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Annual Report 2017 (Apr. 2017–Mar. 2018)

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

JIRCAS

Japan International Research Center for Agricultural Sciences

Annual Report 2017

(April 2017-March 2018)

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Message from the President

President
Dr. Masa Iwanaga
(FY2011-)

Food is an essential element of life. No food, no life. We can't exist without it. Food has driven human civilizations and cultures.

In our daily lives, we often enjoy having delicious meals with our families and friends, but sometimes we take the food we eat for granted, and are not concerned about what it takes to produce them. Global population has just passed 7.5 billion and is projected to reach 10 billion by around 2050. This is indeed an alarming projection. Will we have enough food for all of us in the future?

To answer this question, first, we need to look at the current situation of our food production and health.

With the upward swing in food production in recent years, the total number of hungry people has gradually decreased; but sadly, we still have close to 1 billion people who are not getting enough food and are going to bed hungry. Around 2 billion people are suffering from what we call "hidden hunger," which is due to poor intake of micronutrients such as vitamins and minerals. On the other hand, there is a major surge in the number of people who are overweight or suffering from obesity. More than one in two adults and nearly one in six children are overweight or obese in OECD countries. Sad to say, we have to recognize that we really have obvious and serious problems in food and nutrition even now.

According to FAO (2009), the projected population increase and change in diet to more animal-based products would require raising crop production by at least 70% by 2050. Can we produce that much to meet such ever-increasing demand?

How healthy is our planet now? We are wondering if the current agriculture and food production is sustainable.

Global agriculture feeds over 7.5 billion people, but it is also a leading cause of environmental degradation. Agriculture is the largest user of limited resources such as fresh water and land surface. Agriculture, especially animal production, emits large quantities of greenhouse gases which account for about 25% of total global emission. It is also a major cause of soil erosion, deforestation, biodiversity loss, and environmental contamination. It seems that we are eating at the expense of a sustainable future.

Climate change is the number one risk for agriculture. Agriculture has always been at the mercy of weather. Various extreme weather events, such as drought, heat wave and floods, are the primary ways by which we experience climate change. They have been causing detrimental impacts not only on agriculture but also on our daily lives.

So, with all these impediments to agriculture, what and how well will we eat in the future?

The answer is **"It depends."** It depends on whether we, the world community, can achieve collectively the following:

- No further expansion of crop lands so as not to encroach and destroy forests and other fragile ecological systems
- Increase in crop production by 70%, which means more crops in the same area of land
- Improved use efficiency of inputs such as water, soil nutrients, and labour
- Reduction of environmental impacts
- Lifestyle and societal changes
- Finally, we will need many innovations in technologies, policies, and institutions to ensure that sufficient quantities of nutritious foods are available and affordable to 10 billion consumers.

In conclusion, there's a lot of work to do together. Are we willing to take up the huge challenge we are facing now—the challenge to achieve healthy diets and sustainable food production without harming the environment and within the limit of the Earth's capacity? The answer is upon us.

The year 2017 was highly significant for JIRCAS because it was the second year of the Fourth Medium to Long-Term Plan for FY 2016-2020. We had carried out the Third Medium-Term Plan for FY 2011-2015 with verifiable evidence of successful implementation of the Projects and delivery of expected outputs under our four Programs. We have reformulated our project portfolio in response to changing priorities, placing more emphasis on nutrition and strategic research. This annual report describes how JIRCAS has carried out its major activities under the new five-year plan.

Let me recap the main points of our program-based management and strategy:

Introducing the four Programs

We have retained the same overall structure of program-based management with some modification of the project level components. The number of projects has been reduced from 19 to 14.

The four Programs developed using the mission-based principles are as follows:

1) Program A: Development of agricultural technologies for sustainable management of the environment and natural resources in developing regions
2) Program B: Technology development for stable production of agricultural products in the tropics and other adverse environments
3) Program C: Development of high value-adding technologies and utilization of local resources in developing regions
4) Program D: Collection, analysis and dissemination of information for grasping trends of international agriculture, forestry and fisheries

Program-based management

For FY 2016-2020, we have 14 "Projects" that are placed under "Programs" (see Fig. 1). The programs enable us to clarify our overall goals that need to be achieved and the manner by which we attempt to accomplish our research. Especially assigned Program Directors are in charge of budget, personnel, goal achievement management, and evaluation. Programs A to C have their own so-called flagship projects, representing the most important activity in each program. Projects under each program collectively and coherently contribute to the major goal of their respective programs.

Partnership is the center of our activities

Most of our activities are carried out together with our partner institutions around the world. Effective partnership makes it possible for us to conduct joint research activities that would be of value for social impact for our target beneficiaries in developing regions. The map (Fig. 2) shows locations of our current activities based on formal institutional Memorandums of Understanding.

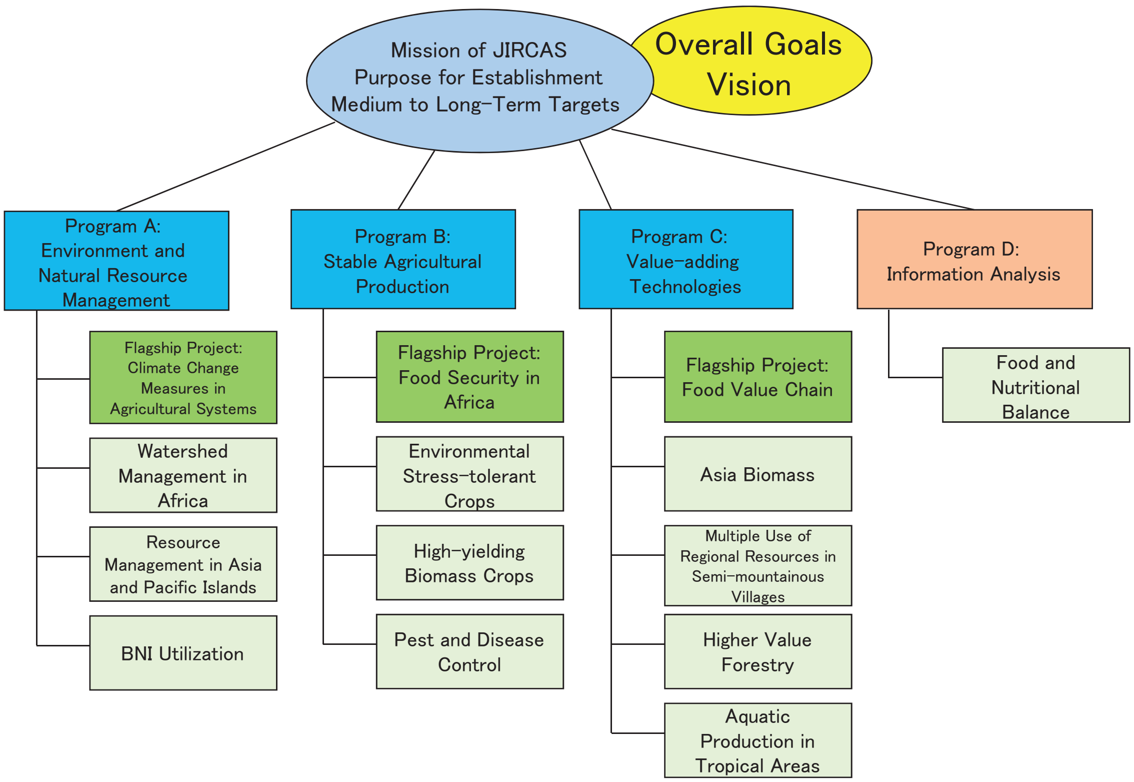


Fig. 1. Program-Project Research Framework

We value such partnerships and place it as our organization's core value. We consulted our partners for their feedback on our research activities, and we made the necessary adjustments in our planned research, accommodating our partners' suggestions and our own reflections. This was needed as a mid-course adjustment for better impact delivery. JIRCAS's operational cycle (Fig. 3) illustrates our focus towards impact-oriented research for development. Consequently, we were able to develop a clear impact pathway for the delivery of our research outputs to the respective target beneficiaries of each project.

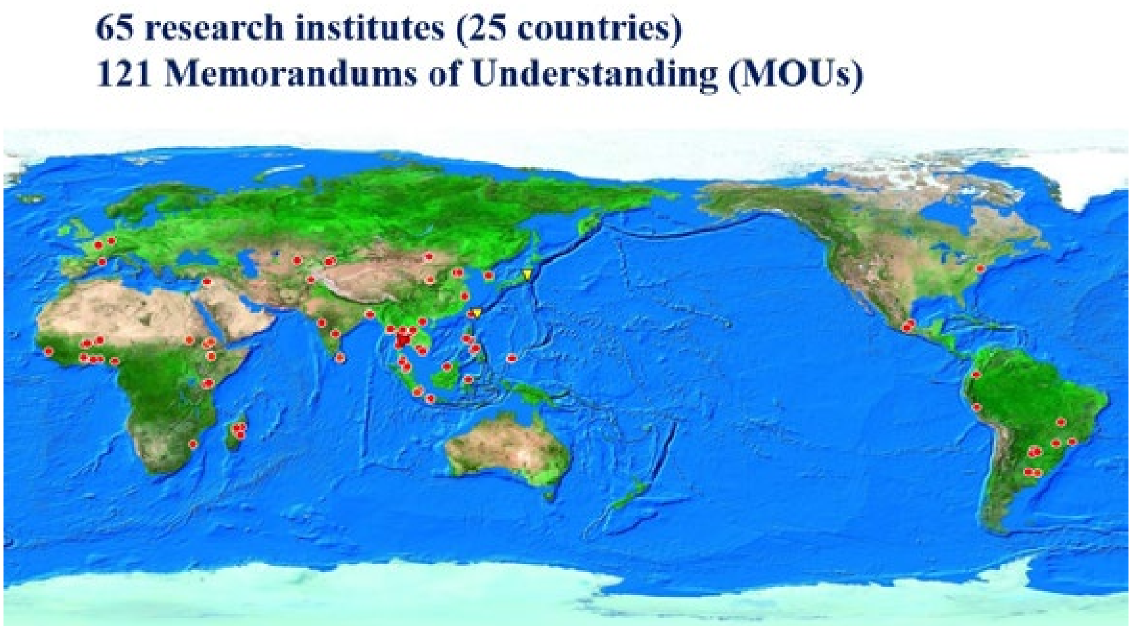


Fig. 2. Locations of our current activities based on 121 MOUs with partner institutions

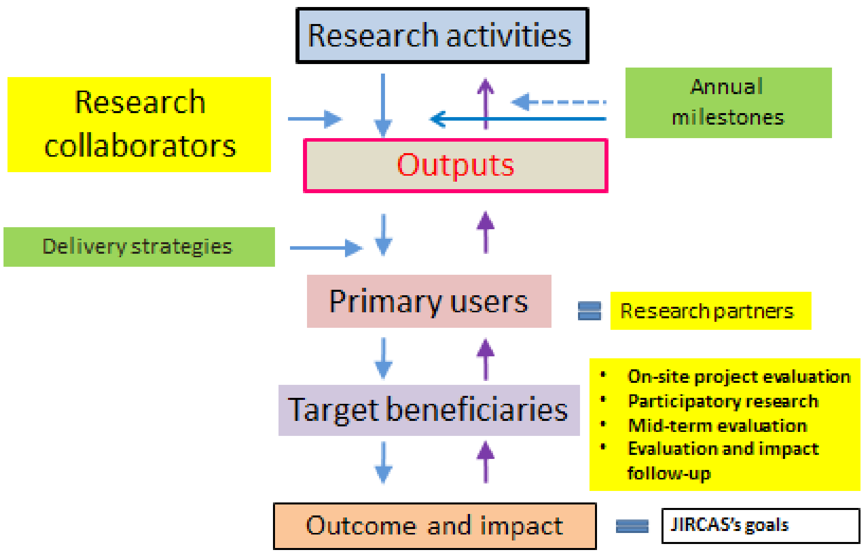


Fig. 3. Impact-oriented research for development (Operational Cycle)

Strive for impacts

By introducing the program-based system for output development and delivery, JIRCAS was able to depict more succinctly, not only to taxpayers and Japanese citizens but also to people in developing countries, what it essentially does and for whom. Promotion of more efficient and accountable research will further be feasible. Accordingly, it is important for every researcher, manager, and support staff to work together to produce well-considered outputs that will be deemed suitable, acceptable, and adaptable for users. We will keep striving to take advantage of this new structure with the undying passion of our 47-year-old "research for development" tradition, hoping to produce deliverables that will be used by our target beneficiaries, resulting in significant and positive social impacts.

HIGHLIGHTS FROM 2017

JIRCAS International Symposium 2017: Promoting an Active Role for Female Researchers in Agriculture, Food, and Nutrition Research

JIRCAS International Symposium 2017, titled "Promoting an Active Role for Female Researchers in Agriculture, Food, and Nutrition Research," was held on November 2, 2017 at the U Thant International Conference Hall, United Nations University (UNU) in Tokyo. The symposium was supported by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) through its "Human Resources in Science and Technology Development Fund."

JIRCAS has been promoting joint research activities in developing areas, as well as showing leadership in fostering human resources and achieving gender equality. In line with this, we have recently adopted the new program titled "Initiative for Realizing Diversity in the Research Environment," which seeks to promote an active role for female researchers and also supported by funds provided by MEXT.

Under the program, JIRCAS and other institutions have established and are now jointly operating a support system for female researchers, with the Tokyo University of Agriculture and Technology as representative institution. The group is leading and expanding the female researchers' network in order to improve the research environment and enable female researchers to develop their career by sharing information through internet and jointly organized symposiums. JIRCAS International Symposium 2017 was accordingly held as one of the related events of the program.

There were three keynote speeches and two sessions. The keynote speeches were titled "Why the World Needs More Women Scientists for a Food-Secure Future," "Biofortification and Agriculture's Primary Role to Provide Nutritious Diets for National Health," and "The Importance of Women's Nutrition for the Next Generation's Health and Community Development." The theme of Session 1 was "Food and Nutrition Research by Female Researchers," and four speakers were invited to present their research, highlighting outcomes that were related to the theme. Session 2 was devoted to a panel discussion where the keynote speakers shared their views on promoting an active role for female researchers in the fields of international agriculture, food, and nutrition research. An informative discussion ensued among the panelists and with members of the audience.

In this symposium, we comprehensively exchanged ideas on agriculture, food, and nutrition. We also took advantage of this occasion to introduce the outputs of our research and discuss how to promote international collaborative research based on global needs. The symposium was also a good opportunity to express our support for the expansion of female researchers' global activities, and we will continue to collaborate with domestic partners and international organizations to promote an active role for female researchers.

JIRCAS International Symposium 2017

JIRCAS-NARO International Symposium on "Agricultural Greenhouse Gas Mitigation"

JIRCAS and NARO (National Agriculture and Food Research Organization) jointly held an international symposium on "Agricultural Greenhouse Gas Mitigation" at Tsukuba International Congress Center on August 31, 2017. The symposium was held in conjunction with the GRA (Global Research Alliance on Agricultural Greenhouse Gases) Council Meeting, which was held in advance in Tsukuba, Japan.

Dr. Masa Iwanaga, president of JIRCAS, opened the symposium by expressing his deep appreciation to all 218 participants, including guests from Asia, Africa, and other regions of the world, and describing the background and objectives of the symposium. Mr. Tomohiro Bessho, director general of the Research Council's Secretariat, the Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan, then delivered a welcome address to all the participants and introduced recent contributions of MAFF to international research activities on agricultural greenhouse gas (GHG) mitigation.

The first keynote speech, entitled "Climate Change and Agriculture: from Challenges to Solutions," was delivered by Dr. Jean-Francois Soussana, vice-president of the French National Institute for Agricultural Research (INRA). The second keynote speech, entitled "More Food without Growing Greenhouse Gas Emissions," was delivered by Dr. Kazuyuki Yagi, research manager for climate change of the National Institute for Agro-Environmental Sciences (NIAES), NARO, Japan, with the lecture showing a clear picture of GRA.

The keynote lectures were followed by thematic sessions, with speakers from Japan, Asia, and Latin America presenting their research activities and achievements in monitoring and mitigating of GHG emissions. Methane emissions from livestock (i.e., from the animals themselves and from swine wastewater) and paddy rice fields in Japan, Southeast Asia, and Latin America were properly investigated and significant progress were reported. On cropland, studies on soil carbon sequestration as well as methane and nitrous oxide (N_2O) gas emissions in Japan were shown, and a unique concept called 'genetic mitigation' of GHG emissions was presented. Then, valuable learning experiences from greenhouse gas inventory studies in Asia, and the integration and dissemination of mitigation technologies in Sub-Saharan Africa, were introduced.

The symposium was concluded by Dr. Akira Hasebe, vice president of NARO, with words of appreciation to all speakers and chairs. He emphasized the great importance of accelerating research on GHG mitigation from agriculture through the GRA Network, and discussed his expectations about the initiatives of Japan, which was officially designated as new chair country at the GRA Council Meeting on August 29-30.

Welcome address by Mr. Bessho, director general of the Agriculture Forestry and Fisheries Research Council's Secretariat, MAFF, Japan

Keynote speech by Dr. Soussana, vice-president of the French National Institute for Agricultural Research (INRA)

A group photo of all symposium participants

JIRCAS-CAAS 20th Anniversary Symposium in Beijing

JIRCAS and the Chinese Academy of Agricultural Sciences (CAAS) have been collaborating through research studies and capacity development since 1997, with the results contributing to food security and agriculture in China. To celebrate the 20th anniversary of partnership and summarize the achievements, JIRCAS and CAAS held a special symposium on July 22, 2017 in Beijing.

The number of participants was approximately 130 persons representing several institutions in China and Japan, including the Ministry of Agriculture of the People's Republic of China, Department of International Cooperation of CAAS, Institute of Agricultural Resources and Regional Planning, Institute of Environment and Sustainable Development in Agriculture, Food and Nutrition Research Institute, China National Rice Research Institute, Nanjing Institute of Soil Science of the Chinese Academy of Sciences, China Agricultural University, Embassy of Japan in China, Meiji University, Institute for Agro-Environmental Sciences of the National Agriculture and Food Research Organization in

JIRCAS-CAAS 20th Anniversary Symposium commemorative photo

Japan, and JIRCAS.

The honor lecture, titled "Subjects and solutions of China agriculture policy," was delivered by Mr. Xiwen Chen followed by four keynote speeches and eleven presentations comprising two sessions, themed "Agro-environmental studies for sustainable development" and "Agro-economy and rural development studies." The symposium highlighted two decades of achievements in a number of collaborative studies, and the partnership established from 20 years ago was highly appreciated. In his closing remarks, Vice-President Osamu Koyama of JIRCAS noted that despite the differences in cultures and attitudes between China and Japan, collaborative study is significant because it allows the group to tackle the same challenges from various aspects. He also emphasized the importance of diversity in research to create new and innovative products and ideas.

2017 Japan International Award for Young Agricultural Researchers (Japan Award)

JIRCAS, in cooperation with the Agriculture, Forestry and Fisheries Research Council (AFFRC) Secretariat, presented the Japan International Award for Young Agricultural Researchers for the 10th consecutive year. The award recognizes and honors young foreign researchers (citizens of developing countries and under 40 years of age) who are highly recommended by their institutes, and whose outstanding achievements promote research and development of agricultural, forestry, fishery and other related industries in developing regions. The 2017 commendation ceremony was held on December 1 at the U Thant International Conference Hall of the United Nations University (UNU) in Tokyo.

The awardees and guests were welcomed by Mr. Yoshio Kobayashi (AFFRC Chairman). Congratulatory remarks were delivered by Dr. Yuko Harayama (Executive Member, Council for Science, Technology and Innovation, Cabinet Office), Dr. Kazuhiko Takemoto (Director, UNU Institute for the Advanced Study of Sustainability), and Mr. Takao Shibusawa (Deputy Director General, Rural Development Department, Japan International Cooperation Agency). The selection process was explained by Dr. Kiyoaki Maruyama (Selection Committee Chairperson), and Mr. Kobayashi together with Dr. Masa Iwanaga (JIRCAS President) presented the prizes.

The seven-member selection committee conducted a document review, with the AFFRC Chairman determining three winners from among 17 candidates. Each awardee received a testimonial and a USD 5,000 cash prize.

The 2017 awardees and their research achievements are as follows:

Dr. Chandra Siddaiah NAYAKA
Nationality: Indian
Institute: University of Mysore
Research Achievement:
Plant-pathogen system biology and biotechnological approaches for plant disease management

Dr. Min AUNG
Nationality: Myanmar
Institute: University of Veterinary Science (Myanmar)
Research Achievement:
Dairy researches on production performances and health of dairy cows, livelihoods of local farmers and environmental concerns

Dr. Sheetal SHARMA
Nationality: Indian
Institute: International Rice Research Institute (IRRI)
Research Achievement:
Development of innovative approaches to enable small-holder farmers of South Asia to achieve gains in productivity and profitability through use of cutting edge Information & Communication Technologies to guide application of site-specific nutrient and crop management options

The 2017 awardees, members of the selection committee, and other officials

NEW RESEARCH COLLABORATION

JIRCAS concluded a Memorandum of Understanding (MOU) with Rwanda Agriculture and Animal Resources Development Board (RAB) in a wide range of research fields to establish soil conservation/management and crop fertilization strategies that would lead to the improvement of agricultural productivity and the promotion of technology innovation for managing natural resources. JIRCAS also concluded an MOU with the Indian Council of Agricultural Research (ICAR) based upon discussions about the current provisional collaboration and after exchanging views on future directions with representatives of ICAR and its umbrella organizations, the Central Soil Salinity Research Institute (CSSRI) and the Indian Agricultural Research Institute (IARI). JIRCAS has already commenced research collaboration on soil salinity mitigation and crop improvement for salinity tolerance with CSSRI and IARI, respectively.

Furthermore, JIRCAS concluded Joint Research Agreements with the National Locust Control Center (Centre National de Lutte Antiacriedienne [CNLA]) in Mauritania and the National Irrigation Commission (NIRC), Arusha Technical College (ATC), Selian Agricultural Research Institute (SARI), and Kilimanjaro Agricultural Training Center (KATC) in Tanzania.

In addition, an MOU that was previously suspended due to unstable regional situation was resumed. JIRCAS and the Republic of Guinea renewed their MOU, which covers research collaboration in rice, fisheries, and livestock production, following discussions with H. E. Professor Alpha Condé, president of the Republic of Guinea, during his visit to JIRCAS.

TROPICAL AGRICULTURE RESEARCH FRONT

The Tropical Agriculture Research Front (TARF) in Ishigaki Island has geographical advantages such as a subtropical climate and an island environment. It comprises 21 hectares of experimental fields, several types of greenhouses, and open research facilities including lysimeters. These advantages and facilities enable researchers to implement precise and reliable experiments that can lead to the development of improved agricultural technologies. Improved technologies help increase crop productivity, and are especially important in developing regions where such research activities are difficult to conduct, such as countries in the tropics/subtropics and island environments. TARF's main activities are described below.

Research and development of agricultural production technologies

Using an artificial sloping field at TARF, we launched a new research activity for the development of a sustainable crop cultivation system based on the three principles of "conservation agriculture" (minimal or partial tillage, mulching with organic materials, and multi-cropping system) targeting Palau in the western Pacific to reduce soil erosion and nutrient leaching into the water systems.

In Negros Island, central Philippines, our surveys revealed that nitrogen fertilizer application in sugarcane fields may become a source of groundwater pollution. We have conducted a set of experiments both in Ishigaki and Negros Islands to develop a new fertilizer application technique to reduce nitrogen leaching to the underground.

To solve the problems encountered by Indica Group rice in developing countries, we introduced, evaluated, and shared rice germplasm and breeding materials between collaborative countries. We are targeting blast disease, one of the most serious biotic stresses affecting rice, as well as abiotic stresses particularly salinity, P deficiency, and low-fertility soil. We are also examining the plant architecture, shoot types and traits such as culm length, number of tillers and size of panicle, and root types and vertical distribution in relation to soil profile, from shallow to deep (Photo 1).

A new paddy field was constructed to conduct all sets of research works at TARF. Transgenic upland rice varieties that expressed a gene encoding galactinol synthase isolated from Arabidopsis was found to have a higher grain yield than original non-transgenic varieties under drought conditions in field environments.

We are introducing a set of traits of *Erianthus* (a wild relative of sugarcane), such as high biomass production and environment stress tolerance, into sugarcane at TARF. To synchronize the flowering periods between sugarcane and *Erianthus* for crossing, a new technique that involves lighting treatment had been developed to delay the flowering period of *Erianthus*. This technique has been applied to Thai *Erianthus*.

Breeding of passionfruit at TARF is ongoing, with the aim of producing a heat-tolerant variety, using not only intraspecific but also interspecific hybrids. In addition, some interesting characteristics such as photoperiodic sensitivity, automatic pollination, and non-abscission have been found among the genetic resources.

Photo 1. Genetic improvement and development of Indica Group rice cultivar under subtropical conditions. YTH183 (B) and IR 64 (C) show higher productivity compared with the Japonica Group cultivar, Hitomebore (D). (A) shows a tall rice plant in which the long-culm gene had been introduced into the genetic background of YTH183.

Contribution to domestic agriculture

In addition to the above, TARF contributes to local agriculture through the following activities:

1) Generation advancement

A set of rice strains sent from the National Agriculture and Food Research Organization (NARO) is grown two or three times per year in order to advance generations for domestic breeding in rice.

2) Sugarcane crossing for F_1 seed production

Approximately 150-200 crosses (200-300 panicles) were produced for domestic sugarcane breeding (Photo 2).

3) Conservation of genetic resources

As a domestic sub-bank for tropical and subtropical resources, TARF conserved a total of 534 accessions of sugarcane and its relatives, 150 tropical fruit trees, and 120 pineapples in the greenhouse and at the fields.

Photo 2. *Erianthus* (JES1 variety) seed production field at TARF

ACADEMIC PRIZES AND AWARDS

"Best Paper Award 2017" from the Japan Society of Information and Knowledge

Dr. Takanori Hayashi, librarian and head of the Information Management Subsection, Research Planning and Partnership Division, received the "Best Paper Award 2017" at the 25th Annual Meeting of the Japan Society of Information and Knowledge in Kyoto on May 28, 2017.

Linked Open Data (LOD) has attracted much attention as a method for publishing data using Web technology. However, since many information resources on the Web are organized for human reading, they are not well structured for LOD. The original paper, entitled "Structure analysis and a schema definition method for creating Linked Open Data from complex information resources" shows and investigates the creation of LOD from complex information resources with different types of elements (in this case, the JIRCAS Research Highlights), achieving interoperability without any information loss. Furthermore, a proposed approach was examined, applying the appropriate LOD structure that compensates lack of information with links to other resources when using information resources designed for human reading. The award appreciates its practicality and suggestions for analyzing the structure and vocabulary based on the description of the information resource, thus making it possible to structure information efficiently to create LOD.

情報知識学会
論文賞
Best Paper Award 2017
Japan Society of Information and Knowledge

林 賢紀 殿

貴殿の論文「複合的な情報資源のLinked Open Data化における構造分析とスキーマ定義手法」は選考の結果2017年度本会論文賞にふさわしい優秀なものと認められましたのでこれを賞します

2017年5月28日

情報知識学会
会長 長塚 隆

Best Paper Award certificate

"Young Agricultural Researcher Award" from the Agriculture, Forestry and Fisheries Research Council

Dr. Kenta Ikazaki, a researcher of the Crop, Livestock and Environment Division, received the "Young Agricultural Researcher Award" from the Agriculture, Forestry and Fisheries Research Council (AFFRC), Ministry of Agriculture, Forestry and Fisheries, for his outstanding achievement that has led to the development of a low-input agricultural practice, called the "Fallow Band System," for controlling wind erosion and improving crop yield in West Africa.

The "Fallow Band System" can control desertification caused by wind erosion by 70% and, at the same time, can improve crop yield by 136% to 181%. It is highly practical for smallholder farmers who are economically challenged and have limited workforce because the system does not impose additional expense nor farm labor.

Dr. Ikazaki is now investigating the effects of the "Fallow Band System" on water erosion control under a collaborative research project with the Institute of Environment and Agricultural Research (INERA), Burkina Faso.

Dr. Kenta Ikazaki (left) and Chairman Yoshio Kobayashi of the AFFRC (right)

“Best Paper Award, Sawada Prize” from International Society of Paddy and Water Environment Engineering

Dr. Hiroshi Ikeura (Senior Researcher, Rural Development Division) and his colleagues received the “Best Paper Award, Sawada Prize” at the 2017 International Conference of International Society of Paddy and Water Environment Engineering (PAWEES) held on November 9, 2017. The award-winning paper titled “Factors affecting differences in the rainy season rice yield in a lowland area of a mountainous village in Lao PDR” was published in the journal *Paddy and Water Environment*, and it presented the results of a study on the factors affecting lowland rice yields in the Lao People’s Democratic Republic, also known as Laos. In this study, the authors found that late ponding caused transplanting delays in the lower parts of the lowland areas, and that rice grain yields in those fields were significantly lower than in the upper and middle parts of the lowland areas. The results suggest that water shortages prior to land preparation lead to delays in transplanting, and that this indirectly results in yield reduction.

Best Paper Award certificate

“Achievement Award for Young Scientists” from The Foundation of Agricultural Sciences of Japan

Dr. Kotaro Maeno, a researcher of the Crop, Livestock and Environment Division, received the “16th Japan Prize in Agricultural Sciences, Achievement Award for Young Scientists” on November 24, 2017. The award is administered by The Foundation of Agricultural Sciences of Japan. He also delivered an award lecture titled “Physiological and ecological studies of the desert locust” during the event, highlighting the contributions of his research in providing guidance on locust control techniques for future research.

Achievement Award certificate

Commemorative group photo
(Dr. Maeno is second from left, back row)

Dr. Maeno receiving his award certificate

"Best Paper Award" from the Japanese Society for Tropical Agriculture

Dr. Hidetoshi Asai, a senior researcher of the Crop, Livestock and Environment Division, received the "Best Paper Award on Tropical Agriculture and Development" at the 123rd Meeting of the Japanese Society for Tropical Agriculture on March 10, 2018. Dr. Asai received the award on behalf of his co-authors, Dr. Kenichiro Kimura (Senior Researcher, Rural Development Division, JIRCAS) and Prof. Masuo Ando (Former Director, Social Sciences Division, Utsunomiya University), for their paper titled "Labour-Saving Practices for the External Expansion of Swidden Agriculture for Upland Rice Production in a Mountainous Area of Laos." The paper was praised for revealing the pros and cons of labour-saving practices such as herbicide application and labour-outsourcing in a mountainous area of Laos. It explains that while these practices have been rapidly adopted by farmers of swidden agriculture (a.k.a. shifting cultivation or slash-and-burn farming) due to its economic rationality, its wide acceptance has also resulted in the outward expansion of field areas and consequent deforestation.


賞　状

Hidetoshi ASAI, Pheunphit SOISOUVANH, Pheng SENGXUA, Kenichiro KIMURA, Banthasack VONGPHUTHINE, and Masuo ANDO 殿

貴論文 "Labour-Saving Practices for the External Expansion of Swidden Agriculture for Upland Rice Production in a Mountainous Area of Laos" は　平成29年に日本熱帯農業学会より刊行された学会誌に掲載され　熱帯農業の発展と情報発信への貢献が大なるものと認め　最も優秀な論文として選ばれました
よってここに表彰いたします

平成30年3月10日

日本熱帯農業学会

会長　縄田　栄治

Best Paper Award certificate

"Society Award" from the Japanese Society of Applied Entomology and Zoology

On March 25, 2018, Senior Researcher Satoshi Nakamura of the Crop, Livestock and Environment Division received the Society Award from the Japanese Society of Applied Entomology and Zoology (JSAEZ). The award, which honors scientific achievements and breakthroughs and its contribution to progress in applied entomology and zoology, was founded in 1957 and presented for the 62nd time in 2018. Dr. Eiji Yano, society president and a former professor at Kindai University, presented the award certificate during the 62nd JSAEZ Annual Meeting held in Kagoshima City. Dr. Nakamura, who also delivered his award lecture titled "Studies on applications of natural enemies and insect feed resources in Southeast Asia" during the event, received high praise for his research on introducing beneficial insects for biological control of insect pests and for providing a guideline for resource circulation from decomposition of food residues to produce livestock feeds. The results of his research have also provided important guidance for further studies on sustainable tropical agriculture management.

Dr. Nakamura receiving the Society Award certificate

Certificate of Appreciation from the Philippine Sugar Regulatory Administration

A six-member delegation led by Administrator Hermenegildo R. Serafica of the Sugar Regulatory Administration (SRA), Department of Agriculture, Philippines, visited JIRCAS Headquarters in Tsukuba and the Tropical Agricultural Research Front (TARF) in Ishigaki on February 4-10, 2018 to enhance the JIRCAS-SRA partnership and provide impetus to the current collaborative project. SRA also took the occasion to award a certificate of appreciation to the invaluable contribution of JIRCAS through the efforts of Dr. Toshihiko Anzai and Mr. Shinkichi Goto, the main project scientists, for developing sustainable sugarcane cultivation systems in the Philippines and for actively disseminating novel technologies and appropriate fertilizer application methods to local sugarcane farmers. The Philippine delegation also interacted with sugarcane scientists at TARF and visited sugarcane farms and a sugar factory in Ishigaki Island.

JIRCAS President Masa Iwanaga (center) receives the certificate of appreciation from SRA Board Member R. B. Beltran (left) and SRA Administrator H. R. Serafica (right).

RESEARCH OVERVIEW

OVERVIEW OF JIRCAS' 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' Fourth Medium to Long-Term Goals in FY 2016, including the maximization of R&D outcomes, the enhancement of research efficiency, and the improvement of financial performance. Based on the Fourth Medium to Long-Term Goals, JIRCAS drafted and began to implement a detailed five-year plan, the Fourth Medium to Long-Term Plan (FY 2016- FY 2020).

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 2017 as follows:

1) Research activities were evaluated, and summary reports were prepared in each Research Program.
2) These reports were then collectively evaluated at the meeting for the evaluation of research programs of the Medium to Long-Term Plan by external reviewers (government officials from the Ministry of Agriculture, Forestry and Fisheries and specialists from other research institutes) and internal reviewers (the President, the Vice-President, the Auditor, the Program Directors and the Directors of each research division) in February 2018.
3) Comprehensive evaluation of all JIRCAS activities, which also include administrative operations, was performed by external reviewers of the JIRCAS External Evaluation Committee in March 2018.

The external reviewers are listed in the Appendix. The results of the in-house evaluation and a summary of all activities were submitted to MAFF in June 2018.

5. Medium to Long-Term Plan

JIRCAS implements four 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 2017 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 Fourth Medium to Long-Term Plan (FY 2016 - FY 2020)

Program	Projects
A (Environment and Natural Resource Management)	4
B (Stable Agricultural Production)	4
C (Value-adding Technologies)	5
D (Information Analysis)	1

Fourth Medium to Long-Term Plan (FY 2016 - FY 2020)

■ Program A
Development of agricultural technologies for sustainable management of the environment and natural resources in developing regions

Projects:

1. Development of agricultural technologies for reducing greenhouse gas emissions and climate-related risks in developing countries
2. Development of intensive watershed management models for soil erosion-prone areas in Sub-Saharan Africa
3. Development of sustainable resource management systems in the water-vulnerable areas of Asia and the Pacific Islands
4. Development of ecologically sustainable agricultural systems through practical use of the biological nitrification inhibition (BNI) function

■ Program B
Technology development for stable production of agricultural products in the tropics and other adverse environments

Projects:

1. Development of sustainable technologies to increase agricultural productivity and improve food security in Africa
2. Development of breeding materials and basic breeding technologies for highly productive crops adaptable to adverse environments
3. Development of technologies for the breeding and utilization of promising high-yielding biomass crops in unstable environments
4. Development of technologies for the control of migratory plant pests and transboundary diseases

■ Program C
Development of high value-adding technologies and utilization of local resources in developing regions

Projects:

1. Formation of food value chain through value addition of food resources to support sustainable rural development
2. Development of saccharification and utilization technology for lignocellulosic biomass resources in Southeast Asia
3. Multiple use and value addition of regional resources for improvement of sustainable productivity in semi-mountainous villages in Indochina
4. Development of silvicultural and forest management techniques for indigenous tree species in Southeast Asia to achieve higher value production
5. Development of technologies for sustainable aquatic production in harmony with tropical ecosystems

■ Program D
Collection, analysis and dissemination of information for grasping trends of international agriculture, forestry and fisheries

Project:

1. Evaluation of global food supply-demand and nutritional balance

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' 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 121 MOUs or JRAs remained in force at the end of FY 2017.

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' 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.

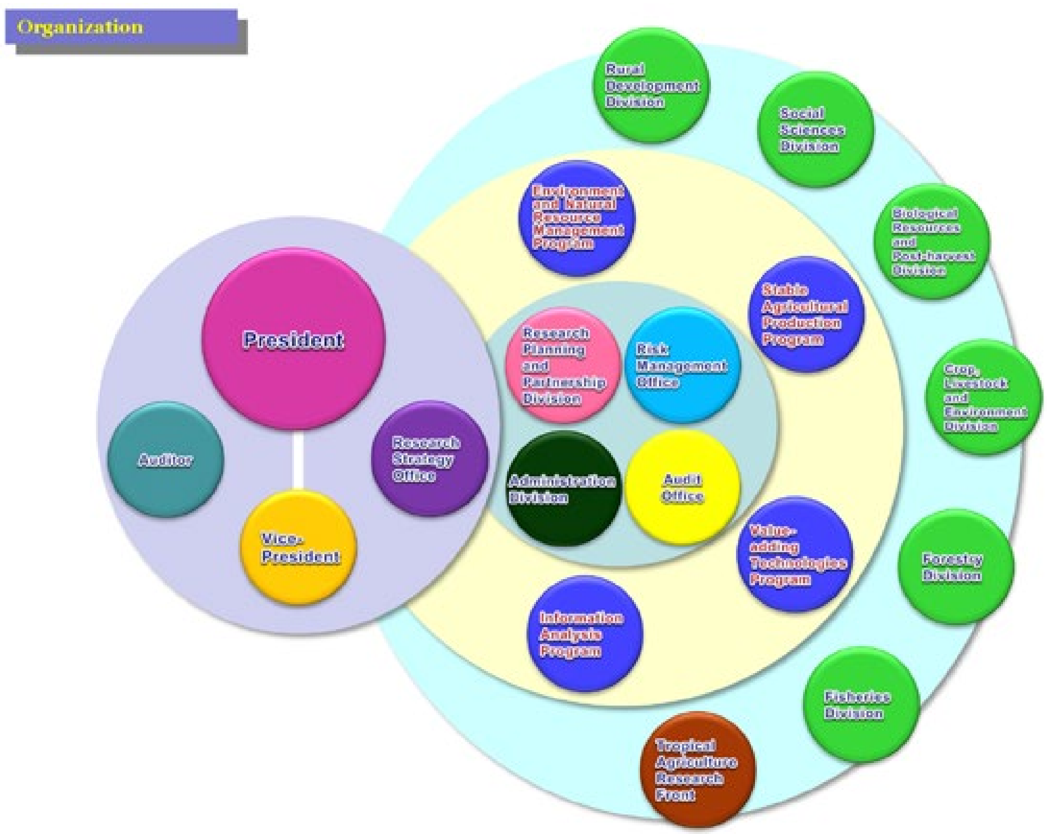
7. Organization of JIRCAS

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

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

The directors of divisions, offices, 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.



MAIN RESEARCH PROGRAMS

PROGRAM A
Environment and Natural Resource Management

"Development of agricultural technologies for sustainable management of the environment and natural resources in developing regions"

The Environment and Natural Resource Management Program aims at the development of technologies for sustainable management of agricultural resources to cope with global environmental issues, climate change and land/soil degradation, especially in vulnerable areas of developing regions.

[Climate Change Measures]

Greenhouse gas (GHG) emissions from agricultural ecosystems account for 14% of anthropogenic GHGs. The development of climate change mitigation technologies for the agricultural sector is therefore of great importance, with the percentage of agriculture-related GHG outputs consequently high in developing regions due to high agricultural activity, in addition to being vulnerable to extreme events caused by climate change.

We are conducting experimental studies in Vietnam and Thailand on new technologies to mitigate greenhouse gas emissions from agricultural activities. We compiled the results of farmers' triple-crop paddy field trials, in which we applied alternate wetting and drying (AWD) irrigation to seven crops from 2015 to 2017 in Mekong Delta, Vietnam. Results confirmed a significant decrease in methane (CH_4) gas emissions and an increase in rice yield in alluvial soils. We also observed a reduction in irrigation pump operating expenses, indicating that there is sufficient incentive for farmers to introduce AWD. Regarding animal husbandry, we confirmed the mitigating effect of feed containing cashew nut shell liquid on methane emissions from the rumen of local beef cattle in Vietnam. In northeast Thailand, we monitored GHG emissions from beef cattle manure storage and found the difference in CH_4 and nitrous oxide (N_2O) emissions over time through time-course experiments. Together with Thai counterpart organizations, we have jointly started compilation and analysis of carbon sequestration data from long-term field experiments in Thailand. We expect the results would contribute to the '4 per 1000' initiative.

We continued our research activities on adapting agriculture to climate change in countries that are vulnerable to extreme weather events. In Bangladesh, based on hydrological data and agricultural statistics, we identified the types of flood in each region and investigated the already existing adaptive technologies that ought to be developed for agricultural fields. In particular, we incorporated climate change projections into an existing model to define suitable areas for growing different rice varieties. In the Ayeyarwady Delta of Myanmar, we started designing a weather index-based insurance system by conducting a baseline survey on the target rural areas, characterizing them according to agricultural weather disaster and insurance demand. The type of flooding is associated with climate, topography, and infrastructure such as embankments and dikes. We also investigated the actual conditions of saltwater intrusion into the river and soil salinity/salt concentration. In the study on water use practices in the Central Dry Zone of Myanmar, we clarified the water use condition in the Yezin irrigation area. We developed an evapotranspiration model and simulated irrigation schemes to evaluate current water use. Regarding decision-making tools for rice farmers in vulnerable areas, WeRise, a product of Japan/IRRI cooperation, was introduced in the central part of Luzon Island in the Philippines to verify its applicability using suitable model parameters.

[Watershed Management in Africa]

This project aims to propose small scale watershed management models to contribute to sustainable and intensified land use in the Central Plateau of Burkina Faso and the Ethiopian Highlands, both of which are at greatest risk of experiencing land degradation in Sub-Saharan Africa. In Burkina Faso, in collaboration with INERA (Institut de l'Environnement et Recherches Agricoles), several prominent soil and water conservation technologies were studied. Tree planting using soil block nursery and soil mound combined with planting of *Andropogon gayanus*, a grass species native to the project site, would be effective in improving land resistance against deterioration for the higher slopes and middle slopes of the watershed, respectively. We have found that the main factor that limits the yield of sorghum, one of the main staple crops, was soil nutrient deficiency rather than soil moisture deficiency. In order to evaluate the impact of new technologies for conserving soil and water as well as increasing farmers' income, baseline data were obtained from intensive village surveys.

In the Ethiopian Highlands, the growth rate of native *Acacia etbaica* woodland species was shown to be extremely low. We have estimated the amount of sediment accumulated in a pond at the watershed terminus due to soil erosion in the pond area, and we propose that it could be utilized again as soil for vegetable cropping around the pond. Effective cropping technologies for 'conservation agriculture' practices were preliminarily applied in sloping uplands in the watershed. Participant observation by rural communities on-site revealed that social norms could influence local people's decision to enroll in communal land allocation programs that are effective to natural resource management in the watershed.

[Resource Management in Asia and the Pacific Islands]

Continuous measurement of water quality, quantity, and meteorological data have been launched in the watershed of Ngerikil River, Babeldaob Island in the Republic of Palau. Soil physical properties in some classified lands were also investigated, which were then used as input data in the Soil and Water Assessment Tool (SWAT) model. According to a GIS map-layered study, 9% of land areas are still occupied by annual grasses 70 years after Japanese immigrant farmers have abandoned the agricultural fields at the end of World War II. These fields were forest areas before the war. An experiment using artificial sloping fields at JIRCAS-Tropical Agriculture Research Front (TARF) in Ishigaki, Okinawa, revealed that a combination of minimum tillage and organic mulch is effective in reducing soil erosion. Results of experiments on nitrogen fertilizer application both in Ishigaki and Negros Islands, the Philippines, showed that delayed or reduced application of basal fertilizer did not affect sugarcane yield, and that nitrogen leaching decreased when application of basal fertilizer was reduced. Estimated values of NO_3-N leaching, sugarcane growth and yield coincided well with actual values in the APSIM (Agricultural Production Systems sIMulator) model. The model predicts that continuous application of harvested sugarcane stover into the fields increases organic carbon in soil even as sugarcane yield remains at the same level.

A modified version of the technical manual summarizing subsurface drainage applications to mitigate soil salinity was introduced to local farmers with the digest version written in local language (in Uzbek language). In India, research studies have been launched, including experiments on subsurface drainage using a "cutsoiler" and lysimeters, which are currently in preparation stage. The salt-tolerance gene, *Ncl*, was introduced into a local Indian soybean strain and progeny seeds were obtained. Salt-tolerant breeding has also been launched in Vietnam.

[BNI Utilization]

Incorporating the biological nitrification inhibition (BNI) function of plants into the agricultural system contributes to sustainable natural resource management through increased N-fertilizer use efficiency in crops and reduced NO_3-N leaching and N_2O emissions into the environment. We published a paper explaining the concept of genetic mitigation technology utilizing the function of BNI. The evaluation of BNI activity using synthetic wheat (AABBDD) suggested that factors of BNI exist in both D genome and AB genome. Field tests in ICRISAT in India using sorghum genetic stocks released different amounts of sorgoleone, a BNI substance, showing that the early growth of highly secreted stocks was superior. In addition, pot experiments in JIRCAS showed that N_2O emission was suppressed by 20% in genetic stocks with a large amount of sorgoleone release as compared with stocks with less amount of sorgoleone release. As for BNI in *Brachiaria* pastures, we developed a genetic population for evaluation of high-resolution markers for BNI ability and addition of new SSR markers. We also measured the parameters of soil nitrification activities etc. in the test fields established at the International Center for Tropical Agriculture (CIAT) headquarters in Colombia to compare the effect of grasses with different BNI abilities on second crops.

TOPIC 1

Continuous application of rice straw compost increases rice yield and contributes to carbon sequestration in paddy fields in the Mekong Delta, Vietnam

The Mekong Delta in Vietnam is the largest rice-producing region in Southeast Asia, contributing more than 20 million tons of rice annually. At present, many farmers in the Mekong Delta simply burn the rice straw in the field, incorporate it into the field after harvest, or ship a part of rice straw for mushroom cultivation. Continuous burning or removing of rice straw from the field may decrease soil organic matter content. Worse, the intensification of land use, combined with a reduced supply of nutrient-laden sediments caused by improved control of floodwater from the Mekong River, may exacerbate the decrease in soil fertility. We cultivated rice 31 times at twice a year (i.e., the dry season crop and the wet season crop) from 2000 to 2015, and evaluated the effects of continuous application of rice straw compost (RSC) on rice yield and total carbon in soil.

We applied RSC (6 Mg ha^{-1} as fresh weight for each crop) and several doses of chemical fertilizer to clarify their effects on rice yields and soil properties. We calculated the yields of treatments where RSC and moderate doses of chemical fertilizer (40% and 60% to a conventional dose) relative to those of the conventionally fertilized plots (i.e., with no added RSC) and analyzed their annual trends. The relative yields gradually increased from 2000 to 2010 (Fig. 1). The rice yields of the treatments where we applied RSC and moderate doses of chemical fertilizer (40% and 60% to a conventional dose) were 0.87 and 0.75 Mg ha^{-1} higher than that of the conventionally fertilized plots for the dry season, respectively, and 0.91 and 0.96 Mg ha^{-1} higher for the wet season on average from 2011 to 2015 (Fig. 2). Available silicon in soil samples from the surface layer (0-10 cm) in treatments with RSC was 10.4 mg kg^{-1} higher on average than that in treatments without RSC (Fig. 3). It seems that the increase of available silicon caused by RSC application contributed to the higher yields. Moreover, RSC application used in combination with moderate doses of chemical fertilizer increased total carbon in the soil at a rate of 356 to 401 kg C ha^{-1} year^{-1} (Fig. 4), indicating that tropical paddy fields can contribute to carbon sequestration.

The results indicate that continuous application of RSC increases rice yield in paddy fields in the Mekong Delta in Vietnam and that tropical paddy soil can contribute to the mitigation of global climate change by carbon sequestration. It is expected that our data will be harnessed by agricultural sectors and/or environmental sectors of the governments of Vietnam and other tropical Asian countries. Regarding the carbon sequestration function of tropical paddy soil, data from other tropical paddy fields needs to be incorporated. Although our RSC is fully fermented with low C/N ratio (less than 17.2), enhanced methane emission accompanied by

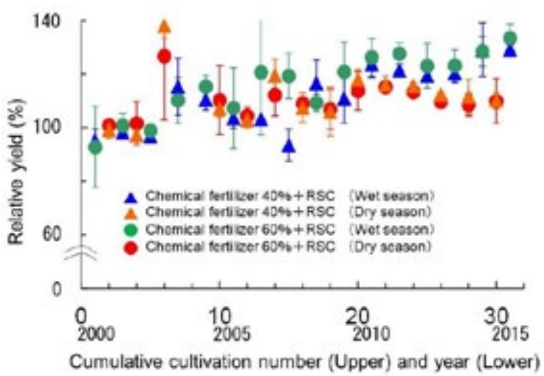


Fig. 1. Annual changes in relative yields.
Bars mean standard deviation (n=3), Relative yield (%) = Yield of treatment / Yield of conventional treatment x 100, For the conventional treatment, chemical fertilizer was applied (as N-P_2O_5-K_2O) without RSC at 80-30-30 (kg ha^{-1}) in the wet season and 100-30-30 (kg ha^{-1}) in the dry season.

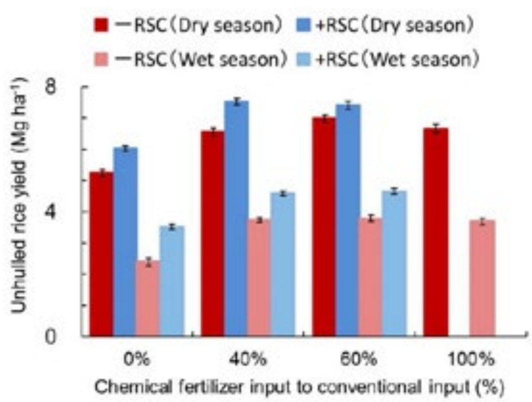


Fig. 2. Average yields for 5 crops (2011 to 2015).
Bars mean standard error (n=3), For the conventional treatment, chemical fertilizer was applied (as N-P_2O_5-K_2O) without RSC at 80-30-30 (kg ha^{-1}) in the wet season and 100-30-30 (kg ha^{-1}) in the dry season.

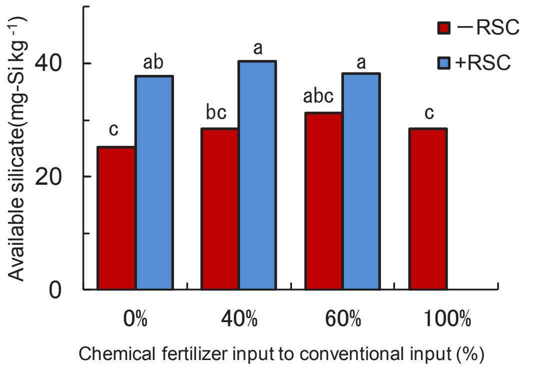


Fig. 3. Available silicon in the soil (0–10 cm) in the experimental paddy field following 25 seasons of rice cropping.
Data with the same letter does not differ significantly (Tukey $p<0.05$). The difference between the average of the +RSC (3 treatments) and average of the −RSC (4 treatments) was 10.4 mg kg^{-1}.

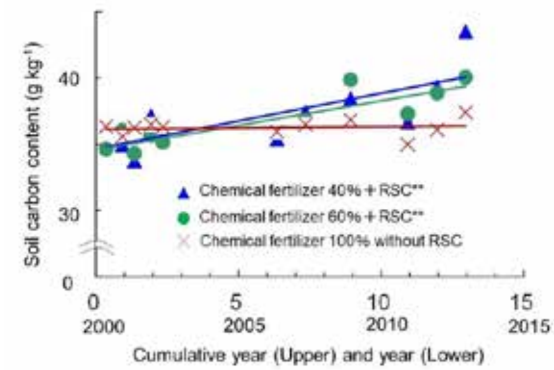


Fig. 4. Change in total carbon (g kg^{-1}) in the soil (0–10 cm) in the experimental paddy.
** indicates that the slope was significantly different from 0 ($p<0.01$). The carbon sequestration ratios (kg C ha^{-1} $year^{-1}$) in the text were calculated from the slopes and soil bulk density.

organic matter input in paddy fields should be considered. Siliceous fertilizer can be an alternative to RSC because it also increases available silicon. However, we need to conduct a cost-benefit analysis to examine its feasibility.

(T. Watanabe, H. M. Luu
[Cuu Long Delta Rice Research Institute])

TOPIC 2

Estimation of nitrogen load to groundwater at a sugarcane monocropping area in the Philippines

The Philippines is one of the major sugarcane-producing countries in Southeast Asia. In particular, a typical sugarcane monocropping area in Negros Island accounts for about 60% of cultivated land throughout the country. The soil in the area consists of a limestone layer with high water permeability, and although groundwater is an important water resource, the nitrogen that is added to the ground surface promptly permeates underground and contaminates groundwater. Therefore, we investigated the actual condition of nitrate nitrogen (NO_3-N) concentration in groundwater. Also, using the annual nitrogen emission data, we calculated the total input amount from various nitrogen inputs in the northern part of the island, which is a typical sugarcane-growing area, and estimated the contribution rate of each input. Lastly, we estimated the nitrogen balance and the potential nitrogen load to the ground due to nitrogen input to the ground surface.

A comparatively high concentration of NO_3-N (i.e., 5.6 ppm average, 8.7 ppm maximum) was detected from shallow groundwater (about 5 to 6 m from ground surface) at nine points in the research area (Fig. 1), indicating that the risk of nitrogen contamination is high (Fig. 2).

The sugarcane cultivation area constitutes 77% of land use. The fertilization area, number of livestock, population, and sugarcane cultivation area (Table 1) were assigned to each of the basic units (amount of nitrogen contained per unit amount) of fertilizer, livestock excreta, human excreta, and rainfall (which becomes nitrogen input to the ground surface) to obtain the total nitrogen input amount to the ground surface. The estimated total nitrogen input amount was 192 kgN ha^{-1} (155, 15, 12, 10 kgN ha^{-1}, respectively), of which 81% is nitrogen fertilizer applied in sugarcane cultivation (Fig. 3). Assuming that nitrogen loss through denitrification was 32% among nitrogen inputs to the ground surface (Yoshimoto et al., 2007), its amount was calculated to be 61 kgN ha^{-1}. In addition, from the measurement result of nitrogen absorption amount of stem and leaf, the nitrogen absorbed by sugarcane, and eventually taken out of the system as stem or leaf as harvest product, was 30 kgN ha^{-1} in the case of stem alone and 49 kgN ha^{-1} including leaf, which is equivalent to only 25% of the total nitrogen input amount. Based on these results and according to nitrogen balance estimation in this area, the potential nitrogen

出典：Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from http://srtm.csi.cgiar.org.

Fig. 1. Research area (Sagay City, Northern Negros Island)

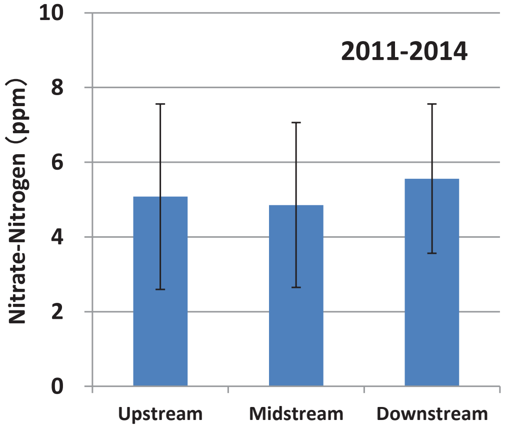


Fig. 2. Nitrate-nitrogen content in shallow groundwater (Error bars indicate standard deviation)

Table 1. Overview of the research area

Area of watershed (ha)	Area of sugarcane cultivation (ha)	Human Population	Animal Population	Amount of rainfall (mm/year)
3,422	2,629	6,577	6,607	1,985

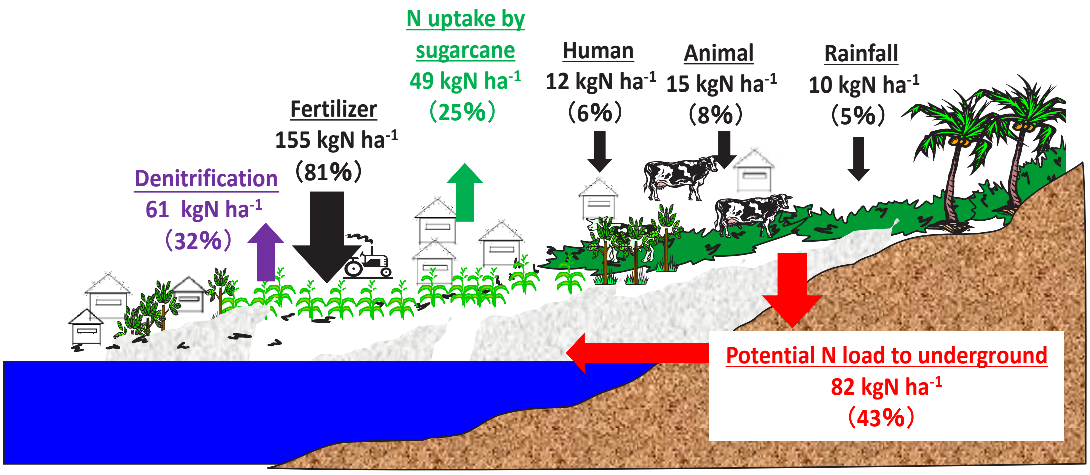


Fig. 3. Estimated nitrogen balance using nitrogen load to ground surface in the research area

load to the underground including surface runoff is lower than that of the nitrogen input to the ground surface when only the sugarcane stem is taken out, and 43% when taking out both stems and leaves of sugarcane (Fig. 3). In the sugarcane cultivation area, the contribution to the underground nitrogen load by fertilizer-derived nitrogen contributes greatly to the NO_3-N contamination of the groundwater. The safe upper limit set by the World Health Organization (WHO) for NO_3-N concentration in drinking water is 10 ppm. A maximum of 8.7 ppm of NO_3-N concentration in the groundwater in the area was detected, thus the amount of nitrogen load to underground should be reduced. It will serve as basic data that can be applied when considering steps to reduce the nitrogen load on the ground surface and underground in this area.

(S. Goto, S. Ando, T. Anzai)

Technical manual on building a low-cost, shallow subsurface drainage system for mitigating salinization

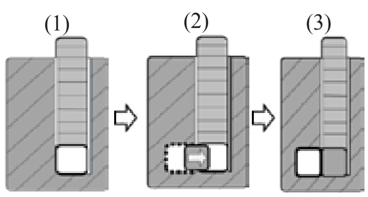
Agricultural productivity in the arid and semi-arid zones of Central Asia increased dramatically during the 1950s owing to large-scale development of irrigated land using the water resources of Amu-darya and Syr-darya Rivers. Simultaneously, however, inadequate water management and poor drainage have led to widespread salinization, especially over a large area in Uzbekistan causing serious damage to agricultural production. Several measures, such as constructing a drainage system, dredging of drainage ditches, and leaching operations to remove salt from farm fields, have been taken to mitigate salinization. Still, salinity levels have remained high in many farm fields as incomplete dredging operations, decreased discharge of deep subsurface drainage, and ineffective vertical drainage systems only had a minimal leaching effect. Thus, we proposed a shallow subsurface drainage technology to ensure effective salt removal (by leaching) from the surface soil layer. The technology was investigated in combination with a new drain drilling machine developed in Japan. The machine can construct relatively stable, low-cost mole holes (hereinafter referred to as "cut-drain") to depths between 60 to 90 cm from the surface. The cut-drain was initially applied in semi-arid areas for reducing salt loads from shallow subsurface drainage. The information gathered about the technology was later described and compiled into a technical manual after field experiments.

The manual is composed of the following sections, namely, "The mechanism of salt accumulation and countermeasures," "The factors of salinization in the experimental site," and "Shallow subsurface drainage technology." The contents are described in a simple manner and conveyed intelligibly using photos or illustrations (Fig. 1). The shallow subsurface drainage is explained in the manual according to the planning and construction method, the appropriate soil conditions (i.e., suitable soil texture and soil moisture), and problems (e.g., collapse of cut-drain) and its countermeasures. In the farm field where the shallow subsurface drainage technology was applied, high salinity water was discharged from the field to the open drainage (Fig. 2), decreasing soil salinity and subsequently resulting to an approximately 20% increase in cotton yield (Fig. 3).

The manual is expected to be applied in arid or semi-arid zones. Cut-drains should be constructed in areas where the soils meet certain texture and moisture conditions (i.e., the texture should have a low proportion of sand or silt, and it should not be too hard and dry). The manual was translated into Japanese, English, and Russian in agreement with the Farmers' Council (FC) and concerned research institutes in Uzbekistan. In addition, an abridged version was also translated into English, Russian, and Uzbek for field use. The drilling machine is relatively expensive for farmers. Therefore, FC has an important role to play in supporting farmers, such as providing easy access to use the machine.

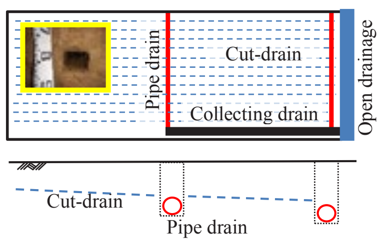
(Y. Okuda, K. Omori, J. Onishi)

Tractor-mounted drilling machine



(1) Cut a column of soil and push it up, creating space
(2) Cut a section of soil (side cut) and slide it into the space created in Step 1.
(3) Underdrain (cut-drain) is completed

Mole hole formation process



Design example of shallow subsurface drainage in combination with cut-drain
(Left photo shows cut-drain's hollow core.)

Fig. 1. Examples of photos and illustrations in the technical manual

High-salinity leach water is discharging into an open ditch.

Fig. 2. Outlet of collecting drain

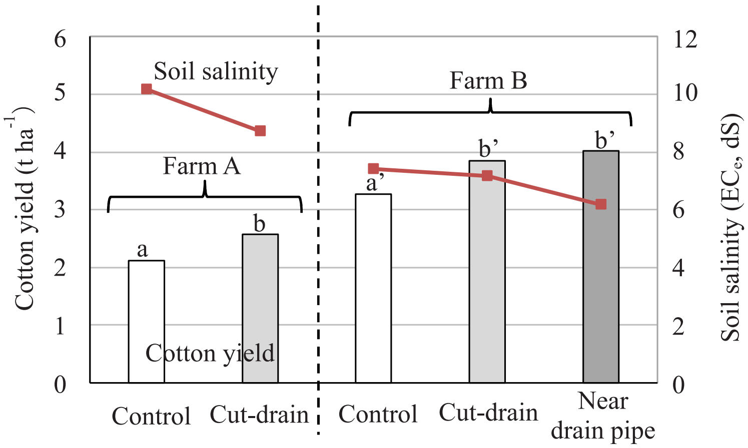


Fig. 3. Crop yield and soil salinity in the field with shallow subsurface drainage

Notes) ・Yield survey (Cotton) and soil sampling (0-100cm) were conducted in September 2017.
・Different alphabets of cotton yield show significant difference (Farm A: $p<0.05$, Farm B: $p<0.01$).
・Although soil salinity of cut-drain was lower than control, there was no significant difference.

TOPIC 4

Further insights into underlying mechanisms for the release of biological nitrification inhibitors from sorghum roots

Sorghum roots release two categories of biological nitrification inhibitors (BNIs) – hydrophilic-BNIs and hydrophobic-BNIs. Earlier research indicated that rhizosphere pH and plasma membrane (PM) H^+-ATPase are functionally linked with the release of hydrophilic BNIs but the underlying mechanisms are not fully elucidated. It was earlier hypothesized that BNIs are transported through anion channels but has not been confirmed. This study is designed to reveal further insights into the regulatory mechanisms of BNI release in root systems using three sorghum genetic stocks. The findings are as follows:

- The levels of sorgoleone (a hydrophobic inhibitor) in root dichloromethane (DCM) wash are positively correlated (Fig. 1).
- A decrease in rhizosphere pH improved the release of hydrophilic-BNIs from the roots of

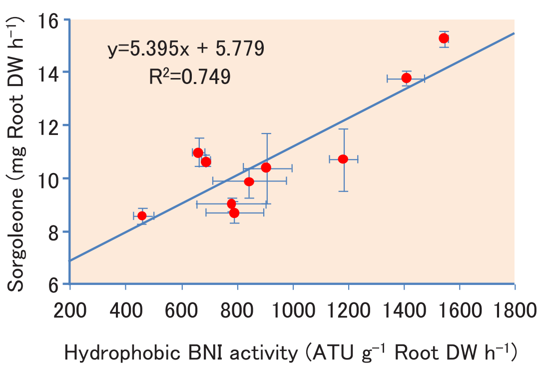


Fig. 1. Relationship between hydrophobic-BNI activity and sorgoleone levels

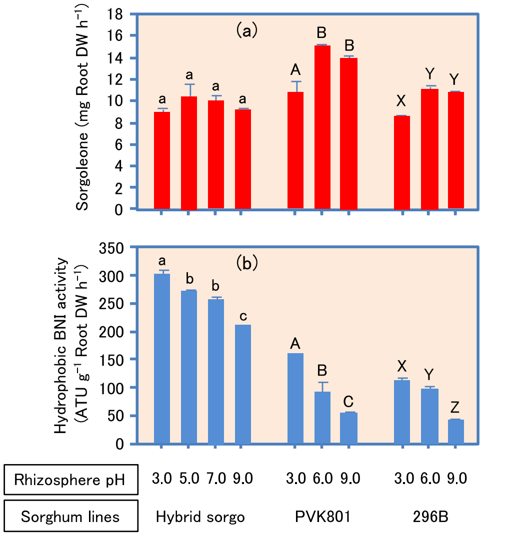


Fig. 2. Rhizosphere pH influence on the release of sorgoleone (a) and hydrophilic nitrification inhibitors (b) from sorghum roots, respectively

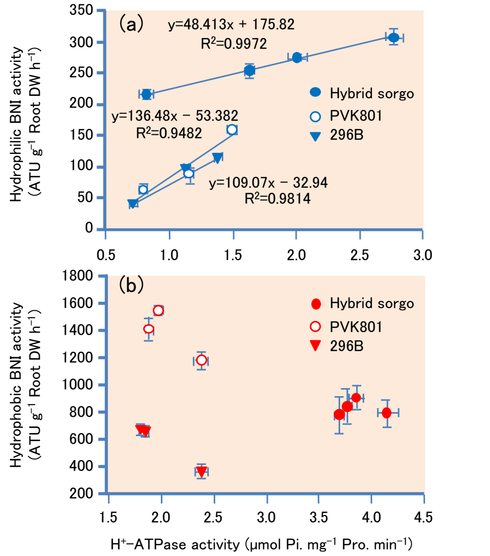


Fig. 3. Relationship between PM H+-ATPase activity and hydrophilic (a) or hydrophobic (b) BNI activity, respectively, in root systems of sorghum

all three sorghum genotypes but had no effect on the release of hydrophobic-BNIs (Fig. 2).

- Fusicoccin, a stimulator of PM H^+ ATPase phosphorylation, promoted H^+ extrusion and stimulated the release of hydrophilic-BNIs. Vanadate, an inhibitor of PM H^+ ATPase phosphorylation, in contrast, suppressed H^+ extrusion and lowered the release of hydrophilic-BNIs.
- The release of hydrophilic-BNIs is positively linked with PM H^+-ATPase activity levels in sorghum roots (Fig. 3a). However, statistical analysis indicates no relationship between PM H^+ ATPase and hydrophobic-BNI release in sorghum root systems (Fig. 3b).
- Anion-channel blockers did not inhibit the release of hydrophilic BNIs, but enhanced H^+-extrusion and hydrophilic-BNIs release. These results indicate that some unknown membrane transporters are operating the release of protonated BNIs, which may compensate for charge balance when transport of other anions is suppressed.

Sorgoleone release from root systems contributes to about 50% of the BNI potential in sorghum roots. The pH insensitivity for sorgoleone release will have implications for BNI-trait expression in soil types with low buffering capacity. Genetic improvements in sorgoleone release can thus result in future sorghum varieties with high-BNI capacity in root systems where the trait is expressed in a range of soil types with varying pH, thus can have wider adaptation to low-N production environments with improvements in agronomic nitrogen use efficiency (NUE).

(G. V. Subbarao, T. Di, T. Yoshihashi, M. R. Afzal [Nanjing Agricultural University], Y. Zhu [Nanjing Agricultural University], S. Deshpande [International Crops Research Institute for Semi-Arid Tropics])

PROGRAM B
Stable Agricultural Production

“Technology development for stable production of agricultural products in the tropics and other adverse environments”

In developing regions including Africa, agricultural production potential has not been sufficiently realized because of adverse conditions such as low soil fertility and drought. Consequently, food and nutrition security has remained relatively low. This program, therefore, aims to enhance agricultural productivity and improve nutrition in developing countries through technology development for stable production of agricultural products in the tropics and other adverse environments.

[Development of sustainable technologies to increase agricultural productivity and improve food security in Africa]

Goal 2 of the United Nations’ 17 Sustainable Development Goals (SDGs) aims to “end hunger, achieve food security and improved nutrition, and promote sustainable agriculture.” A critical challenge toward meeting this goal is overcoming food shortage in Sub-Saharan Africa (SSA), where 215 million people are currently undernourished.

Program B’s flagship project, titled “Development of sustainable technologies to increase agricultural productivity and improve food security in Africa,” was launched and currently being implemented under the Fourth Medium to Long-term Plan period to tackle this huge challenge in front of us. The project aims to contribute to improving food security in SSA using the various outputs of our research activities in collaboration with national and international research institutions.

The planned research for this flagship project was based on three major premises, namely, to improve sustainability with efficient utilization of resources, to utilize unused germplasm efficiently, and to capture the preferences of consumers and needs of farmers. Moreover, the research activities were conducted and differentiated into three sub-themes as follows.

1. Rice production enhancement

For this sub-theme, we focused on generating essential components for efficient rice production in SSA. We have been breeding materials with improved nutrient uptake, developing a simple method for diagnosing soil nutrient conditions, and adopting smart fertilizer management strategies specific to each soil and environmental condition while examining their integration and adaptation. Other challenges under this sub-theme include the development of technologies to improve water use efficiency such as channeling excess water for rice irrigation, and impact assessment and factor analysis of farmers’ acceptance of these new technologies. In FY 2017, we carried out our research and obtained the following results.

We are maintaining progress toward our goal of developing breeding materials that have superior adaptability to low fertility soils leading to high yield by using genes that improve utilization efficiency of nutrients such as phosphorus and nitrogen. Thus far, we have successfully developed notable rice lines harboring a gene that improves nitrogen utilization. The gene *OsACTPK1* regulates the absorption capacity of ammonia nitrogen, and we were the first in the world to identify this gene function. It is known that the absorption capacity of ammonia nitrogen by rice roots decline when the concentration of ammonia nitrogen increases in the paddy field, and the gene was discovered to be the key regulator of this reaction in rice. In the *actpk1* mutant in which the function of this gene was lost, it was revealed that the total absorption of nitrogen increased because the absorption capacity of ammonia nitrogen did not decline even under conditions of high ammonia nitrogen concentration.

In other activities, we revealed the genetic variation of blast resistance in rice germplasm from West Africa. We also developed a highly accurate method of estimating soil nitrogen and carbon content, and obtained excellent results toward improving soil fertility and establishing cultivation methods that enhance nitrogen and phosphorus fertilizer use efficiency. Furthermore, we proceeded with the verification of field applicability and prepared dissemination conditions for the developed technology related to water use. The breeding materials in development will be proposed to the Breeding Task Force (BTF) through AfricaRice for rapid variety dissemination through their scheme, while the cultivation techniques will be shared for dissemination by local extension organizations, etc.

2. Regional crop utilization

Cowpea and white Guinea yam are two important regional crops in West Africa, and they still hold tremendous potential for improving productivity and quality through utilization of unused genetic resources. As for improving the quality of the product, these diverse genetic resources must be compatible with various demands that are deeply linked with regional culture and tradition. We are exerting efforts towards active utilization of the extensive genetic diversity of both crops in international and national breeding programs, by aiming to generate fundamental information of their genetic diversity to explore useful parental materials and by developing tools to enable breeders to select and evaluate their materials effectively.

In FY 2017, we started genetic analysis on the key traits of yam based on the various phenotyping data generated though field trials with rich genetic resources. Genetic analysis of cowpea is also in preparation. To improve the quality of phenotyping data, several improved methods for evaluating genetic resources were developed, such as the nondestructive evaluation tool for above-ground biomass in cowpea and yam, the rapid method of estimating transpiration rate in cowpea, and the improved software for characterizing cowpea grain traits and for evaluation of browning in yam tubers. On yam, which is one of the main agricultural products of West Africa, we decoded the whole genome sequence ahead of the world. And further, using the obtained genomic information, the genomic region that determines the sex of Guinea yam was identified. We think that breeding of this crop can be accelerated by using sex-specific markers at this locus.

3. Crop-livestock integration

In tropical savanna areas with distinct rainy and dry seasons, we aim to develop an effective and efficient crop-livestock integration model by enhancing the utilization of natural resources leading to an increased and stable (year-round) dairy production and a sustainable agricultural system. To link crop and livestock, which are the two main components of the model, we are developing technologies toward stable production of animal feeds utilizing byproducts of crop production and food processing. On the other hand, to improve food crop production and achieve sustainable forage crop production by farmers, we are also developing a soil fertility management method that will enable the utilization of wastes from livestock farming. In FY2017, we determined Southern Mozambique to be the target area for our crop-livestock integration model, and we have started investigation of available technologies such as silage preparation method, etc.

[Development of breeding materials and basic breeding technologies for highly productive crops adaptable to adverse environments]

In order to establish stable and sustainable production of agricultural crops in developing countries vulnerable to climate change, drought, high salinity, and poor soil, we are now working on the development of breeding materials and basic breeding technologies to come up with highly productive crops that are adaptable to such adverse environments. For rice, we aim to develop breeding materials that have high temperature resistance, drought tolerance, phosphate deficiency resistance, and high nitrogen use efficiency. For soybean, development of breeding materials that are tolerant to drought and high salinity will be undertaken. In addition, we are aiming to develop a double haploid breeding technology, a non-GM crop production technology, and a growth evaluation method in a greenhouse that mimics the stress conditions of farm fields. In FY2017, we focused on the following research:

1. For the development of crops adaptable to adverse environments, the genes involved in nitrogen utilization efficiency have been introduced into Philippine rice varieties, and an on-site adaptation test of near isogenic lines of the genes has been started. We have revealed that there was an increase in the yield of rice lines containing the genes involved in improving nitrogen utilization efficiency even in the field.
2. Continuing from the last fiscal year, we introduced a salt tolerance gene into Chinese soybean varieties. Also, we have narrowed down the locus of genes involved in controlling soybean root length.
3. Growth evaluation and gene expression of mutants of genes involved in drought tolerance of soybean were examined. In soybean, suppressing the expression of *GmERA1* gene promoted a physiological response to drought stress, and it was clarified that drought tolerance was improved.

[Development of technologies for the breeding and utilization of promising high-yielding biomass crops in unstable environments]

In this project, we aim to develop sustainable cultivation methods and utilization technologies for multi-purpose use of high-yielding biomass crops such as multi-purpose sugarcane and *Erianthus*, which is a wild relative of sugarcane tolerant to unstable environmental conditions. We also aim to develop new breeding materials that produce high biomass yield in several unstable environments through intergeneric hybridization between sugarcane and *Erianthus*. For this purpose, we are establishing techniques for evaluating important characteristics related to biomass production of *Erianthus* in stress conditions and for selecting intergeneric hybrids using DNA markers. In FY2017, we focused on the following research:

1. For the development of sugarcane with excellent root penetration ability, we developed a method for evaluating root penetration ability of sugarcane and others by quantifying the proportion of roots penetrating the layer of wax embedded in the soil in the pot.
2. In order to perform diverse intergeneric crosses between early heading *Erianthus arundinaceus* varieties collected in Japan and sugarcane, we developed a technique to delay the early heading of *Erianthus arundinaceus* using lighting treatment.
3. In Thailand, we obtained biomass productivity data on promising BC_1 lines, which were the first backcross progenies of the intergeneric F_1 hybrids between sugarcane and *Erianthus* in plant cane. We also created and propagated BC_2 populations, which were the second backcross progenies.
4. The phylogenic relationship of *Erianthus*, *Miscanthus,* and *Saccharum* was clarified based on chloroplast genome information. We also elucidated the genetic characteristics of *Erianthus arundinaceus* collected from Japan and developed simple sequence repeat (SSR) markers. The SSR markers can be used for the identification of intergeneric hybrids such as sugarcane × *Erianthus*.
5. In collaboration with the National Agriculture and Food Research Organization (NARO), Japan, and other organizations, we have succeeded in finding practical applications of our research through development and commercialization of the "regional self-sufficiency fuel" made from JES1, which was a new *Erianthus* variety developed by JIRCAS and NARO.

[Development of technologies for the control of migratory plant pests and transboundary diseases]

Some insect pests and diseases spread transboundary and damage crop production. Against rice planthoppers, we are obtaining information on their occurrence, insecticide resistance, natural enemies, and the resistance of rice varieties in order to develop control techniques. Against desert locusts, we are elucidating the factors that provoke phase polyphenism -- from solitary to gregarious form -- by conducting field observations. Against sugarcane white leaf disease, we are developing an integrated pest management method for healthy seed cane production based on the ecology of the vectors. Through international research networks that have been constructed by JIRCAS, we are developing rice breeding lines resistant to blast disease for Asia by incorporating field resistance genes that are expected to be stable, and soybean cultivars resistant to rust disease for South America by pyramiding resistant genes. In FY2017, we focused on the following research:

1. We have surveyed the population dynamics of rice planthoppers and collected data on the cultivated varieties and the farmers' insecticide application methods in the northern part of Vietnam. In addition, we have identified the environmental factors related to phase polyphenism of desert locusts.
2. Based on the results of experiments, we selected dinotefuran as a highly effective insecticide against a vector insect of sugarcane white leaf disease. The pesticide can be used in the development of a technology to reduce the risk of infection of the disease by the vectors in healthy seedcane propagation fields.
3. A new set of differential varieties consisting of 20 kinds of true resistance genes with a susceptible line US-2 genetic background was developed, and these effects were evaluated using international standard differential blast isolates. For the genetic improvement, hybrid populations introducing partial resistance genes into promising Indica Group rice, such as IR 64 and leading cultivars in Asian countries, were continued.
4. We evaluated the resistance of soybean lines by pyramiding of soybean rust-resistance genes.

Genetic variation of blast resistance in rice germplasm from West Africa

Blast disease caused by the fungal pathogen *Pyricularia oryzae* Cavara is one of the most serious rice diseases worldwide, significantly damaging rice production. Development of cultivars resistant to blast is considered the most effective strategy for protecting the crop, and in West Africa, it is the most economical and effective way of controlling rice blast in the fields of resource-poor farmers. Unfortunately, effective and durable use of blast resistance is limited because the genetic information for resistance to blast disease in rice germplasm from West Africa is quite poor.

To understand the genetic variation and enhance the genetic improvement of rice cultivars in West Africa, we used Simple Sequence Repeat (SSR) markers to investigate the genetic diversity in rice accessions, such as *O. sativa* including interspecific hybrids (NERICA varieties *O. glaberrima* and *O. barthii*), and then evaluated the blast resistance of these accessions. Moreover, we elucidated the relationships between blast resistance and the genome chromosome components of the rice accessions, and discussed the diversity of rice germplasm.

We used 195 rice accessions (Table 1), including *O. sativa* L. (114 accessions), *O. glaberrima* (45), *O. barthii* (5), and differential varieties (DVs) and controls for blast resistance (31), which included two susceptible controls (Lijiangxintuanheigu: LTH and US-2), a Japonica Group cultivar (Nipponbare), and an Indica Group cultivar (Kasalath).

These accessions were classified into three clusters -- the Japonica Group (A), Indica Group (B), and *O. glaberrima* and *O. barthii* (C) -- based on the polymorphism data of 61 SSR markers. Moreover, these were classified again into 3 clusters for resistance -- low (Ia), middle (Ib) and high (II) -- based on its reactions to 32 international standard differential blast isolates. The resistant group Ia included Nipponbare, LTH, US-2, and five DVs that were lowly

Table 1. Classification of rice accessions from West Africa based on the polymorphism data of DNA markers and the genetic variation in resistance to blast disease

Cluster group based on polymorphism data of SSR markers and species		No. of accessions (%)						
		Blast-resistant group						
		Ia		Ib		II		Total
Germplasm form West Africa	A			Upland	4	Upland	15	37
				Upland NERICA	3	Upland NERICA	15	
				O. barthii (Upland)	1	*O. barthii* (Upland)	1	2
	Sum		0		8		31	39
	B			Lowland	4	Lowland	30	77
				Upland	1	Lowland	2	
						Lowland NERICA	40	
				O glaberrima (Lowland)	3	*O. glaberrima* (Lowland)	1	4
				O. barthii (Upland)	1	*O. barthii* (Upland)	1	2
	Sum		0		9		74	83
	C			*O. glaberrima* (Upland)	8			41
				O. glaberrima (Lowland)	33			
				O. barthii (Upland)	1			1
	Sum		0		42		0	42
Sum in each species	*O. sativa*	0		12(10.5)		102(89.5)		114
	O. glaberrima	0		44(97.8)		1(2.2)		45
	O. barthii	0		3(60.0)		2(40.0)		5
	Total	0(0.0)		59(36.0)		105(64.0)		164(100.0)
Differential varieties and controls	A	Japonica Group differential varieties, *Pik-s, Pish, Pi19*(t))	4	Japonica Group differential varieties, *Pik-h, Pib, Pit, Pii, Pi3, Pi5*(t), *Piz, Piz-5, Pik-m, Pik-p, Pi1, Pi7, Pi12*(t), *Pi20*(t), *Pita*(2), *Pita-2*(2))	19	Japonica Group differential varieties (*Piz-t, Pi9*)	2	
		Nipponbare (Japonica Group)	1					
		LTH (Japonica Group susceptible)	1					
	Sum		6		19		2	27
	B	US-2 (Indica Group susceptible)	1	Kasalath (Indica Group)	1			
		Indica Group differential variety (*Pi12*(t))	1	Indica Group differential variety (*Pi5*(t))	1			
	Sum		2		2			4
	Total	8(25.8)		19(61.3)		2(6.5)		31(100.0)

Clusters A and B are corresponded to Japonica Group and Indica Group, respectively, in *O. sativa*, and cluster C includes *O. glaberrima* and its wild relative *O. barthii*.
Group II is highly resistant, and Ib and Ia follow as middle and lowly resistant group, respectively.

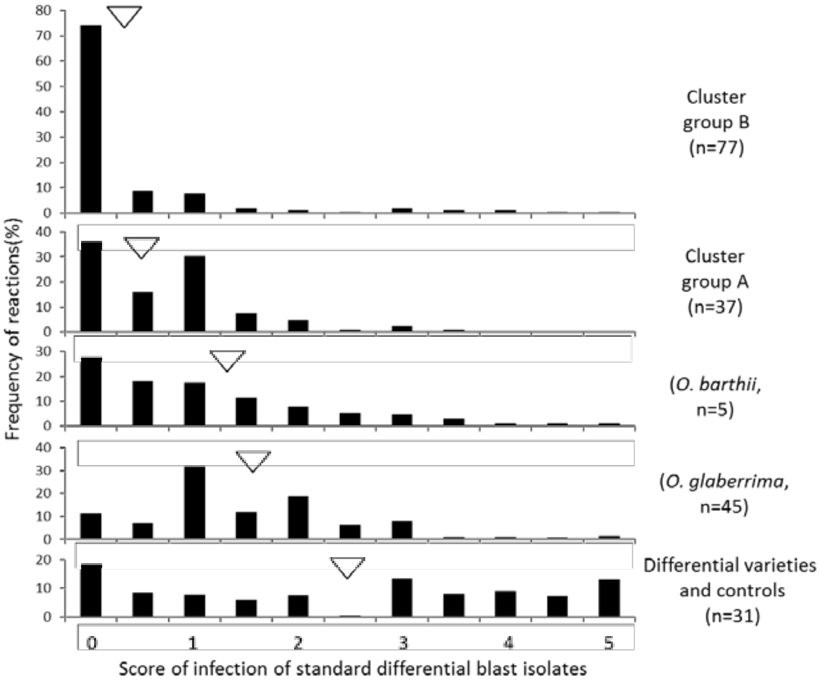


Fig. 1. Resistance of rice accessions from West Africa in each variety group.
The reaction data of rice accessions to 32 standard differential blast isolates are shown in each cultivar group (The data was modified from Odjo et al. 2017).

resistant. Group Ib had many DVs and accessions from cluster C, and group II were accessions of *O. sativa* including mainly lowland and upland NERICA cultivars. Many accessions of *O. glaberrima* were categorized into resistant group Ib, and their resistance were lower than those of lowland and upland cultivars of *O. sativa* and *O. barthii* (Fig.1).

These results clearly demonstrated the genetic variation of rice accessions from West Africa, and the relationships among cultivars of *O. sativa* and *O. glaberrima* and of wild rice *O. barthii.* The information will be useful for the genetic improvement of rice cultivars in West Africa.

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TOPIC 2

Whole genome sequence of Guinea yam (*Dioscorea rotundata*) and development of a DNA marker for sex determination

Yam (*Dioscorea* spp.), a widely cultivated tuber crop in Africa, Asia, and South America, serves as a key food source for people in those regions. However, yam breeding has remained ineffective, constrained by the crop's unique inherent attributes including a long growth cycle, dioecy (i.e., having separate male and female plants among varieties), polyploidy, high heterozygosity, and inconsistent year-to-year fluctuations of various traits. Regarding crop characteristics, the use of advanced genetic tools and resources retains enormous potential to boost the breeding efficiency of yam.

As an initial attempt, we focused on Guinea yam (*D. rotundata*), which is one of the most important species for regional food security and farmer income generation especially in West Africa (Fig. 1). Based on our genome analysis of *D. rotundata*, a 594 Mb of genome sequence was successfully assembled. The results of gene prediction using the genome sequence showed a total of 26,198 genes in *D. rotundata* (Fig. 2). By comparison with other known model plant species, 5,557 *D. rotundata* genes were identified with orthologous relationship to the

Fig. 1. Yam cultivation field (left) and tubers being sold in the market (right).

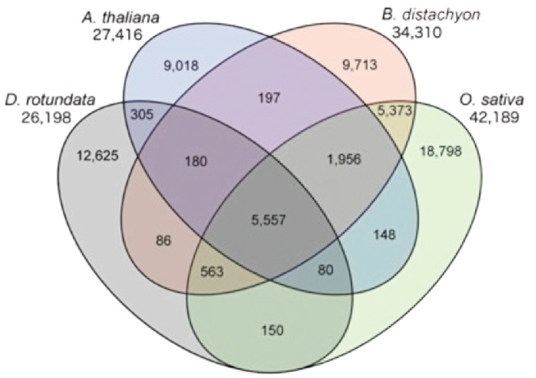

Fig. 2. Venn diagram showing conserved and unique genes at 1:1 correspondence among *D. rotundata*, *Arabidopsis thaliana*, *Brachypodium distachyon*, and *Oryza sativa*. Total gene counts in each genome are given below the species name.

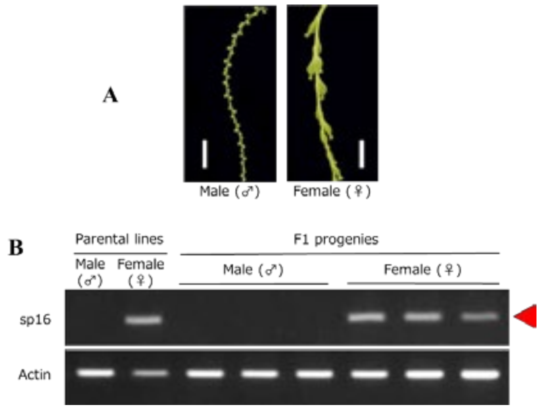

Fig. 3. Sex discrimination by the DNA marker developed in this study. **A**: Male and female inflorescence of *D. rotundata*. Bars = 10 mm. **B**: Results of agarose gel electrophoresis of PCR products amplified by DNA marker sp16 (sp16). Actin from *D. rotundata* (Dr-Actin) served as a control to show that template DNA was present for all samples.

B. distachyon, *O. sativa*, and *A. thaliana* gene models. On the other hand, 12,625 *D. rotundata* genes were uniquely found in *D. rotundata* (Fig. 2). The *Dioscorea* genus is characterized by the occurrence of separate male and female plants (dioecy), a feature that has limited efficient yam breeding. To infer the genetics of sex determination, we performed whole-genome resequencing of bulked segregants (quantitative trait locus sequencing [QTL-seq]) in F1 progeny segregating for male and female plants, and identified a genomic region associated with sex determination. Based on the result, a molecular marker for sex identification of *D. rotundata* was developed, enabling us to discriminate male and female plants at the seedling stage (Fig. 3).

The genome sequence information obtained in this work is expected to greatly accelerate the genetic analysis of *D. rotundata* and relative yam species. While the use of a DNA marker for sex identification should immediately contribute to yam breeding for selection of suitable parental materials at the seedling stage, the effectiveness of the QTL-seq approach demonstrated in this study in outcrossing crops and organisms with highly heterozygous genomes should likewise boost the application of genetic analysis in orphan crops such as yam. This in turn could help contribute to food security and improve the sustainability of tropical agriculture.

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TOPIC 3

Topographical selection and sulfur application enable high grain yields in rice in currently unutilized floodplain ecosystems of northern Ghana

River floodplains in West Africa, most of which are not currently used for farming, are potential land resources for extending rice cultivation areas. The major constraints that limit expansion of crop production in floodplain areas include difficulties in water management and lack of access to tractor services for land preparation at the appropriate timing for planting. In addition, our previous soil survey and pot experiments indicated severe sulfur (S) deficiency for rice production in these land resources (JIRCAS Research Highlights 2012; available at https://www.jircas.go.jp/en/publication/research_results/2012_14). However, there have been no empirical data to demonstrate the potential of rice cultivation in floodplain ecosystems in West Africa. Therefore, three years of field experiments were conducted in no-till and no-bund conditions to determine rice productivity and the responses to different fertilizer applications on various topographical positions in the floodplain ecosystem.

Fig. 1. Natural flooding during rainy season in the floodplain ecosystem of Volta river (near L1)

The experimental results are summarized as follows:

- The target floodplain ecosystem is seasonally flooded in nature, without bunding nor an irrigation system (Fig. 1).
- Unutilized land areas with carbon-rich soils are found within 400 m radius of water reservoirs, i.e., back swamps and main river (Fig. 2).
- Rainfall varied widely, with heavy rainfall during the initial growth stage in 2012, a long dry spell during the middle stage in 2013, and consistent rainfall in 2014.
- Grain yields are consistently high in the currently unutilized lowlands close to water reservoirs (L1-L4) under various rainfall conditions and achieve up to 5.4 t ha^{-1} with N and S application (Fig. 3).

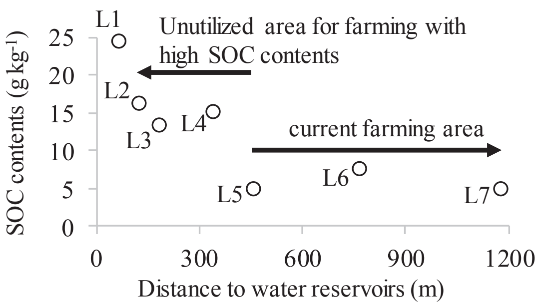

Fig. 2. Distance to water reservoirs and soil organic carbon (SOC) contents of seven experimental fields

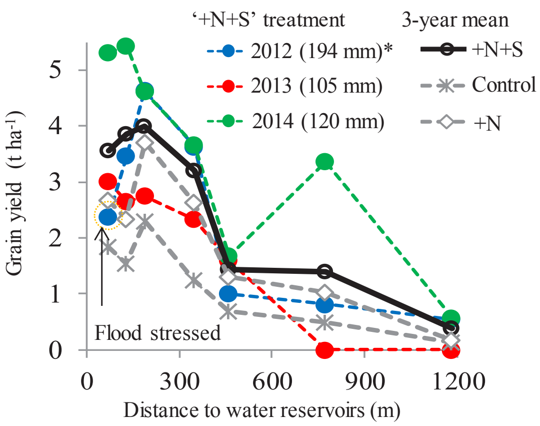

Fig. 3. Effect of topographical condition and fertilizer management on rice yield
*Cumulative rainfall for a month during the initial growth stage from June 15 to July 15. The value was highest in 2012 in our observation from 2010 to 2015. In 2012, the L1 field was completely flooded for 6 days just after emergence.

Table 1. Effect of topographical positions and S application on the agronomic N use efficiency

Treatment*	L1	L2	L3	L4	L5	L6	L7	mean
+N	14.0[b]	11.0[b]	23.6[a]	23.0[b]	8.7[a]	8.8[b]	0.6[b]	13.4[b]
+N+S	28.8[a]	32.1[a]	28.4[a]	32.6[a]	10.2[a]	15.0[a]	4.0[a]	22.8[a]

Values with the same alphabets indicate no significant differences by Tukey HSD (5%). Values are shown as the mean of three experimental years.

*N was applied at the rate of 60 kg ha^{-1} either as urea or ammonium sulfate. S was applied at the rate of 10~68 kg ha^{-1} as ammonium sulfate or sodium sulfate of which any types or amounts had equivalent effect on rice production.

- Sulfur application enhances agronomic N use efficiency (AE_N) from 13.4 to 22.8 kg grain per kg N applied, and its effect is particularly large in the currently unutilized lowlands (L1-L4) with AE_N values ranging from 28.4 to 32.6 (Table1).
- The grain yields and agronomic N use efficiencies of L1 to L4 are as high as those in irrigated paddy fields in West Africa.

Based on these results, it is concluded that cultivation of rice in the currently unutilized floodplain areas offers good opportunities to increase rice production in West Africa. It should be noted that more quantitative risk analysis for the yield reduction by complete submergence and infrastructural enhancement for the tractor access will be required to facilitate the use of these land resources.

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TOPIC 4

Reinforcement technology that can be applied by farmers themselves using ground-cover plants for irrigation facilities in paddy fields

In Ghana, locally produced rice comprises only 34% of consumption, resulting in the importation of the remaining 66%. It is thus necessary to improve paddy rice productivity, and irrigation facilities in paddy fields play an important role in achieving sustainable irrigated rice cultivation. However, irrigation facilities in inland valleys in Ghana have not performed efficiently due to high intensity rainfall and poor maintenance. According to the 1995 FAO Report, 40% soil surface coverage reduced raindrop erosion by 90%. Thus, a reinforcement technology using ground-cover plants to prevent raindrop erosion is being developed in accordance with research policy on preventive maintenance.

Local species are recommended as ground-cover plants as they minimize the impacts on ecosystems and overcome the psychological obstacles for the farmers. Vegetation around paddy field irrigation facilities are relatively resistant to changes in soil hardness and soil moisture, and therefore, has advantages over other plants. The targets of this technology are the levees and irrigation canals at paddy fields and, more specifically, the slopes and crowns of canals except for the wetted perimeter. Ground covers are planted by cuttage (i.e., propagation by plant parts) in a zigzag pattern at 15cm intervals. Local farmers are already familiar with this through rice transplanting, hence they can develop and manage it themselves (Fig. 1). Figure 2 shows that cover plants, especially "*Chrysopogon aciculatus,*" strengthen the soil around the irrigation facilities. Employing this technology, therefore, will eventually establish a dense plant community, which in turn will improve the facilities' functionalities and durability (Fig. 3). The planting will be scheduled based on farmers' viewpoint with due consideration to the following: 1) the dry season from Dec. to Feb. must be avoided as root extension growth tends to be difficult under the hardened topsoil, 2) the agricultural off-season is from Nov. to Mar. when the farmers themselves undertake planting work and implement plans to reduce construction costs, 3) the end of the longer rainy season from Jul. to Nov. promises moderate water supply to rice without significant raindrop impact (Fig. 4). The total cost of implementing this technology, including maintenance costs per 100m of irrigation canal in 10 years, is equal to

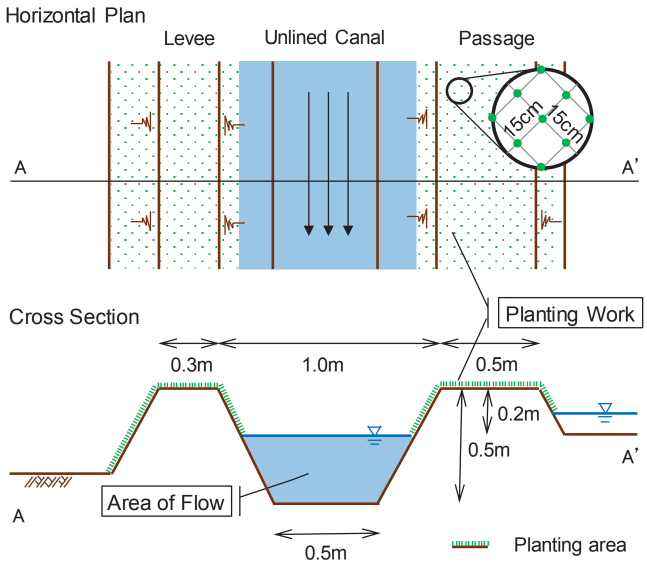

Fig. 1. Standard design of the reinforcement technology

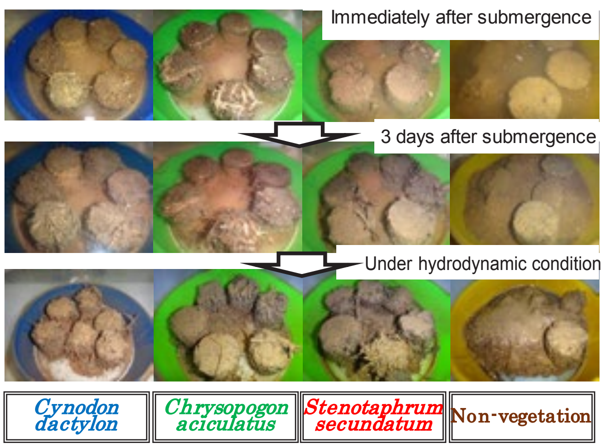

Fig. 2. Grade and process of collapse between three test plants and under non-vegetation condition

Fig. 3. Test canal 6 months after installing.
Left: Canal without vegetation
Right: Canal planted with ground covers

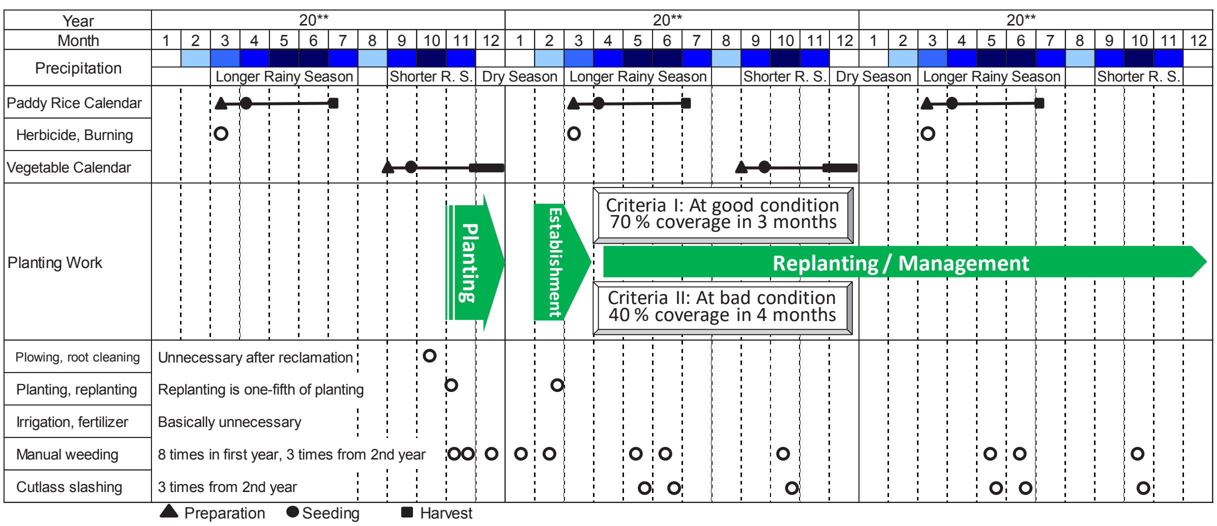

Fig. 4. An example of a construction schedule and maintenance plan for this technology

the current cost of an unlined canal or 50% cost of a concrete-lined canal. Moreover, farmers do not need to spend cash if they install the reinforcement technology by themselves.

This technology is expected to be applied in West Africa where high intensity rainfall is common and irrigation facilities are poorly maintained. Prior to implementation, native plant characteristics will be elucidated and plants preferred by farmers would be selected. Control strategies will be identified and established before introducing new plants so they cannot invade the paddy fields. Thorough maintenance during the first year is key to ensuring the durability of the irrigation facilities because planting work will continually improve the cover plants' erosion prevention function against raindrop impact in the succeeding years.

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TOPIC 5

Identification of a gene that promotes ammonium nitrogen (NH_4^+-N) uptake in rice

Nitrogen is the most essential nutrient to plant growth and grain yield. There are two forms of inorganic nitrogen available to plants: one is NO_3^--form and the other is NH_4^+-form. NH_4^+-form is the major form in paddy fields, thus rice plants grown in the fields uptake mainly NH_4^+-form nitrogen as nitrogen source in roots. Therefore, promoting NH_4^+-form uptake is one of the major targets to increase grain yield in rice. It is known that NH_4^+ influx into roots by a high-affinity transport system (HAT) is down-modulated in response to elevated NH_4^+ concentration around soil surface. We hypothesized that canceling the down-modulation of NH_4^+ influx by HAT would be beneficial on the uptake of NH_4^+-form nitrogen in rice. However, no gene that modulates NH_4^+ influx by HAT has been identified in rice. In this study, we aimed to identify the gene that modulates HAT of rice roots with gene expression analyses. Furthermore, we tried to isolate a gain-of-function gene to promote uptake of NH_4^+-form nitrogen with rice *Tos17* insertion mutants.

To isolate candidate genes concerned in down-modulation of HAT in roots of rice, we performed four-biological-repeat transcriptome analyses. A total of 28,381 out of 36,444 filtered probes were selected as differentially expressed genes based on a false discovery rate of ≤ 0.05. A strong candidate gene for down-modulation of HAT, the coding protein kinase gene *OsACTPK1*, showed 1,071 times higher expression in roots under NH_4^+-rich condition as compared with NH_4^+-deficient condition (Table 1). We then analyzed the detail of *Tos17*-inserted mutant of *OsACTPK1* (*actpk1* mutant) to elucidate *OsACTPK1* as down-modulator of HAT. Kinetic analyses of NH_4^+ influx by HAT revealed that *V*max value of *actpk1* mutant was 2 times higher than that of wild type, whereas there was no significant difference of *K*m value between these two lines (Fig. 1). These results indicated that down-modulation of HAT was canceled in *actpk1* mutant due to the loss-of-function *OsACTPK1*. Total nitrogen content of the *actpk1* mutant was significantly higher (+32%) than that of wild type in 1,000 μM NH_4Cl condition (NH_4^+-rich condition), while the significant difference was not observed in 5 μM NH_4Cl condition (NH_4^+-deficient condition) (Fig. 2A). Furthermore, the longest-root length of the *actpk1* mutant was significantly lower (-22%) than that of wild type in 1,000 μM NH_4Cl condition, while the significant difference was

Table 1. Details for the *OsACTPK1* gene, a strong candidate for down-modulation of HAT

Item	Description
Increase of gene expression in response to elevated external NH_4^+ concentration	1,071-fold
RAP ID	Os02g0120100
Protein function	protein kinase

Rice Oligo DNA Microarray (4X44K RAP-DB) was used in this research. Total RNA was extracted from roots of rice plants grown for 10 days in 5 and 1,000 μM NH_4Cl.

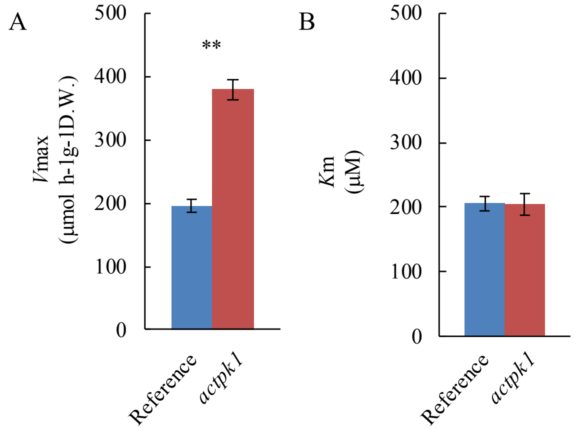

Fig. 1. Kinetic properties of HAT in *actpk1* mutant. *V*max value (A) and *K*m (B) to NH_4^+ were expressed in blue column for reference, Nipponbare and red column for *actpk1*. Plants were hydroponically grown for 10 days in 1,000 µM NH_4Cl. Mean value with standard error (n=3-6) was plotted. Asterisks indicate probability of less than 0.01 between reference and *actpk1* (ANOVA).

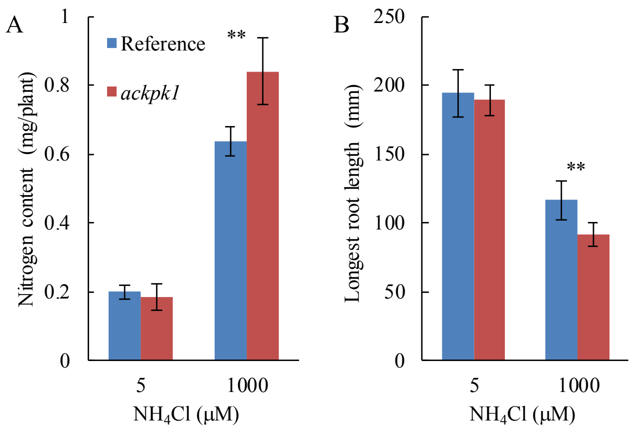

Fig. 2. Total nitrogen content (A) and longest root length (B). Plants were hydroponically grown for 10 days in two NH_4^+ conditions, 5 µM as deficient and 1,000 µM as rich condition of NH_4^+. Mean value with standard deviation (n=6 for total nitrogen content, n=14 for longest root length) was expressed in blue column for Nipponbare as reference and red column for *actpk1*, respectively. Asterisks indicate probability of less than 0.01 between reference and *actpk1* (ANOVA).

observed in 5 µM NH_4Cl condition (Fig. 2B).

We concluded that *OsACTPK1* was a down-modulator of HAT and that loss-of-function *ACTPK1* (*actpk1* gene) could maintain activity of NH_4^+ influx even in elevated NH_4^+ concentration. The *actpk1* gene could be effective in improving nitrogen use efficiency in a rice molecular breeding program. Also, reduction of root elongation in *actpk1* mutant would be used as phenotypic marker in the program. Further analyses to characterize nitrogen use and grain yield of *actpk1* are required for the program since *OsACTPK1* would function to avoid NH_4^+ toxicity.

(M. Obara, M.P. Beier [Tohoku University], T. Hayakawa [Tohoku University])

TOPIC 6

Evaluation method of root angle distribution at seedling stage in rice (*Oryza sativa* L.)

Root type has been one of the breeding targets after the Green Revolution in rice, but research efforts related to genetic improvement of root type was not focused and knowledge accumulation was slow. Evaluation of rice root type is a difficult research subject. Hanzawa et al. (2013) investigated root architecture using a basket as an evaluation method. Unfortunately, the basket method cannot handle a large number of plants and is unsuitable for variation or genetic analyses using many germplasms and big population sizes in hybrid populations. A more efficient evaluation method for root architecture of rice is therefore necessary to clarify the genetic variation of rice germplasms and hybrid populations.

A new method using seedling trays was developed, with the angles (as well as the distribution) and numbers of crown roots of seedlings at 14 days after sowing investigated using a nine-score scale (10: 0-10°, 20: 10-20°,

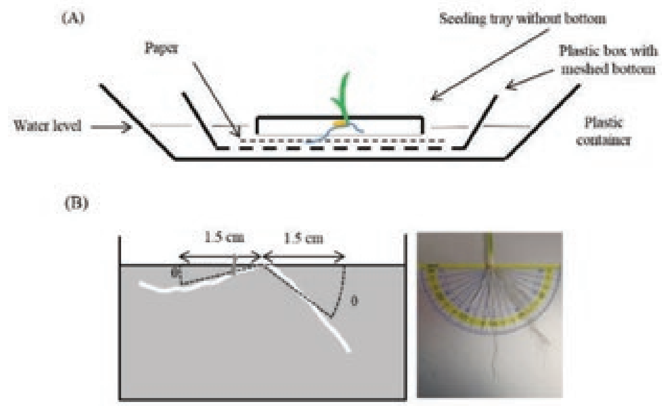

Fig. 1. Seedling tray method for evaluation of crown root angle distribution in rice seedling stage. (A) Set up the seedling tray without bottom in the container. Seedling tray is divided into 17 rows and 2 steps, and 34 rice seedlings are cultivated at the same time. (B) Investigation of growth angle of crown roots from horizontal line, at 14 days after sowing (Modified from Tomita et al. 2017).

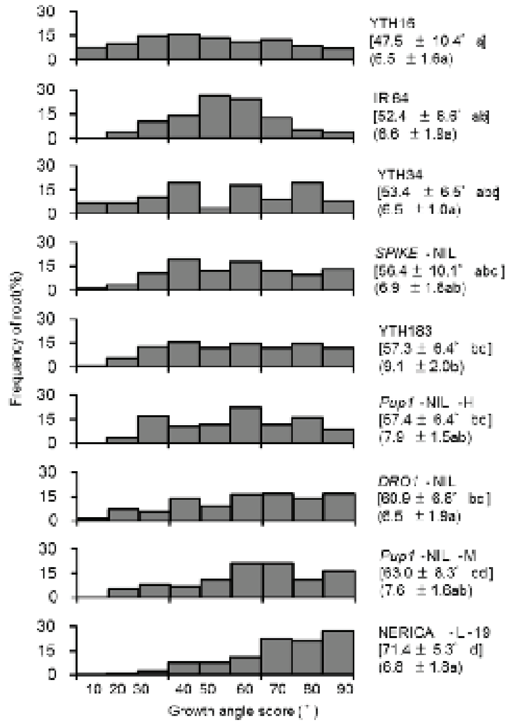

Fig. 2. Root angle distributions in IR 64 and eight accessions with the IR 64 genetic background were investigated using the seedling tray method. The averages of YTH16 and Dro1-NIL were calculated using 22 plants, and the others were calculated using 12 plants. [ ]: Average ± SD of RVA, ( ): Average ± SD of TRN, TRN: total root number, RVA: root vertical angle. Values denoted by different letters are significantly different at *P* = 0.05 by the Tukey-Kramer test. (Modified from Tomita et al. 2017).

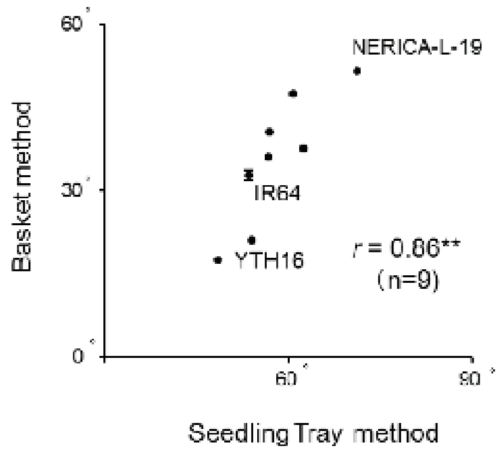

Fig. 3. Root vertical angle (RVA) relationship between the basket and seedling tray methods in IR 64 and eight accessions with the IR 64 genetic background. Average values of RVA for each accession were used as representative data in the seedling tray method and in the basket method of Hanzawa et al. (2013). Error bars indicate SD for each accession. **: significant at *P* = 0.01 (Modified from Tomita et al. 2017).

Table 1. Differences of effects between seedling tray method and basket method

Item	Seedling tray method	Basket method
Duration of cultivation (days)	14	21
No. of plants per m^2	137	44
Scales for root angles	9 (0-90)	4 (0, 15, 45, 75)

30: 20-30°, 40: 30-40°, 50: 40-50°, 60: 50-60°, 70: 60-70°, 80: 70-80°, 90: 80-90°) (Fig. 1B). The experiments revealed that introgression lines and isogenic lines with the common genetic background of an Indica Group rice cultivar, IR 64, showed a wide variation from shallow to deep root. Details on root angle distribution in each line were also clarified (Fig. 2).

The results of investigation using the seedling tray method agreed with those of the basket method (Fig. 3), and it confirmed the effect for the evaluation of root angle distribution in rice.

The advantages of the seedling tray method are as follows: shorter duration of rice seed cultivation, bigger population size of rice samples per square meter, and more detailed score scaling compared with that of the basket method for evaluating root angles (Table 1).

The seedling tray method will be useful in evaluating root types or architectures in rice cultivars, conducting genetic analysis of hybrid populations with big population sizes, and surveying genetic variation in germplasm, which means that this method will be a key technology for root type breeding in the future.

(Y. Fukuta, M. Obara, A. Tomita [University of Tsukuba], T. Sato [Tohoku University], Y. Uga [National Agriculture and Food Research Organization])

Overexpression of *AtGolS2*, an Arabidopsis galactinol synthase gene, increases grain yield in rice under drought stress in the field

Drought is a major abiotic stress, critically limiting the yield of food crops including rice. Many reports have demonstrated that overexpression of stress-related genes could improve drought tolerance in rice. However, very few reports have shown improved grain yields in transgenic rice under drought conditions in field environments. Many genes that may play an important role under drought have been mostly introduced in a single model variety of rice, such as Nipponbare, to understand the functions of the genes. To improve rice varieties by transgenic approaches, it is necessary to consider both adaptation to the target environments and fulfillment of local grain quality and of taste preferences. Here, we describe the generation of

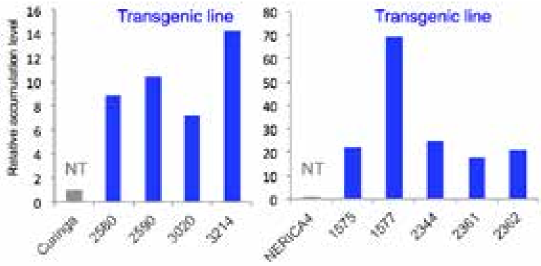

Fig. 1. Accumulation of galactinol in transgenic lines for *AtGolS2*. Numbers indicate ID for each transgenic line. NT, non-transgenic plants.

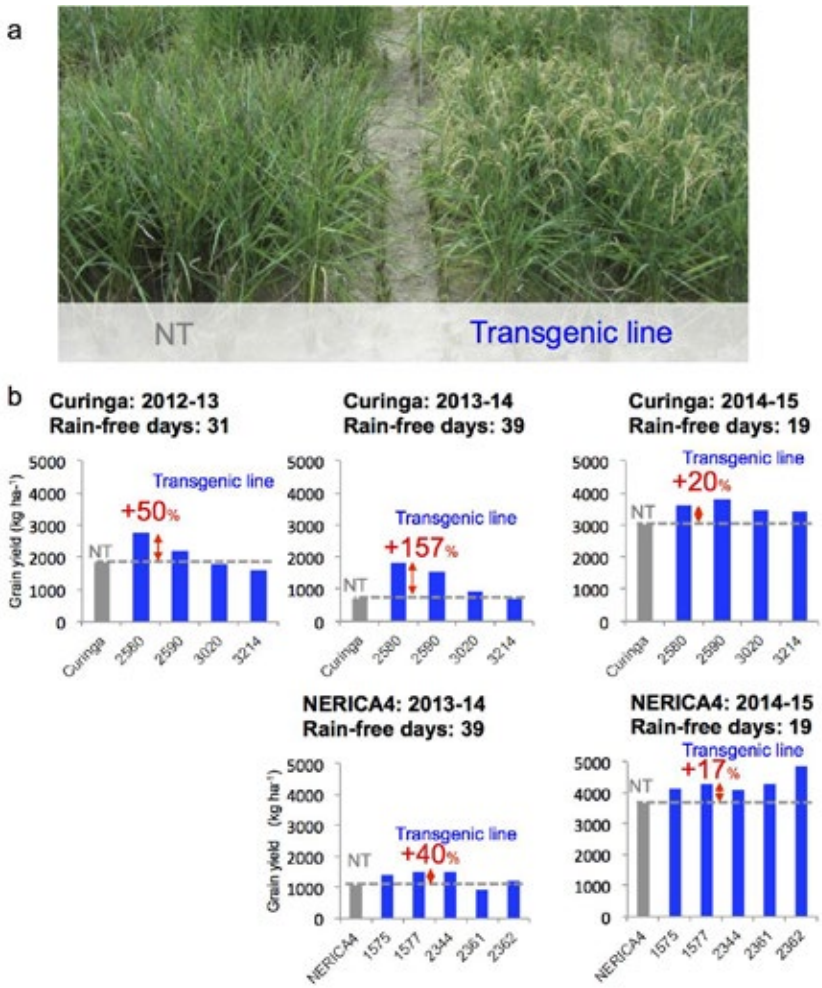

Fig. 2. Improved grain yields of transgenic lines for *AtGolS2* under drought in the field. (a) Evaluation of transgenic rice in a confined field of International Center for Tropical Agriculture located in Colombia. Left, non-transgenic Curinga; right, transgenic lines of Curinga numbered 2580. (b) Grain yield of transgenic lines for *AtGolS2* in the three consecutive field trials. Numbers indicate ID for each transgenic line. NT, non-transgenic plants.

transgenic rice lines that overexpress *AtGolS2*, which is a candidate gene for drought tolerance encoding a galactinol synthase identified in Arabidopsis, in the background of two commercial varieties, and present the increased grain yield of transgenic rice under drought in the field.

We generated transgenic rice lines that express *AtGolS2* in two varieties, Curinga and NERICA4. Curinga is a Brazilian local upland rice variety, and NERICA4 is a popular upland rice variety in African countries. Each transgenic line accumulated significantly higher amounts of galactinol as compared with non-transgenic rice plant (Fig. 1). The transgenic lines grown under drought had higher relative water content in leaves and higher photosynthetic activity than non-transgenic plants, leading to lesser reduction in plant growth. To test the performance of the transgenic lines under drought in the field, three consecutive field trials were carried out from 2012 to 2015. The extent of drought varied among trial years. For instance, trial years 2012-13 and 2013-14 were very dry with continuous rain-free days of 31 and 39, respectively, including flowering periods. Rain-free days in trial year 2014-15, however, were only 19 after flowering. A transgenic Curinga line numbered 2580 and a transgenic NERICA4 line numbered 1577 consistently had higher grain yield than each non-transgenic variety (Fig. 2). Our results provide strong evidence that *AtGolS2* is a useful biotechnological tool to reduce grain yield losses in rice under drought in the field.

For commercialization of the transgenic lines developed in this study, multi-location trials in South America and Africa are required, and the laws and ordinances of each country related to the treatment of genetically modified organisms have to be followed. For dissemination, collaboration with international and local institutes and with private sectors is required.

(T. Ishizaki, T. Ogata, K. Maruyama, K. Nakashima, M. Ishitani [International Center for Tropical Agriculture (CIAT)], M. Selvaraj [CIAT], M. Kusano [University of Tsukuba], F. Takahashi [Riken], K. Shinozaki [Riken])

TOPIC 8

Enhancement of drought tolerance in soybean plants by down-regulation of *GmERA1* genes

Drought is one of the biggest issues affecting global soybean production. A lot of drought tolerance-related genes have been identified in model plants such as *Arabidopsis thaliana*. Functional validation of candidate genes could provide gene resources for breeding varieties of non-model staple crops, such as soybean, that can withstand drought conditions. Previous research has implicated that farnesyltransferase gene *ERA1* in *A. thaliana* is one of promising candidates for genetic manipulation of drought stress tolerance. Although *ERA1* homologs in soybean plants (*GmERA1*) could be a candidate for improving drought tolerance, the function of *GmERA1* had been unrevealed. As soybean is recalcitrant to transformation and gene expression analysis, we employed a virus vector system to validate the potential candidate gene *GmERA1* for drought resistance in soybean.

A plant virus vector derived from *Apple*

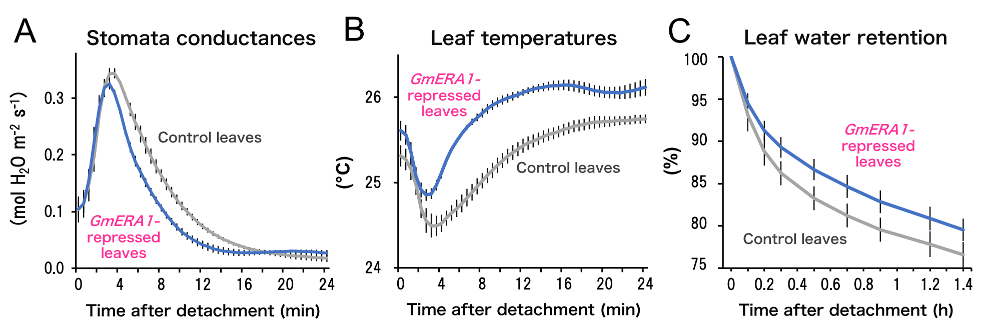

Fig. 1. Improved drought stress responses in *GmERA1*-repressed soybean leaves.
Leaf detachment-induced response of stomatal conductance (A), leaf temperature (B), and water retention (C) in soybean leaves infected with *GmERA1*-recombinant virus were measured. Data are means ± SE (n = 3 to 6). Figures are modified from Ogata et al. (2017).

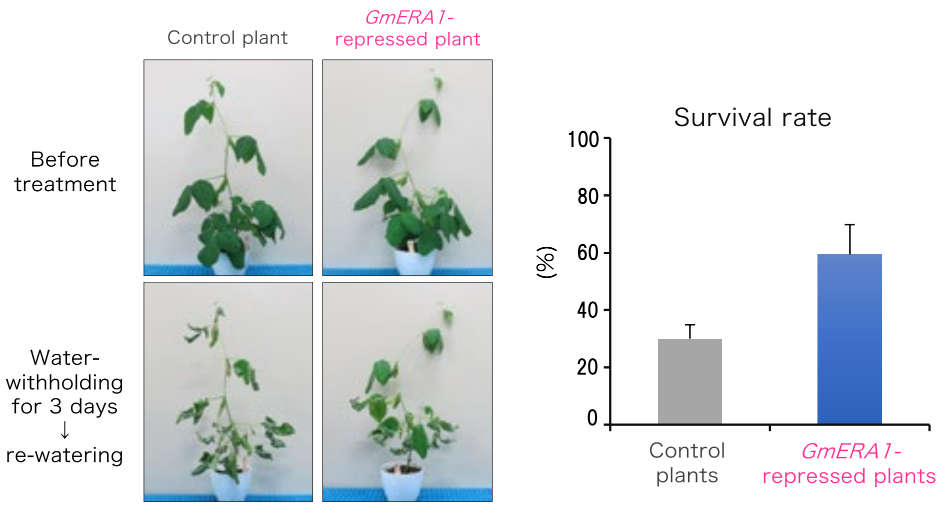

Fig. 2. Improved drought tolerance in *GmERA1*-repressed soybean plants.
The soybean plants infected with *GmERA1*-recombinant virus were withheld water for three days before re-watering (left panels). Survival rate of the plants were recorded after re-watering (right panel). Data are means ± SE (n = 3 to 6). Figures are modified from Ogata et al. (2017).

latent spherical virus (ALSV) was used for the functional analysis of *GmERA1* in soybean plants. Soybean leaves subjected to ALSV-mediated *GmERA1*-down-regulation showed increased drought stress responses with reduced water loss, gas exchanges and higher leaf surface temperature (Fig. 1). *GmERA1*-down-regulated soybean plants also showed reduced wilting and higher survival rate under water-limiting conditions compared to control plants (Fig. 2).

Our data support the proposal that *GmERA1* can be downregulated to increase drought tolerance in soybean. We also demonstrate that the virus vector system, which bypasses the need to generate transgenic plants, is a useful tool for evaluating candidate drought-resistance genes in soybean in the short term.

(T. Ogata, Y. Nagatoshi, Y. Fujita, N. Yamagishi, N. Yoshikawa [Iwate University])

TOPIC 9

Delayed heading technique for early heading *Erianthus arundinaceus* collected in Japan

Erianthus arundinaceus (Retz.) Jeswiet, a wild relative of sugarcane, has received attention as a sugarcane breeding material because of its high biomass productivity in ratoon crops and excellent tolerance to environmental stresses such as drought. Therefore, it has been increasingly utilized to improve sugarcane in several sugarcane breeding countries. However, many *E. arundinaceus* germplasm show earlier heading than that of sugarcane and this mismatch of heading periods between them is one of the biggest limiting factors to achieving intergeneric crossings. The aim of this study is to develop an effective delayed heading technique for early heading *E. arundinaceus* to achieve diverse intergeneric crossings with sugarcane.

Using the early heading Japanese *E. arundinaceus* accessions (JW630 and JW4) as experimental materials, we evaluated the effects on their delayed heading by photoperiodic treatment (PT) with different ratooning times (April, June, and July) (Fig. 1). In the PT plot, long-day treatment (i.e., the day length was extended for 14 h) was applied from 22 June to 23 August, and short-day treatment (i.e., the day length was gradually reduced by 30 min every 2 weeks) was applied from 24 August to 8 November. The illuminance below 1 m from the lamps was about 500 lux.

The heading periods in natural day length of JW630 (mid-September) and JW4 (late October) were earlier than the heading period of sugarcane breeding materials (early November to late December). The effects on their delayed heading were enhanced when we applied PT to the later-ratooning materials (Figs. 2, 3). The difference

Fig. 1. Photoperiodic treatment of *E. arundinaceus*.
Photo: Aug. 2011 at JIRCAS-TARF

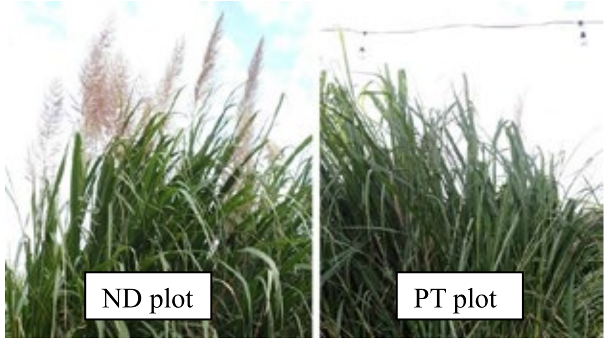

Fig. 2. Heading of JW4 in ND and PT plots.
ND and PT indicate natural day length and photoperiodic treatment, respectively.
Photo: 20 Oct. 2011 at JIRCAS-TARF

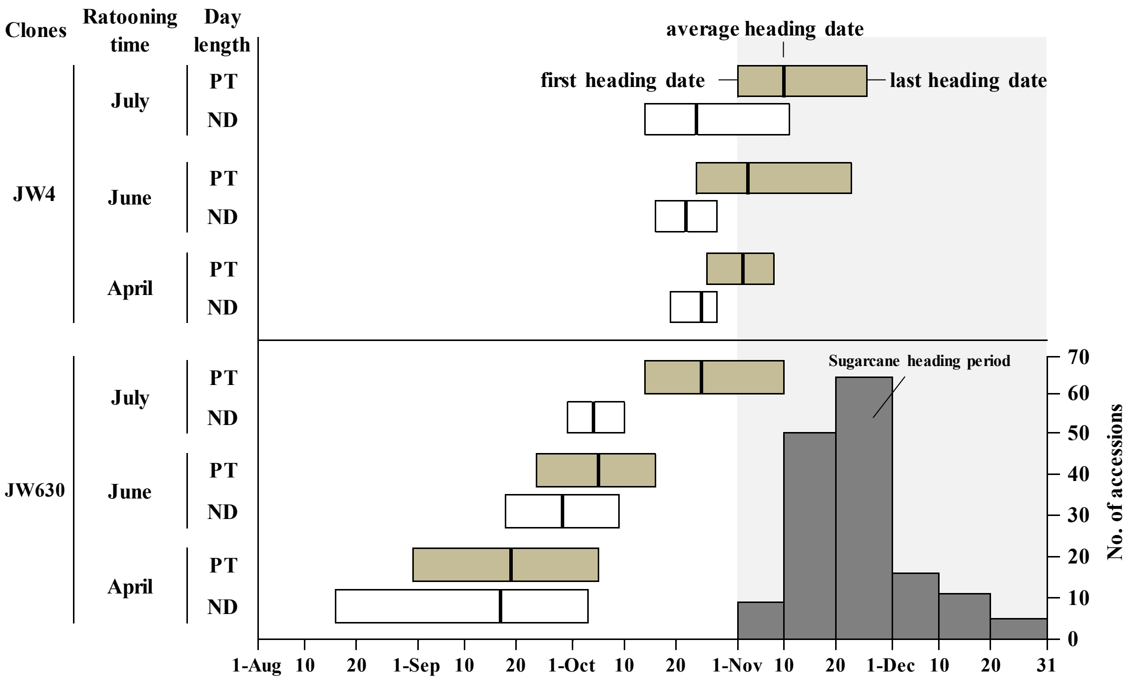

Fig. 3. Effects of ratooning time and photoperiodic treatment on heading dates of JW4 and JW630.
The data in the figure shows the average values of two-year experiments (2010, 2011).
PT and ND indicate photoperiodic treatment and natural day length, respectively.
The black bar means the distribution of the heading period in sugarcane varieties and clones (n=155) in 2009.
PT was more effective on delayed heading in later-ratooning plots, and a significant interaction was observed between ratooning time and day length in ANOVA ($P < 0.01$).

of average heading date between PT and natural day length plots was 2 days in JW630 and 8 days in JW4 with April-ratooning, 8 days in JW630 and 13 days in JW4 with June-ratooning, and 20 days in JW630 and 18 days in JW4 with July-ratooning. As a result, headings could be delayed in JW630 and JW4 until mid-November and late November, respectively, making it possible to cross them with sugarcane heading during these periods. Since pollen-germination rates in PT plots exceeded 25%, they can be used as a male parent for crossing with sugarcane.

This delayed heading technique combining PT and late-ratooning time will expand the possibility to utilize diverse early heading *E. arundinaceus* accessions for sugarcane improvement.

(Y. Terajima, A. Sugimoto, H. Takagi, S. Ando, S. Irei [Okinawa Prefectural Agricultural Research Center], S. Tagane [Kyushu University], H. Hayashi [University of Tsukuba])

Complete chloroplast genomes of *Erianthus and Miscanthus*, and phylogenetic relationships within the *Saccharum* complex

The genera *Erianthus* and *Miscanthus*, both members of the *Saccharum* complex, are of interest as potential resources for sugarcane improvement and as bioenergy crops. Ongoing studies focus on the conservation and use of wild *Erianthus* and *Miscanthus* accessions as breeding materials. However, despite current interest, the taxonomy and phylogenetic relatedness of *Saccharum* and these related genera have been controversial. Because the chloroplast (cp) genome has conserved gene content and uniparental inheritance, polymorphism within the chloroplast genome is a valuable tool for phylogenetic and evolutionary studies. In this study, we determined the complete cp genome sequence of *Erianthus arundinaceus* and *Miscanthus sinensis*. Our analysis of these cp genomes provides insight into the phylogeny and the evolution of the *Saccharum* complex based on the sequence variations of these cp genomes.

The complete cp genomes of *E. arundinaceus* (Accession No.: LC160130) and *M. sinensis* (LC160131) had typical circular structures with 141,210 bp and 141,416 bp in length, respectively (Fig. 1). The number of genes was 143 in *E. arundinaceus* and 141 in *M. sinensis*, including 79 and 78 protein-coding genes, respectively. Alignment of the *E. arundinaceus* and *M. sinensis* chloroplast genome sequences with the known sequence of *S. officinarum* demonstrated a high degree of conservation in gene content and order. Using the data sets of 76 chloroplast protein-coding genes, we performed phylogenetic analysis in the *Saccharum* complex. Our results show that *S. officinarum* is more closely related to *M. sinensis* than to *E. arundinaceus*. We estimated that *E. arundinaceus* diverged from the subtribe Sorghinae before the divergence of *Sorghum bicolor* and the common ancestor of *S. officinarum* and *M. sinensis* (Fig. 2).

This is the first report of the phylogenetic and evolutionary relationships inferred from maternally inherited variation in the *Saccharum*

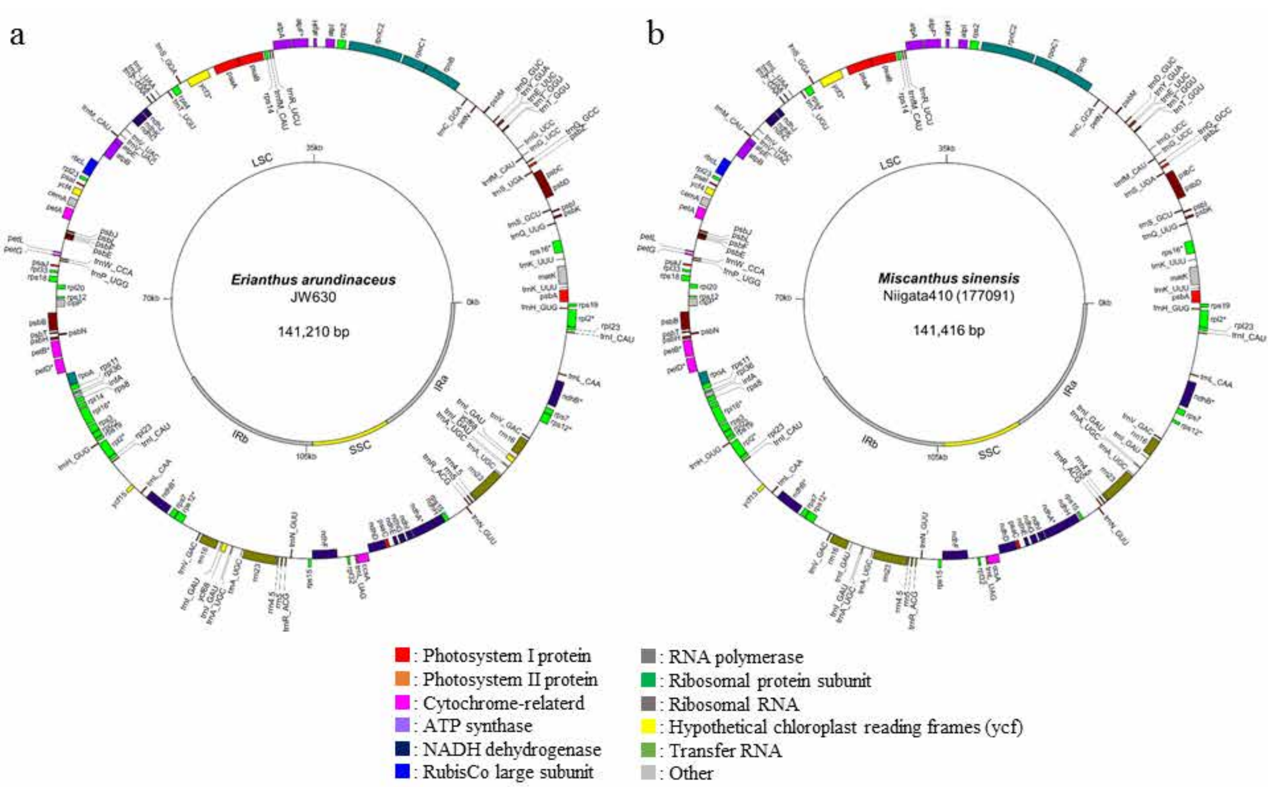

Fig. 1. Chloroplast genome maps of *Erianthus arundinaceus* (a) and *Miscanthus sinensis* (b).
LSC: large single-copy, SSC: small single-copy, IRa and IRb: inverted repeat a and b

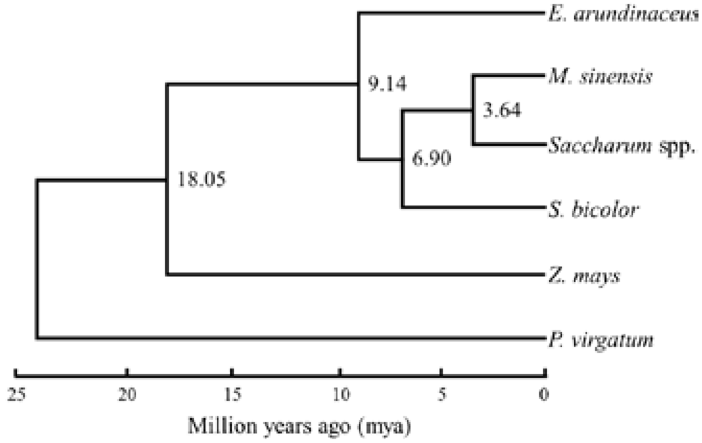

Fig. 2. Divergence times of the *Saccharum* complex estimated based on variation of 76 concatenated protein-coding chloroplast genes

complex. Our study provides an important framework for understanding the phylogenetic relatedness of the economically important genera *Erianthus*, *Miscanthus*, and *Saccharum*.

(S. Tsuruta, M. Ebina [NARO-ILGS], M. Kobayashi [NARO-ILGS], W. Takahashi [NARO-ILGS])

TOPIC 11

Characterization of *Erianthus arundinaceus* collected from Japan based on nuclear DNA content and simple sequence repeat markers

Erianthus arundinaceus, a member of the *Saccharum* complex, has been receiving increased attention as a bioenergy crop and a potential resource for sugarcane improvement. Although *Erianthus* species are widely distributed in tropical and subtropical climates, some wild accessions are well adapted to temperate Japan. To our knowledge, these are wild *E. arundinaceus* accessions that have adapted to the northernmost regions, and thus are potentially novel genetic resources for the development of cultivars or breeding lines suitable for growth in the temperate zone. However, little is known about the genetic characteristics of the Japanese accessions. To facilitate genetic studies and breeding programs, we developed simple sequence repeat markers from *E. arundinaceus* and obtained basic knowledge about the genetic background of this species collected in Japan.

We investigated the 2C DNA content and SSR polymorphisms in *E. arundinaceus* accessions collected from three climatic zones (temperate, subtropical, and tropical) in Japan and Indonesia with flow cytometric analysis. All examined accessions fell into two groups reflecting collection location: the temperate zone in Japan (mean 8.06 pg) and the subtropical and tropical zones in Japan and Indonesia (mean 7.56 pg). Although DNA content differed significantly between the accessions from temperate and tropical/subtropical zones, chromosome number was inferred to be identical in all accessions. A phylogenetic tree of 29 accessions based on detected fragments from 39 SSR primer pairs classified Japanese (26 accessions) and Indonesian (3 accessions) accessions into well-defined distinct groups. Both 2C DNA content and phylogenetic analysis subdivided Japanese accessions into two groups, suggesting that some of the Japanese accessions had different genetic characteristics from other accessions from Japan and Indonesia. In addition, of the 39 SSR primer pairs, 31 primer pairs were amplified in other genera of the *Saccharum* complex including *Saccharum* spp., *Miscanthus sinensis* and *Narenga porphyrocoma* (Fig. 3).

It is unclear how the hexaploidy of *Erianthus* was established in evolution, but the significant differences in DNA contents between the two *E. arundinaceus* groups might reflect a geographical distribution and ecological adaptation after ancestral hexaploidization. Further comprehensive studies including

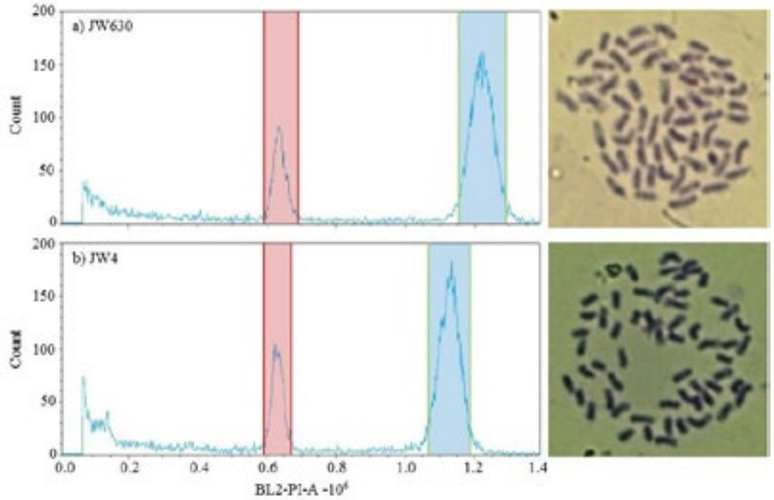

Fig. 1. Histograms of relative DNA content and mitotic metaphase chromosome preparations of *Erianthus arundinaceus* from temperate (a) and subtropical (b) zones.
The peaks marked in red and blue were detected in the internal control and the experimental samples, respectively. The x-axis shows the number of propidium iodide (PI)-labeled cells detected using a BL2A filter (488 nm). The y-axes are on cell counts.

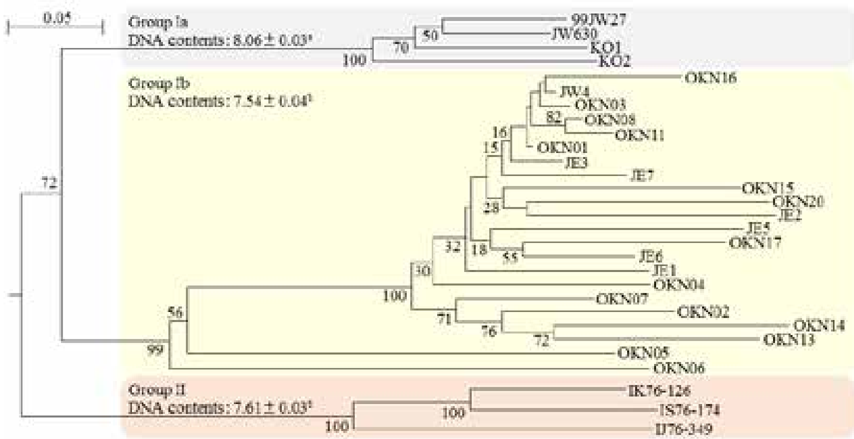

Fig. 2. Phenogram of the 29 accessions based on SSR genotyping data from 39 primer pairs. Numbers beside the branches indicate the values (%) of 1,000 bootstrap replicates. Values of DNA content are mean ± standard deviation within each group. DNA content with different letters indicate statistically significant differences among groups (p<0.001).

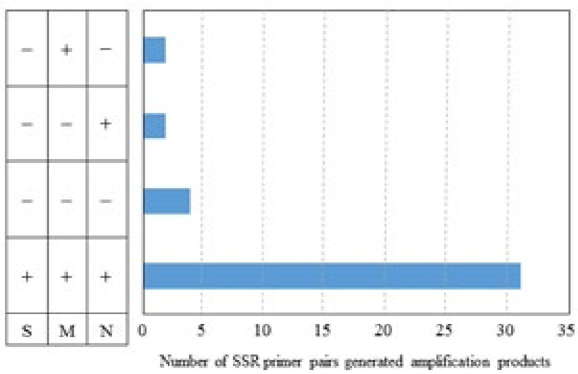

Fig. 3. Application of 39 SSR primer pairs to the *Saccharum* complex.
S: *Saccharum* spp. (7 species), M: *Miscanthus sinensis* (5 accessions), N: *Narenga porphyrocoma* (1 accession). Successful amplification (+), No amplification (–).

additional genetic resources from other countries and genomic information are needed to fully understand the basis of DNA content variability in *E. arundinaceus*.

(S. Tsuruta, Y. Terashima, M. Ebina [NARO-ILGS], M. Kobayashi [NARO-ILGS], W. Takahashi [NARO-ILGS])

An effective pesticide against the dominant insect vector of sugarcane white leaf disease

Sugarcane white leaf (SCWL) disease is an insect-borne disease that severely affects sugarcane production in Southeast Asia, especially in Thailand. The pathogen is phytoplasma. Effective treatments against SCWL disease have not been developed yet, thus an integrated pest management system based on healthy seed cane production by meristem culture is being considered. However, SCWL disease has been spreading to healthy seed cane propagation fields due to transmission by the SCWL disease vector insect, *Matsumuratettix hiroglyphicus,* among others. Therefore, we screened insecticides and determined those that have shown high efficacy against *M. hiroglyphicus*, with the aim of developing an infection risk reduction technique targeting the insect vectors at healthy seed cane propagation fields.

Seven commercial insecticides from among registered insecticides in Thailand were applied on 2-month-old, healthy potted sugarcane plants in a greenhouse (Fig. 1a). Results showed that three of them (i.e., lambda-cyhalothrin 2.5% emulsifiable concentrate, thiamethoxam 25% water dispersible granule, and dinotefuran 1% granule) had long-term residual effects on the mortality of *M. hiroglyphicus* (Table 1). These three selected insecticides from the greenhouse condition test were applied on sugarcane fields (Fig. 1b), and the residual periods were evaluated using a small leaf cage (Fig. 1c). Data revealed that dinotefuran resulted in high mortality and that it had the longest-lasting residual effect among the three pesticides (Table 2). The impacts of the three insecticides on two natural enemies of sugarcane stem borers, *Cotesia flavipes* (Cameron) (larval

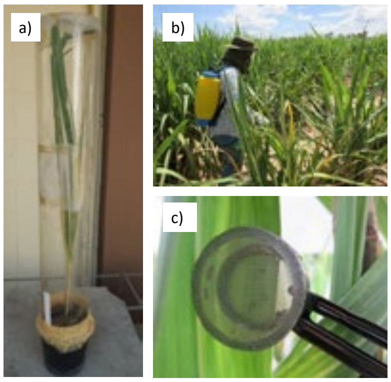

Fig. 1. Greenhouse (indoor) and field (outdoor) testing methods.
a) The pot used for the greenhouse condition test. The insect vectors were kept in the cage.
b) Sugarcane field for the field test. The plant height was about 160cm.
c) The small leaf cage for the field test. The diameter was 20mm.

Table 1. Residual effect of pesticide treatments in *M. hiroglyphicus* mortality under laboratory condition

	Mortality ± S.E. (%)		
Chemical treatment	1 day after	7 days after	30 days after
Carbaryl 85% WP	100 ±0a	100 ±0a	0 ±0b
Carbosulfan 20% W/V EC	100 ±0a	100 ±0a	0 ±0b
Carbofuran 3% GR	0 ±0b	40.6±6.0b	0 ±0b
EPN 45% W/V EC	100 ±0a	100 ±0a	0 ±0b
Lambda-cyhalothrin 2.5% W/V EC	100 ±0a	78.1±6.0a	6.3±6.3b
Thiamethoxam 25% WG	100 ±0a	100 ±0a	87.5±5.1a
Dinotefuran 1% GR	93.8±6.3a	100 ±0a	100 ±0a
Distilled water	3.1±3.1b	0 ±0c	0±0b

The pesticides were applied on two-month-old potted plants and the insect vectors were released 1 day, 7 days and 30 days after the treatment.
The numbers indicate the mortality rates 48 hours after pesticide treatment.
Values with different letters within columns indicate significant difference based on Tukey's honest significant difference test (P<0.05).

Table 2. Residual effect of selected pesticide treatments in *M. hiroglyphicus* mortality under field condition

	Mortality ± S.E. (%)			
Chemical treatment	1 day after	7 days after	30 days after	60 days after
Lambda-cyhalothrin 2.5% W/V EC	34.7±18.5b	4.0±2.3b	1.3± 1.3b	2.7± 1.3ab
Thiamethoxam 25% WG	100 ± 0a	98.6±1.3a	30.7±10.4a	9.3± 5.8ab
Dinotefuran 1% GR	98.7±1.3a	100 ±0a	98.7± 1.3a	49.3±13.1a
Distilled water	5.3±2.7b	1.3±1.3b	2.7± 2.7b	1.3± 1.3b

The pesticides were applied on 6- to 7-month-old plants and the insect vectors were released 1 day, 7 days, 30 days and 60 days after the treatment.
The numbers indicate the mortality rates 48 hours after pesticide treatment.
Values with different letters within columns indicate significant difference based on Tukey's honest significant difference test (P<0.05).

Table 3. Residual effect of the selected pesticides to *C. flavipes* and *T. confusum*

	C. flavipes			*T. confusum*		
	Mortality ± S.E. (%)			Mortality ± S.E. (%)		
Chemical treatment	1day after	7days after	30days after	1day after	7days after	30days after
Lambda-cyhalothrin 2.5% W/V EC	79.0±6.4a	11.0±8.6a	5.0±1.6a	73.0±3.4b	20.5±3.0b	11.0±3.3a
Thiamethoxam 25% WG	65.0±5.0a	8.0±2.0a	8.0±2.6a	98.0±2.0a	41.5±7.2a	12.0±3.7a
Dinotefuran 1% GR	6.0±1.9b	4.0±1.9a	2.0±1.2a	17.0±3.7c	14.0±2.0b	5.0±2.2a
Distilled water	1.0±1.0b	2.0±1.2a	0±0a	10.0±2.2c	9.5±2.2b	3.0±2.0a

The pesticides were applied on five-month-old potted plants and the insects were released 1 day, 7 days and 30 days after the treatment.
The numbers indicate the mortality rates 48 hours after pesticide treatment.
Values with different letters within columns indicate significant difference based on Tukey's honest significant difference test ($P<0.05$).

parasitoid) and *Trichogramma confusum* Viggiani (egg parasitoid), were also evaluated, with the results of the experiments indicating that dinotefuran had no negative effects on the two natural enemies of *M. hiroglyphicus* (Table 3). From these results, we found that dinotefuran showed high efficacy against *M. hiroglyphicus* and that the impact to the natural enemies was not significant. Thus, this pesticide may be used toward developing techniques to reduce the risk of SCWL disease invasion by insect vectors on healthy seed cane at propagation fields.

Planting of healthy seed cane and managing the risks of invasion by insect vectors are essential to producing healthy seed cane at the propagation fields. The findings of this study contribute to the latter factor. To develop an appropriate chemical management technique, we need to understand the residual period of dinotefuran in each growth stage of sugarcane, and analyze the population dynamics and abundance estimation of *M. hiroglyphicus*. Moreover, the registration requirements must first be complied with before using dinotefuran for commercial application and treatment of sugarcane fields.

(Y. Kobori, S. Ando, Y. Hanboonsong [Khon Kaen University])

TOPIC 13

Genetic variation in resistance in rice germplasm and differentiation of blast races in Bangladesh

Rice cultivations are conducted under three conditions in Bangladesh, namely, Aus (upland in early rainy season), Aman (rainfed lowland in late rainy season), and Boro (lowland in winter/dry season). Rice blast disease has been reported in recent years, the most serious of which occur during Boro season. Unfortunately, local information related to the genetic variation in resistance of rice cultivars and the differentiation of blast races is scarce. To build up a stable protection system against the disease, the accumulation of relevant information in rice cultivars and blast races will be important.

A total of 331 blast isolates from Bangladesh were classified into two cluster groups, I and II, based on the reaction patterns to differential varieties for 23 kinds of resistance genes (Fig. 1). Those in cluster I showed higher frequencies of virulence to differential varieties (DVs) for *Pii*, *Pi3*, *Pi5*(t), *Pik-m*, *Pi1*, *Pik-h*, *Pi-k*, *Pik-p* and *Pi7*(t) than those in cluster II (Fig.1). Clusters I and II were dominant in rainfed lowland and irrigated lowland, respectively, and there were no major differences between I and II in each region (Fig. 2). The results, however, were different in the case of other countries such as Japan, Cambodia, and West Africa. Blast isolates from rice cultivars BRRI dhan34 and Sadamota in rainfed lowland were virulent to DVs in [i] and [k] groups (except for *Pik-s*), while those from BRRI dhan28 and BRRI dhan47 in irrigated lowland were avirulent.

On the other hand, 334 rice accessions conserved in Bangladesh Rice Research Institute (BRRI) showed a wide variation in resistance. Variations among the groups in cultivated conditions (Aus, Amam, and Boro) and cultivated groups (Indica Group and Japonica Group) were changed, and showed complexity. BRRI dhan34 and Sadamota (but not BRRI dhan 28 and BRRI dhan 47) were found to harbor the resistance genes in DV groups [i] and [k], but not BRRI dhan 28 and BRRI dhan47.

These results indicated that wide variations

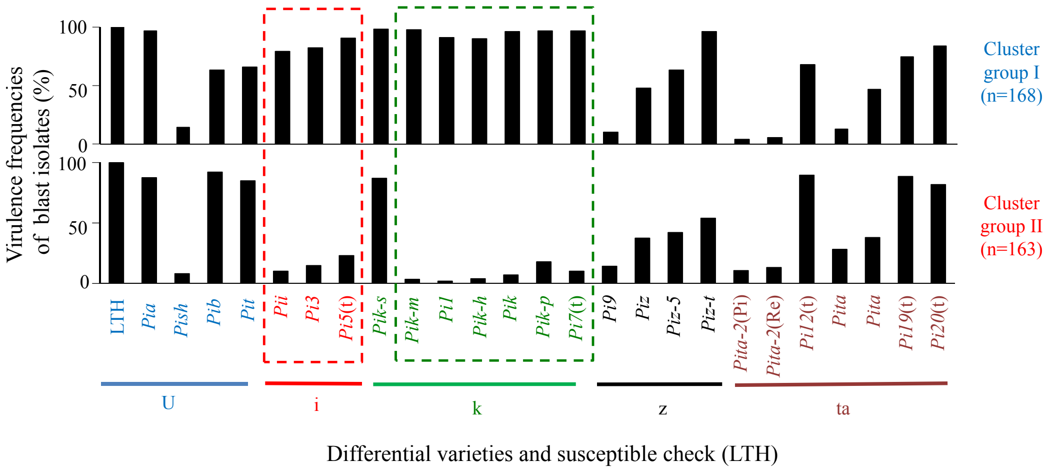

Fig. 1. Virulence frequencies of blast isolates from each cluster group on differential varieties. Cluster analysis using Word's hierarchical clustering method was used to classify a total of 331 blast isolates on the basis of the reaction pattern of 25 differential varieties as well as Lijangxintuanheigu (LTH) for susceptibility checking (Modified from Khan et al. 2017).

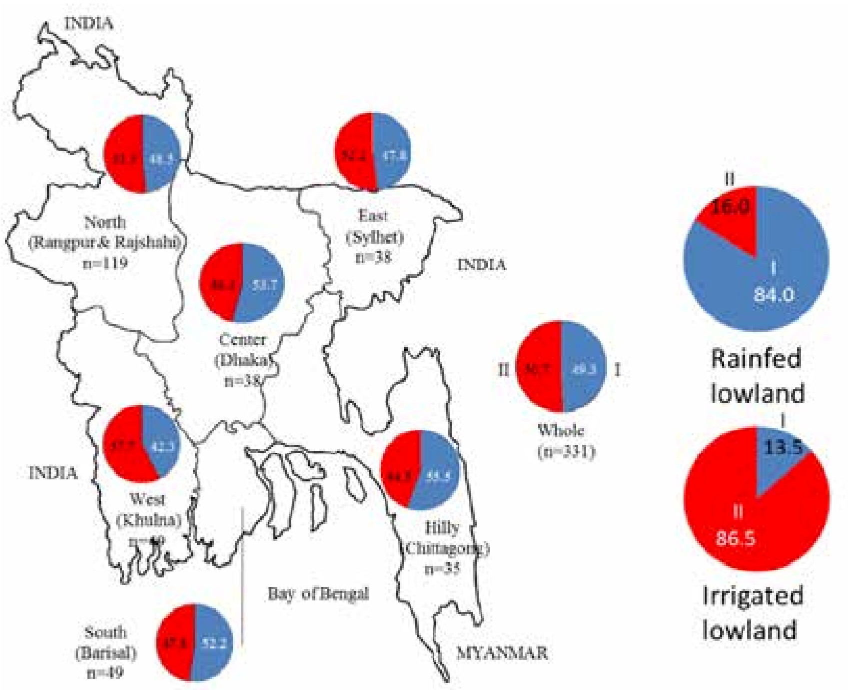

Fig. 2. Geographical distribution of cluster groups for blast isolates in Bangladesh. There were no big differences in frequencies between clusters I and II in each region, but the frequencies were completely different between rainfed lowland and irrigated lowland.

Table 1. Estimated resistance genes in rice cultivars of Bangladesh

Cultivation season	Variety	Estimated resistance gene in genetic background									
		Differential variety									Unknown
		「U」				「i」	「k」		「z」	「ta」	
		Pia	*Pish*	*Pib*	*Pit*	*Pii* *Pi3* *Pi5* (t)	*Pik-s*	*Pik-m* *Pi1* *Pik-h* *Pik* *Pik-p* *Pi7* (t)	*Pi9* (t) *Piz* *Piz-5* *Piz-t*	*Pita-2,* *Pi12* (t) *Pita* *Pi19*(t) *Pi20* (t)	
Aman (Rainfed)	BRRI dhan34				○	1		1			1
	Sadamota	○			○	1		1	1	1	1
Boro (Irrigated lowland)	BRRI dhan28	○	○	○	○		○		1	1	1
	BRRI dhan47		○	○	○		○			1	1

○ : indicates presence of resistance gene, 1: indicates presence of any of the resistance genes in resistance of rice cultivars and blast races were present, and that the differentiation of blast races corresponded with rice cultivars that are cultivated in each region and cultivated condition. This will be the first step in the development of a durable protection system against blast disease in Bangladesh.

(Y. Fukuta, S. Yanagihara, M. Obara, M. Khan [Bangladesh Rice Research Institute], M. Ali [BRRI], M. Monsur [BRRI], M. Mia [BRRI], M. Latif [BRRI], M. Khalequzzaman [BRRI], A. Kawasaki-Tanaka [Tottori University], N. Hayashi [National Agriculture and Food Research Organization], A. Tomita [University of Tsukuba])

PROGRAM C
Value-adding Technologies

"Development of high value-adding technologies and utilization of local resources in developing regions"

The Value-adding Technologies Program addresses the utilization of indigenous regional resources in Asia and the development of high value-adding technologies. To ensure high quality products and stable food value chains, we implement research on the identification of regional food resource characteristics, the development of effective food processing technologies, and the elucidation of customer needs. The program also supports rural development by utilizing regional resources in agriculture, forestry and fisheries. To achieve our goals, we conduct the following five research projects.

[Food Value Chain]

This project was established to study value enhancement of food products through analysis of functions in the Food Value Chain, which consist of consecutive steps from production to consumption. The first major research subject relates to food technology and is composed of two themes, namely 1) Construction of a normalized scheme to evaluate the qualities of local food resources and 2) Development of value addition technology for local food resources. The second major subject relates to socioeconomic research and is composed of two themes, namely 1) Improvement of food production and distribution systems to meet consumer needs and 2) Development of methods to evaluate the food value chain. In the initial year of the project, a research collaboration scheme was constructed with institutes in Thailand, Lao PDR, and P. R. China. We determined cereals, including processed and traditional fermented foods, of which similar products appear widely in the Asian region, to be the main target foods.

One of the major results was extending the shelf-life of fermented rice noodle by simple treatment with acidic buffer. Another significant result was enhancing sulforaphan and inactivating contaminated bacteria in broccoli sprouts production by treatments with slightly acidic electrolyzed water. In relation to socioeconomic study, value chain systems and consumer preferences on a fermented fish in Laos were investigated. Surveys of the production and consumption of rice and other minor crops in China are in progress.

[Asia Biomass]

In order to encourage the use of biofuels and biomaterials produced from agricultural residues, we successfully developed a new saccharification technology and a biodegradable plastic production technology using old palm trunks and wastewater. Toward energy production through application of our technologies, the novel anaerobic thermophilic alkaliphilic microorganism *Herbivorax saccincola* A7 was isolated and has shown a strong lignocellulose-degrading ability. According to the genome sequencing results of *H. saccincola* A7, this strain was revealed to possess new extracellular multienzymatic complex (cellulosome) and xylan degradation enzymes, more than other similar microbes. *H. saccincola* A7 is very useful for the efficient degradation of xylan-rich lignocelluloses such as empty fruit bunch (EFB) and corn stover.

[Multiple Use of Regional Resources in Semi-mountainous Villages]

In order to improve poverty and nutrition in Laos, field trials of upland rice cultivation as alternative to paddy rice cultivation in rainfed paddy areas are now ongoing in the southern part of the country, and early results have indicated better productivities of Indica over Japonica varieties. Furthermore, a categorization of transitional phases of burn fields/fallow forest areas was made based on vegetation flora, and studies on the distribution of non-timber forest products (NTFPs) are in progress. Additionally, investigations are being carried out to evaluate the nutritional status in mountainous villages in mid- and northern Laos, focusing on animal protein intake deficiency among villagers. To improve the current situation, efficient utilization of locally available fishes and their processing techniques are being investigated.

[Higher Value Forestry]

In Thailand, high correlations in stand volume estimates were found between onsite measurement and unmanned aerial vehicle (UAV) observations of teak plantations. In Laos, field survey results showed that exchangeable calcium content in the soil has affected the growth of teak.

In Malaysia, observations and gene expression analysis on secondary growth of trunk and elongation of stem in dipterocarp species were conducted. Some genes were identified to possibly regulate stem elongation. A model was developed to forecast mass synchronized flowering by analyzing the dynamics of flowering gene expression of *Shorea* species and climate. Continuous low precipitation and low temperatures over 9 to 11 weeks stimulated expression of flowering genes, which initiated flower development a month later.

In addition, transfer zones for forest reproductive materials (FRM) (JIRCAS Research Highlights, FY 2014) were formally recommended for adoption by the Forest Department of Peninsular Malaysia. The guideline for transferring FRM for five additional tree species was published.

[Aquatic Production in Tropical Areas]

Development of technologies for sustainable aquatic production was conducted in Southeast Asian countries. In Malaysia, to evaluate the environment of blood cockle fishing ground, a simple technique of estimating the flesh weight of blood cockle without breaking its shells was developed. In Myanmar, the natural environment (habitat) of edible oysters was surveyed to make biological and environment maps of potential fishing grounds. In Thailand, the co-culture demonstration experiments involving giant tiger shrimp with seaweed and snails showed improvement in the survival rate of the shrimps. In Laos, the reproductive biology of indigenous freshwater shrimp was studied to develop captive breeding techniques. In the Philippines, demonstration experiments were conducted in collaboration with local fishermen to disseminate the Integrated Multi-Trophic Aquaculture (IMTA) system for milkfish, seaweeds, and sea cucumber. Also, the effectiveness of complete/partial substitution of fishmeal (in milkfish feed) using alternative protein sources was demonstrated.

TOPIC 1

Improvement of functionality of broccoli sprouts using slightly acidic electrolyzed water

Sprouts are simply germinated seeds of soybean, mung bean, and radish, among others, that are consumed as food. They contain many nutrients and functional components, and provide health benefits. Broccoli sprout, in particular, contains sulforaphane, which has an antioxidant function, and has been attracting attention as a health/functional food. Sulforaphane in broccoli sprout is produced by the myrosinase enzyme from 4-methylsulfinylbutyl glucosinolate (glucoraphanin). Several factors that can promote the accumulation of bioactive compounds have been studied, among them internal factors such as genotypic effect, and external factors including environmental conditions such as light, salinity, sugars, and plant hormones. Slightly acidic electrolyzed water (SAEW) with a near-neutral pH and containing available chlorine concentration (ACC) can be generated by electrolyzing dilute hydrochloric acid using non-membrane electrolytic cell. SAEW has been recognized as having antimicrobial ability and is a promising non-thermal sanitizer for use in the food industry. In Japan, SAEW has been an authorized food additive since 2002 and a specified agricultural chemical since 2014. Previous studies have found that electrolyzed water can enhance the inhibitory activity of angiotensin I-converting enzyme (ACE) in soaked soybeans, influence the germination of mung bean and some grains, elevate the content of γ-aminobutyric acid (GABA) in germinated brown millet, brown rice, and affect antioxidant enzymes in mung bean sprouts. In this study, the effects of SAEW on sulforaphane content and total bacterial count of broccoli sprouts were investigated.

SAEW was prepared with different ACCs (10, 20, 30, 40, 50 ppm) by electrolyzing the tap water with pH 4.35 for a period of time. Broccoli seeds were submerged in different treatment solutions for 3 h. The soaked seeds were then evenly placed on sterile cheesecloth in a polypropylene box consisting of two layers. The upper layer was used for seed germination and the lower layer was filled with the solutions. The seeds were cultivated at 25 °C at a relative humidity of 80% in the dark. The treatment solutions were changed every 24 h until the whole sprouts were harvested after 8 d (Fig. 1). The sulforaphane content increased significantly ($p < 0.05$) by 95% after treatment with SAEW 40 compared with tap water (Fig. 2A). All of the SAEW solutions increased the content of sulforaphane in broccoli sprouts compared with tap water, although the increase between using the SAEW 20 and tap water control treatments was not significant. SAEW 40 significantly enhanced the activity of myrosinase (Fig. 2B). Moreover, the number of

Fig. 1. Broccoli sprouts cultivated with slightly acidic electrolyzed water

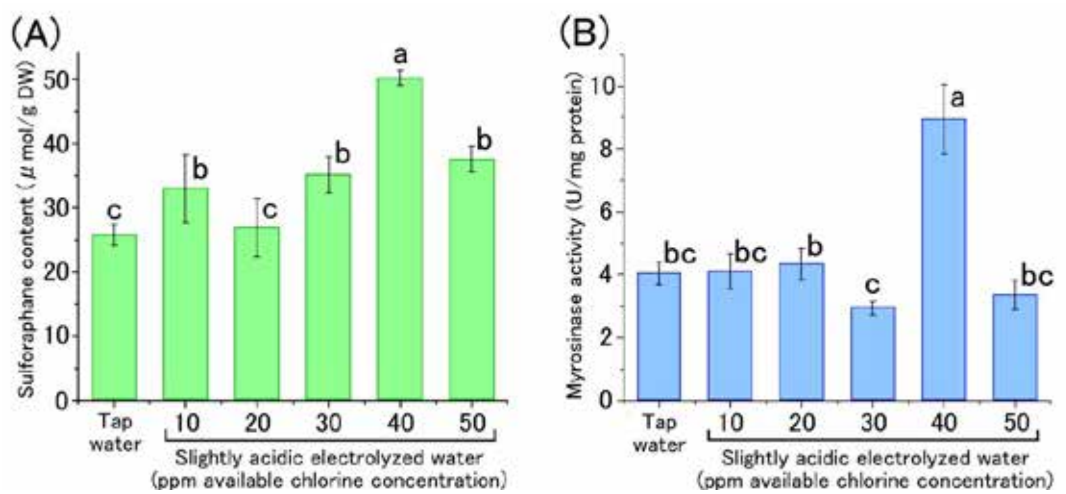

Fig. 2. Sulforaphane content (A) and myrosinase activity (B) of broccoli sprouts treated with different available chlorine concentrations of slightly acidic electrolyzed water.
Different letters mean statistically significant difference (*P*<0.05).

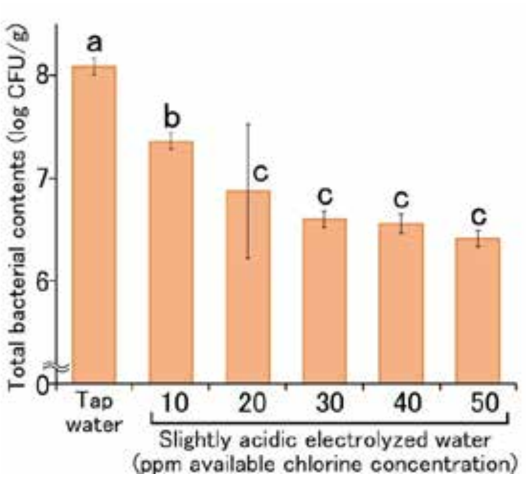

Fig. 3. Total bacterial counts on broccoli sprouts treated with slightly acidic electrolyzed water.
Different letters mean statistically significant difference (*P*<0.05).

microorganisms on the broccoli sprout decreased by 1.71 log CFU/g after using the SAEW with ACC value of 50 mg/L treatment compared with tap water treatment. Figure 3 shows that the bactericidal activity of SAEW on the surface of broccoli sprouts increased as the ACC values increased.

Overall, with a suitable ACC it can be a useful tool for enhancing the amount of sulforaphane and reducing the microbial counts on broccoli sprouts intended for fresh consumption as a functional food.

(S. Nirasawa,
H. Liu [China Agricultural University],
L. Li [China Agricultural University])

pH adjustment of oil palm sap improves lactic acid fermentation

Oil palm sap (OPS) holds great promise as a naturally derived nutrient medium for microbes because it contains large amounts of amino acids, minerals, and free sugars. We have shown the usefulness of OPS as nutrient medium when we investigated ethanol production by fermentation using yeast. However, declining fermentation ability and delayed fermentation were observed during lactic acid fermentation. Lactic acid fermentation is very important in beverage applications and organic acid production, hence it is necessary to develop an improved method (of using OPS) that can also be applied for general purposes. We have developed a simple method to adjust the pH of OPS to remove fermentation inhibitors and revive lactic fermentation ability.

Lactic acid fermentation was obstructed by an ingredient of OPS, and the conversion efficiency of sugar was only about half of the theoretical yield (Table 1). When the pH of OPS was raised progressively, insoluble sediments were formed in weak alkali (Fig. 1). The insoluble sediments were removed and the pH of OPS returned to near neutral. Lactic acid fermentation ability was restored when treated OPS was used for lactic fermentation. In particular, when lactic acid fermentation using the treated OPS (which had

Table 1. Lactic acid production from oil palm sap pretreated using acidic and alkaline precipitation by *Bacillus coagulans* strain 191

pH adjustment	Sugar concentration (g/L)	Concentration (g/L)	Yield (g/g)	Productivity (g/L/h)
Untreated (pH 5.6)	78.7 ± 2.4	42.7± 1.1	0.54	0.89
pH 6.0	61.4± 1.2	53.9 ± 2.2	0.88	2.25
pH 7.0	66.8 ± 0.7	57.1 ± 2.8	0.85	2.38
pH 8.0	65.9 ± 0.7	60.8 ± 2.5	0.92	2.53
pH 9.0	69.0 ± 2.3	63.3 ± 1.4	0.92	2.64
pH 10.0	66.4 ± 1.2	61.2 ± 2.8	0.92	2.55

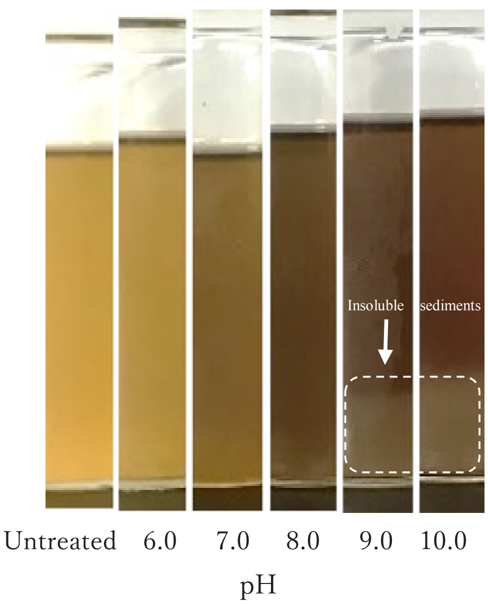

Fig. 1. Treatment of sap at various pH

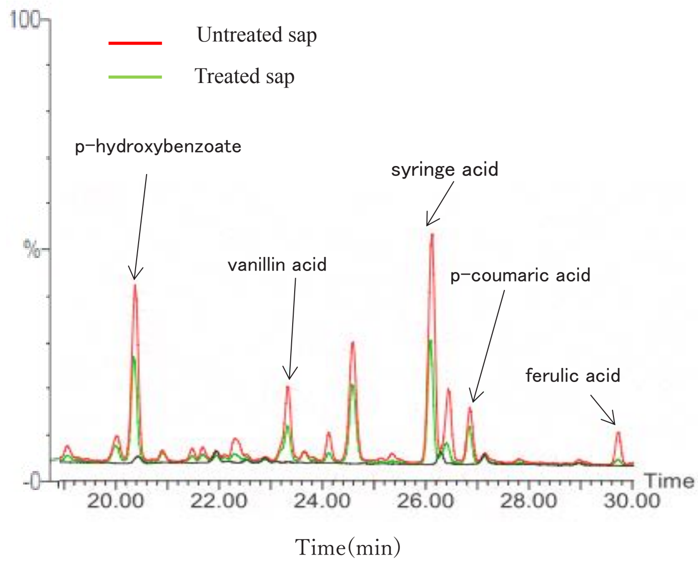

Fig. 2. Identification of aromatic compounds in the treated and untreated sap

been adjusted to alkaline pH 9.0) was performed, the lactic acid amount, the conversion rate, and productivity improved by 1.5-3 times in comparison with lactic acid fermentation that used untreated OPS (Table 1). Fermentation inhibitors such as aromatic compounds contained in plant raw materials have been thought to inhibit the growth of lactic acid bacteria. Identification of aromatic compounds in the treated and untreated OPS was performed by gas chromatography mass spectrometry, and it was found that aromatic compounds such as p-hydroxybenzoate, vanillin acid, syringe acid, p-coumaric acid, and ferulic acid greatly decreased in the treated OPS (Fig. 2).

(T. Arai, A. Kosugi, K. Balakrishnan [Universiti Sains Malaysia], S. Sudesh [Universiti Sains Malaysia])

TOPIC 3

Forecasting mass synchronized flowering in Southeast Asian tropical forest by analyzing the dynamics of flowering gene expression

In Southeast Asian tropical forests, irregular and prolonged synchronized flowering is observed not only on dipterocarp species (the major canopy species in these forests) but also on various tree species belonging to different taxa. Synchronized flowering is basically triggered by environmental factors such as low temperature and drought. However, the mechanisms and the relationship between these factors have not been well studied, making synchronized flowering difficult to forecast. Dipterocarp trees, generally known as Lauan and mainly used for timber and plywood, constitute about 80% of canopy species in Southeast Asian tropical forests. Difficulties on its vegetative propagation have forced us to make planting materials throughout seed collection during fruiting season. However, unpredictable flowering and seeding of dipterocarps restrict the planned production of planting materials. Furthermore, climate change could alter environmental factors, modifying the synchronized flowering pattern in the region and possibly affecting not only the regeneration of tropical tree species but also forest ecosystems. Therefore, we monitored the flowering phenology and expression of flowering genes of two dipterocarp species (*Shorea curtisii* and *S. leprosula*) for about four years, and developed a flowering forecasting model from climate data.

High homology of the RNA sequences with the *Arabidopsis* gene database indicates that the *FT*- and *LFY*-like genes of *S. curtisii* also regulate flowering of the species. These genes were expressed in leaf and bud tissues at least one month before synchronized flowering (Fig. 2). We then developed a flowering forecasting model to estimate the parameters of gene expression and degradation, and to determine the environmental factors that cause flowering. The estimation showed that both low temperature and drought were necessary for flowering. The environmental thresholds for daily temperature and precipitation (drought) ranged from 25.5 to 25.7 and from 156 to 182 mm over 9-11 weeks, respectively (Fig. 2), suggesting that lower temperatures and dry conditions (i.e., the values are below threshold over 9-11 weeks) express the flowering genes. Flowering is initiated after more than one month. The estimation can contribute to planned seed collection because it enables stakeholders to prepare seed collections at least 9-11 weeks before flowering.

Our model and estimated parameters can also be utilized for forecasting flowering under climate change conditions. We can input environmental data (temperature and precipitation) and incorporate climate change scenarios into our

Fig. 1. Seeding of *S. curtisii* (at Semangkok Forest Reserve in July 2014)

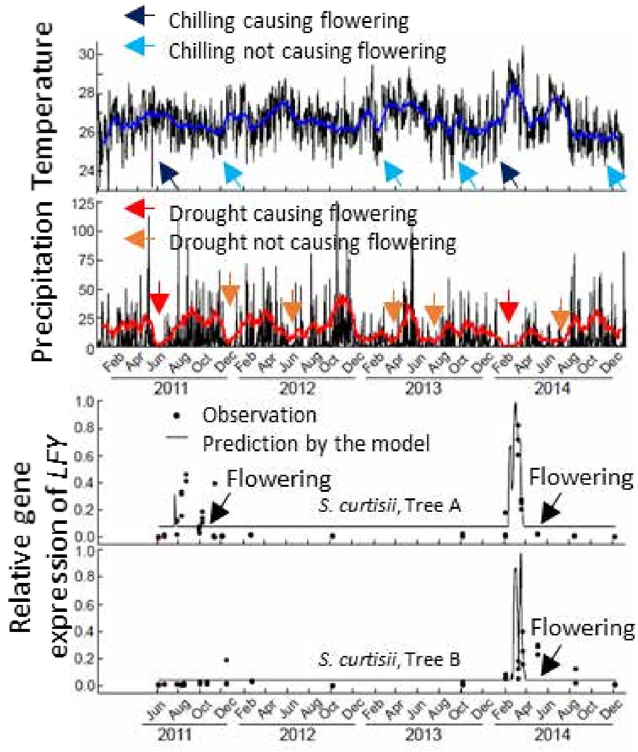

Fig. 2. Daily temperature and rainfall (top), and expression of flowering gene during observation period (bottom)

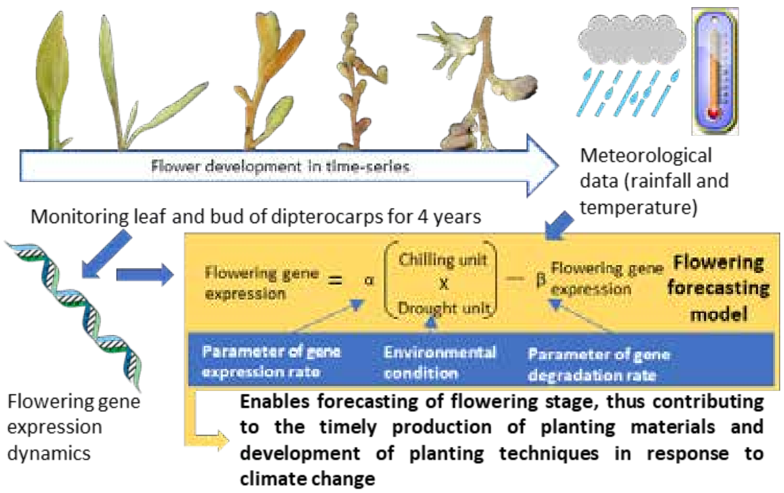

Fig. 3. Method for developing the flowering forecasting model

model to predict gene expression behavior, thus contributing to the discussion on the effects of climate change on forest regeneration and the ecosystem. It should be noted, however, that the estimated parameters and environmental conditions were based only on two flowering events over the four-year observation period, and that more monitoring data are required to develop a more precise model.

(N. Tani, A. Satake [Kyushu University], T. Ichie [Kochi University], S. Numata [Tokyo Metropolitan University], S. H. Yeoh [University of Malaya], S. L. Lee [Forest Research Institute Malaysia], N. Basherudin [FRIM], N. Muhammad [FRIM])

Development of a rearing technique for the free-swimming zoea larvae of the freshwater shrimp *Macrobrachium yui* from Northern Laos

In Laos, many freshwater prawns (*Macrobrachium* spp.) have been found in a variety of freshwater environments including rivers, ponds, and caves. They have high market value and thus are economically important for the local farmers. *Macrobrachium yui* (Holthuis 1950, Fig. 1), which mainly inhabits the northern part of Laos, fetches the highest price at the local market. The females of *M. yui* have been reported to migrate toward the inner part of the cave stream to spawn and hatch their eggs. After the zoea larvae hatch out (Fig. 1A), they stay inside the cave until development into postlarvae (Fig. 1B). Then, they change their habitat from the cave stream to the aboveground river and develop into juveniles. Thus, this species inhabits two different water environments in its life cycle. In Laos, *M. yui* catch has decreased dramatically, and the genetic diversity in some local populations has already been greatly reduced by environmental deterioration and overfishing. In order to aid in conserving and recovering local populations of

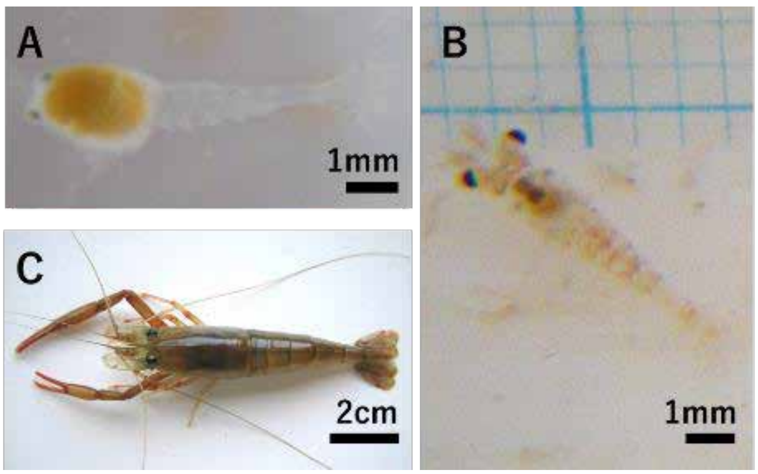

Fig. 1. The developmental stages of *M. yui*.
A: Hatched larva
B: Postlarva
C: Female broodstock

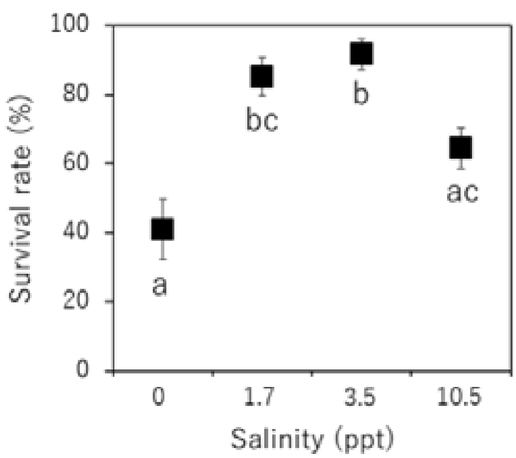

Fig. 2. Survival rates of larvae during the free-swimming zoea larval stages when reared at 4 different (0-10.5 ppt) salinities. The results are expressed as the mean ± SE of 23 replicates. Different letters indicate significant differences ($P < 0.05$).

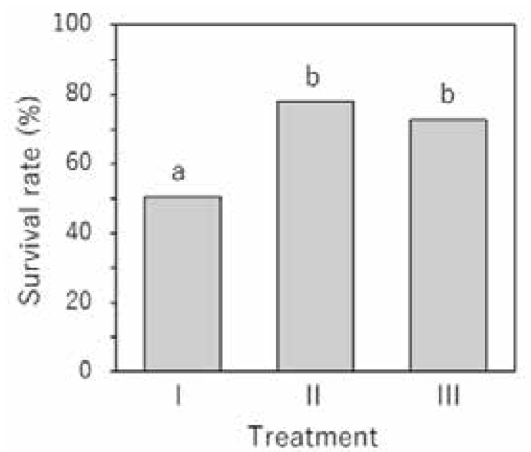

Fig. 3. Survival rates of postlarvae during the 2 weeks after settling to the bottom, in three treatment groups: Treatment I (n = 93), Treatment II (n = 100), and Treatment III (n = 107). Different letters indicate significant differences ($P < 0.01$).

Table 1. The concentration (mg/l) of major ions in 3.5 ppt artificial seawater, cave stream water, and aboveground water. The U and P values indicate statistical results of the comparison of seven ions between cave stream water and aboveground water by the Mann-Whitney U test.

Ions	Artificial seawater at 3.5ppt*	Cave stream water (n=4) (mean (SE))	Aboveground water (n=12) (mean (SE))	*U* value	*P* value
Cl^-	1767.9	1.04 (0.14)	0.34 (0.12)	53	0.025
NO_3^-	N.D.**	2.06 (0.63)	0.19 (0.06)	57	0.006
SO_4^{2-}	270.4	67.48 (46.88)	9.52 (3.96)	52	0.034
Na^+	1053.9	6.34 (0.46)	8.85 (1.33)	28	0.505
K^+	41.5	0.68 (0.06)	1.07 (0.09)	12	0.009
Mg^{2+}	134.9	16.61 (3.60)	8.49 (1.48)	53	0.025
Ca^{2+}	62.5	108.28 (4.80)	41.18 (5.12)	58	0.004

*Kester et al., (1967) Limnol. Oceanogr., 12: 176-179.

**N.D., no data

M. yui, production of *M. yui* larvae may be one promising solution. In this study, we aimed to develop a technique for rearing *M. yui* larvae without using cave stream water.

According to the relationship between egg size and salinity tolerance of larvae of the *Macrobrachium* species, it was hypothesized that (1) the larvae of *M. yui* can develop at a certain water salinity during zoea larvae stage and (2) they can adapt to freshwater after development into postlarvae. We compared the survival rate of the zoea larvae when reared in 4 different salinities (0-10.5 ppt). Among the tested waters, the zoea larvae showed the highest survival rate, at 91.7 % on average, in 3.5 ppt (Fig. 2). Next, we tested acclimation to freshwater during the postlarval stage using three experimental treatments: rearing at 0 ppt salinity (freshwater) for both the first and second weeks (treatment I), rearing at 1.7 ppt for the first week and 0 ppt for the second week (treatment II), and rearing at 3.5 ppt salinity for both the first and second weeks (treatment III). The postlarvae survived better in treatments II (78%) and III (73%) than in treatment I (51%) (Fig. 3). Finally, the water from the Xuang river in Luang Prabang Province, Laos, where *M. yui* inhabits, was analyzed using ion chromatography to know ion concentrations. The concentrations of SO_4^{2-}, Mg^{2+}, and Ca^{2+} of 3.5 ppt artificial seawater were similar to those in cave water (Table 1).

This study succeeded in rearing zoea larvae of *M. yui* using 3.5 ppt artificial seawater instead of cave water. The postlarvae showed high survival rates when rearing salinities were gradually decreased. The technique developed in this study will contribute to artificial seed production of *M. yui* in aquaculture facilities without cave water, and help in recovery efforts for the endangered local populations of *M. yui*.

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Program D
Information Analysis

"Collection, analysis and dissemination of information for grasping trends of international agriculture, forestry and fisheries"

The global situation and problems surrounding agricultural production and the food market as well as food and nutrient supply are widely diverse, and they are constantly affected and changing along with global phenomena such as climate change, deteriorating natural environments, and international socio-economic trends. To address the stable and sustainable development concerns of agriculture, forestry, and fisheries, it is essential to do the following: analyze the current status, identify the problems, assess the impact of past development efforts, and integrate foresight studies. It is also important to provide regular feedback and turn the results of analyses into institutional strategies to make the research for development activities more adequately focused, efficient, and cost-effective. Program D's major outputs for the fiscal year are summarized below.

First, in the project titled "Evaluation of global food supply-demand and nutritional balance," the time-series trends in nutrient intake per person in Madagascar were analyzed, with the results showing a tendency for reduced absorption of vitamins and minerals.

Second, a site survey was conducted for the project titled "Agricultural Development in the Cerrado Region of Brazil." JIRCAS has been contributing through collaborative research activities since the early stages, and the survey team has analyzed information related to the actual effects of Japan's investment in research and development.

Third, data on livestock products were added in performing global analysis using the food commodity supply and demand model (developed by JIRCAS) to make projections related to agro-food products. The improved model provides more precise analysis with changes in nutrient intake. The model made clear that nutrient intake would improve in Sub-Saharan Africa (SSA) by 2030 and decline in the mid-latitudes due to climate change. These results were reported to international organizations, such as the Organization for Economic Co-operation and Development (OECD), and to some agricultural agencies such as the US Department of Agriculture (USDA) during the World Outlook Conference.

Finally, to promote better research on nutrition issues, JIRCAS invited the director of the international research program "HarvestPlus" and the director general of the International Food Policy Research Institute (IFPRI) to share experiences and exchange ideas.

In 2016, JIRCAS started its Fourth Medium to Long-Term Plan, carrying out goal-oriented basic research with a view toward developing technology seeds that would lead to future innovation. The Plan tackles novel research ideas in the hope that the results of pure research will lead to technological innovation and the creation of new businesses in the agricultural, forestry, fisheries, and food industries. Five subjects are currently being implemented after securing the necessary materials and establishing the framework for cooperation with concerned research institutes. The research activities attained results on the following subjects: 1) specific characteristics of the collected rice breeding materials for making good use of rice germplasm, 2) functional components in non-conventional yeast for a new feed supplement, 3) genetic information for developing gene discovery systems, 4) shrimp ovarian growth information for development of advanced seed production, and 5) specific characteristics of mango for domestic and international research development. A characterization of mango genetic resources has been introduced in the JIRCAS website.

Under Program D, JIRCAS, as a representative of Japan on matters relating to information analysis, actively participated in several important meetings. JIRCAS participated as a member in the First Steering Committee Meeting and Partners' Conference of the Initiative for Food and Nutrition Security in Africa (IFNA) in Ethiopia, whose launching was mentioned by Prime Minister Shinzo Abe at TICAD VI. JIRCAS also participated in the 6th Meeting of G20 Agricultural Chief Scientists (G20 MACS) and the side events of COP23 in Germany, the CGIAR System Council Meeting in Colombia, the Coalition for African Rice Development (CARD) Steering Committee Meeting in Kenya, the World Outlook Conference in Ireland, the Wheat Initiative (WI) in Austria and Italy, and the Tropical Agriculture Platform (TAP) in Lao PDR. Throughout these meetings, JIRCAS presented its activities, collected information about trends in international research, and exchanged information with related organizations. JIRCAS was especially involved during the side events of COP23, where it presented the activities of the Global Research Alliance (GRA) in finding ways to achieve sustainable food production without growing greenhouse emissions, and held the seminar titled “Effective Use of Agro-Residues - Renewable Energy Solutions for Forest Conservation and REDD+” with the co-sponsorship of the International Renewable Energy Agency (IRENA).

Furthermore, JIRCAS continuously gathered local information concerning agricultural research priorities, particularly on agriculture, forestry and fisheries, nutrition, poverty, population and urbanization, etc. in Southeast Asia and Africa (The World Agroforestry Centre [ICRAF]), by maintaining liaison offices in Thailand and Kenya, respectively. The regional representatives also attended various meetings and events to exchange ideas on the current status and future directions of the research.

In addition, a staff member of JIRCAS was sent on a long-term assignment to IRENA to assess the bio-energy supply potential of five Asian countries. Another staff member was sent on a long-term assignment to the CGIAR System Management Office in France to promote partnership between JIRCAS and international agricultural research institutes. JIRCAS’s agricultural research was coordinated with CGIAR operations, thus contributing in the assessment of research management performance and the establishment of an evaluation system. They also gathered and provided information on international research trends.

Finally, JIRCAS and the National Agriculture and Food Research Organization (NARO), in collaboration with GRA, jointly organized an international symposium on “Agricultural Greenhouse Gas Mitigation” at Tsukuba International Congress Center on August 29-30, 2017. JIRCAS also organized the JIRCAS International Symposium, titled “Promoting an Active Role for Female Researchers in Agriculture, Food, and Nutrition Research,” at the U Thant International Conference Hall, United Nations University, Tokyo, Japan, on November 2, 2017, with an aim to foster human resources and promote gender equality through joint research in developing areas.

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 at counterpart organizations. These programs facilitate the exchange of information and opinions on agriculture, forestry, and fisheries research. At the same time, their implementation and administration serve as an opportunity to strengthen research ties among scientists and administrators in participating countries, mostly in the developing regions. Current programs are described in detail below.

Administrative Invitation Program

Under the Administrative Invitation Program, JIRCAS invites administrators from counterpart organizations to its Tsukuba premises to engage in discussions and reviews of ongoing researches to ensure that collaborative projects run smoothly. In addition, the program exposes administrators to the current activities at JIRCAS and other MAFF-affiliated National Research and Development Agencies (NRDAs). Furthermore, the program provides opportunities for the exchange of information and opinions concerning policy-making and project design at the administrative level, thereby contributing to deeper mutual understanding and international collaboration. Fifty-seven visits to JIRCAS were made during FY 2017 under the Administrative Invitation Program. Invited administrators and their home institutions are listed below.

Administrative Invitations, FY 2017

Thiti Visaratana	Royal Forest Department, Forest Research and Development Bureau, Thailand	Apr. 23 - 29, 2017
Regina Sagoe	Council for Scientific and Industrial Research (CSIR), Crops Research Institute, Ghana	Aug. 24 - Sep. 3, 2017
Robert Bellarmin Zougmore	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Mali	Aug. 25 - Sep. 3, 2017
Famoï Béavogui	Institut de Recherche Agronomique de Guinée (IRAG), Guinea	Aug. 25 - Sep. 3, 2017
Alioune Fall	Institut Sénégalais de Recherches Agricoles (ISRA), Senegal	Aug. 25 - Sep. 3, 2017
Joseph G. Mureithi	Kenya Agricultural and Livestock Research Organization (KALRO), Kenya	Aug. 26 - Sep. 3, 2017
Theresia Willy Massoy-Amon	Ministry of Agriculture, Livestock and Fisheries, Tanzania	Aug. 27 - Sep. 3, 2017
Cao Ziyi	Department of Science, Technology and Education, Ministry of Agriculture, PR China	Aug. 28 - Sep. 2, 2017
Ding Ding	Department of Climate Change, National Development and Reform Commission, PR China	Aug. 28 - Sep. 2, 2017
Guan Dahai	Rural Energy and Environment Agency, Ministry of Agriculture, PR China	Aug. 28 - Sep. 2, 2017
Xiaobo Qin	Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences (CAAS), PR China	Aug. 28 - Sep. 3, 2017
Sun Hao	Rural Energy and Environment Agency, Ministry of Agriculture, PR China	Aug. 28 - Sep. 2, 2017
Yue Li	Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences (CAAS), PR China	Aug. 28 - Sep. 3, 2017
Hongmin Dong	Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences (CAAS), PR China	Aug. 28 - Sep. 2, 2017

Administrative Invitations, FY 2017		
Sommart Kritapon	Khon Kaen University, Thailand	Aug. 30 - Sep. 1, 2017
Nipat Sukhvibul	Office of Agricultural Research and Development, Region 1, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Thirachat Vichitcholchai	Post-Harvest and Product Processing Research and Development Office, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Suradet Patchimkul	Office of Agricultural Research and Development, Region 6, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Rungtiva Rodchan	Plant Standards and Certification Division, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Preeyanooch Tippayawat	Plant Standards and Certification Division, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Jintawee Thaingam	International Agricultural Affairs Group, Planning and Technical Division, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Pismai Chantanamatha	Research Systems Group, Planning and Technical Division, Department of Agriculture, Thailand	Sep. 19 - 22, 2017
Thammarat Thongmee	Field and Renewable Energy Crops Research Institute, Thailand	Sep. 19 - 22, 2017
Warunee Thanapase	Kasetsart Agriculture and Agro-Industrial Product Improvement Institute (KAPI), Kasetsart University, Thailand	Sep. 22 - 27, 2017
Pilanee Vaithanomsat	Kasetsart Agriculture and Agro-Industrial Product Improvement Institute (KAPI), Kasetsart University, Thailand	Sep. 22 - 27, 2017
Kristina Toderich	International Center for Biosaline Agriculture for Central Asia and Caucasus, Uzbekistan	Oct. 27 - Nov. 3, 2017
Ismahane Elouafi	International Center for Biosaline Agriculture, United Arab Emirates	Oct. 28 - Nov. 4, 2017
Felamboahangy Henintsoa Rasoarahona	Food Science and Technology, School of Agricultural Sciences, University of Antananarivo, Madagascar	Oct. 29 - Nov. 4, 2017
Mercy Gloria Vwamula Lung' aho	International Center for Tropical Agriculture (CIAT), Regional Office for Africa, Kenya	Oct. 30 - Nov. 3, 2017
Howarth Earle Bouis	HarvestPlus c/o International Rice Research Institute (IRRI), Philippines	Oct. 31 - Nov. 3, 2017
Michael Gomez Selvaraj	International Center for Tropical Agriculture (CIAT), Colombia	Nov. 22 - 30, 2017
Manabu Ishitani	International Center for Tropical Agriculture (CIAT) , Colombia	Nov. 26 - Dec. 1, 2017
Carolina Saint Pierre	International Maize and Wheat Improvement Center (CIMMYT), Mexico	Nov. 27 - 30, 2017
Jimmy Lamo	National Agricultural Research Organization, National Crops Resources Research Institute (NaCRRI), Uganda	Nov. 27 - Dec. 1, 2017
Kayode Abiola Sanni	African Agricultural Technology Foundation (AATF), Kenya	Nov. 27 - Dec. 2, 2017
Jos van Boxtel	Arcadia Biosciences Inc., United States of America	Nov. 27 - Dec. 2, 2017
Li Xiaohua	Rural Energy and Environment Agency, Ministry of Agriculture, PR China	Nov. 27 - Dec. 1, 2017
Liang Miao	Rural Energy and Environment Agency, Ministry of Agriculture, PR China	Nov. 27 - Dec. 1, 2017
Ju Xuehai	Rural Energy and Environment Agency, Ministry of Agriculture, PR China	Nov. 27 - Dec.1, 2017

Administrative Invitations, FY 2017		
Jin Tuo	Rural Energy and Environment Agency, Ministry of Agriculture, PR China	Nov. 27 - Dec. 1, 2017
Amelia Henry	International Rice Research Institute (IRRI), Philippines	Nov. 28 - 30, 2017
Md. Ismail Hossain	Agricultural Statistics Division, Bangladesh Rice Research Institute (BRRI), Bangladesh	Dec. 10 - 16, 2017
Md. Abu Bakr Siddique	Agricultural Economics Division, Bangladesh Rice Research Institute (BRRI), Bangladesh	Dec.10 - 16, 2017
Suresh Kumar Chaudhari	Indian Council of Agricultural Research (ICAR), India	Dec. 18 - 22, 2017
Tejbir Singh	NRM Division, Indian Council of Agricultural Research (ICAR), India	Dec.18 - 22, 2017
Parbodh Chander Sharma	Central Soil Salinity Research Institute (CSSRI), India	Dec.18 - 22, 2017
Ashok Kumar Singh	Indian Agricultural Research Institute (IARI), India	Dec. 18 - 22, 2017
Shenggen Fan	International Food Policy Research Institute (IFPRI), United States of America	Dec. 21 - 23, 2017
Raymond Rabeson	National Center of Applied Research and Rural Development (FOFIFA), Madagascar	Jan. 23 - Feb. 1, 2018
Tantely Razafimbelo	Laboratory of Radioisotopes, University of Antananarivo, Madagascar	Jan. 23 - Feb. 1, 2018
Hermenegildo R. Serafica	Sugar Regulatory Administration, Department of Agriculture, Philippines	Feb. 4 - 10, 2018
Jennifer Marie S. Artates	Sugar Regulatory Administration, Department of Agriculture, Philippines	Feb. 4 - 10, 2018
Arlene C. Matti	Sugar Regulatory Administration, Department of Agriculture, Philippines	Feb. 4 - 10, 2018
Ignacio S. Santillana	Sugar Regulatory Administration, Department of Agriculture, Philippines	Feb. 4 - 10, 2018
Rosemarie S. Gumera	Sugar Regulatory Administration, Department of Agriculture, Philippines	Feb. 4 - 10, 2018
Roland B. Beltran	Sugar Regulatory Administration, Department of Agriculture, Philippines	Feb. 4 - 10, 2018
Zhao Minjuan	College of Economics and Management, Northwest Agriculture and Forestry University, PR China	Feb. 5 - 10, 2018

Counterpart Researcher Invitation Program

The Counterpart Researcher Invitation Program provides invitations for periods of up to six months to researchers engaged in collaborative work with JIRCAS research staff. Counterparts conduct in-depth research at JIRCAS, at other MAFF-affiliated NRDAs, at prefectural research institutes, or at national universities. This invitation program aims to enhance the quality of research conducted overseas and to facilitate exchanges of individual research staff between JIRCAS and the counterpart institutions. Twenty-five researchers were invited under this program during FY 2017. Invited researchers, their affiliated research organizations, and their research activities are summarized below.

Counterpart Researcher Invitations, FY2017

Cedric Bartschi	ETH Zurich Institute for Agricultural Science, Switzerland	Training on throughput phenotyping	Apr. 3 - Sep. 1, 2017
Woraphun Himmapan	Royal Forest Department, Forest Research and Development Bureau, Thailand	Research activities for collaboration on “Efficient silvicultural practices for promoting teak plantation”	Apr. 23 - 29, 2017
Terry James Rose	Southern Cross Plant Science, Southern Cross University, Australia	Research on “Comparison of screening methods to evaluate nutrient efficiency in rice”	Jun. 23 - Jul 1, 2017
Andry Andriamananjara	Laboratoire de Radioisotopes, University of Antananarivo (LRI), Madagascar	Study on “Breakthrough in nutrient use efficiency for rice by genetic improvement and fertility sensing techniques in Africa”	Jul. 25 - Sep. 2, 2017
Michel Rabenarivo	Laboratoire de Radioisotopes, University of Antananarivo (LRI), Madagascar	Study on “Breakthrough in nutrient use efficiency for rice by genetic improvement and fertility sensing techniques in Africa”	Jul. 25 - Sep. 2, 2017
Sayvisene Boulom	Faculty of Agriculture, National University of Laos (NUoL), Laos	Research and technology development of traditional fermented foods for effective use and high value addition for sustainable rural livelihood improvement	Aug. 26 - Sep. 16, 2017
Baboucarr Manneh	STRASA/GSR Africa Rice Center, Senegal	Research visit for “Improving Stress Tolerance and the Productivity of Rice for Africa, Phase II”	Sep. 11 - 17, 2017
Rose Ann Miagao Diamante	South East Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD), Philippines	Demonstration and Verification of Sustainable and Efficient Aquaculture Techniques by Combination of Multiple Organisms	Sep. 19 - 30, 2017
Amafe Belleza Gavile	South East Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD), Philippines	Study on the “Development of low fish meal feed for aquaculture using alternative resources”	Sep. 19 - 30, 2017
Mohammad Ashik Iqbal Khan	Bangladesh Rice Research Institute (BRRI), Bangladesh	Study on the “Improvement of rice resistance to blast disease using a differential system.”	Sep. 21 - 24, 2017
Sarah Tojo Mandaharisoa	Centre National de Recherche Appliquee au Developpement Rural (FOFIFA), Madagascar	Study on “Breakthrough in nutrient use efficiency for rice by genetic improvement and fertility sensing techniques in Africa”	Sep 26 - Nov. 5, 2017
Sapto Indrioko	Faculty of Forestry Gadjah Mada University, Indonesia	Training on genotyping technics for dipterocarp timber species	Oct. 1 - 11, 2017

Counterpart Researcher Invitations, FY2017			
Widiyatno	Faculty of Forestry Gadjah Mada University, Indonesia	Study on "DNA extraction and genotyping for dipterocarp timber species (*Shorea leprosula*)"	Oct. 1 - 22, 2017
Suchirat Sakuanrungsirikul	Khon Kaen Field Crop Research Center, Thailand	Study on the "Development of integrated pest management system for sugarcane white leaf disease based on the ecology of the vector insects"	Oct. 14 - 24, 2017
Salisa Sungviset	Khon Kaen Seed Research and Development Center, Thailand	Study on the "Development of integrated pest management system for sugarcane white leaf disease based on the ecology of the vector insects"	Oct. 14 - 21, 2017
Bounsong Vongvichith	Living Aquatic Resources Research Center (LARReC), Laos	Study on the "Growth and reproduction of an important commercial fish "Pa keo" (*Clupeichthys aesarnensis*)"	Dec. 3 - 13, 2017
Bounpasakxay Khamphoumi	Forestry Research Center, National Agriculture and Forestry Research Institute (NAFRI), Laos	Study on the "Development of Forestry Technologies of the Indigenous Tree Plantations on the Slopes in Laos"	Dec. 4 - 15, 2017
Masazurah binti A. Rahim	Fisheries Research Institute (FRI) Batu Maung, Malaysia	Study on the "Development of fisheries resource utilization system using natural circulation function"	Dec. 13 - 22, 2017
Rattiya Waeonukul	Pilot Plant Development and Training Institute (PDTI), King Mongkut's University of Technology Thonburi (KMUTT), Thailand	Study on biological saccharification technology using *Clostridium thermocellum*	Jan. 9 - Mar. 20, 2018
Chonlayut Raweewan	Food Functionality Evaluation Center, National Food Institute, Thailand	Preparation of 2-acetyl-1-pyrroline, potent flavor component in aromatic rice by chemical synthesis, and simplification of the extraction from pandan leaves	Jan. 21 - Feb. 10, 2018
Hua Cong	Institute of Crop Germplasm Resources, Xinjiang Academy of Agricultural Sciences, PR China	Research on the "Evaluation of soybean for environmental stress tolerance in field conditions and development of soybean elite breeding lines"	Jan. 23 - Feb 3, 2018
Sreyneang Nhim	Pilot Plant Development and Training Institute (PDTI), King Mongkut's University of Technology Thonburi (KMUTT), Thailand	Study on biological saccharification technology using new anaerobic thermophilic bacteria	Feb. 6 - Mar. 20, 2018
Jonathan M. Niones	Genetic Resources Division, Philippine Rice Research Institute (PhilRice), Philippines	Rice breeding research for genetic improvement of root system to increase yielding and tolerance to problem soil	Feb. 26 - Mar. 10, 2018
Teodora E. Mananghaya	Genetic Resources Division, Philippine Rice Research Institute (PhilRice), Philippines	Rice breeding research for genetic improvement of root system to increase yielding and tolerance to problem soil	Feb. 26 - Mar. 10, 2018
Widiyatno	Faculty of Forestry, Gadjah Mada University, Indonesia	Study on "DNA extraction and genotyping for dipterocarp timber species (*Shorea leprosula*)"	Mar. 18 - 30, 2018

Project Site Invitation Program

In FY 2007, JIRCAS launched this 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 other countries where workshops or planning meetings are held. Forty-one invited researchers implemented their programs during FY 2017 as listed below.

Project Site Invitations, FY 2017			
Erdiman	Faculty of Economics and Management, Bogor Agricultural University (BAU), Indonesia	Participation in a series of meetings for the project "Development of agricultural technologies for reducing greenhouse gas emissions and climate-related risks in developing countries," Myanmar	May 6 - 19, 2017
Resfa Fitri Amir	Faculty of Economics and Management, Bogor Agricultural University (BAU), Indonesia	Participation in a series of meetings for the project "Development of agricultural technologies for reducing greenhouse gas emissions and climate-related risks in developing countries," Myanmar	May 7 - 18, 2017
Kyaw Myaing	Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation (MOALI), Myanmar	Conduct of field survey and attendance to the Indonesian nationwide SALIBU seminar under the project "Development of agricultural technologies for reducing greenhouse gas emissions and climate-related risks in developing countries," Indonesia	May 17 - 25, 2017
Rafael Moreira Soares	Embrapa Soja, Brazil	Participation in the annual meeting for the project "Development of soybean varieties resistant to Asian soybean rust and other soybean diseases" (at Posadas)," Argentina	Sep. 3 - 7, 2017
Julio César García Rodríguez	National Institute of Forestry, Agricultural, and Livestock Research (INIFAP), Mexico	Participation in the annual meeting for the project "Development of soybean varieties resistant to Asian soybean rust and other soybean diseases" (at Posadas)," Argentina	Sep. 3 - 8, 2017
Antonio Juan Gerardo Ivancovich	National University of Northwestern Province of Buenos Aires (UNNOBA), Pergamino, Argentina	Participation in the annual meeting for the project "Development of soybean varieties resistant to Asian soybean rust and other soybean diseases" (at Posadas)," Argentina	Sep. 4 - 7, 2017
Miguel Lavilla	National University of Northwestern Province of Buenos Aires (UNNOBA) Pergamino, Argentina	Participation in the annual meeting for the project "Development of soybean varieties resistant to Asian soybean rust and other soybean diseases" (at Posadas)," Argentina	Sep. 4 - 7, 2017
Ruth Scholz	Centro de Investigación Capitán Miranda (CICM), Instituto Paraguayo de Tecnología Agraria (IPTA), Paraguay	Participation in the annual meeting for the project "Development of soybean varieties resistant to Asian soybean rust and other soybean diseases" (at Posadas)," Argentina	Sep. 4 - 7, 2017

Project Site Invitations, FY 2017			
Anìbal Morel Yurenka	Instituto de Biotecnología Agrícola (INBIO), Paraguay	Participation in the annual meeting for the project “Development of soybean varieties resistant to Asian soybean rust and other soybean diseases” (at Posadas),” Argentina	Sep. 4 - 7, 2017
Miori Uno Shimakawa	Fundacion Nikkei-Cetapar (Cetapar), Paraguay	Participation in the annual meeting for the project “Development of soybean varieties resistant to Asian soybean rust and other soybean diseases” (at Posadas),” Argentina	Sep. 4 - 7, 2017
Silvina Stewart	Instituto Nacional de Investigacion Agropecaria (INIA) - La Estanzuela, Uruguay	Participation in the annual meeting for the project “Development of soybean varieties resistant to Asian soybean rust and other soybean diseases” (at Posadas),” Argentina	Sep. 4 - 7, 2017
Ingo Kliewer	Fundacion Nikkei-Cetapar (Cetapar), Paraguay	Participation in the annual meeting for the project “Development of soybean varieties resistant to Asian soybean rust and other soybean diseases” (at Posadas),” Argentina	Sep. 4 - 7, 2017
Adrian Dario De Lucia	Instituto Nacional de Tecnologia Agropecuaria (INTA), Argentina	Participation in the annual meeting for the project “Development of soybean varieties resistant to Asian soybean rust and other soybean diseases” (at Posadas),” Argentina	Sep. 4 - 6, 2017
Baboucarr Manneh	STRASA/GSR Africa Rice Center, Senegal	Workshop for the research on “Improving Stress Tolerance and the Productivity of Rice for Africa, Phase II,” Indonesia	Sep. 11 - 17, 2017
Mohammad Ashik Iqbal Khan	Bangladesh Rice Research Institute (BRRI), Bangladesh	Participation in the joint workshop “Genetic improvement for biotic and abiotic stress under unfavorable environment condition in rice cultivation” and the annual meeting for JIRCAS Blast Research Network and Environmental Stress-Tolerant Rice,” Indonesia	Sep.18 - 20, 2017
Jonathan M. Niones	Philippine Rice Research Institute (PhilRice), Philippines	Participation in the joint workshop “Genetic improvement for biotic and abiotic stress under unfavorable environment condition in rice cultivation” and the annual meeting for JIRCAS Blast Research Network and Environmental Stress-Tolerant Rice,” Indonesia	Sep.18 - 21, 2017
Jennifer Tagubase Niones	Philippine Rice Research Institute (PhilRice), Philippines	Participation in the joint workshop “Genetic improvement for biotic and abiotic stress under unfavorable environment condition in rice cultivation” and the annual meeting for JIRCAS Blast Research Network and Environmental Stress-Tolerant Rice,” Indonesia	Sep.18 - 21, 2017

Project Site Invitations, FY 2017			
Nguyen Thi Minh Nguyet	Agriculture Genetics Institute (AGI), Vietnam	Participation in the joint workshop "Genetic improvement for biotic and abiotic stress under unfavorable environment condition in rice cultivation" and the annual meeting for JIRCAS Blast Research Network and Environmental Stress-Tolerant Rice," Indonesia	Sep. 18 - 21, 2017
Vipa Surojanametakul	Institute of Food Research and Product Development, Kasetsart University, Thailand	Attendance to the project meeting for Flagship Project 2, Upgrading Rice Value Chains, under the CGIAR Research Program - Rice Agri-food Systems (CRP RICE) at CIRAD headquarters in Montpellier, France	Oct. 22 - 30, 2017
Prajongwate Satmalee	Institute of Food Research and Product Development, Kasetsart University, Thailand	Attendance to the project meeting for Flagship Project 3, Upgrading Rice Value Chains, under the CGIAR Research Program - Rice Agri-food Systems (CRP RICE) at CIRAD headquarters in Montpellier, France	Oct. 22 - 30, 2017
Aung Naing Oo	Aquaculture Division, Ministry of Agriculture, Livestock and Irrigation, Myanmar	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 3 - 7, 2017
Nyo Nyo Tun	Marine Science Department, Myeik University, Myanmar	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 3 - 8, 2017
Dusit Aue-Umneoy	Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 4 -7, 2017
Kaviphone Phouthavong	Living Aquatic Resource Research Center (LARReC), Laos	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 4 - 7, 2017
Phonenaphet Chanthason	Living Aquatic Resource Research Center (LARReC), Laos	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 4 - 7, 2017
Roger Edward P. Mamauag	Southeast Asian Fisheries Development Center/Aquaculture Department, Philippines	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 4 -7, 2017

Project Site Invitations, FY 2017			
Rose Ann Miagao Diamante	Southeast Asian Fisheries Development Center/Aquaculture Department, Philippines	Participation in the annual meeting for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Malaysia	Dec. 4 - 7, 2017
Erdiman	Faculty of Economics and Management, Bogor Agricultural University(BAU), Indonesia	Meeting with counterparts from the Department of Agricultural Research (DAR), Ministry of Agriculture, Livestock and Irrigation (MOALI), for the research "Improvement of irrigation water productivity for paddy rice production by means of SALIBU ratoon technology in CDZ, Myanmar"	Jan. 21 - 28, 2018
Resfa Fitri Amir	Faculty of Economics and Management, Bogor Agricultural University(BAU), Indonesia	Meeting with counterparts from the Department of Agricultural Research (DAR), Ministry of Agriculture, Livestock and Irrigation (MOALI), for the research "Improvement of irrigation water productivity for paddy rice production by means of SALIBU ratoon technology in CDZ, Myanmar"	Jan. 22 - 27, 2018
Govind Pratap Rao	Division of Plant Pathology, Indian Agricultural Research Institute (IARI), India	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018
Ajay Kumar Tiwari	UP Council of Sugarcane Research, Sugar Research Institute, India	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018
Nguyen Bao Quoc	Research Institute for Biotechnology and Environment, Nong Lam University, Vietnam	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018
Bich Tran	Research Institute for Biotechnology and Environment, Nong Lam University, Vietnam	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018
San Thein	Myanmar Sugarcane and Sugar Related Producers and Manufacturers' Association, Myanmar	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018
Nyo Nyo Aung	Industrial Crops Development Division, Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation (MOALI), Myanmar	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018

Project Site Invitations, FY 2017			
Chay Bounphanousay	National Agriculture and Forestry Research Institute (NAFRI), Ministry of Agriculture, Laos	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 20, 2018
Chanthakhone Boualaphanh	National Agriculture and Forestry Research Center (NAFRC), Laos	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb. 18 - 21, 2018
Ari Kristini	Indonesian Sugar Research Institute, Indonesia	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb.18 - 21, 2018
Rosalyn T. Luzaran	Philippine Sugar Research Institute (Philsurin), Philippines	Joining the Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia, Thailand	Feb. 18 - 21, 2018
Maria Junemie Hazel Lebata-Ramos	Southeast Asian Fisheries Development Center/Aquaculture Department, Philippines	On-site field survey and lecture on the development of oyster culture techniques in Myanmar for the research project "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems," Myanmar	Mar. 2 - 9, 2018
Gawharay Paluashova	Research Institute of Irrigation and Water Problem, Uzbekistan	Participation and delivery of an oral presentation at the 13th International Conference on Desert Technology (DT13) and the International Conference on Arid Land (ICAL3), Pondicherry, India	Mar. 11 - 18, 2018

FELLOWSHIP PROGRAMS AT JIRCAS

JIRCAS Visiting Research Fellowship Program at Tsukuba and Okinawa

The current JIRCAS Visiting Research Fellowship Program has its beginnings in FY 1992 with the launching of the JIRCAS Visiting Research Fellowship Program at Okinawa under which researchers are invited to conduct research on topics relating to tropical agriculture for a period of one year at the Tropical Agriculture Research Front (TARF, formerly Okinawa Subtropical Station). Since October 1995, a similar program (JIRCAS Visiting Research Fellowship Program at Tsukuba) has been implemented at JIRCAS's Tsukuba premises, with the aim to promote collaborative researches that address various problems confronting countries in developing regions. In FY 2006, these fellowship programs were modified and merged into one. In FY 2017, a total of two researchers were invited to conduct research at JIRCAS HQ and two researchers were invited to conduct research at JIRCAS TARF.

JIRCAS Visiting Research Fellowship at Tsukuba (October 2017 - September 2018)

Pradipta Ranjan Pradhan	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Validation on the suppression effect of sorgoleone for nitrous oxide (N_2O) emission using sorghum RIL strains with different abilities of the release	Oct. 15, 2017 - Sep. 28, 2018
Phakhinee Thianheng	Department of Food Business Management, University of the Thai Chamber of Commerce, Thailand	Construction of efficient saccharification process on lignocellulosic biomass using novel alkali-thermophilic anaerobic bacteria A7	Nov. 10, 2017 - Sep. 28, 2018

JIRCAS Visiting Research Fellowship at Okinawa (October 2017 - September 2018)

Abdelhalim Awad Abdelhalim Ismail	Soil and Water Department, Faculty of Agriculture, Tanta University, Egypt	Development of sustainable cropping and manuring technologies with utilization of lysimeter in Okinawa	Oct. 1, 2017 - Sep. 29, 2018
Chhourn Orn	Plant Breeding Division, Cambodian Agricultural Research and Development Institute (CARDI), Cambodia	Selection and development of breeding line for blast resistance in Indica Group's leading rice (*Oryza sativa* L.) cultivar	Oct. 1, 2017 - Sep. 29, 2018

JIRCAS Visiting Research Fellowship Program at Project Sites

This fellowship program has been implemented since May 2006 at collaborating research institutions located in developing countries where collaborative researches are being carried out by JIRCAS researchers. It aims to promote the effective implementation of ongoing collaborative researches at the project sites through the participation of local research staff. Furthermore, through this fellowship program, JIRCAS intends to contribute to capacity-building of the collaborating research institutions. In FY 2017, one researcher was invited to Myanmar. The fellow and his research subject are listed on the next page.

For inquiries on the JIRCAS Visiting Research Fellowship Program, please contact the International Relations Section (Tel. +81-29-838-6336; Fax +81-29-838-6337; e-mail: irs-jircas@ml.affrc.go.jp)

JIRCAS Visiting Research Fellowship at Project Site (October 2017 - September 2018)			
Saw-Htoo-Thaw	JIRCAS Overseas Outsourcing Staff, Department of Marine Science, Myeik University, Myanmar	Creation of distribution map on biological and environmental information in the coastal waters of Myeik, Myanmar	Oct. 1, 2017 - Sep. 30, 2018

Other Fellowships for Visiting Scientists

The Government of Japan sponsors a postdoctoral fellowship program and a researcher exchange program for foreign scientists through the Japan Society for the Promotion of Science (JSPS). The program places postdoctoral and sabbatical fellows in national research institutes throughout Japan according to research theme and prior arrangement with host scientists, for terms of generally one month to three years. Fellowships can be undertaken in any of the ministries, and many fellows are currently working at various NRDAs affiliated with MAFF. The visiting scientists who resided at JIRCAS in FY 2017 are listed below.

JSPS Postdoctoral Fellowship for Overseas Researchers (April 2017 to March 2018)			
Hsiang-Yin Chen	University of North Carolina Wilmington, USA	Shrimp reproduction, the roles of stimulatory hormones, and new aquaculture technology	Jul. 1, 2015 - Jun. 30, 2017
Clement N. Bardon	Claude Bernard University Lyon 1, France	Characterization of the biological nitrification inhibition (BNI) function in *Sorghum bicolor*	Aug. 1, 2016 - Apr. 29, 2017

Seminar on "Shallow sub-surface drainage for mitigating salinization" in Uzbekistan

A seminar was held on November 29, 2017 in Gliston, Syr Darya State, Uzbekistan, to publicly disclose and disseminate the technology manual titled "Shallow Sub-Surface Drainage for Mitigating Salinization." The manual is a conclusive product of the Ministry of Agriculture, Forestry and Fisheries (MAFF)-subsidized project from 2013 to 2016 and is currently a research subject of the JIRCAS project titled "Development of sustainable resource management systems in the water vulnerable areas of Asia and Pacific Islands." The seminar was attended by 30 people, including local farmers from the State of Syr Darya and representatives of the Farmers' Council (FC) of Uzbekistan, the counterpart organization of the project, as well as government officials and researchers from the capital Tashkent.

At the seminar, the JIRCAS team led by Mr. Yukio Okuda presented the contents of each chapter of the manual, with a focus on soil salinization mechanisms and monitoring methodologies, and irrigation technologies and sub-surface drainage construction using the 'cut-drain' machine to mitigate saline-affected soils. The farmers showed great interest in these technologies, especially in the 'cut-drain' concept, as it showed the significant impact of salt removal and the resulting yield increase. Inquiries were raised by farmers about the durability of the sub-surface drainage and the cost of the 'cut-drain' machine. The farmers and the FC unanimously agreed to request government support to accelerate diffusion of the technologies.

The 'cut-drain' machine was exhibited to participants at the courtyard outside the seminar venue.

Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia

On February 19-20, 2018, JIRCAS held the 'Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease (SCWLD) in Asia' together with Thailand's Department of Agriculture (DOA) and Khon Kaen University (KKU), which also provided the workshop venue. More than 60 people from 10 countries (United States, India, Indonesia, Australia, Thailand, Philippines, Vietnam, Myanmar, Laos and Japan) participated in the workshop.

Presentations were delivered, followed by active discussions on the current situation of SCWLD occurrence in Asian countries and the latest research outcomes including results of the joint research by KKU, DOA, and JIRCAS. Specific examples of technology dissemination efforts by several organizations and private companies were also introduced.

In the general discussion, an agreement was reached to share knowledge, and ensure that future research and dissemination activities are made with the aim of suppressing further spread of SCWLD and reducing damage in the affected countries. A working group of representatives from each country will also be established, and a standardized method for the identification of SCWLD in the field and collection of vector insects necessary for comparing and sharing research results will be developed. Along with that, discussions on budget acquisition methods and other matters relating to the international framework will continue. After the indoor meeting, the participants visited the experimental fields to witness a demonstration of a hypothesis concerning the healthy cane propagation technology obtained in the previous research. The feasibility of healthy stem production in white leaf disease-contaminated areas was discussed during the field activity.

Group picture of workshop participants

Field visit at the experimental site

International Symposiums and Workshops, FY 2017			
1	JIRCAS-PhilRice Climate Change Project 2017-2020 Kick-off Meeting	May 10, 2017	Nueva Ecija, Philippines
2	JIRCAS-NAFRI-NUOL Annual Meeting on Collaborative Projects	May 25, 2017	Vientiane, Laos
3	Steering Committee Meeting on JIRCAS-NAFRI Collaborative Projects	May 26, 2017	Vientiane, Laos
4	Seminar and Training Course on “Adopting Smart Beef Cattle Feeding Techniques”	June 2-3, 2017	Nakhon Ratchasima, Thailand
5	Kick-off meeting for the project “Establishment of the model for fertilizing cultivation promotion using Burkina Faso phosphate rock”	June 12, 2017	Ouagadougou, Burkina Faso
6	Food Value Chain Project Workshop: Agricultural Development through High Value-addition	July 21, 2017	Beijing, PR China
7	JIRCAS-CAAS 20th Anniversary Symposium on Collaborative Research in Agricultural Science and Technology	July 22, 2017	Beijing, PR China
8	Inception meeting for the project “Development of sustainable and environment-friendly aquaculture techniques in coastal waters in Myanmar (MYSEFAT Project)”	August 7, 2017	Yangon, Myanmar
9	JIRCAS-NARO International Symposium on Agricultural Greenhouse Gas Mitigation	August 31, 2017	Tsukuba, Japan
10	Workshop for the project “Development of sustainable resources management system in Palau”	September 5, 2017	Koror, Palau
11	Annual Meeting for the project “Development of soybean varieties resistant to Asian soybean rust and other diseases”	September 5-6, 2017	Cerro Azul, Argentina
12	Joint Workshop titled “Genetic improvement for biotic and abiotic stress under unfavorable environment condition in rice cultivation” and Annual Meetings of the “JIRCAS Blast Research Network” and “Environmental Stress-Tolerant Rice” Project	September 19-20, 2017	Bogor, Indonesia

International Symposiums and Workshops, FY 2017			
13	JIRCAS-CTU-UM Climate Change Project Workshop 2017	September 22, 2017	Can Tho, Vietnam
14	1st JCC (Joint Coordination Committee) & Kick-off meeting for the SATREPS project "Fertility sensing Variety Amelioration for Rice Yield (FY VARY)"	October 5, 2017	Antananarivo, Madagascar
15	Food Value Chain Project Meeting for Thailand and Laos	October 6, 2017	Bangkok, Thailand
16	UNFCCC-COP23 Side Event: Effective Use of Agro-Residues-Renewable Energy Solutiions for Forest Conservation and REDD+	November 14, 2017	Bonn, Germany
17	2nd Steering Committee Meeting on the RFD-JIRCAS Project	November 17, 2017	Bangkok, Thailand
18	JIRCAS Seminar 2017: Shallow sub-surface drainage for mitigating salinization	November 29, 2017	Gulistan, Uzbekistan
19	International Workshop titled "Development of Drought-Tolerant Crops for Developing Countries and Future Prospects"	November 29, 2017	Tsukuba, Japan
20	Annual meeting for the JIRCAS project titled "Development of technologies for sustainable aquatic production in harmony with tropical ecosystems"	December 5-6, 2017	Penang, Malaysia
21	MoU Signing Ceremony and Special Seminar for the New Collaboration between JIRCAS and the Indian Council of Agricultural Research (ICAR)	December 20, 2017	Tsukuba, Japan
22	Workshop on "Sustainable Rural Bioenergy Solutions in Africa"	January 19, 2018	Nairobi, Kenya
23	NARO-MARCO Symposium 2018 on "MINCERnet: Multi-site monitoring network to cope with the heat stress of rice under climate change"	January 26, 2018	Tsukuba, Japan
24	JIRCAS C4 Project (Higher Value Forestry) Knowledge Transfer Seminar	February 6, 2018	Khon Kaen, Thailand
25	Technical Coordinating Committee meeting for the project "Establishment of the model for fertilizing crop cultivation promotion using Burkina Faso phosphate rock"	February 9, 2018	Koudougou, Burkina Faso
26	Second International Workshop on Network Development and Information Sharing for Management of Sugarcane White Leaf Disease in Asia	February 19-20, 2018	Khon Kaen, Thailand
27	KNUST-JIRCAS Workshop titled "Effective development of paddy fields in Ghana"	March 8, 2018	Kumasi, Ghana
28	Second Meeting: Development of technologies for reducing greenhouse gas emissions and avoiding risks in livestock production systems	March 30, 2018	Tokyo, Japan

APPENDIX

PUBLISHING AT JIRCAS

English		
1) JARQ (Japan Agricultural Research Quarterly)		
	Vol. 51	No. 3, No. 4
	Vol. 52	No. 1, No. 2
2) Annual Report 2016		
3) JIRCAS Newsletter	No.82, No.83	
4) JIRCAS Working Report Series	No. 86	Soil Fertility Improvement with Indigenous Resources in Lowland Rice Ecologies in Ghana

Japanese	
1) Koho JIRCAS	Vol. 1
2) JIRCAS News	No.82, No.83

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Underline indicates researcher at JIRCAS
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FOURTH 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 helping improve technologies for agriculture, forestry, and fisheries in tropical and subtropical areas, as well as in other overseas developing regions (hereinafter referred to as "developing regions"), by performing technical trials and research.

During the First Medium-Term Goal period (FY 2001 to 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 (FY 2006 to 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 international activities from the dissolved Japan Green Resources Agency and strengthened its field activities.

During the Third Medium-Term Goal period (FY 2011 to 2015), a program/project scheme was developed for three principal research areas: 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.

On the basis of the outcomes of JIRCAS's commitments and in accordance with the Basic Plan for Agriculture, Forestry and Fisheries Research (determined at the meeting of the Agriculture, Forestry and Fisheries Research Council on March 31, 2015), three principal research areas have been identified for the Medium to Long-Term Goal period, namely: (1) development of agricultural technologies for sustainable management of the environment and natural resources in developing regions; (2) technology development for stable production of agricultural products in the tropics and other adverse environments; and (3) development of high value-adding technologies and utilization of local resources in developing regions. Resources will be allocated to these research areas on a priority basis, and innovations in research management will be promoted to maximize R&D outcomes. To best understand the needs and seeds of technological development in developing regions and to promote R&D in line with Japan's policy, JIRCAS will strengthen its capability related to the collection, analysis, and dissemination of information on international agriculture, forestry, and fisheries.

Through this series of activities, JIRCAS, as Japan's only research institution mandated to carry out comprehensive international research in agriculture, forestry, and fisheries, is committed to strengthening the framework of collaboration with related organizations and to play a key role in R&D targeting developing regions. In this way, it will help solve global food problems and sophisticate Japan's research in agriculture, forestry, and fisheries.

I. Improving the Quality of Operations, Including Maximizing R&D Outcomes

JIRCAS will promote and evaluate the following five operational items as individual segments:

i. Promotion of research planning and partnership [1 to 5]

ii. Development of agricultural technologies for sustainable management of the environment and natural resources in developing regions [6(1); Attachment 1]

iii. Technology development for stable production of agricultural products in the tropics and other adverse environments [6(1); Attachment 2]

iv. Development of high value-adding technologies and utilization of local resources in developing regions [6(1); Attachment 3]

v. Collection, analysis, and dissemination of information to understand trends in international agriculture, forestry and fisheries [6(2)]

(Note) Notations within the above square brackets indicate subsections relevant to each item of operation.

<Promotion of research planning and partnership >

1. Promotion of research in line with government policy and enhancement of the PDCA (Plan, Do, Check, Action) cycle

(1) Strategic promotion of research in line with government policy

a) JIRCAS will identify research subjects and research promotion measures and will promote R&D strategically in consideration of the following issues: the need for technical improvement of agriculture, forestry, and fisheries in developing regions; the international situation; the need to contribute to government policy; the need to sophisticate Japan's research on agriculture, forestry, and fisheries; and ripple effects of R&D outcomes on technological improvement.
b) If JIRCAS, through its R&D, obtains technology seeds and findings useful to companies and producers in Japan, it will actively provide information and local support toward commercialization.
c) JIRCAS will manage the progress of research topics by preparing a process sheet stipulating the specific goals of each fiscal year before the start of research.
d) JIRCAS will evaluate research subjects adequately and rigorously, with the involvement of external experts, in accordance with the progress of the Medium to Long-Term Plan.
e) JIRCAS will pursue the approach of selection and concentration of research in light of the results of these evaluations and changes in social circumstances and will review, change, enhance, or terminate research subjects as necessary.

(2) Evaluation of the agency as a whole and allocation of resources

a) JIRCAS, as a whole agency, will develop a mechanism to conduct adequate self-evaluation and checking of the state of project management and the progress of research and will strengthen its PDCA cycle by reviewing plans adequately in light of the results of this evaluation and checking. Evaluation will be conducted according to the evaluation items and indexes specified by the Ministry of Agriculture, Forestry and Fisheries.
b) On the basis of the evaluation results, JIRCAS will develop and manage a system to allocate research resources such as budget amounts and personnel adequately to promote research activity. Effective incentives will be given to research personnel at the discretion of the President, and the research environment will be improved.
c) To further promote the Medium to Long-Term Plan, JIRCAS will make vigorous efforts to obtain external research funds, such as funds for commissioned projects and competitive funds.
d) The results of evaluations by the competent minister, and other findings, will be reflected adequately in the project management on a timely basis.

2. Promotion and enhancement of collaboration and cooperation between industry, academia, and government

a) JIRCAS will enhance collaboration and coordination with international organizations, domestic and international research institutes, extension organizations, universities, and private companies and will actively promote the exchange of information and staff.
b) In accordance with government strategies such as the Global Food Value Chain Strategy (developed on June 6, 2014 by the Committee for Global Food Value Chain Strategy), JIRCAS will use research networks to strengthen domestic and international collaboration.
c) JIRCAS will strengthen its cooperation in the use of technology seeds and human resources with such organizations as the National Agriculture and Food Research Organization (NARO) (including sections in charge of international collaboration), the Forestry and Forest Products Research Institute, and the Japan Fisheries Research and Education Agency.
d) By using the locational advantage of the Tropical Agriculture Research Front, JIRCAS will cooperate in the Genebank Project, NARO and a breeding study conducted by NARO, as well as in research projects conducted by other research organizations, to help advance agriculture, forestry, and fisheries in Japan.

3. Strategic promotion of intellectual property management

(1) Development of basic policy on intellectual property management

The basic policy on intellectual property management to promote the social implementation of R&D outcomes in developing regions will be reviewed in consideration of the Ministry of Agriculture, Forestry and Fisheries' Intellectual Property Strategy 2020 (issued on May 28, 2015 by the Ministry of Agriculture, Forestry and Fisheries) and the Policy on Intellectual Property in Research in Agriculture, Forestry and Fisheries (decreed by the Agriculture, Forestry and Fisheries Research Council on February 23, 2016).

(2) Promotion of social implementation of R&D outcomes through intellectual property management

a) A system of intellectual property management applicable to a series of processes from the planning stage of R&D to the stage after the completion of R&D will be developed and managed.
b) With goals that include using R&D outcomes as global public goods in developing regions, JIRCAS will study methods of obtaining the intellectual property rights for, preserving the confidentiality of, and disclosing R&D results; it will also study the policy of licensing. It thus aims to improve the speed of social implementation of research results and will pursue the smooth management of intellectual property.
c) On the basis of the basic policy on intellectual property management, JIRCAS will take the actions necessary for strategic management of intellectual property.

4. Enhancement of social implementation of R&D outcomes

(1) Publication of R&D outcomes

The outcomes of R&D will be published through research highlights, academic journals, and academic conferences. On such occasions, due consideration will be given to the possibility of obtaining intellectual property rights to research results and the need to preserve confidentiality.

(2) Promotion of technology dissemination

a) JIRCAS will quickly disseminate research results by converting them into databases and manuals; research results will be presented in forms available to farmers, companies, and extension organizations.
b) JIRCAS will collaborate with the relevant organizations to disseminate research results in countries and regions where the results may be utilized.

(3) Enhancement of public relations activities

a) JIRCAS will develop and implement publicity strategies to make its activities known to the public and increase its name recognition in Japan and other countries.
b) JIRCAS will disseminate information by using various media and opportunities, such as press releases, interviews, publication of journals and email magazines, and participation in external exhibitions.
c) JIRCAS will effectively disseminate information adapted to research areas and will target end-users through locally held workshops and explanatory meetings.

(4) Interactive communication with the public

a) JIRCAS will promote effective, interactive communication by holding symposiums and seminars and arranging educational tours and technical consultations.
b) JIRCAS will actively conduct outreach activities such as participating in external exhibitions and science café events and offering visiting lectures, in addition to making its facilities open to the public, in order to gain public feedback and increase public understanding of its activities.
c) JIRCAS will seek the understanding of residents in the areas targeted by research through cooperation with research partners and local governments in these target areas.

(5) Understanding and publication of medium to long-term ripple effects of R&D outcomes

a) JIRCAS will conduct follow-up surveys systematically regarding the main R&D outcomes it has achieved since becoming an incorporated administrative agency. It will publicize the survey results on its web site and by other means.
b) JIRCAS will disseminate information through its web site and by other means to make it widely known to the public that its R&D outcomes and activities have helped advance agriculture and society in Japan and developing regions.

5. Reinforcement of ties with government departments and other organizations

a) JIRCAS will closely exchange information with the relevant administrative departments to respond to their needs at various stages, from the design of research to the dissemination and commercialization of research results. JIRCAS will invite the relevant administrative departments to annual meetings to discuss the research results.
b) On request from administrative departments, JIRCAS will cooperate in conducting emergency operations, holding liaison conferences and symposiums, and dispatching experts.
c) On request from national and local governments, organizations, or universities, JIRCAS will perform analyses and appraisals that require its highly specialized knowledge and are difficult for other bodies to perform.
d) JIRCAS will welcome participants and trainees from other national research and development agencies, universities, national and public institutions, the private sector, and overseas organizations so as to develop human resources and raise technical standards.
e) As an organization that performs comprehensive research on agriculture, forestry, and fisheries, JIRCAS will dispatch its staff to committee meetings and conferences held by related international organizations and academic associations and will cooperate in other activities on request.

<Research work>

6. Promotion of research work (experiments, research, investigations)

(1) Focused areas and direction of research

a) JIRCAS will focus on the research subjects listed in the Attachment in consideration of the need for technical improvement of agriculture, forestry, and fisheries in developing regions, the international situation, the need to contribute to government policy, the need to sophisticate Japan's research on agriculture, forestry, and fisheries; and ripple effects of R&D outcomes on technological improvement.
b) JIRCAS will exchange information and develop systems of collaboration with relevant organizations in Japan and abroad and will promote effective international joint research in collaboration with developing regions, developed countries, international research organizations such as CGIAR, private organizations (including NGOs), and international research networks.
c) JIRCAS will further strengthen its alliances with other national research and development agencies in the field of agriculture, forestry, and fisheries and will effectively promote collaborative research utilizing research resources owned by the relevant organizations.

(2) Collection, analysis and dissemination of information for grasping trends of international agriculture, forestry and fisheries

a) To help solve global food and environmental problems, JIRCAS will analyze the current status of food supply and demand, nutritional improvement, and food systems in foreign countries and will forecast the future—and analyze the ripple effects—of research results.
b) To contribute to agriculture, forestry, and fisheries R&D in developing regions and to Japan's policies, such as the development of a global food value chain, JIRCAS will collaborate with the relevant organizations in Japan and abroad and will dispatch personnel to focus areas. It will collect and organize information and materials related to the international food situation and to agricultural, forestry, and fishery industries and rural areas in a regular, institutional, and systematic manner, and it will supply this information widely to researchers, administrative agencies, and

companies in Japan and abroad.

c) To strengthen the systematic exchange of information among relevant organizations in Japan, JIRCAS will manage the Japan Forum on International Agricultural Research for Sustainable Development (J-FARD).
d) JIRCAS will promote goal-oriented basic research by using Presidential incentive expenses and other means.
e) In promoting goal-oriented basic research, JIRCAS will, in principle, abide by the Basic Plan for Agriculture, Forestry, and Fisheries Research and will choose research subjects in consideration of the significance and effectiveness of its own involvement. In addition, JIRCAS will focus on the future potential of pioneering research, including the creation of technology seeds leading to innovation and the development of new research areas through the combination of different research disciplines. Furthermore, JIRCAS will evaluate the progress of research and will take the necessary management actions, such as modification of the method of research or termination of research topics.

II. Efficient Business Management

1. Cost reduction

(1) Reduction in costs such as general and administrative expenditures

Administrative operations implemented by operational grants will be reviewed and efficiency will be further promoted. Average annual reduction targets are at least 3% with respect to the previous year for general and administrative expenditures (excluding personnel expenditures), and at least 1% with respect to the previous year for research expenditures.

(2) Streamlining of procurement

a) JIRCAS will develop a Procurement Streamlining Plan, including quantitative targets and specific indexes, by the end of June each fiscal year. It will implement the plan consistently and will conduct a self-evaluation of the plan's performance at an implementation evaluation session each fiscal year.
b) JIRCAS will maintain fairness by clarifying the reasons for adopting free contracts (e.g., when only one company can provide a special item) and extending unit-price contracts. It will try to procure items for R&D rapidly.
c) JIRCAS will collaborate with NARO to improve efficiency by conducting joint procurement and sharing tender price information.

2. Review and improvement of efficiency in organization and operations

(1) Restructuring of organization and operations

a) JIRCAS will review its organization and operations flexibly toward achieving the Medium to Long-term Goal and strengthening the PDCA cycle.
b) JIRCAS will promote the computerization of operations by, for example, improving the corporation's information systems. It will improve efficiency by using a TV conference system and Information and Communication Technology (ICT).
c) Through the above efforts, JIRCAS will optimize personnel arrangement and operations.

(2) Integration of research facilities and equipment (plan of facilities and equipment)

Planned renovation and upgrading of facilities essential to research promotion will be primarily implemented for research facilities and equipment, which are classified into three categories as follows on the basis of their age-related condition and the research prioritization of JIRCAS: facilities that will not be conducive to research promotion without renovation and upgrading; facilities that will hamper the progress of research without renovation owing to their severe age-related condition; and facilities required to be renovated by law or regulations. Increased use of such facilities will be promoted.

[Attachment] Directions related to research and investigations

The following research work will be conducted by the end of FY 2020.

1. Development of agricultural technologies for sustainable management of the environment and natural resources in developing regions

To cope with increasingly serious global problems such as climate change and environmental degradation, which affect Japan substantially, JIRCAS will develop technologies in cooperation with local research organizations. It will disseminate and establish technologies through verification tests in farm fields and collaboration with local extension organizations. These works will be implemented in developing regions, mainly in Asia and Africa. More specifically, the following priority research projects will be carried out.

To reduce greenhouse gas emissions in agriculture, JIRCAS will develop a water-saving irrigation method and a system to reduce methane generation through integration of cropping and livestock farming and will evaluate its carbon budget. JIRCAS will also address the issues of flooding and other extreme phenomena and climate change, including warming, and will develop technologies to mitigate the damage associated with such issues. [Importance: high][1]

In river basins where precipitation is unstable and vegetation is being degraded, and in areas where soil degradation and other soil problems are becoming serious, JIRCAS will develop technologies to sustain stable crop yields from the perspectives of breeding, cultivation, and soil and water control and will present a model for technological dissemination.

For the effective use of nitrogen fertilizer and the reduction of nitrous oxide emissions from agricultural land, JIRCAS will develop breeding materials utilizing the biological nitrification inhibition function.

2. Technology development for stable production of agricultural products in the tropics and other adverse environments

To enhance food production and improve nutritional status in Africa and other parts of the world, JIRCAS will conduct technological development and verification trials in cooperation with local organizations and will prepare manuals and commentary articles in tropical areas and other developing regions where potential crop productivity is not fully exploited owing to adverse conditions such as droughts and low fertility. In addition, JIRCAS will promptly disseminate the technologies it develops to breeders, government departments, and farmers. More specifically, the following priority research projects will be carried out.

In Africa, JIRCAS will develop technologies to utilize the diversity of food crop genetic resources; crop breeding materials of high productivity adapted to the planting environment and those materials adapted to local preferences; and crop production and livestock raising technologies that effectively utilize organic materials, water, and other local resources. [Importance: high][2]

JIRCAS will develop basic technologies for producing high-yield crops adaptable to adverse conditions such as low fertility, drought, and salt damage. It will also develop pioneering breeding materials, as well as technologies for their evaluation and utilization in the field in developing regions.

To control migratory plant pests and transboundary diseases that can spread and invade Japan, JIRCAS will work on pest control based on the epidemiology of migratory pests and vectors, and will develop technologies to prevent their invasion and spread. In addition, JIRCAS will develop disease-resistant varieties by using the research networks it has developed.

3. Development of high value-adding technologies and utilization of local resources in developing regions

In Asian areas where development needs are increasing along with economic growth, JIRCAS will use diverse regional resources and will develop new high value-adding technologies. In this way, it will support rural development by pursuing environmentally friendly and sustainable agriculture, forestry, and fisheries; help increase the incomes of farmers in developing regions; and contribute to the Global Food Value Chain Strategy promoted by Japan. More specifically, the following priority research projects will be carried out.

To secure high-quality products and develop food value chains, JIRCAS will develop a way of evaluating potential high value-added products of agriculture, forestry, and fisheries and will develop the processing and distribution technologies needed to add high value. In addition, JIRCAS will work on enhancing value addition by clarifying consumer needs and improving distribution systems. [Importance: high][3]

To establish agriculture, forestry, and fisheries in a sustainable, resource-recycling way, JIRCAS will develop technologies for saccharification from unused biomass resources such as agricultural waste and will promote their advanced use. JIRCAS will also develop technologies for the sustainable production and use of diverse resources to produce high value-added products in semi-mountainous areas. It will develop technologies for the development and maintenance of forest resources, technologies for the production of high value-added wood products, and technologies for improving the productivity of forest plantations in harmony with ecosystems. Moreover, JIRCAS will develop efficient aquaculture technologies and will utilize aquatic resources in harmony with ecosystems with the aim of sustainable consumption of aquatic resources.

In these efforts, JIRCAS will use international research networks, collaborate with Japanese and local private sectors, and promote systematization and transfer of technologies. Furthermore, JIRCAS will prepare technical manuals and exhibit technologies for dissemination among farmers and will provide information for technology transfer to local processors and distributors.

<Descriptions of importance>

[1] [Importance: high] According to the Fifth Assessment Report of the IPCC, adaptation to climate change may exceed a limit in the future, and a combination of effective adaptation measures and mitigation measures will promote a resilient society and sustainable development. In this regard, it is very important to take action in developing regions, where agriculture contributes to a large proportion of the economy.

[2] [Importance: high] As outlined in Goal 2 of the sustainable development goals (SDGs), i.e., to “end hunger, achieve food security and improved nutrition, and promote sustainable agriculture,” it is very important to solve the food problems in Africa, where large populations are deficient in nutrients and agricultural productivity is low.

[3] [Importance: high] Because the Global Food Value Chain Strategy indicates that we need to develop a food value chain that adds high value in agriculture, forestry, and fisheries, it is very important to help increase farmers’ incomes through this effort.

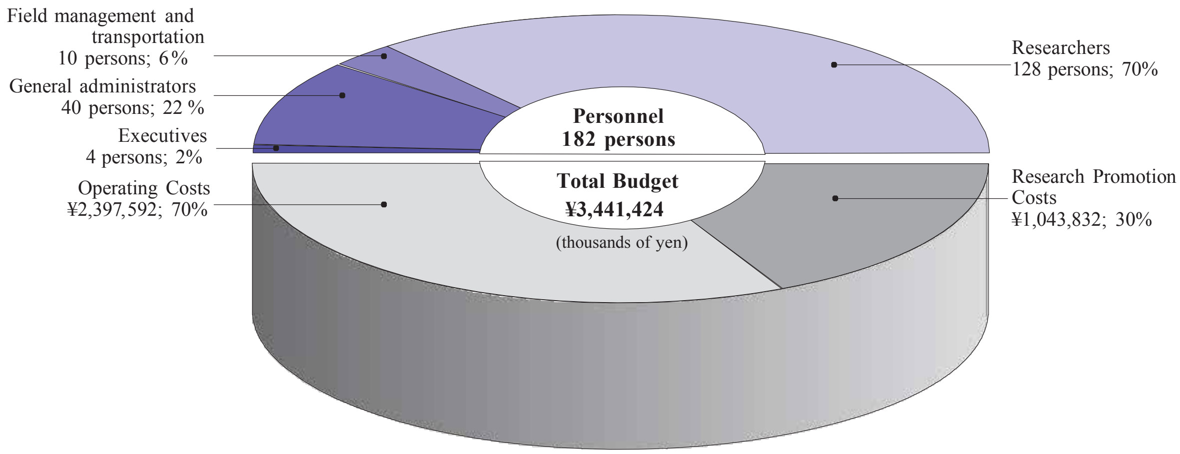
FINANCIAL OVERVIEW

Fiscal Year 2017

	thousands of yen
TOTAL BUDGET	**3,441,424**
OPERATING COSTS	**2,397,592**
Personnel (182)	2,116,322
President (1), Vice-President (1), Executive Advisor & Auditor (2)	
General administrators (40)	
Field management (10)	
Researchers (128)	
* Number of persons shown in ( )	
Administrative Costs	281,270

RESEARCH PROMOTION COSTS	1,043,832
Research and development	471,124
Overseas dispatches	202,650
Collection of research information	79,041
International collaborative projects	265,897
Fellowship programs	25,120

Budget FY 2017 (Graph)



MEMBERS OF THE EXTERNAL EVALUATION COMMITTEE

Members of the JIRCAS External Evaluation Committee

Hiroto ARAKAWA	Advisor, Sumitomo Corporation
Hiroko ISODA	Professor, Alliance for Research on North Africa, University of Tsukuba
Toshihiko KOMARI	Science Advisor, Corporate Strategy Division, Japan Tobacco Inc.
Shin-ichi SHOGENJI	Professor, Faculty of Agricultural and Food Sciences, Fukushima University
Hisayo YASUDA	Attorney-at-law, Yasuda International Law Office

JIRCAS STAFF in FY 2017

President

Masa Iwanaga

Vice-President

Osamu Koyama

Executive Advisor & Auditor

Hisaya Kakiuchi
Mari Inoue

Research Strategy Office

Kunihiro Doi, Director

Research Coordinators
Yasuko Inoue, Bioenergy, Forestry and Rural Development
Miyuki Iiyama, Development Economics
Satoru Muranaka, Plant Physiology

Regional Representative for Southeast Asia
Naruo Matsumoto, Representative of Southeast Asia Office (Thailand)

Researcher
Sakiko Shiratori, Agricultural Economics

Program Directors

Satoshi Tobita, Program A: Environment and Natural Resource Management
Kazuo Nakashima, Program B: Stable Agricultural Production
Yukiyo Yamamoto, Program C: Value-adding Technologies

Research Planning and Partnership Division

Masayoshi Saito, Director

Research Planning and Management Office
Tomohide Sugino, Head

Research Planning Section
Taro Izumi, Head

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

Senior Researcher
Kazuo Ise, Rice Breeding

Technical Specialist
Elvira G. Suto

Field Management Section
Takashi Komatsu, Field Operator
Hiroyuki Ishiyama, Field Operator

Research Support Office
Norio Tadokoro, Head

Research Coordination Section
Koichi Iioka, Head
Keiko Ikeda, International Affairs Expert
Toshiki Kikuchi, Coordination Subsection Head
Reiko Nagatsuka, Overseas Travel and Invitation Program Subsection Head
Kenji Iwasa, Overseas Affairs Subsection Head
Jun-ichi Irino, Overseas Affairs Subsection Specialist

Research Support Section
Akira Urushibara, Head
Koichi Fuse, Budget Subsection Head
Takayuki Yamamoto, Support Subsection Head

Information and Public Relations Office
Eizo Tatsumi, Head

Senior Researcher
Masaki Morishita, Rural Development

Public Relations Section
Yumiko Arai, Head

International Relations Section
Kunimasa Kawabe, Head

Publications and Documentation Section
Akira Hirokawa, Head
Hiromi Miura, Network Subsection Head
Takanori Hayashi, Information Management Subsection Head (Librarian)

Administration Division

Katsuhiko Nomiya, Director

General Affairs Section
Takayoshi Takeda, Head
Hakumi Kumagai, General Affairs Assistant Head
Takashi Oosato, Personnel Management Assistant Head
Gaku Takeda, Personnel Subsection Expert
Yumiko Sasaya, Welfare Subsection Head
Sachiyo Tatebe, Personnel Subsection 1 Officer
Kumi Ehara, Personnel Subsection 2 Head

Accounting Section
Tadao Yatabe, Head
Kiyoyuki Sunaoka, Accounting and Examination Assistant Head
Toru Shimura, Procurement and Asset Management Assistant Head
Ryoichi Mise, Financial Subsection Head
Noriko Osonoe, Accounting Subsection Officer
Aki Tamura, Audit Subsection Officer
Yuka Takatsuto, Procurement Subsection 1 Officer
Yuki Hibiya, Procurement Subsection 2 Head
Shoko Yoshida, Supplies/Equipment Subsection Officer
Tadahisa Akiyama, Facilities Subsection Head

Administration Section (Tropical Agriculture Research Front)
Joji Ikeda, Head
Hiroe Nagatomo, General Affairs Subsection Head
Takashi Ichimi, Accounting Subsection Head

Risk Management Office

Yasuyuki Nakanishi, Head

Compliance Management Section
Maiko Saito, Management Subsection Officer

Safety Management Section
Masakazu Yamada, Head

Inspection Section
Gen-ichiro Hanaoka, Inspection Subsection Officer

Audit Office

Osamu Kato, Head

Rural Development Division

Nobuyoshi Fujiwara, Director

Subproject Leader
Naoki Horikawa, Hydrology

Senior Researchers
Kazumi Yamaoka, Agricultural Water Management
Motomu Uchimura, Resource Management
Yukio Okuda, Rural Engineering
Kazuhisa Kouda, Agricultural Engineering
Shinji Hirouchi, Agricultural Engineering
Takeshi Matsumoto, Grassland Management
Koichi Takenaka, Rural Development Forestry
Mamoru Watanabe, Rural Development
Haruyuki Dan, Rural Development
Keisuke Omori, Soil Salinization in Dryland
Naoko Oka, Agriculture Water Management
Hiroshi Ikeura, Irrigation
Shutaro Shiraki, Rural Development
Ken-ichiro Kimura, Forest Chemistry
Katsumi Hasada, Rural Development
Ken-ichi Uno, Agricultural Engineering
Junya Onishi, Irrigation
Chikako Hirose, Agricultural Engineering

Researcher
Toshihiko Anzai, Irrigation and Drainage

Social Sciences Division

Satoshi Uchida, Director

Project Leader
Jun Furuya, Agricultural Economics

Subproject Leader
Fumika Chien, Agricultural Economics

Senior Researchers
Shigeki Yokoyama, Agricultural Economics
Kazuo Nakamoto, Agricultural Economics
Shunji Oniki, Agricultural Economics
Akira Hirano, Geographic Information Systems
Shintaro Kobayashi, Agricultural Economics
Eiichi Kusano, Agricultural Economics

Researchers
Kensuke Kawamura, Remote Sensing and Grassland Ecology
Toru Sakai, Remote Sensing & GIS
Rie Muraoka, Agricultural Economics
Junji Koide, Agricultural Economics

Biological Resources and Post-harvest Division

Takeshi Urao, Director

Project Leaders
Masayasu Kato, Plant Pathology
Seiji Yanagihara, Rice Breeding
Akihiko Kosugi, Molecular Microbiology

Subproject Leader
Kazuhiko Nakahara, Food Chemistry

Senior Researchers
Xu Donghe, Plant Molecular Genetics
Satoru Nirasawa, Food Functionality
Yasunari Fujita, Plant Molecular Biology
Tadashi Yoshihashi, Food Science
Yoshinori Murata, Applied Microbiology
Naoki Yamanaka, Plant Molecular Genetics
Kyonoshin Maruyama, Plant Molecular Biology
Mitsuhiro Obara, Plant Physiology and Genetics
Takamitsu Arai, Molecular Microbiology

Toshiyuki Takai, Crop Science and Genetics
Jun-ichiro Marui, Molecular Microbiology

Researchers
Yukari Nagatoshi, Plant Molecular Biology
Kaori Fujita, Crop Science and Food Engineering
Kohtaro Iseki, Crop Science and Breeding
Shimpei Aikawa, Applied Microbiology
Takuya Ogata, Plant Molecular Biology
Takeshi Kashiwa, Plant Pathology

Crop, Livestock and Environment Division

Fujio Nagumo, Director

Project Leader
Yasuo Ando, Plant Microbiology

Subproject Leaders
Yasukazu Hosen, Soil Science
Tetsuji Oya, Crop Science

Senior Researchers
Cai Yimin, Animal Science
Masato Oda, Crop Management
Satoshi Nakamura, Insect Ecology
Guntur V. Subbarao, Crop Physiology and Nutrition
Matthias Wissuwa, Physiology and Genetics
Seishi Yamasaki, Animal Nutrition
Takeshi Watanabe, Soil Chemistry
Keiichi Hayashi, Soil Management
Takayuki Ishikawa, Plant Physiology
Yoshiko Iizumi, Hydrological Science
Koki Maeda, Environmental Science, Manure Management and Microbial Ecology
Yasuhiro Tsujimoto, Crop Science

Researchers
Hidetoshi Asai, Crop Science
Kenta Ikazaki, Soil Science
Satoshi Nakamura, Soil Science
Kotaro Maeno, Entomology
Sarr Papa Saliou, Soil Microbiology
Mizuki Matsukawa, Plant Protection

Forestry Division

Gen Takao, Director

Senior Researchers
Naoki Tani, Forest Genetics
Gaku Hitsuma, Physiological Ecology and Silviculture
Akihiro Imaya, Soil Science
Masazumi Kayama, Tree Physiology

Researcher
Masaki Kobayashi, Tree Molecular Biology

Fisheries Division

Tetsuo Fujii, Director

Project Leader
Shinsuke Morioka, Fish Biology

Senior Researchers
Marcy N. Wilder, Crustacean Biochemistry
Toru Shimoda, Marine Chemistry
Isao Tsutsui, Aquaculture
Hajime Saito, Marine Bivalve Ecology
Tsuyoshi Sugita, Fish Nutrition and Fish Physiology
Masashi Kodama, Marine Chemistry
Tomoyuki Okutsu, Aquatic Animal Physiology

Researcher
Bong Jung Kang, Aquatic Animal Physiology

Tropical Agriculture Research Front

Kazuhiro Suenaga, Director
Koshun Ishiki, Public Relations Officer

Project Leaders
Hide Omae, Crop Science
Shotaro Ando, Soil Science

Subproject Leader
Mariko Shono, Plant Physiology

Senior Researchers
Yoshimichi Fukuta, Rice Breeding
Tatsushi Ogata, Pomology
Shinsuke Yamanaka, Molecular Biology
Shinkichi Gotoh, Soil Science
Takuma Ishizaki, Plant Molecular Biology
Yoshifumi Terajima, Sugarcane Breeding
Youichi Kobori, Entomology

Researchers
Shin-ichi Tsuruta, Molecular Genetics
Hiroki Saito, Rice Breeding and Molecular Genetics

Technical Support Office
Yasuaki Tamura, Head
Hirokazu Ikema, Machine Operator
Masato Shimajiri, Machine Operator
Masakazu Hirata, Machine Operator
Yasuteru Shikina, Machine Operator
Masashi Takahashi, Machine Operator
Masahide Maetsu, Machine Operator
Yuto Hateruma, Machine Operator
Takaya Shinmori, Machine Operator

THE JAPANESE FISCAL YEAR AND MISCELLANEOUS DATA

The Japanese Fiscal Year and the Annual Report 2017

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) 2017 covers the period from April 1, 2017 through March 31, 2018.

The Annual Report 2017 summarizes the full extent of JIRCAS activities that occurred during this period. The subsequent Annual Report will detail events and programs from April 1, 2018 through March 31, 2019 (FY 2018).

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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About the new JIRCAS logo (shown on the front and back covers)

The new logo incorporates design elements from the original, retaining the Earth motif while enhancing the lettering for better visual recognition. The acronym is displayed in a deep and rich shade of blue (indigo), traditionally called "Japan Blue," and the red circle above "I" represents an image of the sun (Hinomaru) illuminating our planet.

2018年（平成 30 年）10月 5日 発行

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