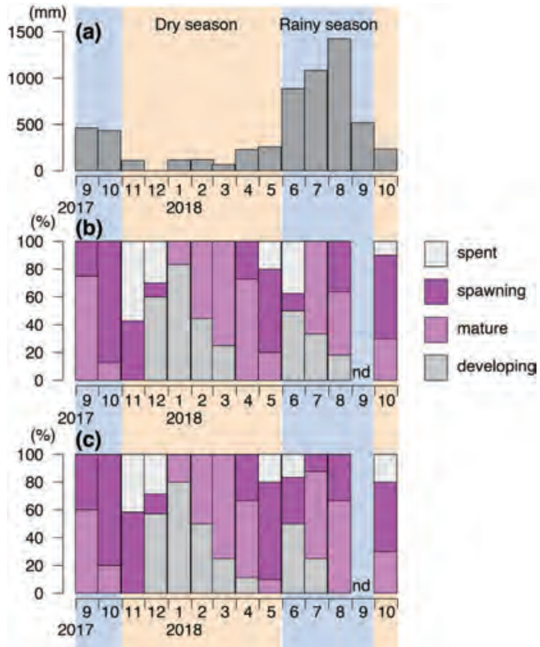

Fig. 3. Monthly precipitation in Myeik (a) and sexual maturity stages of edible tropical oysters (b, female; c, male)
The length of the rainy season varies slightly from year to year. Percentage of gonads in spawning stage is higher in October and May, which is the transition between the rainy and dry seasons.
nd: no data.

The local climate is a tropical monsoon climate with a distinct dry and rainy season, with significantly higher rainfall in the rainy season. During the study period, monthly rainfall exceeded 400 mm in September–October 2017 and June–September 2018 (Fig. 3a). Histological analysis of *C. belcheri* gonads revealed that spawning occurred throughout the study period except January–March 2018, peaking at the beginning and end of the dry season in October–November and April–May, respectively (Fig. 3b, c).

The installation of collectors in the sea during the transition from dry to rainy season or from rainy to dry season is expected to increase the efficiency of natural seedling collection. Local meteorological information makes it possible to estimate the spawning season of edible tropical oysters, thus the timing of the placement of seedling collectors in the sea. However, during the rainy season, the survival and growth of juvenile oysters recruited before the rainy season would be hampered by low salinity due to freshwater inflow, etc. Further research is needed on survival and growth rates after the spawning season to establish efficient natural seedling collection techniques.

Reference

Khin-May-Chit Maung et al. (2023) *Japan Agricultural Research Quarterly* 57(3).

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(M. Toyokawa, T. Yurimoto, Khin-May-Chit-Maung [Myeik University], H. Saito [Japan Fisheries Research and Education Agency])

Clarifying the genetic diversity of *Amaranthus tricolor* ‘Hiyuna,’ a traditional Asian vegetable

Amaranthus tricolor L., called ‘hiyuna’ in Japanese, is used as a traditional leafy vegetable in Asia. *A. tricolor* is resistant to major diseases, is more tolerant to environmental stresses, and is a rich source of nutrients such as iron and calcium, as well as vitamin C and beta-carotene. Yet despite this diversity and excellent nutritional quality, breeding of improved cultivars is widely neglected in modern breeding. *A. tricolor* accessions are conserved in the World Vegetable Center (WorldVeg) genebank (https://avrdc.org) and in the USDA National Plant Germplasm Information System (https://www.ars-grin.gov). These accessions hold a wide variety of genetic variations and useful agronomic traits with a high potential for breeding improved cultivars (Fig. 1).

Fig. 1. Phenotypes of *A. tricolor* accessions cultivated at World Veg
The photos exhibit phenotypic diversity, including leaf color, shape, and height. We cultivated 465 *A. tricolor* genetic resources.

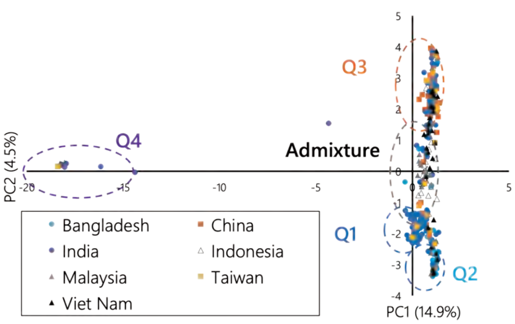

Fig. 2. Principal coordinate analysis (PCoA) of *A. tricolor* accessions based on genome-wide SNPs
Seven countries from which at least 10 accessions are derived are shown. The plots are colored to illustrate the origin of the accessions and to show the clustering according to population structure and geography.

Some studies have reported on the evaluation of *A. tricolor* genetic resources, but the diversity conserved in both genebanks has not yet been systematically evaluated.

In this study, we evaluated the genetic diversity in the collection of *A. tricolor* accessions conserved by the WorldVeg and USDA genebanks based on genome-wide single-nucleotide polymorphisms (SNPs) developed using double-digest RAD-Seq (ddRAD-Seq), and created a core collection, which is valuable in improving crop breeding programs for performing extensive evaluations with minimal materials.

We analyzed the genetic diversity and population structure among 465 *A. tricolor* accessions with SNPs developed by ddRAD-Seq. We identified a set of 5,638 SNPs without missing data in 440 accessions in order to establish a breeding platform. We analyzed genetic diversity by principal coordinate analysis (PCoA) of the accessions using this marker set. The 377 *A. tricolor* accessions clustered into 4 main subpopulations (Q1–Q4) and an admixture group (Fig. 2). The proportion of accessions from India, Bangladesh, and China in Q1, Q2, and Q3 was significantly higher than that in other countries, and the proportion of the admixture group in all accessions was highest in accessions from Southeast Asia, especially Indonesia and Malaysia (Fig. 3). In addition, we created a core collection of 105 accessions representing the genetic diversity of 377 source accessions. This core collection is available for research and breeding

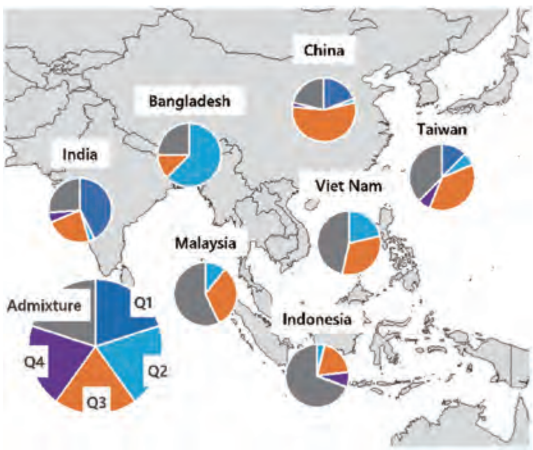

Fig. 3. Classification and geographic distribution of *A. tricolor* genetic resources using SNP markers
The pie graphs show the proportions of accessions of specific subpopulations in each country.

through the WorldVeg genebank.

Marker selection breeding using the SNP markers and core collection obtained this time will pave the way for the development of breeding techniques and new varieties to improve nutritional value, eating quality, and yield. It is also expected to contribute to sustainable vegetable production in tropical and subtropical regions.

Reference

Hoshikawa et al. (2022) *Scientia Horticulturae* 307: 111428.

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(K. Hoshikawa, Y. Yoshioka [University of Tsukuba], K. Shirasawa [Kazusa DNA Research Institute])

TOPIC 8

Selection of a promising donor for developing zinc-biofortified rice based on genomic prediction model

Increasing zinc (Zn) concentrations in edible parts of food crops, an approach termed Zn-biofortification, is a global breeding objective to alleviate micro-nutrient malnutrition. In particular, infants in countries like Madagascar are at risk of Zn deficiency because their dominant food source, rice, contains insufficient Zn. Biofortified rice varieties with increased grain Zn concentrations would offer a solution and our objective is to explore the genotypic variation present among rice gene bank accessions and verify their performance under farmers' field conditions. A training set of 253 rice accessions was grown at two field sites in Madagascar. A genomic prediction model was developed from the above training set to predict brown rice Zn concentrations of 3,024 sequenced rice accessions. Predicted concentrations ranged from 17.1 to 40.2 ppm Zn with significant differences among rice sub-populations, of which *aus* group (n=201) had highest Zn concentrations (Fig. 1). The prediction accuracy of the developed model was evaluated using 61 previously untested accessions, and the relatively high coefficient of determination (R^2=0.55) between measured and predicted values confirmed the model validity (Fig. 2). Very high predicted grain Zn concentrations of accessions belonging to the *aus* sub-species were confirmed in additional field experiments, with one potential

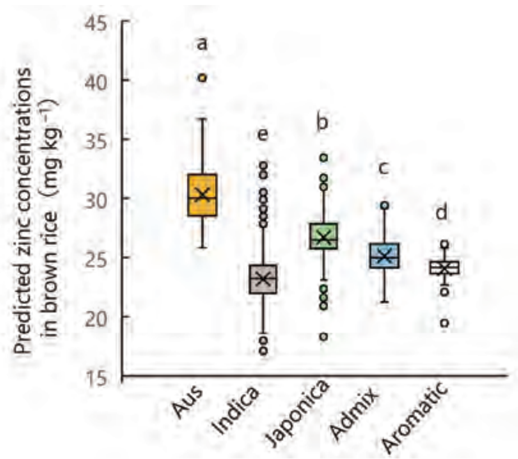

Fig. 1. Predicted variations in brown rice zinc concentrations of 3,024 accessions from five rice sub-populations
Aus (n=201); Indica (n=1,089); Japonica (n=855); Admix (n=103); Aromatic (n=76). Different alphabets indicate significant differences in the means (shown in ×) among sub-populations by Tukey's HSD at *P*<0.05. The sub-populations were categorized by IRRI genebank.

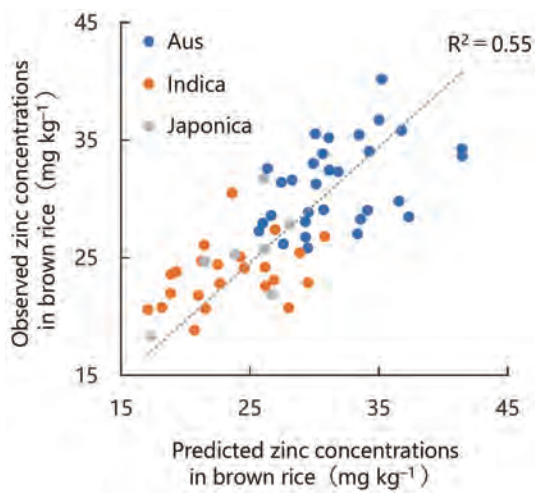

Fig. 2. Relationship between observed and predicted brown rice zinc concentrations of 61 unseen accessions

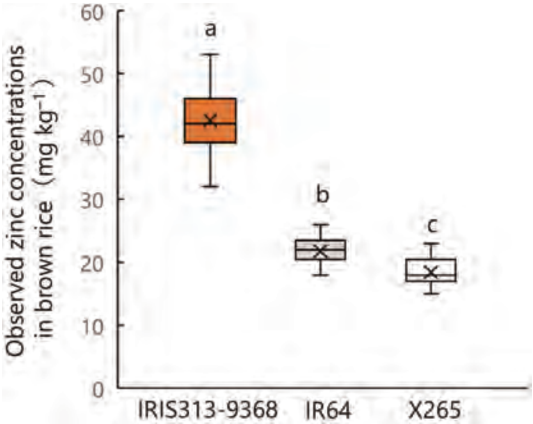

Fig. 3. Observed brown rice zinc concentrations of three rice accessions across 10 different growth conditions
IRIS313-9368: the aus type predicted to have high Zn concentration; IR64: a popular high-yielding lowland variety in the tropical region; X265: a leading lowland variety in Madagascar. Different alphabets indicate significant differences in the means (shown in ×) among sub-populations by Tukey's HSD at $P<0.05$.

donor (IRIS313-9368) having more than twice the grain Zn compared to a local check variety (X265) (Fig. 3). We conclude that utilizing donors from the *aus* sub-species and employing genomic selection during the breeding process are the most promising approaches to raise grain Zn concentrations in rice.

Reference

Rakotondramanana et al. (2022) *Theoretical and Applied Genetics* 135: 2265–2278.

(M. Wissuwa, Y. Tsujimoto, J. Tanaka, M. Rakotondramanana [The National Center for Applied Research on Rural Development (FOFIFA)], R. Tanaka [University of Tokyo], J. Stangoulis [Flinders University], C. Grenier [The French Agricultural Research Centre for International Development (CIRAD)])

TOPIC 9

Increased lowland rice yield improves nutrition of farmers in Madagascar

Sub-Saharan Africa has the highest rate of hunger in the world, accompanied by serious micronutrient deficiencies. Since low agricultural productivity of staple crops is a major challenge in this region, increasing crop yield is urgently needed and expected to increase farmers' energy intake and cash income. Agriculture is said to have an effect on farmer's nutrition; however, only a few studies have evaluated the impact of increased productivity of staple food crops on farmers' nutritional supply in rural areas of Sub-Saharan Africa. To explore the pathways and effects of lowland rice yield on farmers' nutrient supply, we monitored the agricultural production and food consumption of 600 households over a three-year period from 2018 to 2020 in the rural areas of Madagascar, where rice is the main staple food.

We found that the elasticities of energy, zinc, iron, and vitamin A with respect to lowland rice yield are significantly positive (Fig. 1). Higher lowland rice yield increases the supply of these nutrients, for which deficiencies are particularly widespread in the target area. We also showed that an increase in rice yield leads not only to rice consumption but also to cash revenue from rice sales (Table 1). Increased cash revenue accelerates purchases of nutritious foods such as vegetables, fruits, and meat & fish at the market (Fig. 2). While yield has a significant positive impact on whether rice is sold (Yes/No), the interaction term of yield and distance to the main road has a significant negative impact (Table 2). Good market access promotes rice sales, suggesting the importance of the role that the market plays. This pathway is illustrated in Figure 3. In addition to increasing rice consumption (red line in Fig. 3), higher productivity of lowland rice increases purchases of nutritious foods through market channels (blue line in Fig. 3). Therefore,

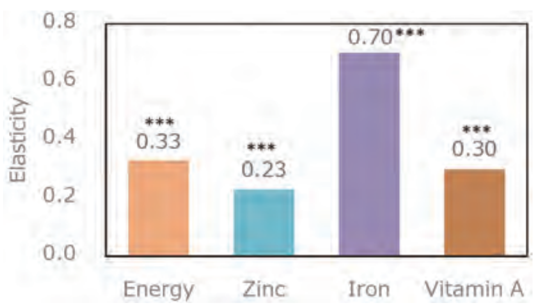

Fig. 1. Elasticities of lowland rice productivity on nutrient supply
***: Significant at 1% level

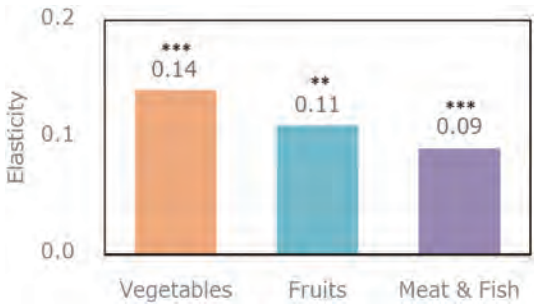

Fig. 2. Elasticities of cash revenue from lowland rice sales on food expenditure
***, **: Significant at 1% & 5% levels, respectively

Table 1. Elasticities of lowland rice yield on rice consumption and on cash revenue from rice sales

Consumption	Cash Revenue
0.20***	0.41***

***: Significant at 1% level

Table 2. Effects of lowland rice yield and distance to the main road on rice commercialization

Yield	Yield * Distance (ln)
0.16***	–0.08***

***: Significant at 1% level

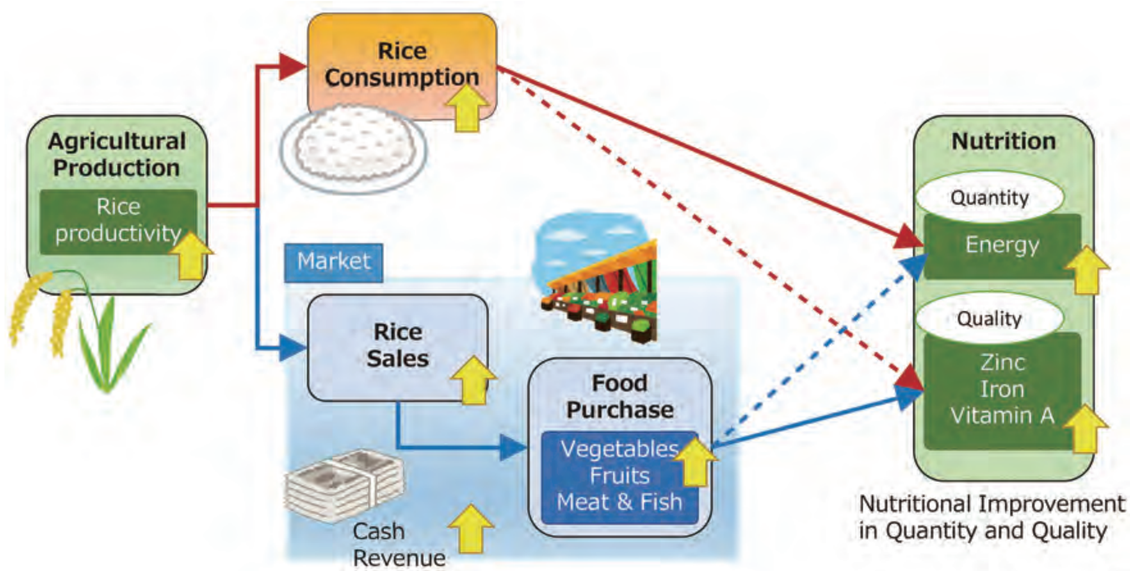

Fig. 3. Linkage from agricultural production to farmers' nutritional supply
Pathway (red): Increased rice productivity leads to an increase in self-consumption of rice, contributing to nutritional improvement mainly in terms of quantity.
Pathway (blue): Increased rice productivity increases rice sales and hence cash revenue from that. It leads to an increase in purchase of nutritious foods, which contributes to nutritional improvement mainly in terms of quality.
Solid-line and dashed-line arrows indicate major and secondary contributions, respectively.

improving lowland rice productivity is effective in improving farmers' nutrition in terms of both quantity (energy supply) and quality (nutrition balance including micronutrients).

These findings contribute to the formulation and implementation of measures to improve nutrition by increasing the productivity of staple crops grown in rural areas of Sub-Saharan Africa. Technological interventions aimed at increasing the productivity of staple crops are effective in improving the nutrition of poor farmers and, in turn, SDG Goal 2 (Zero Hunger). This is the result of diversifying purchasing behavior through the market as well as through self-consumption, and it is necessary to ensure farmers' access to the market along with technology adoption.

Reference

Nikiema et al. (2023) *Food Secur.* https://doi.org/10.1007/s12571-022-01333-5

(S. Shiratori, R. Ozaki,
N.A. Nikiema [University of Tokyo],
T. Sakurai [University of Tokyo],
J. Rafalimanantsoa [National Office of Nutrition, Madagascar])

Mitigating income stagnation and volatility in African smallholder agriculture using small reservoir irrigation technology and stochastic programming model

Due to the precarious nature of rainfed crop production, smallholder farmers in Africa are confronted with the peril of insufficient and unstable income (hereinafter referred to as "risk"). While irrigation has been recognized as a means of mitigating this risk, irrigation plans that are well-suited for farmers' risk management are seldom explored. This study introduces a farm management planning model that integrates the production of irrigated crops utilizing a small reservoir with that of rainfed crops. This model is based on the results of a participatory on-farm trial and survey conducted over a five-year period in northern Ghana. Using stochastic programming, the model considers the variability of crop yields, prices, and costs under the prevailing farm, water, and social conditions in order to identify the most effective irrigation cropping patterns that enhance and stabilize income (Fig. 1).

The model analysis revealed three distinct types of optimal cropping based on the level of risk and income: minimal risk, actual risk, and maximal income. To minimize risk, pepper production, which is highly profitable but risky, should be reduced, and rice and leafy vegetables should be grown instead, using a small reservoir. If farmers can tolerate the actual level of risk in rainfed agriculture, it is suggested that they decrease maize production, the primary staple, to a self-sufficient level and expand irrigated rice and leafy vegetable production, which could result in a 60% increase in expected income. Reducing rainfed rice production to a level that enables rice self-sufficiency and increasing pepper production will maximize expected income. Although risk will increase, the income level is expected to exceed that of rainfed agriculture even in the case of a downturn in income (Fig. 2). Note that the investment in irrigation facilities is difficult to recoup in the "minimal risk type" due to the limited increase in expected income. The "maximal income type" can recoup its investment in approximately four years, while the "actual risk type" can do so in approximately eight to twelve years (Fig. 3).

To facilitate the improvement of local cropping systems, a program called BFMgh has been

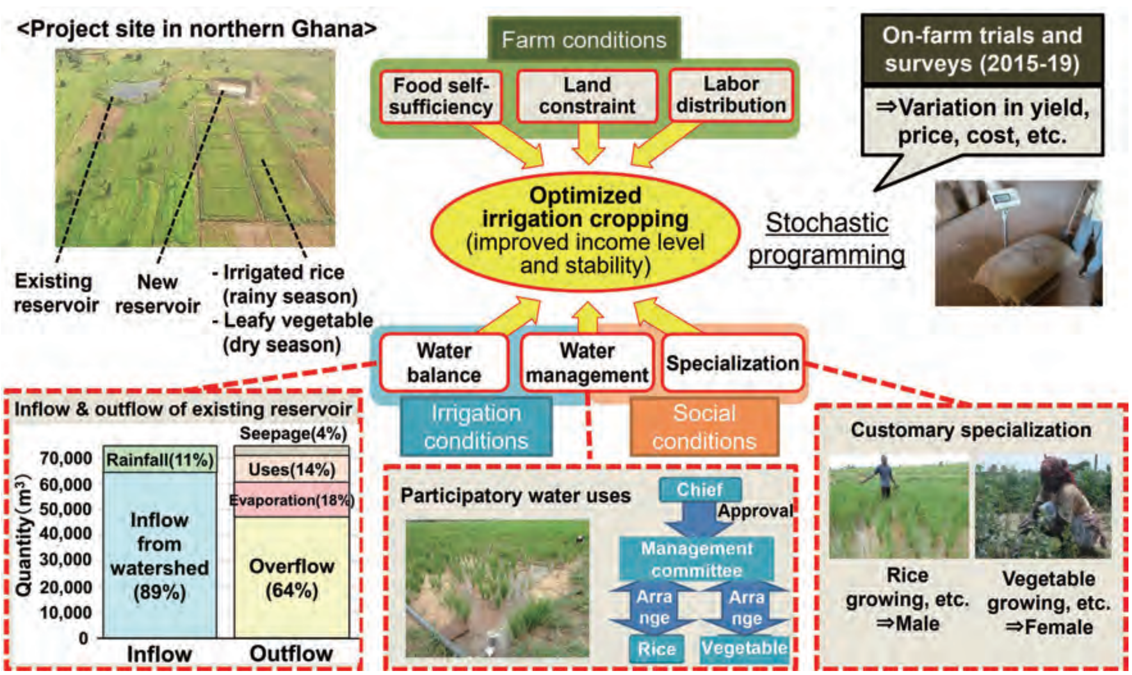

Fig. 1. Schematic diagram of the constructed model

Water allocation to irrigated crops will be optimized based on the available water capacity of the newly constructed reservoir designed to store excess water from the existing reservoir.

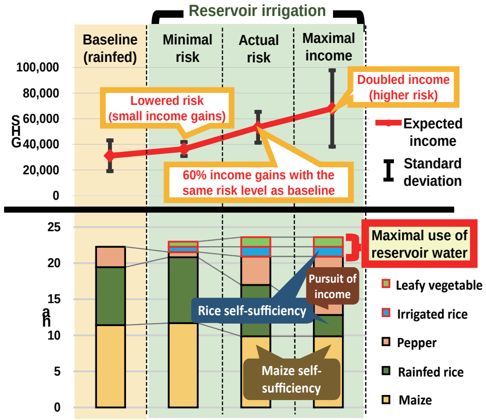

Fig. 2. Optimal cropping plan (below) and its income enhancing and stabilizing effect (above)
The results of model analysis for 30 irrigated farmers using the new reservoir (water storage capacity: 5000 m^3) constructed at a project site in northern Ghana are shown.
The risk denotes the standard deviation of income (bars in the figure).
GHS: Ghanaian Cedi

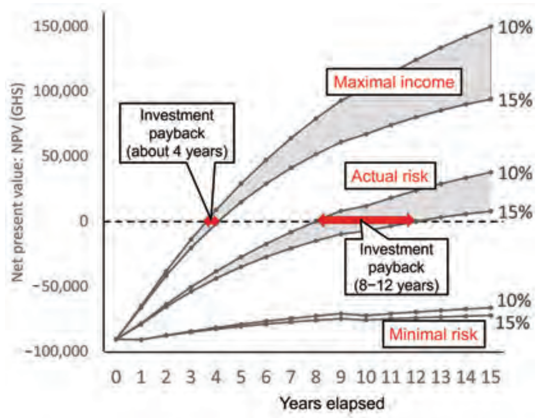

Fig. 3. Return on investment according to optimal cropping plan and discount rate (10%−15%)
NPV: the present value of the expected income from each optimal cropping plan minus the investment cost for irrigation facilities (95,624 GHS).
The intersection with zero is the number of years required for investment payback (red arrow in the figure). It varies slightly depending on the discount rate.
GHS: Ghanaian Cedi

developed to create enhanced farming plans for smallholders in Ghana. The program stores sample data on irrigated and rainfed crops collected during this study and is available on the JIRCAS website. In northern Ghana, attention should be given to potential conflicts over reservoir water usage as some individuals may seek to utilize a portion of the reservoir water for domestic purposes, even if it was constructed for agricultural purposes.

References

1) Koide et al. (2021) *Agric. Syst.* 1031:49. https://doi.org/10.1016/j.agsy.2021.103149
Figures reprinted/modified with permission.
2) “BFMgh: Program for creating Improved Farming Plans for African Smallholders” (2022) https://www.jircas.go.jp/ja/database/farm_management_model_for_shfa

(J. Koide, S. Yokoyama, S. Hirouchi, N. Oka, C. Hirose, S. Yanagihara, M. Oda, W. Oishi [University of Tsukuba])

TOPIC 11

Phosphate rock-enriched compost with rhizosphere soil increases sorghum yield equivalently to chemical fertilizers

The limited availability of phosphorus in sub-Saharan African soils is a significant constraint to agricultural production. Cereal production in the area is only 1.59 tons per hectare, while the world average is 4.15 tons per hectare (World Bank, 2021). In view of the demographic trend showing high population growth in sub-Saharan Africa, increasing crop production by improving soil nutrient availability is of high priority. Unfortunately, the recent surge in the prices of chemical fertilizers complicates their effective use by smallholder farmers. Therefore, in a previous study, we formulated a new compost type by co-composting crop residue with low-grade phosphate rock and soil collected from the sorghum root rhizosphere area (S-PrCo). The rhizosphere soil, influenced by complex molecular exchanges between roots and microbes via root exudates, is generally rich in beneficial microbes, including phosphorus solubilizers. We included a phosphate rock-enriched compost without rhizosphere soil (PrCo) and compost with only crop residues (Co). All composts were made with 100 kg of sorghum straw as crop residue and 460

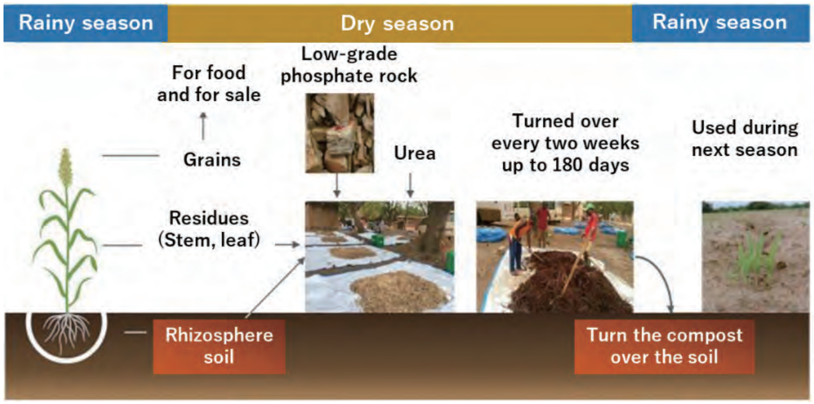

Fig. 1. Conceptual diagram of the utilization of phosphate rock-soil-enriched compost

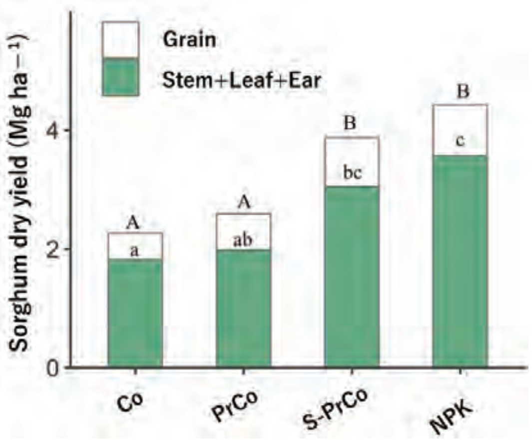

Fig. 2. Fertilization effect of phosphate rock soil-enriched compost
*Co: residue compost, PrCo: phosphate rock-enriched compost, S-PrCo: phosphate rock-soil-enriched compost, NPK: commercial NPK fertilizer
*Different alphabet capital letters between treatments show significant differences in total dry matter yield (grain plus sum of stem-leaf-ear). Different alphabet lower case letters show significant differences in grain yield

g of urea to reduce the C/N ratio from 55/1 to 25/1 and ease the decomposition. We added 10 kg of phosphate rock and 10 kg of rhizosphere soil where necessary. Each compost pile was arranged in five successive layers, the moisture content was adjusted to 65%, and the composting lasted 180 days (Fig. 1). The available phosphorus and phosphate-solubilizing microbes increased in S-PrCo.

The present study evaluated S-PrCo, PrCo, and Co on sorghum growth and soil properties compared to the chemical fertilizer NPK (nitrogen-phosphorus-potassium). The results showed that S-PrCo significantly increased sorghum dry matter (grain, stem/leaf/ear) compared to PrCo and Co and gave a yield equivalent to the chemical fertilizer (Fig. 2). S-PrCo also improved soil biological properties by increasing the population of arbuscular mycorrhizal fungi involved in the uptake and transfer of phosphorus to the roots. It also enhanced the abundance of P-cycling microbes, such as phosphate-solubilizing bacteria with the glucose dehydrogenase (*gcd*), acid phosphatase (*aphA*), phosphonatase (*phnX*), and phosphate specific transporter (*pstS*) genes as shown in Figure 3. The study clarified that the significant yield-increasing effect of the new compost type (S-PrCo) is not only due to the increase of available phosphorus in the compost prior to application but also due to the improvement of soil biological activity with the promotion of phosphorus solubilization and absorption during the cultivation period. S-PrCo also improves soil chemistry by correcting the soil pH. This research indicates that co-composting crop residues with low-grade phosphate rock and rhizosphere soil is expected to provide farmers in sub-Saharan Africa with a new fertilizer option against rising chemical fertilizer prices and soil degradation.

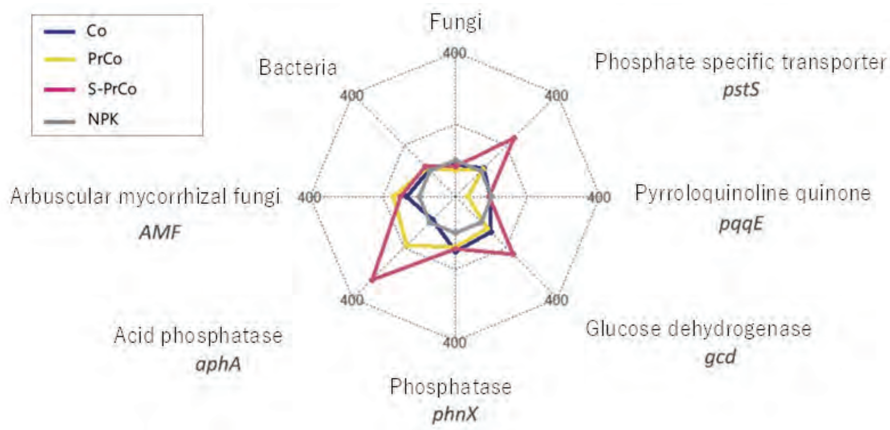

Fig. 3. Amount of effective microbes in rhizosphere soil during sorghum growth

*Co: residue compost, PrCo: phosphate rock-enriched compost, S-PrCo: phosphate rock-soil-enriched compost, NPK: commercial NPK fertilizer

*Shown as a relative value (%) with the case of applying imported chemical fertilizer NPK (gray in the figure) as 100%

*Arbuscular mycorrhizal fungi (AMF), glucose dehydrogenase (gcd), and phosphate-specific transporter-producing microbes (pstS) show the values at 52 days after seeding, which is the early stage of growth

* For other items, average values for 52 days, 93 days, and 115 days after seeding are shown.

References

Sagnon et al. (2022) *Scientific Reports,* https://doi.org/10.1038/s41598-022-18318-1.

Sarr et al. (2020) *Frontiers in Environmental Science*, doi:10.3389/fenvs.2020.559195

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(P.S. Sarr)

TOPIC 12

A curve number estimation model to accurately calculate reservoir inflow

There are many reservoirs in Northern Region, Ghana (Fig. 1). The reservoirs overflow during the rainy season, and the overflowing water flows into rivers without being used downstream. If the overflowing water can be used for irrigation, agricultural productivity is expected to increase. To utilize overflow water for irrigation, it is necessary to estimate the volume of water that flows out of the watershed when rain falls (runoff). The curve number method calculates the volume of runoff from the watershed using the curve number (CN), rainfall, and watershed area (Fig. 2). Using standard CN (Fig. 3, Standard CN), observed runoff per rainfall could not be presented (NSE=–4.46), and the difference with the observed runoff was large during the whole period (Fig. 3). This study proposes a CN estimation model to calculate runoff with accuracy and practicality.

To approximate the observed runoff, a model

Fig. 1. Bird's-eye view of the reservoir

was devised to estimate CN by multiple regression analysis, using CN calculated backwards from the observed runoff for each rainfall as the objective variable; and daily rainfall, dry period, and hourly maximum rainfall as explanatory variables. Of the devised models, the method of estimating CN using daily rainfall (log-transformed), number of days in a dry period, and hourly maximum rainfall (Method (1)) had the best reproducibility with an average NSE of 0.74. In districts where hourly rainfall data are difficult to obtain, Method (2), which estimates CN using only daily rainfall (log-transformed) and the number of days in a dry period (NSE=0.51), is recommended. Also, methods (1) and (2) show a small difference between the observed and the calculated runoffs for the whole period (Fig. 3). Using CN estimated by these methods, runoff per rainfall can be calculated, and from the calculated runoff and the water balance equation, the volume of water that overflows (Fig. 4), i.e., when the water level in the reservoir exceeds 2.1 m, can be calculated. Applying Method (1) to 2017, it can be calculated that 5,890 m^3 of overflow water was generated from the reservoir (Fig. 5). The CN estimation model devised in this study can estimate runoff using only rainfall and can be used in developing regions with data scarcity.

The "Supplementary Irrigation Manual for Rice Production Using Small Reservoirs," which describes a method of using overflow water for irrigation in rice farming, is available on the JIRCAS website. The results of this study are based on model calculations for one of the many reservoirs in Northern Region, Ghana, hence the regression coefficients will need to be recalculated for application to other reservoirs.

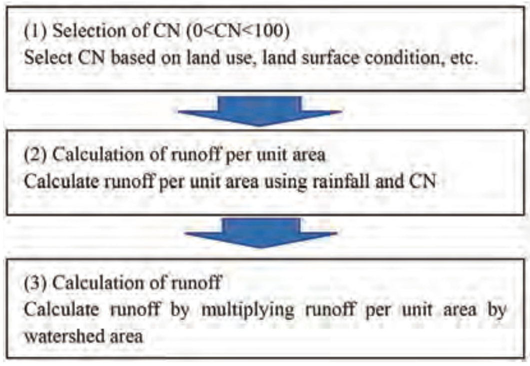


Fig. 2. How to calculate runoff using the CN method

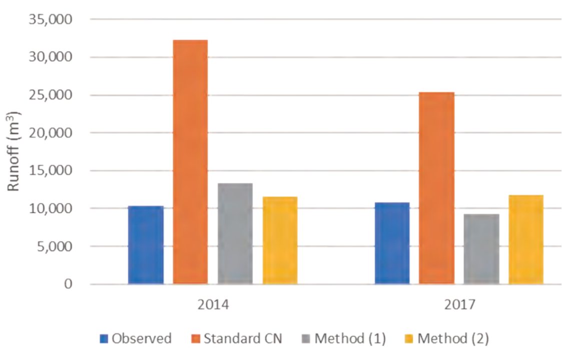


Fig. 3. Observed and calculated runoffs

Method (1) y = -13.38ln x 1 - 0.362 x 2 + 0.407 x 3 + 116.741

Method (2) y = -8.718ln x 1 - 0.448 x 2 + 109.305

where

y: estimated CN, x1: daily rainfall (mm), x2: number of days in a dry period (d), x3: hourly maximum rainfall (mm)

Calculation period: from the start of water storage till the start of water overflow

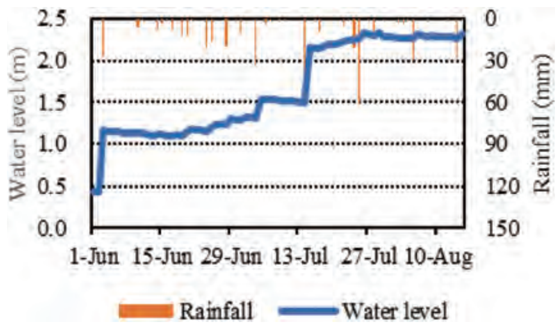
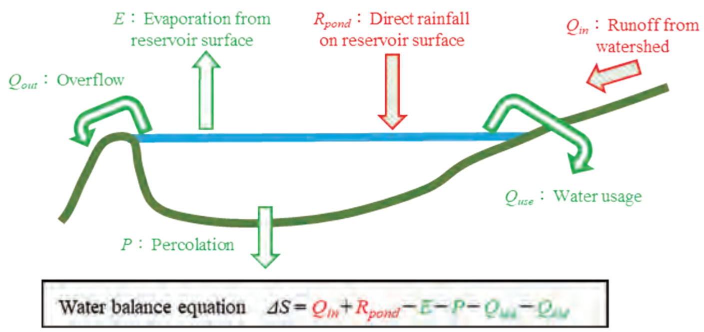


Fig. 4. Water levels and daily rainfall in the reservoir (2017)

When the water level in the reservoir exceeds 2.1 m, overflow occurs.



where ΔS: Change in storage content of reservoir (m^3/d), Q_{in}: Runoff from watershed (m^3/d), R_{pond}: Direct rainfall on reservoir surface (m^3/d), E: Evaporation from reservoir surface (m^3/d), P: Percolation (m^3/d), Q_{use}: Water usage (domestic and livestock use) (m^3 /d), Qout: Overflow (m^3/d)

Fig. 5. Annual water balance of the reservoir calculated using reservoir water balance components, water balance equation, and Method (1) (2017)

Q_{in}: 21,229 m^3, R_{pond}: 3,950 m^3
E: 9,017 m^3, P: 6,063 m^3
Q_{use}: 4,035 m^3, Q_{out}: 5,890 m^3
ΔS: 174 m^3

Reference

Hirose et al. (2022) *IDRE Journal* No. 314 (90-1): II_29–II_41.

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(C. Hirose, S. Hirouchi, M. Yamada, N. Oka, H. Furihata, H. Horino [Osaka Metropolitan University])

Program C
Information

"Strengthening function as an international hub for providing strategic information on agriculture, forestry and fisheries, and mobilizing new research partnerships"

Strengthening function as an international hub for providing strategic information on agriculture, forestry and fisheries is one of the pillars of the JIRCAS Fifth Medium to Long-Term Plan (FY 2021-2025) which began in April 2021. The 'Information Program' aims to collect data and analyze challenges affecting the agriculture, forestry and fisheries sector and global food systems in an increasingly complicated and multifaceted world, and provide strategic and evidence-based information on potential solutions.

[Information hub]

In recent years, the momentum for solving global issues has been accelerating, while the continuous progress of science and technology has brought about great changes in the world. We are now in an era where international competitiveness depends on the difference in strategies such as cooperation in different fields and the introduction of cutting-edge technologies. In order to promote the transition to a healthy and sustainable global food system for both the earth and humankind, it is expected that comprehensive information linking socioeconomics, food nutrition, and technological development will be collected, analyzed, and disseminated. The "Information hub" project systematically organizes information on international agriculture, forestry, and fisheries, through the use of dashboards and the creation of original content, in an effort to establish our position as among Japan's leading information centers on scientific topics related to global food security, climate change, and food systems.

In FY 2022, we organized several international events, including two official side-events at the 8th Tokyo International Conference on African Development (TICAD 8) and JIRCAS International Symposium 2022, which was held on the occasion of the International Year of Artisanal Fisheries and Aquaculture, with strategic development and academic partners to showcase JIRCAS's comparative advantage as an information hub for agriculture, forestry and fisheries research in developing regions. Our original "Pick Up" articles sought to provide updates on the status of global food security, which is facing growing uncertainties over fuel, fertilizer, and food volatilities induced by the interlinked impacts of COVID-19, climate change, and conflicts. In addition to analyzing these trends, we are also working on the development of economic models that can evaluate the impacts of climate change and/or their mitigation/adaptation policies on the global agriculture, forestry, and fisheries sectors. Examples include models that evaluate the environmental, nutritional, and other socio-economic impacts of agricultural technologies.

[Research applications/ventures]

In order to respond to the needs of society both domestically and internationally in an accurate and timely manner, and in accordance with the "Law on the Revitalization of Science, Technology and Innovation Creation" promulgated in FY 2019, JIRCAS has recognized that it is important to promote more actively the societal implementation of research results/technologies generated by JIRCAS researchers. This project is composed of three main pillars: 1) Commercial deployment of shrimp seed production/recirculating aquaculture technology developed by JIRCAS; 2) Promotion of JIRCAS's Asian Monsoon Model Plant Factory system, and 3) Establishment of a platform to support and promote practical application/societal implementation of JIRCAS's research results.

In FY 2022, regarding work relating to shrimp, JIRCAS conducted research with the goal of enabling the development of seed production technology suitable for commercial usage. In particular, emphasis was placed on developing a methodology for achieving artificial maturation of female prawns under re-circulating rearing systems. In addition, JIRCAS's first institute-related business venture, ShrimpTech JIRCAS, Inc. (established February 2022), commenced consulting activities related to re-circulating aquaculture of the Pacific whiteleg shrimp, *Litopenaeus vannamei*.

In regard to plant factory-related research, at JIRCAS's Tropical Agriculture Research Front (TARF), located on Ishigaki Island, staff researchers worked closely with the private sector and Japan's National Agriculture and Food Research Organization (NARO) to develop year-round systems for cultivating tomatoes and strawberries under controlled conditions. Based on results obtained at TARF, a joint research agreement was signed with Indonesia's

Universitas Padjadjaran in order to conduct collaborative research with the aim of introducing the above-mentioned Asian Monsoon Model Plant Factory technology into Indonesia.

In addition, regarding the establishment of our platform for promoting research results, several technologies developed under JIRCAS's Fourth Medium to Long-Term Plan (FY 2016-2020) were selected for further development/societal promotion as follows: 1) soybean varieties showing high resistance to soybean rust disease in Argentina, 2) rice varieties suitable for stable production in the Philippines and other relevant countries, and 3) a rice huller roll suitable for use with long-grain rice in Thailand.

Regarding Topic 1) above, a new soybean cultivar having high rust resistance, "Doncella INTA-JIRCAS," was developed in conjunction with Argentina's National Institute of Agricultural Technology (INTA) and was registered in Argentina on April 25, 2022. "Doncella INTA-JIRCAS" is a unique, non-genetically modified soybean rust cultivar that harbors high resistance to soybean rust and was achieved through the introduction of three soybean rust-resistance genes using selective breeding. The introduction of this cultivar to the field is expected to reduce production costs and environmental impact by greatly lowering the use of fungicides.

Finally, for the above soybean and rice technologies, JIRCAS has executed service contracts to test these varieties on-site in several locations, and in addition has obtained basic trait data that will allow plant variety registration under the auspices of the relevant country authorities.

[Digital agriculture]

There are growing expectations on the role of smart agriculture in solving food security problems caused by climate change and agricultural labor constraints in developing regions, as it enables the use of advanced technology and digital information to make agriculture more efficient and labor-saving. The digitalization of agriculture is progressing rapidly in sub-Saharan Africa and is positioned as an important area that will drive agriculture in the region. However, since the development stage of agricultural digital technologies varies greatly from country to country, ensuring regional representation is a challenge. Therefore, this project, as a two-year feasibility study, attempted to appropriately collect, analyze, and disseminate information on the problems and regional characteristics of each country.

During the feasibility study, JIRCAS and its partners collected representative information on agricultural digitalization through a systematic literature review on the one hand and implemented a small pilot project in Ethiopia on the other with its national partner to test commercially available digital tools and equipment developed by a Japanese software company, understand the logistical challenges of installing them, and evaluate their functionality to collect agronomic data. While digital agriculture has the potential to provide spatially and temporally fine-scale, tailored information to allow smallholders to improve crop productivity and enhance resilience, still more efforts are needed to overcome technical and institutional constraints and enable its adoption by extension systems/farmers. At the end of FY 2022, a workshop was held to share the lessons learned so far and identify areas for future collaboration with stakeholders.

[Tropical crop genetic resources]

JIRCAS maintains diverse genetic resources of sugarcane, indica rice, tropical fruits, and *Brachiaria* (tropical grass). These tropical crops play important roles as food, energy production, calorie and nutrient sources, cash crops, and fodder in the production areas, particularly in developing countries/regions. Amid concerns about global climate change, the sustainable and stable production of these tropical crops is an urgent issue. In addition, the introduction of tropical crops and their cultivation and dissemination technologies is expected to be one of the measures to combat global warming in Japan and contribute to the expansion of production areas and the diversification of food and nutrition sources.

The JIRCAS "Tropical crop genetic resources" project promotes the development of strategic genetic resources information, breeding technologies, varieties and materials, and cultivation and dissemination technologies based on the problems and research needs of each crop in Japan and overseas, taking advantage of the diverse and abundant genetic resources of tropical crops and the geographical advantage of our subtropical island research facility. In addition, by sharing and providing information and technologies, we aim to strengthen collaborations that will lead to the formation of networks with domestic and overseas research institutions to promote the utilization of tropical crop genetic resources. In FY 2022, the "JIRCAS-*Erianthus* Database on morphological and agronomic characteristics of native *Erianthus* germplasm in Thailand" and the English version of the "JIRCAS Mango Genetic Resources" database were developed and published on our website. An implementation manual and an explanatory video describing a simple and practical virus-free technology for passion fruit were also launched.

[Green Asia]

In 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. In line with this strategy, JIRCAS has been assigned to implement the "Green Asia" project (full title: Accelerating application of agricultural technologies which enhance production potentials and ensure sustainable food systems in the Asia-Monsoon region).

The advisory board, which consists of internationally renowned agricultural scientists and representatives from agricultural research institutes in the Asia-Monsoon region, was formed to guide the activities of Green Asia, with the first meeting held in hybrid format in October 2022 and the second meeting held online in March 2023. The International Center for Strategy "MIDORI" was also established under the project. In collaboration with domestic and overseas research institutes, the center will facilitate the collection, analysis, and sharing of existing and latest information on agricultural, forestry, and fishery technologies under advice from the International Scientific Advisory Board for Strategy "MIDORI."

Some of the research products of Green Asia in FY 2022 include the Technology Catalog Contributing to Production Potential and Sustainability in the Asia-Monsoon Region Ver.1.0, a compilation of technologies developed by JIRCAS and NARO or through international collaboration. The technologies listed in the Catalog can potentially be scaled out to the Asia-Monsoon region, if tailored to local contexts, and have attracted a lot of interest from stakeholders in the region.

TOPIC 1

Development of "Doncella INTA-JIRCAS," a new soybean variety with high Asian soybean rust resistance

Asian soybean rust (ASR) is a serious soybean disease that accelerates defoliation and reduces yield of soybean. Farmers have been using fungicides for ASR control, but the fungicide resistance of the pathogen is increasing. The use of resistant varieties would reduce production cost and environmental impact by limiting the excessive use of fungicides. Resistance genes (*Rpp*s) to ASR have been identified in soybean. In addition, JIRCAS has shown that soybean plants with multiple *Rpp* genes are not only resistant to many strains of the ASR pathogen with different virulence, but also show a high level of resistance to them. In this study, we developed a soybean variety with high ASR resistance adapted to Argentina, using the *Rpp*-pyramided lines bred by JIRCAS.

We crossed the ASR-resistant line "No6-12-1," which has three resistance genes (*Rpp2*, *Rpp4*, and *Rpp5*) developed by JIRCAS, as a non-recurrent parent and the variety "INTA ALIM5.09" from the National Agricultural Technology Institute (INTA), as a recurrent parent. The F_1 individuals were then backcrossed to the recurrent parent, and individuals carrying the three resistance genes were selected using DNA markers. This process was done continuously, and the line with the best production characteristics was selected and registered in the National Seed Institute (INASE) of the Ministry of Agriculture, Livestock and Fisheries of Argentina as "Doncella INTA-JIRCAS." The official date of registration of the new soybean variety was April 25, 2022 (Variety Registration Number: 4304). The new variety was similar to the recurrent parent, INTA ALIM5.09, for major soybean traits such as stem termination (Table 1). However, ASR severity on the leaves in the field experiment was less than 1% for the new variety, compared to more than 30% for the recurrent parent, INTA ALIM5.09 and the reference varieties, INTA Paraná 629 and INTA Paraná 5500, indicating that the new variety has high ASR-resistance derived from "No6-12-1" (Fig. 1).

Because both infection and spore production of ASR are suppressed in the new variety (Fig. 1), fungicide use can be significantly reduced. Actually, soybean varieties developed in Paraguay by introducing the same gene combinations have yielded 1.4- or 1.7-fold higher than pre-improved

Table 1. Major characteristics of new soybean variety and reference varieties

	New variety Doncella INTA-JIRCAS	Reference variety 1 (Recurrent parent) ALIM5.09	Reference variety 2 INTA Paraná 629	Reference variety 3 INTA Paraná 5500
Stem termination	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Flower color (hypocotyl color)	Purple	Purple	Purple	Purple
Pubescence color (stem and pod)	Gray	Gray	Gray	Gray
Leaflet shape	Oval	Oval	Oval	Oblong
Seedcoat color	Yellow	Yellow	Yellow	Yellow
Hilum color	Yellow	Yellow	Light brown	Black
Growth period	104 days	107 days	119 days	121 days
Plant height	69.4 cm	69.1 cm	93.8 cm	87.5 cm
100-seed weight	18.5 g	21.1 g	15.2 g	11.9 g
Seed lipid content [1)]	23.1%	22.6%	23.5%	23.4%
Seed protein content [1)]	40.5%	40.9%	35.6%	34.0%
Stem canker resistance	Moderately resistant	Moderately resistant	Resistant	Resistant
Asian soybean rust resistance	**Resistant**	**Susceptible**	**Susceptible**	**Susceptible**
Herbicide resistance	Susceptible	Susceptible	Susceptible	Resistant
Yield (t/ha) in INTA experimental stations [2)]				
2018−2019 Cerro Azul	1.7667	1.7778	1.8326	1.8289
2018−2019 Parana	3.9286	4.0715	4.5631	3.8447
2018−2019 Marcos Juarez	3.5929	3.8782	4.0828	3.0326
2017−2018 Cerro Azul	2.7370	2.9699	2.8815	2.6359
2017−2018 Parana	2.5236	1.6240	2.1481	2.0371

[1)] Seed protein and lipid content are averages from the Marcos Juarez and Parana experimental stations.
[2)] The significance levels (5%) for a total of five yield data for two years at three locations are 0.2686, 0.5281, 0.5043, 0.7936, and 0.4001 (t/ha) from top to bottom.

	New variety	Reference variety 1 (Recurrent parent)	Reference variety 2	Reference variety 3
Name of variety	Doncella INTA-JIRCAS	ALIM5.09	INTA Paraná 629	INTA Paraná 5500
Severity (%±SD)	Less than 1	37.3±1.1	46.2±4.0	50.8±1.1
Sporulation level	0	3	3	3
Infected leaves				

Fig. 1. Severity and resistance of a new soybean variety and reference varieties to Asian soybean rust
Severity (% area of lesions) and resistance (sporulation level 0–3 on lesions) of new variety: Doncella INTA-JIRCAS and the reference varieties for registration: INTA ALIM5.09 (recurrent parent), INTA Paraná 629, and INTA Paraná 5500. Results of trials in INTA-Cerro Azul Experimental Station, Argentina.

varieties under fungicide-free conditions. However, in order to maintain the resistance of new varieties for a long time, it is necessary to suppress the emergence of new ASR pathogens that can break the resistance, so fungicides should be used in appropriate quantities and frequencies.

References

Variety registration in INASE (number: 4304 and date: April 25, 2022).

Kato et al. (2022) *Tropical Plant Pathology* 47: 599–607.

Yamanaka and Hossain (2019) *Plant Breeding* 138: 686–695.

Data in Figure 1 and Table 1 taken from the application for variety registration.

(N. Yamanaka,
A. De Lucia [National Agricultural Technology Institute],
M. Heck [National Agricultural Technology Institute])

Training and Invitation Programs

Information Events

Invitation Programs at JIRCAS

In keeping with its role as an international research center, JIRCAS has implemented several invitation programs for foreign researchers and administrators from counterpart organizations. These invitation programs are designed to facilitate the exchange of information and opinions on agriculture, forestry, and fisheries research, and their implementation and administration simultaneously provide an opportunity to strengthen research ties among scientists and administrators in participating countries, mostly in developing regions. However, due to the restrictions on travel and other activities caused by the COVID-19 pandemic, most of the scheduled invitation programs of JIRCAS were affected in FY 2021. The situation improved from FY 2022, and the travel restrictions were eventually lifted. Japan reopened its border to international travelers and the JIRCAS invitation programs resumed. The following is a summary of JIRCAS invitation programs implemented in FY 2022.

Administrative Invitation Program

The purpose of this program is to invite administrators with a high level of specialized knowledge or management capabilities to Japan to exchange information and opinions, and to promote research collaboration through workshops, seminars, and international symposiums organized by JIRCAS. Furthermore, this program explores opportunities to discuss the progress and direction of collaborative research through evaluation and working group meetings and to strengthen cooperation with collaborative research institutions. A total of forty-seven (47) administrators visited JIRCAS under this invitation program in FY 2022. The visiting administrators and their length of stay are listed below.

Administrative Invitations, FY 2022

No.	Name	Institution/Organization	Duration
1	Nguyen Huy Chung	Pathology and Phyto-immunology Division, Plant Protection Research Institute, Vietnam	Aug. 21 - Aug. 28, 2022
2	Traore Mamoudou	Bureau National des sols /National Soils Office (BUNASOLS), Burkina Faso	Oct. 08 - Oct. 18, 2022
3	Bambara Dasmané	Natural Resources Management and Production System Department, Institute of Environment and Agricultural Research (INERA), Burkina Faso	Oct. 08 - Oct. 18, 2022
4	Mohamad Zabawi Bin Abdul Ghani	Malaysian Agricultural Research and Development Institute (MARDI), Malaysia	Oct. 23 - Oct. 27, 2022
5	Fadjry Djufry	Indonesian Agency for Agricultural Research and Development (IAARD), Indonesia	Oct. 23 - Oct. 27, 2022
6	Husnain*	Indonesian Agency for Agricultural Research and Development (IAARD), Indonesia	Oct. 23 - Oct. 27, 2022
7	Erlita Adriani*	Indonesian Agency for Agricultural Research and Development (IAARD), Indonesia	Oct. 23 - Oct. 27, 2022
8	Syafaruddin	Indonesian Center for Estate Crops Research and Development, Indonesian Agency for Agricultural Research and Development (IAARD), Indonesia	Oct. 23 - Oct. 27, 2022
9	Jacqueline D'Arros Hughes	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Oct. 23 - Oct. 28, 2022
10	Jean Balie	International Rice Research Institute, Philippines	Oct. 24 - Oct. 27, 2022
11	Phisamai Srichayet	Institute of Food Research and Product Development (IFRPD), Kasetsart University, Thailand	Oct. 24 - Oct. 27, 2022

Administrative Invitations, FY 2022			
No.	Name	Institution/Organization	Duration
12	Benjaluk Pavasopon	Institute of Food Research and Product Development (IFRPD), Kasetsart University, Thailand	Oct. 24 - Oct. 27, 2022
13	Hans-Joachim Braun	International Maize and Wheat Improvement Center (CIMMYT), Mexico	Nov. 11 - Nov. 20, 2022
14	Michael Peters	International Center for Tropical Agriculture (CIAT), Colombia	Nov. 13 - Nov. 21, 2022
15	Jacobo Arango Meija	International Center for Tropical Agriculture (CIAT), Colombia	Nov. 14 - Nov. 21, 2022
16	Victor Maurice Kommerell	International Maize and Wheat Improvement Center (CIMMYT), Mexico	Nov. 14 - Nov. 21, 2022
17	Nithya Rajan*	Texas A&M University (TAMU), USA	Nov. 14 - Nov. 23, 2022
18	Nithya Kanjikoil Subramanian*	Texas A&M University (TAMU), USA	Nov. 14 - Nov. 23, 2022
19	Odeny Damaris	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Nov. 15 - Nov. 20, 2022
20	Nedumaran Swamikannu	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Nov. 15 - Nov. 20, 2022
21	Cesar Daniel Petroli	International Maize and Wheat Improvement Center (CIMMYT), Mexico	Nov. 15 - Nov. 20, 2022
22	Hannes Walter Karwat	International Maize and Wheat Improvement Center (CIMMYT), Mexico	Nov. 15 - Nov. 20, 2022
23	Habyarimana Ephrem	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Nov. 15 - Nov. 20, 2022
24	Rakesh Kumar Sribastava	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Nov. 15 - Nov. 20, 2022
25	Muthu Valayapalayam Bagavathiannan*	Texas A&M University (TAMU), USA	Nov. 15 - Nov. 21, 2022
26	Sanjay Antony Babu*	Texas A&M University (TAMU), USA	Nov. 15 - Nov. 21, 2022
27	Amir Mohamed Hussein Ibrahim	Texas A&M University (TAMU), USA	Nov. 15 - Nov. 21, 2022
28	Timothy Darrow Searchinger	Princeton University, USA	Nov. 15 - Nov. 21, 2022
29	Michael James Thomson	Texas A&M University (TAMU), USA	Nov. 15 - Nov. 21, 2022
30	Cecile Rangin	University of Aberdeen King's College (UABDN), UK	Nov. 15 - Nov. 22, 2022
31	Neelu Jain	Indian Agricultural Research Institute (IARI), India	Nov. 15 - Nov. 22, 2022
32	Uttam Kumar	Borlaug Institute for South Asia (BISA), India	Nov. 15 - Nov. 22, 2022
33	Ganendra Pratap Singh	Indian Institute of Wheat and Barley Research (IIWBR), India	Nov. 15 - Nov. 22, 2022
34	David Baltensperger	Texas A&M University (TAMU), USA	Nov. 15 - Nov. 28, 2022
35	Shi Weiming*	Institute of Soil Science, Chinese Academy of Sciences (ISCAS)	Nov. 16 - Nov. 23, 2022

Administrative Invitations, FY 2022			
No.	Name	Institution/Organization	Duration
36	Jeff Wright	Institute for Marine and Antarctic Studies (IMAS), University of Tasmania (UTAS), Australia	Nov. 19 - Nov. 28, 2022
37	Jon P. Altamirano	Southeast Asian Fisheries Development Center, Aquaculture Department (SEAFDEC/AQD), Philippines	Nov. 20 - Nov. 25, 2022
38	Shakuntala Haraksingh Thilsted	WorldFish, Malaysia	Nov. 20 - Nov. 25, 2022
39	Bendula Wismen	WorldFish, Malaysia	Nov. 20 - Nov. 25, 2022
40	Giovanna Rocio Almanza Vega	Chemical Research Institute-Department of Chemistry-University of San Andres (Universidad Mayor de San Andrés UMSA), Bolivia	Jan. 27 - Feb. 11, 2023
41	Felix Wilfredo Rojas	FUNDACIÓN PROINPA, Bolivia	Jan. 27 - Feb. 11, 2023
42	Yonny Rene Flores Segura	Chemical Research Institute-Department of Chemistry-University of San Andres (Universidad Mayor de San Andrés UMSA), Bolivia	Jan. 27 - Feb. 11, 2023
43	Rolando Gregorio Oros Martínez	FUNDACIÓN PROINPA, Bolivia	Jan. 31 - Feb. 11, 2023
44	Tilahun Tadesse Fereke	Ethiopian Institute of Agricultural Research (EIAR), Ethiopia	Feb. 25 - Mar. 03, 2023
45	Endeshaw Habte Hailemichael	Ethiopian Institute of Agricultural Research (EIAR), Ethiopia	Feb. 25 - Mar. 03, 2023
46	Humnath Bhandri	International Rice Research Institute (IRRI), Nepal	Mar. 16 - Mar. 21, 2023
47	Yann-Rong Lin	World Vegetable Center, Taiwan	Mar. 31 - Apr. 05, 2023

*own expense

Counterpart Researcher Invitation Program

The purpose of this program is to invite collaborative researchers from counterpart organizations of JIRCAS to facilitate competent collaboration. The invited counterparts carry out data analysis in close cooperation with Japanese researchers and conduct experiments and advanced research using high-precision equipment, etc., in order to promote research activities efficiently. Besides JIRCAS, researchers from counterpart organizations also conduct in-depth research at other MAFF-affiliated national research and development agencies, prefectural research institutes, or national universities in Japan. As the restrictions on activities and border controls related to the COVID-19 pandemic eased in FY 2022, the Counterpart Researcher Invitation Program gradually increased the number of invitees. A total of twenty-nine (29) researchers were invited under this program in FY 2022. The names of the visiting counterpart researchers, their research themes, and duration of stay are listed on the following pages.

Counterpart Researcher Invitations, FY 2022

No.	Name	Institution/Organization	Research Theme	Duration
1	Ayu Pratiwi	Turku School of Economics, The University of Turku, Finland	Dissemination of agricultural information and technology through virtual community of practices: evidence from shrimp farms	Jun. 20 - Aug. 14, 2022
2	Eva Franziska Mundxhenk*	Isotope Biogeochemistry and Gas Fluxes, Leibniz Centre for Agricultural Landscape Research (ZALF) e.V., Germany	Impact of rhizosphere traits on phosphorus acquisition efficiency of upland rice	Jun. 21 - Aug. 02, 2022
3	Christiana Staudinger*	Universität für Bodenkultur Wien / Institut für Bodenforschung (IBF), Austria	Exploitation of novel rhizosphere functions enabling environment-friendly agriculture by efficient use of phosphorus	Jun. 30 - Aug. 04, 2022
4	Harisoa Nicole Ranaivo	Centre National de Recherche Appliquee au Developpement Rural (FOFIFA), Madagascar	Selection of breeding lines for Malagasy low-input conditions and training in marker assisted selection	Jul. 01 - Aug. 30, 2022
5	Mbolatantely Fahazavana Rakotondramanana Ep Rakotonandrasana	Centre National de Recherche Appliquee au Developpement Rural (FOFIFA), Madagascar	In-depth characterization of newly released varieties FyVary32 and FyVary85 and selection of nutrient efficient and high-Zn breeding lines for Madagascar	Jul. 01 - Aug. 30, 2022
6	Andry Andriamananjara	Laboratoire des Radio-Isotopes – Université d'Antananarivo (LRI), Madagascar	Development of effective farmyard manure application method for rice yield improvement in Madagascar highlands	Jul. 15- Aug. 30, 2022
7	Viviane Raharinivo	Centre National de Recherche Appliquee au Developpement Rural (FOFIFA), Madagascar	Development of breeding materials to improve grain yield and nutrient use efficiency under low-input and low-fertility soil conditions	Aug. 08 - Sep. 01, 2022
8	Nguyen Thi Tho	Pathology and Phyto-immunology Division, Plant Protection Research Institute, Vietnam	Establishment of IPM system for controlling rice planthoppers in the overwintering region in Indochina Peninsula	Aug. 21 - Sep. 09, 2022
9	Gao Xiang	Chinese Academy of Agricultural Sciences, China	Nitrogen dynamics and plant physiological analysis in field trials of selected BNI-enabled sorghum lines	Aug. 23 - Jan. 20, 2022
10	Md Hasri, Nur Hanis Alisa	School of Biological Sciences, Universiti Sains Malaysia, (USM), Malaysia	Technology development of producing high sugar accumulation in OPT	Sep. 05 - Nov. 23, 2022

Counterpart Researcher Invitations, FY 2022				
No.	Name	Institution/Organization	Research Theme	Duration
11	Ya-Ping Lin	World Vegetable Center, Taiwan	Evaluation of tomato and amaranth genetic resources	Sep. 22 - Oct. 02, 2022
12	Aung Aung Aye	Myeik University (MU), Myanmar	Development of Sustainable and Environment-Friendly Aquaculture Techniques in Coastal Waters in Myanmar (MYSEFAT project)	Oct. 03- Oct. 14, 2022
13	Bin Saipol Anuar, Mohd Amar Shafiq	School of Biological Sciences, Universiti Sains Malaysia, (USM), Malaysia	Elucidation of the effect of palm seedlings on OPT mixed soil on soil microbial flora and isolation of decomposing microbes	Oct. 03 - Nov. 23, 2022
14	Sagnon Adama	Institute of Environment and Agricultural Research (INERA), Burkina Faso	Establishment of the model for fertilizing cultivation promotion using Burkina Faso phosphate rock	Oct. 08 - Nov. 01, 2022
15	Dinh Thi Lam	Institute of Agricultural Science for Southern Vietnam (IAS), Vietnam	Impact of rhizosphere traits on phosphorus acquisition efficiency of upland rice	Oct. 12 - Nov. 19, 2022
16	Gurvinder Pal Singh*	University of British Columbia (UBC), Canada	The 4th BNI-International Consortium Biennial Meeting	Nov. 15 - Nov. 20, 2022
17	Gurcharn Singh Brar*	University of British Columbia (UBC), Canada	The 4th BNI-International Consortium Biennial Meeting	Nov. 15 - Nov. 20, 2022
18	Arindam Alok Ghatak*	University of Vienna (UNIVIE), Austria	The 4th BNI-International Consortium Biennial Meeting	Nov. 15 - Nov. 21, 2022
19	Bal Krishna Maharjan*	Texas A&M University (TAMU), USA	The 4th BNI-International Consortium Biennial Meeting	Nov. 15 - Nov. 21, 2022
20	Bryan David Emmett*	USDA-ARS, National Laboratory of Agricultural Environment (NLAE), USA	The 4th BNI-International Consortium Biennial Meeting	Nov. 15 - Nov. 21, 2022
21	Dinesh Phuyal*	Texas A&M University (TAMU), USA	The 4th BNI-International Consortium Biennial Meeting	Nov. 15 - Nov. 22, 2022
22	Serme Idriss	Institute of Environment and Agricultural Research (INERA), Burkina Faso	Project on establishment of the model for fertilizing cultivation promotion using Burkina Faso phosphate rock	Nov. 28 - Dec. 11, 2022
23	Sreyneang Nhim	School of Bioresources and Technology, King Mongkut's University of Technology Thonburi (Bangkhuntien Campus), Thailand	Advancement of Microbial Saccharification Technology by Improving *Thermobrachium celere* A9	Dec. 26, 2022 - Mar. 23, 2023

Counterpart Researcher Invitations, FY 2022				
No.	Name	Institution/Organization	Research Theme	Duration
24	Syariful Mubarok	Universitas Padjadjaran, Indonesia	Development of Asian Monsoon Plant Factory System Model in Indonesia	Jan. 08 - Jan. 14, 2023
25	Shantosa Yudha Siswanto	Universitas Padjadjaran, Indonesia	Development of Asian Monsoon Plant Factory System Model in Indonesia	Jan. 08 - Jan. 14, 2023
26	Yantyati Widyastuti*	Research Center for Applied Zoology, National Research and Innovation Agency (BRIN), Indonesia	Fermentation control of silage and total mixed ration (TMR) prepared with rice straw and development of livestock feeding technology	Jan. 15 - Jan. 29, 2023
27	Ki Ageng Sarwono*	Research Center for Applied Zoology, National Research and Innovation Agency (BRIN), Indonesia	Fermentation control of silage and total mixed ration (TMR) prepared with rice straw and development of livestock feeding technology	Jan. 15 - Jan. 29, 2023
28	Sara Maria Neyrot Bernal	Instituto deInvestigaciones Químicas (IIQ), Universidad Mayor de San Andrés (UMSA), Bolivia	Strengthening of Resilience in Arid Agro-Ecosystems Vulnerable to Climate Change, Through Research on Plant Resources and Technological Applications	Jan. 18 - Jun. 30, 2023
29	Jorge Angel Nicolas Quezada Portugal	Instituto de Biología Molecular Biotecnología; Biology Department Universidad Mayor de San Andrés (UMSA), Bolivia	Strengthening of Resilience in Arid Agro-Ecosystems Vulnerable to Climate Change, Through Research on Plant Resources and Technological Applications	Mar. 29 - Jun. 30, 2023

*own expense

Project Site Invitation Program

Since FY 2007, JIRCAS has been implementing the Project Site Invitation Program to invite researchers from developing countries to the project sites in developing countries where JIRCAS researchers are engaged in JIRCAS-funded collaborative research activities, on various research themes relevant to the projects on-site and in other countries where workshops or planning meetings are held. Only one (1) researcher was invited to this program in FY 2022 as listed below.

Project Site Invitations, FY 2022				
No.	Name	Institution/Organization	Purpose	Duration
1	Ni Ni Htain	Biological Control Section, Plant Protection Division, Department of Agriculture, Yangon, Myanmar	Development of IPM system against fall armyworm based on the ecological characteristics in Indochina peninsula	Oct. 25 - Oct. 28, 2022

Fellowship Programs at JIRCAS

JIRCAS Visiting Research Fellowship Program

JIRCAS launched the JIRCAS Visiting Research Fellowship Program in 1992. Every year since then, JIRCAS has been inviting talented researchers from research organizations in developing countries to conduct research under the supervision of JIRCAS researchers to accelerate scientific research and advance the expertise of invited researchers. In FY 2021, six researchers were selected and offered the JIRCAS Fellowship Program, and they planned to conduct research at JIRCAS HQ in Tsukuba. However, due to the ongoing COVID-19 pandemic and entry restrictions, only one researcher was accepted at JIRCAS in FY 2021, with the remaining five fellows starting their research in FY 2022 and arriving in Japan after the relaxation of entry restrictions from March 2022. Three of the six researchers will continue their research at JIRCAS by extending their stay until the end of September 2023, and the final presentation of their research outputs and awarding of JIRCAS Fellowship completion certificates will be held in September 2023. The list of invitees to the JIRCAS Visiting Research Fellowship Program for FY 2022 is shown below.

JIRCAS Visiting Research Fellowship at Tsukuba

No.	Name	Institution/Organization	Research Theme	Duration
1	Sornyotha Somphit	King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand	Elucidation of the decomposition mechanism of microorganisms that decompose protein-mixed agricultural waste and its application	Apr. 25, 2022 - Sep. 30, 2023
2	Jiang Mingli	Nanjing Agricultural University, China	BNI-characterization of maize parental lines to develop phenotyping methodology for evaluation of double haploid population for BNI-capacity	Jun. 05, 2022 - Jun. 04, 2023
3	Oscar Miguel Rollano Penaloza	Universidad Mayor de San Andres, Bolivia	Elucidation of the molecular basis for strengthening the resilience of quinoa	Apr. 17, 2022 - Sep. 30, 2023
4	Arafa Ramadan Ahmed	Agricultural Research Center, Plant Pathology Research Institute, Egypt	Genetic analysis of resistance against *Cercospora* Leaf Blight (CLB) disease in soybean germplasm	Apr. 17, 2022 - Apr. 04, 2023
5	Dinh Hoan Xuan	Plant Protection Research Institute, Vietnam	Identification of a growth-promoting gene for enhancing soybean yield potential	May 13, 2022 - May 12, 2023
6	Elsie Akua Serwaa Sarkodee-Addo	University of Ghana, Ghana	Establishment of screening methods for microbiological resources toward improved crop phosphorus (P) uptakes under highly P-deficient soils in the tropics	Jan. 24, 2022 - Sep. 30, 2023

Other Fellowships for Visiting Scientists

The Visiting Researcher Program accepts scientists with excellent research achievements from domestic and overseas research institutions or universities to conduct overseas research on agriculture, forestry, and fisheries in tropical or subtropical regions and developing countries. In FY 2022, JIRCAS hosted one visiting researcher from Suzhou University of Science and Technology, China. The visiting scientist who resided at JIRCAS in FY 2022 is listed below.

Visiting Researcher (April 2022 to March 2023)

Name	Institution/Organization	Research Theme	Duration
Yan Xu	School of Geography Science and Geomatics Engineering, Suzhou University of Science and Technology, China	Global cropland expansion potential and distribution under socioeconomic, biophysical, and environmental constraints	Sep. 14, 2022 - Jul. 31, 2023

Workshops

TICAD 8 Side-Event “Managing African Soil for Food Security and Environmental Sustainability”

An official side event of the 8th Tokyo International Conference on African Development (TICAD 8) entitled “Managing African Soil for Food Security and Environmental Sustainability” was organized by JIRCAS on August 30, 2022, with the support of the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA). The purpose of this event was to share experiences and lessons learned about how to lead research outputs to social implementation by inviting not only researchers but also a private company and an NGO that have worked on fertilizer development and marketing and farmer training in Africa.

In his opening remarks, JIRCAS President Osamu Koyama expressed hope that the event would provide an opportunity for stakeholders to discuss how to make Africa’s agricultural sector more resilient. In their welcome remarks, Dr. Tsukasa Nagamine, former Vice-President of the National Agriculture and Food Research Organization (NARO) and Research Supervisor of the Science and Technology Research Partnership for Sustainable Development (SATREPS), and Dr. Shuichi Asanuma (Special Advisor, Economic Development Department, JICA) expressed their expectations for the dissemination of the results of SATREPS projects promoted by JIRCAS.

In the keynote lecture, Dr. Bernard Vanlauwe, R4D Director, Central Africa and Natural Resource Management, International Institute of Tropical Agriculture (IITA), gave a video presentation on Integrated Soil Fertility Management (ISFM) and future opportunities, which he has been working on in sub-Saharan Africa (SSA) for 20 years.

In Session 1, “Technology development to solve low fertility/nutrient bottlenecks,” Dr. Shinya Funakawa, Professor at the Graduate School of Global Environmental Studies, Kyoto University, gave a lecture on adaptive agriculture in SSA’s diverse soils. Dr. Yasuhiro Tsujimoto, Project Leader at JIRCAS, and Dr. Fujio Nagumo, Seinior Researcher at JIRCAS, followed with presentations of the major results of SATREPS Madagascar and SATREPS Burkina Faso, respectively, and their efforts toward dissemination.

In Session 2, “Social Implementation,” Mr. Akira Wada, Director and General Manager of Africa Planning Department, Africa Division, Toyota Tsusho Corporation, presented his company’s activities to improve agricultural productivity in Kenya through the fertilizer business, and Ms. Stella Kabiri, Leader of Sasakawa Africa Association (SAA) Ethiopia, presented SAA’s activities toward environmental and regenerative agriculture.

In the panel discussion moderated by Dr. Misa Masuda, Professor Emeritus at the University of Tsukuba and Research Supervisor of JST/SATREPS, the speakers discussed from different perspectives the challenges and solutions for the development of soil management technologies for the future of food in Africa and for the diffusion of

Screenshot

soil management technologies to improve the livelihood of small farmers in Africa. Based on the discussions, the following three points were summarized as outputs.

1. Examples of soil and manure management technologies that can both increase sustainable productivity and restore soil health to achieve truly sustainable food security were presented, and the need for further technological development was identified.
2. There is no one-size-fits-all solution, and it was confirmed that there is a need for soil and fertilizer management technologies and dissemination methods that are suited to local agro-climatic, soil, and socioeconomic conditions and that can be practiced by small-scale farmers.
3. In order to develop soil and fertilizer management technologies and dissemination methods, it was confirmed that there is a need for collaborative cooperation among related organizations (research institutions, extension agencies, NGOs, companies, etc.) and for the development of human resources who will be responsible for the future of food in Africa.

In his closing remarks, Dr. Kazuo Nakashima, Director of JIRCAS Food Program, referred to the TICAD 8 "Tunis Declaration" and stated the need for cooperation among related organizations and human resource development to realize sustainable development in Africa. He likewise expressed hope that this event would be an opportunity to promote future cooperation among related organizations.

Toward food and nutrition security in Africa, JIRCAS will promote efforts to develop and disseminate soil fertility and oligotrophic soil management technologies in Africa in cooperation with related organizations. We hope that this event served as an opportunity to share our vision with national and international R&D partners, government agencies, the private sector, NGOs, and others who value "soil health" in Africa, and that it promoted collaboration among related organizations to find solutions for resolving the low fertility and nutrient bottleneck in Africa. We strongly hope that by creating healthy soils that lead to improved health of people, stable and sustainable food security in Africa will be achieved.

This event was attended by over 200 online participants/members from Japan, Africa, and 17 other countries around the world, showing the high level of interest in African agronomy, soil fertility, and oligotrophic soil management.

The symposium video has been archived on the the JIRCAS YouTube channel (split into four parts as below).

Part1: https://youtu.be/duyT3dT46e4
Part2: https://youtu.be/h-kIK1BverU
Part3: https://youtu.be/5Qtr-VJ0o6w
Part4: https://youtu.be/QuVWBpDfOug

JIRCAS-FFTC International Workshop on "Innovation and Networking of Sugarcane Research for Future Sugarcane Industry in the Asian and Pacific Region"

The workshop on "Innovation and Networking of Sugarcane Research for Future Sugarcane Industry in the Asian and Pacific Region," co-hosted by JIRCAS and the Food and Fertilizer Technology Center for Asia and the Pacific (FFTC), with the support of Kasetsart University, was held online on September 15, 2022.

The objectives of the workshop were to identify specific problems and requirements in sugarcane production in the Asia-Pacific region, to introduce advances in sugarcane breeding using interspecific and intergeneric hybrids and new technologies for the utilization of sugar mill by-products, and to discuss breeding directions for the future sugarcane industry and networking in sugarcane research.

President Osamu Koyama of JIRCAS gave the opening remarks, followed by Dr. Su-San Chang, Director of FFTC, and Dr. Sutkhet Nakasathien, Vice President of Kasetsart University, Thailand, who delivered the welcome remarks. Mr. Shotaro Ando, Representative of JIRCAS Southeast Asia Liaison Office in Bangkok, explained the objectives of the workshop. The workshop consisted of three sessions, with the session presentations followed by a question-and-answer segment.

In the first session, Mr. Makoto Umeda (National Agriculture and Food Research Organization), Dr. Yoshifumi Terajima (JIRCAS), and Dr. George Piperidis (Sugar Research Australia) introduced sugarcane breeding using interspecific and intergeneric hybrids, which are effective in expanding the narrow genetic base of current sugarcane varieties and for developing varieties that suit diverse purposes.

In the second session, Mr. Amit Raj Singh (Sugarcane Research Institute of Fiji), Mr. Risvan Kuswurjanto (Indonesian Sugar Research Institute), Mr. Rimmon T. Armones (Sugar Regulatory Administration, Philippines), Dr. Jian-Cheng Chang (Taiwan Sugar Research Institute), Ms. Nattapat Khumla (Department of Agriculture, Thailand), and Dr. Cao Anh Duong (Sugarcane Research Institute, Vietnam) reported on the current status and specific issues affecting sugarcane research and the sugarcane industry in the Asia-Pacific region.

In the third session, Associate Professors Wirat Vanichsriratana of Kasetsart University and Satoshi Ohara of the University of Tokyo gave presentations on sugarcane biorefinery and by-product utilization.

In the general discussion, future collaborations were discussed. Lastly, Dr. Tomonari Watanabe, Deputy Director of FFTC, gave the closing remarks. More than 200 people from 21 countries and regions pre-registered for the event, and about 130 people participated online on the day of the workshop. A particularly large number of participants joined from Japan, Thailand, and the Philippines. The workshop was well organized and provided insights and future perspectives on the wide utilization of sugarcane and breeding strategies, as well as the current situation of sugarcane production and its related industries.

Poster of the workshop

Group photo

International Symposiums, Workshops, and Seminars, FY 2022			
1	Workshop on Science and Policies for Sustainable Production of Blood Cockles in Southeast Asia	April 21, 2022	Held online
2	The First Meeting of National Participating Organizations for the SATREPS Project titled "Strengthening Tropical Forest Resilience Based on Management and Utilization of Genetic Resources Capable of Climate Change Adaptation"	April 22, 2022	Tsukuba, Japan (hybrid format)
3	Workshop to demonstrate and disseminate new techniques learned from Output 1 during the FY VARY project phase	April 29, 2022	Antananarivo, Madagascar
4	The First Joint Coordination Committee Meeting of the SATREPS Super Food Bolivia Project	May 18, 2022	Held online
5	JIRCAS-SRA Joint Research Meeting	June 15, 2022	Held online
6	JIRCAS-CTU Climate Change Project Workshop 2022	June 17, 2022	Can Tho, Viet Nam (hybrid format)
7	8th Technical Coordinating Committee for the "Project on establishment of fertilizing crop cultivation promotion model using Burkina Faso phosphate rocks"	June 21, 2022	Held online
8	Regional Workshop on the Japanese Irrigation Technique/Technology	July 4, 2022	Bangkok, Thailand (hybrid format)
9	JIRCAS-SEAFDEC/AQD Collaborative Research Workshop on the "Development of sustainable aquaculture technologies in tropical areas"	August 2, 2022	Ilo-ilo, Philippines (hybrid format)
10	TICAD8 Official Side Event: "Healthy soils for food security in Africa" -Potential of Regenerative Agriculture-	August 5, 2022	Held online
11	TICAD8 Official Side Event: Managing African Soil for Food Security and Environmental Sustainability -Opportunities and Challenges of Agronomy to Solve Low Fertility/Nutrient Bottlenecks-	August 30, 2022	Held online
12	Kick-off Meeting for "Enhancing Climate Change Resilience of Socio-Ecological Systems in the Coral Triangle and Its Surrounding Areas (EnSES)"	September 1, 2022	Held online
13	Kick-off Meeting for the SATREPS Project titled "Establishment of nitrogen-efficient wheat production system in Indo-Gangetic plains by the deployment of BNI technology"	September 2, 2022	New Delhi, India
14	Closing ceremony of the FyVary project "Breakthrough in nutrient use efficiency for rice by genetic improvement and fertility sensing techniques in Africa"	September 8, 2022	Antananarivo, Madagascar (hybrid format)
15	Final Workshop of the FyVary project "Breakthrough in nutrient use efficiency for rice by genetic improvement and fertility sensing techniques in Africa"	September 8, 2022	Antananarivo, Madagascar (hybrid format)
16	JIRCAS-FFTC Workshop titled "Innovation and Networking of Sugarcane Research for Future Sugarcane Industry in the Asian and Pacific Region"	September 15, 2022	Held online
17	4th Joint Coordination Committee (JCC) meeting for the SATREPS project titled "Sustainable Replantation of Oil Palm by Adding Value to Oil Palm Trunk through Scientific and Technological Innovation"	September 21, 2022	Held online

18	Roundtable on the Multi-functionality of Paddy Fields in Africa	September 28, 2022	Dar es Salaam, Tanzania (hybrid format)
19	MOU and Work Plan Signing Ceremony with the Royal University Agriculture of Cambodia	September 28, 2022	Phnom Penh, Cambodia
20	Opening Ceremony and Project Implementation Seminar for the SATREPS Project titled “Strengthening Tropical Forest Resilience Based on Management and Utilization of Genetic Resources Capable of Climate Change Adaptation”	October 3, 2022	Yogyakarta, Indonesia
21	24th International Congress on Irrigation and Drainage (ICID) Special Event by FAO-JIRCAS-ADBI on “Maximizing the Benefits from Paddy Fields: Multi-functional Roles of Paddy Fields and Agricultural Water Management”	October 5, 2022	Adelaide, Australia
22	FAO Science and Innovation Forum 2022 Side Event: “Creating Sustainable Food Systems in Asia-Monsoon Region through Science and Innovation”	October 13, 2022	Held online
23	JIRCAS-DAR Workshop for Ratoon Rice Research	October 20, 2022	Held online
24	The First Meeting of the International Scientific Advisory Board for Strategy “MeaDRI”	October 25-26, 2022	Tokyo, Japan (hybrid format)
25	Research Seminar: The Forefront of Agricultural Research to Promote Resource Recycling on a Semi-tropical Island, Ishigaki, Japan	October 26, 2022	Ishigaki, Japan
26	Progress report and information sharing on the Research on IPM Development Against Fall Armyworm	November 4, 2022	Bangkok, Thailand
27	The 4th BNI-International Consortium Biennial Meeting	November 17-19, 2022	Tsukuba, Japan (hybrid format)
28	JIRCAS International Symposium 2022: Artisanal Fisheries and Aquaculture in the Sustainable Food Systems	November 22, 2022	Hitotsubashi University, Japan (hybrid format)
29	Seminar on “The application of science and traditional knowledge to foster the utilization of foods obtained from local landscapes for improved nutrition and livelihoods”	December 12, 2022	Tokyo, Japan (hybrid format)
30	The 1st Technical Committee (TC) Meeting on African Rice Promotion Support Survey (Ghana)	February 7, 2023	Accra, Ghana (hybrid format)
31	SATREPS Symposium: The Wonder of Superfood “Quinoa” Native to South America	February 7, 2023	Obihiro University, Japan (hybrid format)
32	BRRI - JIRCAS Kickoff Meeting on AWD and Rice Blast Research under the Green Asia Project	February 16, 2023	Gazipur, Bangladesh
33	The 1st Technical Committee (TC) Meeting on African Rice Promotion Support Survey (Tanzania)	February 23, 2023	Arusha, Tanzania (hybrid format)
34	Feasibility Study Completion Workshop: Towards the development of digital agriculture technologies in Sub-Saharan Africa	February 28, 2023	JIRCAS and Tokyo, Japan (hybrid format)
35	The 9th Enlarged Technical Coordinating Committee for the “Project on establishment of fertilizing crop cultivation promotion model using Burkina Faso phosphate rocks”	March 10, 2023	Ouagadougou, Burkina Faso (hybrid format)

36	Rhizosphere Traits of Upland Rice	March 13, 2023	Müncheberg, Germany (hybrid format)
37	2022 Steering Committee Meeting: FRIM–JIRCAS Project	March 13, 2023	Kuala Lumpur, Malaysia (hybrid format)
38	JIRCAS and Central Soil Salinity Research Institute (ICAR-CSSRI) Joint Research Seminar	March 14, 2023	Karnal, Haryana, India
39	The Second Meeting of the International Scientific Advisory Board for Strategy “MIDORI”	March 16, 2023	Held online
40	Special Session titled “Creating Sustainable Agri-food Systems in Asia-Monsoon Region: Roles of Science and Innovation” at the 11th Asian Society of Agricultural Economists (ASAE) International Conference	March 19, 2023	Aoyama Gakuin University, Japan

Appendix

Publishing at JIRCAS

English

1. JARQ (Japan Agricultural Research Quarterly)

   Vol. 56 No. 3 (Published in July 2022)

   Vol. 56 No. 4 (Published in October 2022)

   Vol. 57 No. 1 (Published in January 2023)

   Vol. 57 No. 2 (Published in April 2023)

2. Annual Report

   2021 (Published on 29 October 2022)

3. JIRCAS Newsletter

   No.93 (Published on 9 November 2022)

   No.94 (Published on 15 March 2023)

4. JIRCAS International Agriculture Series

   No.26 (Published on 24 March 2023)

Japanese

1. Kōhō JIRCAS

   Vol. 10 (Published on 7 October 2022)

   Vol. 11 (Published on 17 February 2023)

2. JIRCAS NEWS

   No.93 (Published on 9 November 2022)

   No.94 (Published on 15 March 2023)

Refereed Journal Articles 2022-2023

Program A

Arai, W., Kameya, H., Hashim, R., Sulaiman, R., Arai, T., Sudesh, K., Yusuff, I.M., Ghani, S.M., Rashid, A.H.A., Kosugi, A.[*] (2022.4) Reactive oxygen species scavenging capacities of oil palm trunk sap evaluated using the electron spin resonance spin trapping method. *Industrial Crops and Products*, 182: 114887.

Leon, A.[*], Izumi. T. (2022.4) Impacts of AWD on rice farmers' profits and life cycle greenhouse gas emissions in An Giang Province in Vietnam. *Journal of Cleaner Production*, 354: 131621.

Oniki, S.[*], Berhe, M., Negash, T., Etsay, H. (2022.4) Communal land conservation in northern Ethiopia: The relationship between urban area access and individual and social norms. *Land Degradation & Development*, 33: 2757–2768.

Sharma, S., Suwa, R., Ray, R.[*], Mandal, M.S.H. (2022.4) Successive cyclones attacked the world's largest mangrove forest located in the Bay of Bengal under pandemic. *Sustainability*, 14(9): 5130.

Angthong, W., Mori, A., Kitwetcharoen, H., Kaeokliang, O., Kamphayae, S., Suzuki, T., Cai, Y., Maeda, K.[*] (2022.5) Comprehensive assessment of greenhouse gas emissions from Thai beef cattle production and the effect of rice straw amendment on the manure microbiome. *Frontiers in Environmental Science*, 10: 872911

Gao, X., Uno, K., Sarr, P.S., Yoshihashi, T., Zhu, Y., Subbarao, G.V.[*] (2022.5) Highsorgoleone producing sorghum genetic stocks suppress soil nitrification and N_2O emissions better than lowsorgoleone producing genetic stocks. *Plant and Soil*, 477: 793–805.

Nardi, P.[*], Müller, C., Pietramellara, G., Subbarao, G.V., Nannipieri, P. (2022.5) Recommendations about soil Biological Nitrification Inhibition (BNI) studies. *Biology and Fertility of Soils*, 58: 613–615.

Hirata, M.[*], Oniki, S. (2022.6) Transformation of Afar pastoralism with climate change and a market economy. *Journal of Arid Land Studies*, 32(1): 1–13.

Jucker, T.[*] et al. (159名中69番目 Tanaka, K). (2022.6) Tallo – a global tree allometry and crown architecture database. *Global Change Biology*, 28:5254–5268.

Tokuoka, Y.[*], Kimura, K., Oka, M. (2022.6) Anthropogenic legacies shaping the present composition of demarcation trees in a temperate upland field landscape in Japan. *Journal of Ethnobiology and Ethnomedicine*, 18(1): 45. (4期以前成果)

Ng, C.H.[*], Ng, K.K.S., Lee, S.L., Suwa, R., Lee, C.T., Tnah, L.H. (2022.7) Growth performance and scale insect infestation of *Shorea leprosula* in a common garden experimental plot. *Journal of Forestry Research*, 14(9): 5130.

Yadav, N.G., Yadav, R.K.[*], Kumar, S., Kumar, A., Sehwag, M., Prasad, G., Vivekanand, Onishi, J., Anzai, T. (2022.7) Salinity management through Cut-soiler Preferential Sub-surface Drainage (PSSD) improve pearl millet growth and yield under saline irrigation. *Journal of Soil Salinity and Water Quality*, 14(1): 117–125.

Takaragawa, H.[*], Okamoto, K., Terajima, Y., Anzai, T. (2022.7) Evaluation of root distribution and nitrate leaching in sugarcane, *Erianthus*, and their intergeneric hybrid at new planting. *Plant Production Science*, 25: 298–310.

Azuma, W.A.[*], Kawai, K., Tanabe, T., Nakahata, R., Hiura, T. (2022.8) Intraspecific variation in growth-related traits—from leaf to whole-tree—is in three provenances of *Cryptomeria japonica* canopy trees grown in a common garden. *Ecological Research*, https://doi.org/10.1111/1440-1703.12349

Ellsworth, D.S.[*], Crous, K.Y., De Kauwe, M.G., Verryckt, L.T., Goll, D., Zaehle, S., Bloomfield, K.J., Ciais, P., Cernusak, L.A., Domingues, T.F., Dusenge, M.E., Garcia, S., Guerrieri, R., Ishida, F.Y., Janssens, I.A., Tanaka, K., Ichie, T., Medlyn, B.E., Meir, P., Norby, R.J., Reich, P.B., Rowland, L., Santiago, L.S., Sun, Y., Uddling, J., Walker, A.P., Weerasinghe, K.W.L.K., van de Weg, M.J., Zhang, Y.B., Zhang, J.L., Wright, I.J. (2022.8) Convergence in phosphorus constraints to photosynthesis in forests

around the world. *Nature Communications*, 13: 5005.

Rathnappriya, R.H.K.[*], Sakai, K.[*], Okamoto, K., Kimura, S., Haraguchi, T., Nakandakari, T., Bandara, W.B.M.A.C. (2022.8) Global sensitivity analysis of key parameters in the APSIMX-Sugarcane model to evaluate nitrate balance via treed gaussian process. *Agronomy*, 12(8): 1979.

Siriatcharanon, A.-K., Sutheeworapong, S., Waeonukul, R., Pason, P., Uke, A., Kosugi, A., Ratanakhanokchai, K., Tachaapaikoon, C.[*] (2022.8) *Cellulomonas palmilyticum* sp. nov., from earthworm soil biofertilizer with the potential to degrade oil palm empty fruit bunch. *International Journal of Systematic and Evolutionary Microbiology* 72(8), https://doi.org/10.1099/ijsem.0.005494

Zhang, J., Kuang, L., Mou, Z., Kondo, T., Koarashi, J., Atarashi-Andoh, M., Li, Y., Tang, X., Wang, Y.P., Peñuelas, J., Sardans, J., Hui, D., Lambers, H., Wu, W., Kaal, J., Li, J., Liang, N., Liu, Z.[*] (2022.8) Ten years of warming increased plant-derived carbon accumulation in an East Asian monsoon forest. *Soil and Plant*, https://doi.org/10.1007/s11104-022-05642-8

飯田真一[*], 清水貴範, 玉井幸治, 壁谷直記, 清水晃, 荒木誠, 大貫靖浩, 伊藤江利子, 田中憲蔵, 鳥山淳平, 久保田多余子, 山中勤, Chann, S., Levia, D.F. (2022.8) カンボジア熱帯季節林地帯の落葉林における蒸発散過程：上層木および下層植生による水循環への寄与の解明に向けて. *日本水文科学会誌*, 52(2): 1–8.

Heng, S., Sutheeworapong, S., Champreda, V., Uke, A., Kosugi, A., Pason, P., Waeonukul, R., Ceballos, R.M., Ratanakhanokchai, K., Tachaapaikoon, C.[*] (2022.9) Genomics and cellulolytic, hemicellulolytic, and amylolytic potential of *Iocasia fonsfrigidae* strain SP3-1 for polysaccharide degradation. *PeerJ*, 10: e14211.

Izma, J.N., Fazita, M.R.N.[*], Leh, C.P., Hashim, R., Haafiz, M.K.M., Ibrahim, M., Tay, G.S., Arai, T., Sudesh, K., Kosugi, A. (2022.9) Potential of polyhydroxyalkanoate and nanocellulose from oil palm trunk as raw materials for additive manufacturing. *Polymer Composites*, https://doi.org/10.1002/pc.27034

Okura, F., Budiasa, I.W., Kato, T.[*] (2022.9) Exploring a Balinese irrigation water management system using agent-based modeling and game theory. *Agricultural Water Management*, 274: 107951.

Takenaka, K.[*], Gebru, S.N., Tetemke, A.B., Tabuchi, R. (2022.9) Short-term biomass change of a *Vachellia etbaica* stand in a closed area in the highlands of eastern Tigray, Ethiopia: A case study. *Journal of Arid Land Studies*, 32(2): 37–52.

Tanaka, K.[*], Yoneda, R., Alias, M.A. (2022.9) Estimation of above and belowground biomass for grass, herb and fern species in Peninsula Malaysia. *Tropical Ecology*, https://doi.org/10.1007/s42965-022-00268-4

Yamashita, S.[*], Salleh, Z., Wasli, M.E., Alias, M.A., Itioka, T., Tanaka, K., Ichie, T. (2022.9) Coarse woody debris provides cobenefits between carbon stock and diversity of polypore fungi in Malaysian forest stands. *Tropics*, 31(2): 33–41.

岡直子, 安西俊彦, 竹中浩一, 岡本健, 寺島義文, 奥津智之, 菊地哲郎 (2022.9) 石垣島からネグロス島へ、みどり戦略の提唱に向けた取組み. *水土の知 : 農業農村工学会誌*, 90(9): 35–38.

渡辺守, 松本成夫, 泉太郎 (2022.9) アジアモンスーン地域での農地土壌炭素貯留の課題と展開方向. *水土の知 : 農業農村工学会誌*, 90(9): 39–42.

北田裕道, 泉太郎. (2022.9) みどりの食料システム戦略と海外農業農村開発協力. *水土の知 : 農業農村工学会誌*, 90(9): 31–34.

Alfaro-Sayes, D.A., Amoah, J., Aikawa, S., Matsuda, M., Hasunuma, T., Kondo, A., Ogino, C.[*] (2022.10) Alginate immobilization as a strategy for improving succinate production during autofermentation using cyanobacteria *Synechocystis* sp. PCC 6803. *Biochemical Engineering Journal*, 188(15): 108681.

Arai, H.[*] (2022.10) Increased rice yield and reduced greenhouse gas emissions through alternate wetting and drying in a triple-cropped rice field in the Mekong Delta. *Science of the Total Environment*, 842: 156958. (4期以前成果)

Etsay, H., Oniki, S.*, Berhe, M., Negash, T. (2022.10) The watershed communal land management and livelihood of rural households in Kilte Awlaelo woreda, Tigray region, Ethiopia. *Sustainability*, 14(20): 13676.

Huynh, K.C.*, Minamikawa, K., Nguyen, N.V.C., Nguyen, C.H., Nguyen, C.V. (2022.10) Effects of cattle biogas effluent application and irrigation regimes on rice growth and yield: a mesocosm experiment. *Japan Agricultural Research Quarterly*, 56(4): 341–348. (4期以前成果)

Pulingam, T., Lakshmanan, M., Chuah, J.A., Surendran, A., Zainab-L, I., Foroozandeh, P., Uke, A., Kosugi, A., Sudesh, K.* (2022.10) Oil palm trunk waste: Environmental impacts and management strategies. *Industrial Crops and Products*, 189: 115827.

Tee, T.P.*, Goh, Y.M., Mohd Zainudin, M.H., Candyrine, S.C.L., Sommart, K., Kongphitee, K., Sumamal, W., Phaowphaisal, I., Namsilee, R., Angthong, W., Sunato, S., Keaokliang, O., Maeda, K., Thu, N.V., Trung, T.T., Dong, N.T.K., Purnomoadi, A., Kurihara, M., Jayanegara, A., Higuchi, K., Kobayashi, Y., Ohtani, F., Abe, H., Terada, T., Kumagai, H., Matsuyama, H., Nonaka, I., Takusari, N., Shiba, N., Hosoda, K., Suzuki, T., Kamiya, Y., Nishida, T., Hayasaka, K., Shibata, M., Wang, M., Tan, Z.L., Wang, R., Kebreab, E., van Lingen, H.J., Hristov, A.N., Liang, J.B.* (2022.10) Prediction of enteric methane emission, yield and intensity in South-east Asia beef cattle using an intercountry database. *Animal Feed Science and Technology*, 294: 115474.

Teshirogi, K.*, Kanno, M., Shinjo, H., Uchida, S., Tanaka, U. (2022.10) Distribution and dynamics of the Cynodon dactylon invasion to the cultivated fields of pearl millet in north-central Namibia. *Journal of Arid Environments*, 205: 104820. (4期以前成果)

Villegas, D.M., Arévalo, A., Sotelo, M., Nuñez, J., Moreta, D., Rao, I., Ishitani, M., Subbarao, G.V., Arango, J.* (2022.10) Phenotyping of *Urochloa humidicola* grass hybrids for agronomic and environmental performance in the Piedmont region of the Orinoquian savannas of Colombia. *Grass and Forage Science*, https://doi.org/10.1111/gfs.12582

Kikuchi, T.*, Anzai, T., Ouchi, T., Okamoto, K., Terajima, Y. (2022.11) Assessing the impact of watershed characteristics and management on nutrient concentrations in tropical rivers using a machine learning method. *Environmental Pollution*, 316: 120599.

Ogawa, S., Yamamoto, K., Uno, K., Thuan, N.C.*, Togami, T., Shindo, S. (2022.11) Optimal water level management for mitigating GHG emissions through water-conserving irrigation in An Giang Province, Vietnam. *Sensors*, 22: 8418. (4期以前成果)

Tanaka, K.*, Mohamad, M., Ichie, T. (2022.11) Leaf toughness increases with tree height and is associated with internal leaf structure and photosynthetic traits in a tropical rain forest. *Frontiers in Forests and Global Change*, 5: 1002472.

Yoshikai, M.*, Nakamura, T., Bautista, D.M., Herrera, E.C., Baloloy, A., Suwa, R., Basina, R., Primavera-Tirol, Y.H., Blanco, A.C., Nadaoka, K. (2022.11) Field measurement and prediction of drag in a planted *Rhizophora* mangrove forest. *Journal of Geophysical Research: Oceans*, 127: e2021JC018320.

凌祥之, 山岡賢, 中村真人, 折立文子, 泉太郎, 大土井克明, 中山博敬, 治多伸介, 松田英樹 (2022.11) 現代農業農村の資源循環を支える科学技術の経過を考える. *水土の知 : 農業農村工学会誌*, 90(11): 17–22.

Anzai, T.*, Onishi, J., Okamoto, K., Yadav, R.K., Yadav, G., Narjary, B. (2022.12) Effect of shallow subsurface drainage constructed by Cut-soiler on mitigation of soil salinization. *Journal of Arid Land Studies*, 32(S): 107–111.

Kawai, K.*, Waengsothorn, S., Ishida, A. (2022.12) Sapwood density underlies xylem hydraulics and stored carbohydrates across 13 deciduous tree species in a seasonally dry tropical forest in Thailand. *Trees-Structure and Function*, https://doi.org/10.1007/s00468-022-02364-3

Lai, J., Cheah, W.*, Palaniveloo, K.*, Suwa, R., Sharma, S. (2022.12) A systematic review on physicochemical and microbial diversity of well-preserved, restored, and disturbed mangrove forests: What is known and what is the way forward? *Forests*, 13: 2160.

Dulay, R.M.R.*, Batangan, J., Kalaw, S.P., De Leon, A.M., Cabrera, E.C., Kimura, K., Eguchi, F., Reyes, R.G. (2023.1) Records of wild mushrooms in the Philippines: A Review. *Journal of Applied Biology & Biotechnology*, 11(4): 11–32.

Fujimaki, H.*, Abdelbaki, H.M., Toderich, K., Saito, T., Onishi, J., Jitsuno, M. (2023.1) Optimization of irrigation depth for Mungbean considering the cost for water under a saline condition. *Journal of Arid Land Studies*, 32(4): 135–138.

Liu, G., Bua, X., Chen, C., Fu, C., Chi, Z., Kosugi, A., Cui, Q., Chi, Z. Liu, Y.* (2023.1) Bioconversion of non-food corn biomass to polyol esters of fatty acid and single-cell oils. *Biotechnology for Biofuels and Bioproducts*, 16(9), https://doi.org/10.1186/s13068-023-02260-z

Ndubuisi, I.A., Amadi, C.O., Nwagu, T.N., Murata, Y., Ogbonna, J.C.* (2023.1) Non-conventional yeast strains: Unexploited resources for effective commercialization of second generation bioethanol. *Biotechnology Advances*, 63: 108100.

Neha, Yadav, G.*, Rai, A.K., Yadav, T., Vivekanand, Yadav, R.K.*, Sharma P.C., Omori, K., Onishi, J.*, Anzai, T., Okamoto, K., Watanabe, T. (2023.1) Salinity management by Cut-soiler increases production of mustard-pearl millet cropping system in India. *Journal of Arid Land Studies*, 32(S): 117–122.

Okamoto, K.*, Omori, K., Onishi, J., Anzai, T., Yadav, R.K., Yadav, G., Narjary, B. (2023.1) A lysimeter study on the dynamics of salt and water in salt-affected soil after the construction of material-filled subsurface drainage. *Journal of Arid Land Studies*, 32(S): 221–226.

Onishi, J.*, Anzai, T., Okamoto, K., Yadav R.K., Yadav, G., Narjary, B., Vivekanand, Fujimaki, H. (2023.1) Water saving with permanent skip furrow irrigation under Cut-soiler drainage condition. *Journal of Arid Land Studies*, 32(S): 83–87.

Yadav, R.K., Yadav, G.*, Neha, Narjary, B., Sharma, P.C., Omori, K., Onishi, J., Watanabe, T., Anzai, T., Okamoto, K. (2023.1) Gypsum and crop residue placement by Cut-soiler help to manage soil sub-surface sodicity in semi-arid Indo-Gangetic Plains. *Journal of Arid Land Studies*, 32(4): 113–116.

進藤惣治 (2023.1) PAWEESを必要とした背景と今後への期待. *水土の知：農業農村工学会誌*, 91(4): 1–2.

Ichie, T.*, Igarashi, S., Tanimoto, T., Inoue, Y., Mohamad, M., Tanaka, K. (2023.2) Ecophysiological responses of seedlings in 6 dipterocarp species to experimental short time drought in tropical rainforest. *Frontiers in Forests and Global Change*, 6: 1112852.

大西純也, 安西俊彦, 岡本健, ヤダフ R.K., ガジェンドラ, ネハ, 北川巌, 奥田幸夫 (2023.2) トラクタ作業と畝間灌漑の改良による持続的な塩類集積対策. *水土の知:農業農村工学会誌*, 91(2): 11–14.

木村健一郎, 爲季誠, 折笠世紀, 松本武司, 神谷康雄 (2023.2) 地域未利用資源を活用した燃料ブリケットの改良と普及方法. *水土の知:農業農村工学会誌*, 91(2): 15–18.

Chhe, C., Uke, A.*, Baramee, S., Tachaapaikoon, C., Pason, P., Waeonukul, R., Ratanakhanokchai, K., Kosugi, A.* (2023.3) *Insulambacter thermoxylanivorax* sp. nov., a thermophilic xylanolytic bacterium isolated from compost. *International Journal of Systematic and Evolutionary Microbiology*, 73(3): 5724.

Koda, K.*, Tsujimura, M., Uchida, T. (2023.3) Groundwater flow and water pumping method during drought in atoll islands - Laura Island in the Republic of the Marshall Islands -. *Paddy and Water Environment*, https://doi.org/10.1007/s10333-023-00933-x

Ray, R.*, Suwa, R., Miyajima, T., San Diego-McGlone, M.L., Nadaoka, K. (2023.3) Sedimentary blue carbon dynamics based on chronosequential observations in a tropical restored mangrove forest. *Biogeoscience*, 20(4): 911–928.

河合清定, 田中憲蔵, 漢那賢作, 石田厚 (2023.3) 亜熱帯樹木群集における葉形質の乾燥応答: 種の置き換わりと種内変異に着目して. *関東森林研究*, 74: 77–80.

田中憲蔵*, 大谷達也, 星野大介, Nur Hajar, Z.S. (2023.3) 植栽後20年以上経過したマレーシアのフタバガキ科樹木の成長特性. *関東森林研究*, 74: 33–36.

Program B

Hossain, M.M., Yasmin, L., Rubayet, M.T., Akamatsu, H., Yamanaka, N.* (2022.4) A major variation in the virulence of Asian soybean rust pathogen (*Phakopsora pachyrhizi*) in Bangladesh. *Plant Pathology*, 71: 1355–1368.

Iseki, K.*, Matsumoto, R., Olaleye, O., Shimizu, M., Asfaw, A. (2022.4) Variability of flowering sex and its effect on agronomic trait expression in white Guinea yam. *Frontiers in Plant Science*, 13: 837951.

Kang, Y., Lee, K., Hoshikawa, K., Kang, M., Jang, S.* (2022.4) Molecular bases of heat stress responses in vegetable crops with focusing on heat shock factors and heat shock proteins. *Frontiers in Plant Science*, 13: 837152.

Sarker, U.*, Lin, Y.P., Oba, S., Yoshioka, Y., Hoshikawa, K.* (2022.4) Prospects and potentials of underutilized leafy *Amaranths* as vegetable use for health-promotion. *Plant Physiology and Biochemistry*, 182: 104–123.

Larzábal, J., Rodríguez, M., Yamanaka, N., Stewart, S.* (2022.5) Pathogenic variability of Asian soybean rust fungus within fields in Uruguay. *Tropical Plant Pathology*, 47:574–582.

Pariasca-Tanaka, J., Rakotondramanana, M., Mangaharisoa, S.T., Ranaivo, H.N., Tanaka, R., Wissuwa, M.* (2022.5) Phenotyping of a rice (*Oryza sativa* L.) association panel identifies loci associated with tolerance to low soil fertility on smallholder farm conditions in Madagascar. *PLoS ONE*, https://doi.org/10.1371/journal.pone.0262707

Rakotondramanana, M., Tanaka, R., Pariasca-Tanaka, J., Stangoulis, J., Grenier, C., Wissuwa, M.* (2022.5) Genomic prediction of zinc-biofortification potential in rice gene bank accessions. *Theoretical and Applied Genetics*, 135: 2265–2278.

Rinasoa, S., Nishigaki, T., Rabeharisoa, L., Tsujimoto, Y., Rakotoson, T.* (2022.5) Organic materials with high P and low C: P ratio improve P availability for lowland rice in highly weathered soils: Pot and incubation experiments. *Journal of Plant Nutrition and Soil Science*, 185: 475–485.

Du, Z., Sun, L., Lin, Y., Yang, F.*, Cai, Y.* (2022.6) Using PacBio SMRT sequencing technology and metabolomics to explore the microbiota-metabolome interaction related to silage fermentation of woody plant. *Frontiers in Microbiology*, 13: 857431.

Ishimaru T.*, Sasaki, K., Lumanglas, P.D., Cabral, C.L.U., Ye, C., Yoshimoto, M., Kumar, A., Henry, A. (2022.6) Effect of drought stress on flowering characteristics in rice (*Oryza sativa* L.): A study using genotypes contrasting in drought tolerance and flower opening time. *Plant Production Science*, 25: 359–370.

Kato, M., Morel, A. Yamanaka, N.* (2022.6) Resistance to Asian soybean rust and yield of new soybean cultivars, JFNC 1 and JFNC 2, harboring three resistance genes. *Tropical Plant Pathology*, 47: 599–607.

Prodhan, M.A.*, Pariasca-Tanaka, J., Ueda, Y., Hayes, P.E., Wissuwa, M. (2022.6) Comparative transcriptome analysis reveals a rapid response to phosphorus deficiency in a phosphorus-efficient rice genotype. *Scientific Reports*, 9460.

Sasaki, K., Obara, M.* (2022.6) Mapping of quantitative trait loci for root elongation in rice (*Oryza sativa* L.) treated with various nitrogen sources and concentrations. *Soil Science and Plant Nutrition*, 68: 454–462.

Yang, J., Tang, K., Tan, H., Cai, Y.* (2022.6) Characterization of lactic acid bacteria isolated from banana and its application in silage fermentation of defective banana. *Microorganisms*, 10: 185.

團晴行*, 足立忠司, 廣内慎司, Agodzo, S. (2022.6) ガーナ国における土水路と畦畔法面の崩落に対する植物根系による補強効果. *農業農村工学会論文集*, 90(1): I_183–I_190. (4期以前成果)

廣内慎司, 廣瀬千佳子, 堀野治彦 (2022.6) 途上国における土水路漏水評価と農家で実施可能な漏水対策. *水土の知：農業農村工学会誌*, 90(6): 415–420.

Fukuta, Y.*, Koide, Y., Kobayashi, N., Kato, H., Saito, H., Telebanco-Yanoria, M. J., Ebron, L.A., Mercado-Escueta, D., Tsunematsu, H., Ando, I., Fujita, D., Obara, M., Tomita, A., Hayashi, N., Imbe, T. (2022.7) Lines for blast resistance genes with genetic

background of Indica Group rice as international differential variety set. *Plant Breeding*, 141: 609–620.

Minato, T., Yamaguchi, T., Hoshizaki, M., Nirasawa, S., An, J., Takahashi, S., Penninger, J.M., Imai, Y., Kuba., K.* (2022.7) ACE2-like enzyme B38-CAP suppresses abdominal sepsis and severe acute lung injury. *PLoS ONE*, 17(7): e0270920. (4期以前成果)

Yoon, D.K., Suganami, M., Ishiyama, K., Kagawa, T., Tanaka, M., Nagao, R., Takagi, D., Ishida, H., Suzuki, Y., Mae, T., Makino, A.*, Obara, M.* (2022.7) The *gs3* allele from a large-grain rice cultivar, Akita 63, increases yield and improves nitrogen-use efficiency. *Plant Direct*, 6: e417.

羽佐田勝美, 川村健介, 木村健一郎, 山田隆一 (2022.7) ラオス農山村の動物性タンパク質摂取に影響を与える地域特性要因. 開発学研究, 33(1): 1–17. (4期以前成果)

Khin Thuzar Win, Kobayashi, M., Tanaka, F., Takeuchi, K., Aung Zaw Oo, Jiang, C.* (2022.8) Identification of *Pseudomonas* strains for the biological control of soybean red crown root rot. *Scientific Reports*, https://doi.org/10.1038/s41598-022-18905-2

Sagnon, A., Iwasaki, S., Tibiri, E.B., Zongo, N.A., Compaore, E., Bonkoungou, I.J.O., Nakamura, S., Traore, M., Barro, N., Tiendrebeogo, F., Sarr, P.S.* (2022.8) Amendment with Burkina Faso phosphate rock-enriched composts alters soil chemical properties and microbial structure, and enhances sorghum agronomic performance. *Scientific Reports*, 12: 13945.

Kondo, T.*, Ikazaki, K., Koala, J., Takenaka, K. (2022.9) Effects of porous material and irrigation frequency on the survival rate and vegetative growth in mango seedling at Burkina Faso. *Tropical Agriculture and Development*, 66(3): 89–94.

Ueda, Y., Wissuwa, M.* (2022.9) Physiological evidence that nitrate use positively correlates with internal phosphorus utilization efficiency and phosphorus uptake efficiency in rice (*Oryza sativa* L.). *Plant and Soil*, 481: 547–561.

Guo, B., Sun, L., Ren, H., Sun, R., Wei, Z., Hong, H., Luan, X., Wang, J., Wang, X., Xu, D., Li, W., Qiu, L.* (2022.10) Soybean genetic resources contributing to sustainable protein production. *Theoretical and Applied Genetics*, 135: 4095–4121.

Matsumoto, Y.*, Takami, H. (2022.10) The effect of brown kelp phenology on abalone locomotion and spatial distribution; acoustic telemetry and spatially explicit individual-based model approach. *Fisheries Science*, 88: 693–701.

Mukai, M., Hiruma, K.*, Nishigaki, T., Utami, D.Y., Otaka, J., Yoshihashi, T., Sarr, P.S., Aung Zaw Oo, Takai, T., Tujimoto, Y.* (2022.10) Dysbiosis of the rhizosphere microbiome caused by γ-irradiation alters the composition of root exudates and reduces phosphorus uptake by rice in flooded soils. *Plant and Soil*, https://doi.org/10.1007/s11104-022-05726-5

Rakotonindrina, H.*, Moritsuka, N., Kawamura, K., Tsujimoto, Y., Nishigaki, T., Andrianary, B.H., Razafimbelo, T., Razakamanarivo, H., Andriamananjara, A. (2022.10) Prediction of the soil properties of Malagasy rice soils based on the soil color and magnetic susceptibility. *Soil Science and Plant Nutrition*, https://doi.org/10.1080/00380768.2022.2136929

Ranaivo, H.N., Lam, D.T., Ueda, Y., Pariasca-Tanaka, J., Takanashi, H., Ramanankaja, L., Razafimbelo, T., Wissuwa, M.* (2022.10) QTL mapping for early root and shoot vigor of upland rice (*Oryza sativa* L.) under P deficient field conditions in Japan and Madagascar. *Frontiers in Plant Science*, 13: 1017419.

Sasaki, K.*, Obara, M. (2022.10) A near-isogenic line for spikelet number in rice with a genetic background of IR64 under various fertilizer conditions. *Plant Production Science*, https://doi.org/10.1080/1343943X.2022.2132966

Ilyas, M., Shah, S.H., Fujita, Y., Maruyama, K., Nakashima, K., Yamaguchi-Shinozaki, K., Jan. A.* (2022.11) OsTZF1, a CCCH-tandem zinc finger protein gene, driven under own promoter produces no pleiotropic effects and confers salt and drought tolerance in rice. *Plant Signaling & Behavior*, 17(1): e2142725.

Larzábal, J., Yamanaka, N., Ceretta, S., Rodríguez, M., Stewart, S.* (2022.11) Introgression of Asian soybean rust resistant genes into elite soybean lines from Uruguay. *International Journal of Pest Management*, 68(4): 319–327.

Aung Zaw Oo, Tsujimoto, Y.* (2022.12) Localized phosphorus application via P-dipping is more effective for improving initial rice growth in lower temperature conditions. *Plant Production Science*, 104467.

Chen, C., Xin, Y., Li, X., Ni, H., Zeng, T., Du, Z., Guan, H., Wu, Y., Yang, W., Cai, Y.*, Yan, Y.* (2022.12) Effects of *Acremonium* cellulase and heat-resistant lactic acid bacteria on lignocellulose degradation, fermentation quality and microbial community structure of hybrid elephant grass silage in humid and hot areas. *Frontiers in Microbiology*, 13: 1066753.

Laminou, R.H.M.*, Ndiaye, S., Guissé, A., Djibril, D., Dieye, A.B., Sarr, P.S. (2022.12) Effect of microdose chemical fertilization method on soil chemical properties and productivity of maize (*Zea mays* L.) in West-Central Senegal. *International Journal of Life Science Research Archive*, 3(2): 176–185.

Liu, D., Park, C., Wang, Q., Xu, D.* (2022.12) Validation and genetic characterization of a seed weight quantitative trait locus, *qSW17.1*, in progenies of cultivated and wild soybeans. *Crop & Pasture Science*, https://doi.org/10.1071/CP22211

Maeno, K.O.*, Piou, C., Leménager, N. (2022.12) Egg size-dependent embryonic development in the desert locust, *Schistocerca gregaria*. *Journal of Insect Physiology*, 104467.

Nakano, H.*, Takai, T., Kondo, M. (2022.12) Identification of quantitative trait loci regulating γ-oryzanol concentration using a cross between cultivars with extremely high and low γ-oryzanol levels. *Cereal Chemistry*, https://doi.org/10.1002/cche.10639

董春霞, 王佳敏, 藤田薫*, 栾广忠* (2022.12) Effect of atmospheric popping on the physicochemical properties of Tartary buckwheat flour. 粮食与油脂, 35(2): 38–42. (4期以前成果)

Hoshikawa, K., Lin, Y.P., Schafleitner, R., Shirasawa, K., Isobe, S., Ohsawa, R., Yoshioka, Y.* (2023.1) Genetic diversity analysis and core collection construction for *Amaranthus tricolor* germplasm based on genome-wide single-nucleotide polymorphisms. *Scientia Horticulturae*, 307: 111428.

Hou, M., Wang, Z.*, Sun, L., Jia, Y., Wang, S., Cai, Y.* (2023.1) Characteristics of lactic acid bacteria, microbial community and fermentation dynamics of native grass silage prepared in Inner Mongolian Plateau. *Frontiers in Microbiology*, 13: 1072140.

Iseki, K.*, Ikazaki, K., Batieno, B.J. (2023.1) Heterogeneity effects of plant density and fertilizer application on cowpea grain yield in soil types with different fertility and water conditions. *Field Crops Research*, 292: 108825.

Maeno, K.O.*, Ould Ely, S., Ould Mohamed, S., Jaavar, M.E.H., Ould Babah Ebbe, M.A. (2023.1) Thermoregulatory behavior of lekking male desert locusts, *Schistocerca gregaria*, in the Sahara Desert. *Journal of Thermal Biology*, https://doi.org/10.1016/j.jtherbio.2023.103466

Nikiema, R.A.*, Shiratori, S., Rafalimanantsoa, J., Ozaki, R., Sakurai, T. (2023.1) How are higher rice yields associated with dietary outcomes of smallholder farm households of Madagascar? *Food Security*, https://doi.org/10.1007/s12571-022-01333-5

Ishizaki, T.*, Ueda, Y., Takai, T., Maruyama, K., Tsujimoto, Y. (2023.2) In-frame mutation in rice *TEOSINTE BRANCHED1* (*OsTB1*) improves productivity under phosphorus deficiency. *Plant Science*, https://doi.org/10.1016/j.plantsci.2023.111627

Kamiyama, R.*, Miyata, T. (2023.2) Applicability of data envelopment analysis using vessel-level data to the estimation of technical efficiency and capacity utilization of the small-scale squid angling fishery in Aomori Prefecture, Japan. *Fisheries Research*, https://doi.org/10.1016/j.fishres.2023.106664

羽佐田勝美, 浅井英利, 川村健介, ポンサニット･ポンナチット, 山田隆一 (2023.2) ラオスにおけるコメのフードセキュリティの地域間格差とコメ不足地域の課題. *開発学研究*, 33(2): 31–38.

Odama, E., Tsujimoto, Y., Yabuta, S., Akagi, I., Sakagami, J.* (2023.3) P-dipping improved NERICA 4 rice seedling resilience to water and nutrient stresses under rainfed-like conditions. *Rhizosphere*, 26: 100688.

Rinasoa, S., Rakotoson, T., Rabeharisoa, L., Tsujimoto, Y., Nishigaki, T.* (2023.3) Farmyard manure application increases lowland rice yield in phosphorus-deficient soils, but not in soils with high pH and phosphorus-fixing capacity. *Field Crops Research*, 296: 108906.

Shiratori, S.*, Narmandakh, D., Rafalimanantsoa, J. (2023.3) Seasonal energy deficiency of rural rice farmers in Madagascar. *Japanese Journal of Agricultural Economics*, 25: 13–16.

Takai, T.*, Taniguchi, Y., Takahashi, M., Nagasaki, H., Yamamoto, E., Hirose, S., Hara, N., Akashi, H., Ito, J., Arai-Sanoh, Y., Hori, K., Fukuoka, S., Sakai, H., Tokida, T., Usui, Y., Nakamura, H., Kawamura, K., Asai, H., Ishizaki, T., Maruyama, K., Mochida, K., Kobayashi, N., Kondo, M., Tsuji, H., Tsujimoto, Y., Hasegawa, T., Uga, Y. (2023.3) *MORE PANICLES 3*, a natural allele of *OsTB1/FC1*, impacts rice yield in paddy fields at elevated CO_2 levels. *Plant Journal*, https://doi.org/10.1111/tpj.16143

Program C

Fujita, D., Tagle, A.G., Koide, Y., Simon, E.V., Fukuta, Y., Ishimaru, T., Kobayashi, N.* (2022.4) Characterization of QTLs for grain weight from New Plant Type rice cultivars through the development of near-isogenic lines with an IR 64 background. *Euphytica*, 218: 50.

Nyairo, R.*, Hasegawa, T., Fujimori, S., Wu, W., Takahashi, K. (2022.4) Socio-economic trajectories, urban area expansion and ecosystem conservation affect global potential supply of bioenergy. *Biomass and Bioenergy*, 159: 106426.

Jannat, A., Ishikawa-Ishiwata, Y., Furuya, J.* (2022.5) Does climate change affect rapeseed production in exporting and importing countries? Evidence from market dynamics syntheses. *Sustainability*, 14(10): 6051.

Negash, T*., Oniki, S., Berhe, M., Etsay, H. (2022.7) Household's communal resource use and willingness to supply extra free labor days to conserve communal land in northern Ethiopia: Evidence from Kilte-Awlaelo woreda of Tigrai region. *Journal of Forest Economics*, 37(3): 319–345.

Sakaigaichi, T.*, Suematsu, K., Terajima, Y., Kobayashi, A., Kawata, Y., Kai, Y. (2022.7) Evaluation of mother and daughter root traits in sweet potato germplasm cultivated by direct planting. *Plant Production Science*, 25(3): 407–412.

Nong, Y., Zhao, M., Chien, H.* (2022.9) Path relationship of consumers' perceived susceptibility and severity of health problems with their purchase of buckwheat functional foods in China. *Heliyon*, 8(9): e10671.

Hassouna, M.*, van der Weerden, T.J., Beltran, I., Amon, B., Alfaro, M.A., Anestis, V., Cinar, G., Dragoni, F., Hutchings, N., Leytem, A., Maeda, K., Maragou, A., Misselbrook, T., Noble, A., Rychła, A., Salazar, F., Simon, P. (2022.11) DATAMAN: A global database of methane, nitrous oxide and ammonia emission factors for livestock housing and outdoor storage of manure. *Journal of Environmental Quality*, https://doi.org/10.1002/jeq2.20430

Lim, S., Onoda, A., Orn, C., Iwamoto, H., Ishikawa, R., Saito, H., Sato, Y., Ishii, T.* (2022.12) Variations in grain traits among local rice varieties collected more than half-century ago in Indochinese countries. *Plants*, 12(1): 133.

Nakayama, M.*, Matsuda, H. (2022.12) Soilless cultivation of 'Ruby Star' passion fruit: Effects of NO_3-N application, pH and temperature on fruit quality. *Scientia Horticulturae*, 306: 111462.

Saito, H.*, Orn, C., Thun, V., Makar, O., Tomita, A., Sasaki, K., Obara, M., Kobayashi, N., Fukuta, Y. (2023.1) Diversity of traits related to panicle architecture and grain size in Cambodian rice germplasm and newly developed mini-core collection. *Japan Agricultural Research Quarterly*, 57(4): 21–36.

ザケア·スルタナ, 姜奉廷, 野原節雄, 木下俊輔, マーシー·ワイルダー* (2023.1) 実験条件下において異なる飼餌料で飼育されたバナメイエビ *Litopenaeus vannamei*の繁殖能力およびそれに及ぼす眼柄切除の影響. *日本水産学会誌*, 10.2331/suisan.22-00039

Sultana, Z., Kang, B.J., Wilder, M.N.* (2023.2) Examination of the effects of thoracic ganglion and brain extracts on vitellogenin gene expression in the ovary of whiteleg shrimp, *Litopenaeus vannamei*, and possible vitellogenesis-stimulating activity. *Aquaculture Research*, https://doi.org/10.1155/2023/8164370

Tomita, R., Reyes, V.P., Fukuta, Y., Gichuhi, E.W., Kikuta, M., Menge, D.M., Doi, K., Makihara, D.* (2023.2) Genetic variation of blast (*Pyricularia oryzae* Cavara) resistance in the Longistaminata Chromosome Segments Introgression Lines (LCSILs) and potential for breeding use in Kenya. *Plants*, 12(4): 863.

Uddin, M.N.*, Hilton, S., Fukuta, Y., Hossain, M.Z., Khan, S.M.M.K. (2023.2) Genetic variation in phosphorus difficiency tolerance among Bangladeshi Rice (*Oryza sativa* L.) cultivars and introgressions with IR 64 genetic background. *Journal of Animal and Plant Sciences*, 33(1): 110–116.

Chang, Q., Zhang, C., Chien, H., Wu, W., Zhao, M.* (2023.3) Impact of outsourcing agricultural production on the frequency and intensity of agrochemical inputs: Evidence from a field survey of 1211 farmers in major food-producing areas in China. *Environment, Development and Sustainability*, https://doi.org/10.1007/s10668-023-03109-z

Muraoka, R.*, Chien, H., Zhao, M. (2023.3) Production and market participation of buckwheat farmers: Micro-evidence from Shaanxi Province, China. *Sustainability*, 15(6): 4822.

Others

Sushida, H., Sakai, H., Moriya, N., Nakano, K.*, Ashimine, N., Minami, M., Tamotsu, H., Nakanishi, T., Ohki, S.*, Teruya, K., Hirano, T.*, Yamasaki, S., Suzuki, C.*, Satou, K.*, Kimoto-Nira, H. (2022.4) Complete genome sequence of *Lactococcus cremoris* strain 7-1, a lactic acid bacterium isolated from a traditional Mongolian milk product possessing mucin-adhesive ability. *Microbiology Resource Announcements*, 11(4): e00143-22.

Li, L., Ma, P., Nirasawa, S., Liu, H.* (2023.2) Formation, immunomodulatory activities, and enhancement of glucosinolates and sulforaphane in broccoli sprouts-a review for maximizing the health benefits to human. *Critical Reviews in Food Science and Nutrition*, https://doi.org/10.1080/10408398.2023.2181311

福田善通. (2023.2) 陸畑、天水稲と水稲の違いを利用したこれからのイネ育種. *畑地農業*, 771: 7–21.

This list includes papers published by staff members of overseas collaborating research institutes.
Underline indicates researcher at JIRCAS.
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Fifth Medium to Long-Term Plan of the Japan International Research Center for Agricultural Sciences

The Japan International Research Center for Agricultural Sciences (JIRCAS) has been contributing to the improvement of practices and technologies related to agriculture, forestry and fisheries in tropical and subtropical regions, as well as in other developing regions overseas, by conducting technical tests and research.

During the First Medium-Term Goal period (FY2001-2005), JIRCAS worked on research and development (R&D) for the sustainable development of agriculture, forestry and fisheries, as well as on the expansion of international research exchanges and networks, taking into account both domestic and overseas situations, such as the adoption of the United Nations Millennium Development Goals for the eradication of poverty and hunger in the world.

During the Second Medium-Term Goal period (FY2006-2010), JIRCAS created a multilateral collaborative research system, promoted collaborative research with world-class research organizations led by the Consultative Group on International Agricultural Research (CGIAR), established a dynamic research system, and implemented major research projects. In FY 2008, JIRCAS took over the international operational activities of the former Japan Green Resources Agency (JGRA), and strengthened its field activities overseas.

During the Third Medium-Term Goal period (FY2011-2015), a program/project scheme was developed for three principal research areas, namely, environment and natural resource management, stable food production, and livelihood improvement of the rural population. In addition, flagship projects to which research resources were intensively allocated were set up to promote research. Furthermore, systems were developed to strengthen the process of disseminating research results and ensuring the safe management of experimental materials.

During the Fourth Medium to Long-Term Goal period (FY2016-2020), environment and natural resource management, stable agricultural production, and high value-adding technologies were positioned as priority research areas, and innovations in research management were promoted to maximize R&D outcomes. In addition, operations related to the collection, analysis, and dissemination of information on international agriculture, forestry, and fisheries were strengthened.

In the Fifth Medium to Long-Term Goal period, JIRCAS will focus on research areas that address the growing expectations for the development of technologies in the agriculture, forestry, and fisheries sectors to achieve the Sustainable Development Goals (SDGs), in accordance with the “Basic Plan for Food, Agriculture, and Rural Areas” (approved by the Cabinet on March 31, 2020) and the new policy “Measures for Decarbonization and Resilience with Innovation (MIDORI).” These research areas include the development of agricultural technologies for climate change, resource recycling and environmental conservation; technology development towards building a new food system with improved productivity, sustainability and resilience; and strengthening function as an international hub for providing strategic information on agriculture, forestry and fisheries, and mobilizing new research partnerships. In addition, with an eye on the post-coronavirus society, priority research resources will be allocated and new R&D and business management methods will be established.

Through these efforts, as the sole research institution in Japan mandated to carry out comprehensive research in international agriculture, forestry and fisheries, JIRCAS is committed to strengthen its framework of collaboration with related organizations, play a key role in research and development targeting developing regions, and contribute to solving global food problems and enhancing Japan’s research in agriculture, forestry and fisheries.

Section 1. Improving the Quality of Operations and Maximizing R&D Outcomes

The following four operational activities will be promoted as individual segments, and evaluated in accordance with the guidelines and criteria set by the Ministry of Agriculture, Forestry and Fisheries (MAFF).

- ○ Management of research and development activities (Planning Segment)
- ○ Development of agricultural technologies for addressing climate change, resource recycling and environmental conservation (Environment Segment)
- ○ Development of technologies towards building a new food system with improved productivity, sustainability and resilience (Food Segment)
- ○ Strengthening function as an international hub for providing strategic information on agriculture, forestry and fisheries, and mobilizing new research partnerships (Information Segment).

1. Management of research and development activities (Planning Segment)

(1) Strategic promotion of R&D in accordance with government policies

In order to strategically promote R&D for solving global issues related to mitigation of climate change and establishing new food systems that will benefit both Japan and the developing regions, JIRCAS will undertake the following efforts.

a) Establish a research agenda that can flexibly respond to local conditions, build a research promotion system that includes conducting research with international research institutions and research networks, and utilization of domestic research facilities, in order to address the risk of constraints on activities in the target regions.
b) Manage the progress of research projects based on a timetable, select and focus on projects based on results of evaluation, and review each project flexibly according to the progress of research and changes in social conditions.
c) Provide incentives to research staff at the discretion of the President, enhance the research environment, as well as to work actively to obtain external funding, and make efficient use of research funds.
d) Promote goal-oriented basic research that will lead to the creation of future technological seeds and the development of innovative technologies.
e) Establish a system utilizing ICT etc. that enables effective and efficient research to be conducted even under conditions where the movement of people is restricted due to the impact of COVID-19 pandemic.

(2) Strengthen industry-academia-government collaboration and cooperation

JIRCAS will actively promote international joint research and personnel exchange with research institutes and universities in developing regions and developed countries, international research institutions such as CGIAR, private organizations including NGOs, and international research networks, in order to contribute in raising the level of research and solving problems related to agriculture, forestry, and fisheries in developing regions.

In addition, JIRCAS will support the establishment of strategic partnerships in the Information Segment, and expand opportunities for exchange of information, personnel and research with the National Agriculture and Food Research Organization (NARO), Forest Research and Management Organization (FRMO), Japan Fisheries Research and Education Agency (FRA) and other organizations, to promote R&D and other activities that leverage the strengths of each research agency and bring about synergies. As the sole research institute in Japan that comprehensively conducts research on international agriculture, forestry and fisheries, JIRCAS will contribute to the advancement of R&D in domestic agriculture, forestry and fisheries by strengthening cooperation, including personnel exchange with NARO, FRMO, FRA and other organizations, while playing a central role in research on agriculture, forestry and fisheries in the tropical/subtropical regions and developing countries.

(3) Strategic promotion of intellectual property management

The R&D outcomes are considered as global public goods and will be handled from the perspective of promoting their utilization in developing regions. The following measures will be taken to promote strategic management of intellectual property for rapid social implementation and dissemination of technology.

a) The most appropriate method will be adopted based on the necessity and effectiveness of the invention in terms of confidentiality, rights (including agreement on the ownership/sharing ratio of rights, licensing policy, and handling of improved inventions), standardization, and public knowledge at the time of invention, as well as the release of patents and other rights after acquisition, exclusive licensing, and other measures.
b) In conducting joint research, a nondisclosure agreement will be concluded as necessary to prevent infringement of intellectual property, such as outflow of technology or leakage of information. In addition, the handling of intellectual property obtained through joint research will be stipulated in the joint research agreement.

(4) Strengthen efforts for social implementation of R&D outcomes

The following measures will be undertaken to promote the dissemination and social implementation of R&D outcomes, and to utilize investments, as well as human and technical support as necessary, in accordance with the Law on the Revitalization of Science, Technology and Innovation Creation (Act No. 63, 2008).

a) The possibility of obtaining rights and the need for confidentiality will be considered for R&D outcomes, and those results that are desirable to be made public knowledge will be published in the JIRCAS Annual Report and academic journals, etc.
b) In countries and regions where the results are expected to be utilized, seminars, workshops, and explanatory meetings for local residents will be held to promptly provide information to the beneficiaries.
c) Results that are expected to be of particular use will be selected as major research result for publication and dissemination to promote their actual utilization.
d) Support efforts in the Information Segment for technology dissemination and application through strategic partnerships with the development sector and businesses.
e) Conduct follow-up surveys on major R&D outcomes in a systematic manner and publicize them on the website, etc.

(5) Promote public relations activities and interactive communication with the public

The following efforts will be made to promote public understanding of the activities and achievements, the need for international research and development targeting developing regions, the contributions to science and technology diplomacy through research activities.

a) Support efforts of the Information Segment to provide strategic information. Expand opportunities for information dissemination and interactive communication both domestically and internationally by making effective use of the media, including press releases and media coverage, as well as by utilizing a variety of media and communication tools, such as printed publications, sending out e-mail newsletters, and participation in various external events.
b) In addition to the public open house, engage in outreach activities such as participation in exhibitions, science cafes, and visiting lectures, as well as in new types of outreach activities, such as online symposiums and seminars.
c) Promote efforts to enhance the understanding of local residents in the regions where the research is being conducted by holding on-site workshops and explanatory meetings, in collaboration with partner institutions of joint research and government agencies of those countries.

(6) Strengthen cooperation with government departments

The following efforts will be promoted in order to ensure appropriate R&D activities and measures that respond and contribute to national policies.

a) Coordinate closely with relevant government departments, exchange information at each stage of research from research design to dissemination and practical application of results, and request for their participation in annual review meetings to discuss and verify the results.
b) Respond to requests from government departments for cooperation in conducting emergency operations, holding liaison meetings and symposiums, and dispatching experts to international

organizations, academic conferences etc.

c) Respond to requests from national and local government, organizations, or universities etc. to perform analyses and appraisals that require expertise of staff and are difficult for other bodies to perform.

2. Development of agricultural technologies for climate change, resource recycling and environmental conservation (Environment Segment)

In order to cope with global climate change and prevent further environmental degradation in developing regions that depend heavily on agriculture, forestry, and fisheries, it is necessary to balance sustainable agriculture, forestry, and fisheries with appropriate resource management by maximizing resource use efficiency without crossing the so-called planetary boundaries, based on scientific assessment of risks related to the maintenance of the global system. To achieve this objective, the following research initiatives will be undertaken.

Develop water-saving cropping systems in rice paddies and their water management methods, and technologies to reduce greenhouse gas emissions by effectively utilizing livestock waste, etc. targeting developing regions, mainly in Asia, while also taking domestic benefits into consideration.

Develop carbon recycling technologies to convert agricultural waste into resources, using the power of microorganisms to break down and convert agricultural waste into raw materials for fuels and chemical products.

Develop low-impact agricultural production systems by utilizing biological nitrification inhibition (BNI) technology in order to reduce the environmental burden caused by fertilization using nitrogen compounds.

Develop afforestation technologies to enhance forestry productivity and environmental adaptability of tropical forests by utilizing the indigenous genetic resources of tropical forests in Southeast Asia and other regions.

In addition, environmental conservation technologies will be developed through the yama-sato-umi agroecosystem connectivity in subtropical islands, soil conservation technologies in drylands, and technologies to mitigate the risk of drought.

3. Development of technologies towards building a new food system with improved productivity, sustainability and resilience (Food Segment)

In order to respond to the diversified agricultural development needs of developing regions and to contribute to stable food production in the target regions as well as to international food supply and demand and food and nutrition security, a new food system that improves agricultural productivity and nutrition will be established. To achieve this objective, the following research initiatives will be undertaken.

Develop breeding materials and production technologies that contribute to enhancing the resilience of major crops and local indigenous crops, in order to contribute to sustainable production in harsh environments and improved nutrition in developing regions, by utilizing advanced technologies. In addition, technologies will be developed to acquire breeding materials, agricultural products, and food products that will benefit both Japan and developing regions, mainly in the Asian region, which shares a common food culture with Japan, by clarifying the characteristics of various indigenous crops, utilizing genetic resources, introducing IoT to cultivation management, and meeting new demand through food processing.

Develop efficient and environmentally friendly control technologies for transboundary pests, which are a global problem, in cooperation with international organizations.

Develop sustainable aquaculture technologies through community-based aquaculture management that maintains ecosystem functions in order to revitalize the fisheries industry through appropriate management of aquaculture fishing grounds.

Develop water management technologies, breeding materials, and cultivation technologies effective for doubling rice production in the Sub-Saharan Africa as contribution to the Coalition for African Rice Development (CARD).

Develop field crop systems that can improve productivity, profitability and sustainability of small-scale farming including field crops and livestock production, to contribute in the improvement of agricultural productivity and resilience in the African region.

4. Strengthening function as an international hub for providing strategic information on agriculture, forestry and fisheries, and mobilizing new research partnerships (Information Segment)

The following initiatives will be undertaken to disseminate information domestically and internationally.

To understand the challenges and development needs of agriculture, forestry, fisheries, and food systems in developing regions, JIRCAS will analyze the current status of food supply and demand, nutrition improvement, and food systems in other countries, forecast the future under various scenarios, and evaluate the impact of developed technologies. A system for continuous, systematic, and organized collection, organization, and dissemination of a wide range of information to researchers, government organizations, companies, etc. will be established. In addition, JIRCAS will actively participate in international discussions on food and the environment through the G20 Meeting of Agricultural Scientists (MACS) and other forums. High-quality information will be provided by creating original contents and effective dissemination methods to target audiences will be devised through various media and opportunities, including participation in external events, exhibitions, and creation of publications and videos.

As part of efforts for social implementation of R&D outcomes that also benefit Japan, cooperation in developing regions, participation in domestic and international forums related to R&D, and the establishment of strategic partnerships with domestic and foreign organizations will be promoted in order to disseminate developed technologies. Furthermore, demonstration tests for dissemination and commercial deployment, information gathering for the application of digital technologies such as ICT, and research on subtropical agriculture in Japan using the Tropical Agriculture Research Front (TARF) will be conducted.

In addition, the following efforts will be made by utilizing the center functions.

a) Cooperate in the promotion of domestic breeding and gene bank projects by utilizing the research environment possessed by JIRCAS.
b) Conduct international joint research projects and special projects for dispatch of researchers to foster researchers in developing regions and Japan, and to accept trainees from other national research institutes, universities, national and public institutions, the private sector, and overseas institutions to contribute to human resource development and the improvement of technical standards.

Financial Overview

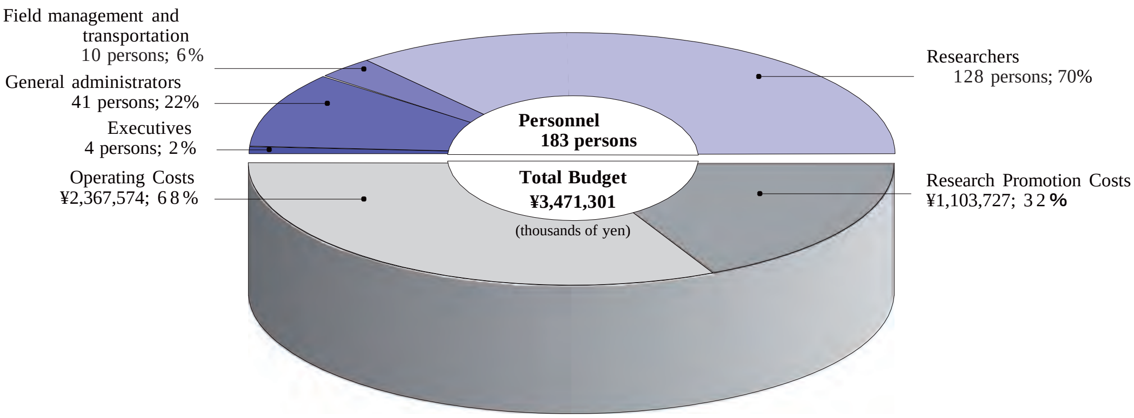
Fiscal Year 2022

thousands of yen

TOTAL BUDGET	**3,471,301**
OPERATING COSTS	**2,367,574**
Personnel (183)	2,054,580
President (1), Vice-President (1), Executive Advisor & Auditor (2)	
General administrators (41)	
Field management (10)	
Researchers (128)	
* Number of persons shown in ( )	
Administrative Costs	312,994

RESEARCH PROMOTION COSTS	**1,103,727**
Research and development	588,020
Overseas dispatches	196,929
Collection of research information	146,126
International collaborative projects	137,189
Fellowship programs	35,463

Budget FY 2022 (Graph)



Members of the External Evaluation Committee

Members of the JIRCAS External Evaluation Committee

Hironobu SHIWACHI	Professor, Department of International Agricultural Development, Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture (Tokyo NODAI)
Yasuhiko TORIDE	Professor, Institute for International Strategy, Tokyo International University
Eriko HIBI	Director, Food and Agriculture Organization (FAO) Liaison Office in Japan

JIRCAS Staff in FY 2022

President

Osamu Koyama

Vice-President

Yukiyo Yamamoto

Auditors

Teruyoshi Kumashiro
Hiroko Isoda

Information and Public Relations Office

Keisuke Omori, Head

Public Relations and Publications Section
Kazuhiko Okada, Head
Takanori Hayashi, Information Management Expert
Misaki Ohashi, Information Management Staff

International Relations Section
Shinichi Tsuruta, Head

Regional Coordinator
Shotaro Ando, Representative of Southeast Asia Office (Thailand)

Project Leader
Norihito Kanamori, Plant Molecular Biology

Senior Researcher
Sakiko Shiratori, Agricultural Economics

Program Directors

Keiichi Hayashi, Program A: Environment
Kazuo Nakashima, Program B: Food
Miyuki Iiyama, Program C: Information

Research Planning and Partnership Division

Tomohide Sugino, Director

Research Planning and Management Office
Takeshi Watanabe, Head

Research Planning Section
Tomoyuki Okutsu, Head

Research Management Section
Mie Kasuga, Head
Katsunori Kanno, Intellectual Property Expert

Field Management Section
Hiroyuki Ishiyama, Field Operator
Kaichi Matayoshi, Field Operator

Communications Advisor
Baltazar Antonio

Research Support Office
Masaki Shiraishi, Head

Research Coordination Section
Yuji Ebihara, Head
Toshiki Kikuchi, International Affairs Expert
Harumi Sawasato, Overseas Travel and Invitation Program Subsection Head
Gen-ichiro Hanaoka, Research Coordination Subsection Staff
Mizuho Jin, Overseas Affairs Subsection Head

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Akemi Nomiya, Head
Takayuki Yamamoto, Budget Subsection Head
Takehito Kato, Support Subsection Staff

Research Platform Office
Eizo Tatsumi, Head

Digital Technology Section
Hiromi Miura, Information Security Expert
Shota Miyai, Information System Management Subsection Staff

Safety Management Section
Masaki Morishita, Head

Administration Division

Takaaki Shimura, Director

General Affairs Section
Takashi Oosato, Head
Takeshi Usuku, General Affairs Assistant Head
Jun Yatabe, Personnel Management Assistant Head
Yume Nakano, General Affairs Staff
Shoko Yoshida, Welfare Subsection Staff
Yoshiyuki Seki, Personnel Subsection 1 Head
Noriko Osonoe, Personnel Subsection 1 Staff
Asami Takatsu, Personnel Subsection 2 Head

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Koichi Fuse, Accounting and Examination Assistant Head
Yuji Shirata, Procurement and Asset Managing Assistant Head
Ryoichi Mise, Financial Subsection Head
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Aki Tamura, Audit Subsection Staff
Itsuko Ikeda, Procurement Subsection 1 Head

Mizuha Furukawa, Procurement Subsection 2 Staff
Yuma Sukegawa, Supplies/Equipment Subsection Staff
Tadahisa Akiyama, Facilities Subsection Head

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Ryousuke Itami, General Affairs Subsection Head
Maretomo Fujimoto, Accounting Subsection Head

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Compliance Management Section
Sota Toyoshima, Management Subsection Staff

Acceptance Section
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Yoshinori Kawasaki, Head

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Jun-ya Onishi, Irrigation

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Mamoru Watanabe, Rural Development
Hideki Furihata, Agricultural Engineering
Naoko Oka, Agriculture Water Management
Haruyuki Dan, Rural Development
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Jun Furuya, Agricultural Economics

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Ai Leon, Environmental Impact Assessment
Guenwoo Lee, Development Economics and International Cooperation Studies
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Kyonoshin Maruyama, Plant Molecular Biology

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Yoshinori Murata, Applied Microbiology
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Jun-ichiro Marui, Molecular Microbiology
Yukari Nagatoshi, Plant Molecular Biology
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Kotaro Iseki, Crop Science and Breeding
Takeshi Kashiwa, Plant Pathology
Masahiro Kishii, Wheat Wide Crossing and Cytogenetics

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Junnosuke Otaka, Natural Products Chemistry
Park Cheolwoo, Plant Breeding and Genetics
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Ayaka Uke, Molecular Microbiology

Crop, Livestock and Environment Division

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Rempei Suwa, Forest Ecology
Masaki Kobayashi, Tree Molecular Biology

Researcher
Kiyosada Kawai, Tree Physiology and Wood Anatomy

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Masaya Toyokawa, Marine Planktology
Ryogen Nambu, Benthic Biology
Tatsuya Yurimoto, Aquatic Biology
Bong Jung Kang, Aquatic Animal Physiology

Researcher
Minoru Saito, Aquatic Ecology
Ryuya Matsuda, Marine Phycology

Tropical Agriculture Research Front

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Project Leaders
Shinsuke Yamanaka, Plant Genetic Resources
Toshihiko Anzai, Irrigation and Drainage

Senior Researchers
Shotaro Ando, Soil Science
Nobuya Kobayashi, Plant Breeding
Takuma Ishizaki, Plant Molecular Biology
Yoshifumi Terajima, Sugarcane Breeding
Hiroki Saito, Molecular Breeding and Genetics

Researchers
Hiroki Tokunaga, Plant Molecular Genetics
Ken Okamoto, Agricultural Engineering
Hiroshi Matsuda, Tropical Pomology
Masakazu Nakayama, Vegetable Crop Science
Hiroo Takaragawa, Crop Science
Takashi Kanda, Soil Science
Kosuke Hamada, Soil Science
Daichi Kuniyoshi, Rice Breeding

Technical Support Office
Kunimasa Kawabe, Head
Takashi Komatsu, Machine Operator
Masato Shimajiri, Machine Operator
Masakazu Hirata, Machine Operator
Yasuteru Shikina, Machine Operator
Shinji Ogata, Machine Operator
Masashi Takahashi, Machine Operator
Masahide Maetsu, Machine Operator
Yuto Hateruma, Machine Operator

The Japanese Fiscal Year and Miscellaneous Data

The Japanese Fiscal Year and the Annual Report 2022

The Japanese fiscal year is defined as the period of fiscal activity occurring from April 1 through March 31 of the following year. Thus, Fiscal Year (FY) 2022 covers the period from April 1, 2022 through March 31, 2023.

The Annual Report 2022 summarizes the full extent of JIRCAS activities that occurred during this period. The subsequent Annual Report will detail events and programs from April 1, 2023 through March 31, 2024 (FY 2023).

Buildings and campus data

Land	(units: m^2)
Tsukuba premises	109,538
Okinawa Tropical Agriculture Research Front	294,912
Total	404,450

Buildings	(units: m^2)
Tsukuba premises	10,766
Okinawa Tropical Agriculture Research Front	9,485
Total	20,251

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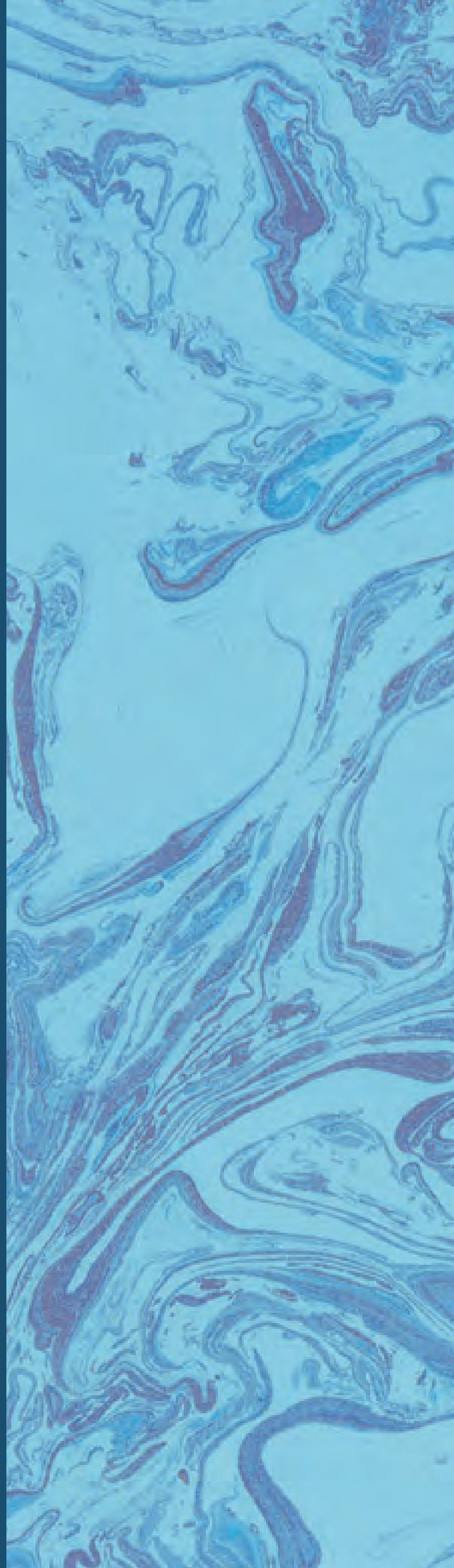

JAPAN INTERNATIONAL RESEARCH CENTER
FOR AGRICULTURAL SCIENCES