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Annual Report 2015 (Apr. 2015–Mar. 2016)

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

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JIRCAS
JAPAN

Japan International Research Center for Agricultural Sciences

Annual Report 2015

(April 2015-March 2016)

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CONTENTS

Annual Report JIRCAS 2015

Message from the President

President
Dr. Masa Iwanaga
(FY2011-)

Recent events around the world – droughts, land rush (investing in foreign farmlands), and shocks in energy supplies and prices – underline the scarcity of resources we depend on to produce the world's food supply. According to a recent FAO estimate, we will have 9.6 billion people by 2050 – an increase of 2.6 billion people from 2013. It is increasingly clear that sustainably feeding an ever-increasing number of people requires a much more careful and integrated approach to the use of land, water, and energy than we currently apply. It is an absolute must that we start now to produce more food using fewer resources and to use the harvest more efficiently. Demographic changes, rising incomes (and associated consumption patterns), and unstable climatic conditions, alongside persistent poverty and inadequate policies and institutions, are all placing serious pressure on the natural resource base that supports current and future societies. This presents a 'perfect storm' scenario, especially in light of the recent trends in and increased likelihood of extreme weather events. For example, the World Economic Forum's Global Risks Report 2016 named (1) water crises, (2) failure of climate change mitigation and adaptation, (3) extreme weather events, and (4) food crisis as the top four global risks of the highest concern for the next ten years.

In 2015, the international community witnessed two major actions that demonstrated its commitment to achieving sustainable development. The first action was the United Nations Sustainable Development Summit on 25 September 2015, with world leaders adopting the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) and 168 targets to end poverty, fight inequality and injustice, and tackle climate change by 2030. According to the UN, the new SDGs and the broader sustainability agenda "go much further than the Millennium Development Goals (MDGs) of 2000-2015, addressing the root causes of poverty and the universal need for development that works for all people." Meanwhile, the UN Global Compact, the world's largest corporate sustainability initiative, declares that these new global goals "result from a process that has been more inclusive than ever, with Governments involving business, civil society and citizens from the outset." It further stated that "we are all in agreement on where the world needs to go" and that "successful implementation will require all players to champion this agenda."

The second action was the 21st Conference of Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC) on 12 December 2015, with 195 countries adopting the Paris Agreement, which deals with greenhouse gas emission mitigation, adaptation, and finance starting in the year 2020. The successful negotiation of the Paris Agreement was truly remarkable since it demonstrated collective political willingness to confront the most pressing issue threatening humanity, overcoming the individualistic interests of COP members with different national interests.

The year 2015 was highly significant for JIRCAS because it was the final year of the 5-Year Business Plan for 2011-2016. We have seen verifiable evidence of successful implementation of the Projects and delivery of expected outputs under our four newly formed Programs (Fig. 1). This annual report describes how JIRCAS has carried out the major activities that have produced proud moments and highlights.

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

Introducing the four Programs

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

1) Development of agricultural technologies based on sustainable management of the environment and natural resources in developing regions (Environment and natural resources management)
2) Technology development for increased productivity and stable production of agricultural products in the tropics and other unstable environments (Stable food production)
3) Technology development for income and livelihood improvement of the rural population in developing regions (Rural livelihood)
4) Information gathering, analysis, and dissemination of domestic and overseas data of the agricultural, forestry and fishery industries in developing regions (Information analysis)

Program-based management

For FY 2011-2015, we had 17 "Projects" that were placed under "Programs" (see Fig. 1). The programs enabled us to clarify our overall goals that needed to be achieved and the manner by which we attempted to accomplish our research. Especially assigned Program Directors were in charge of budget, personnel, goal achievement management, and evaluation. Programs A to C had their own so-called flagship projects, representing the most important activity in each program. Projects under each program collectively and coherently contributed 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. We value such partnerships and place it as our organization's core value. In 2013, 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.

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 45-year-old "research for development" tradition, hoping to produce deliverables that will be used by our target beneficiaries.

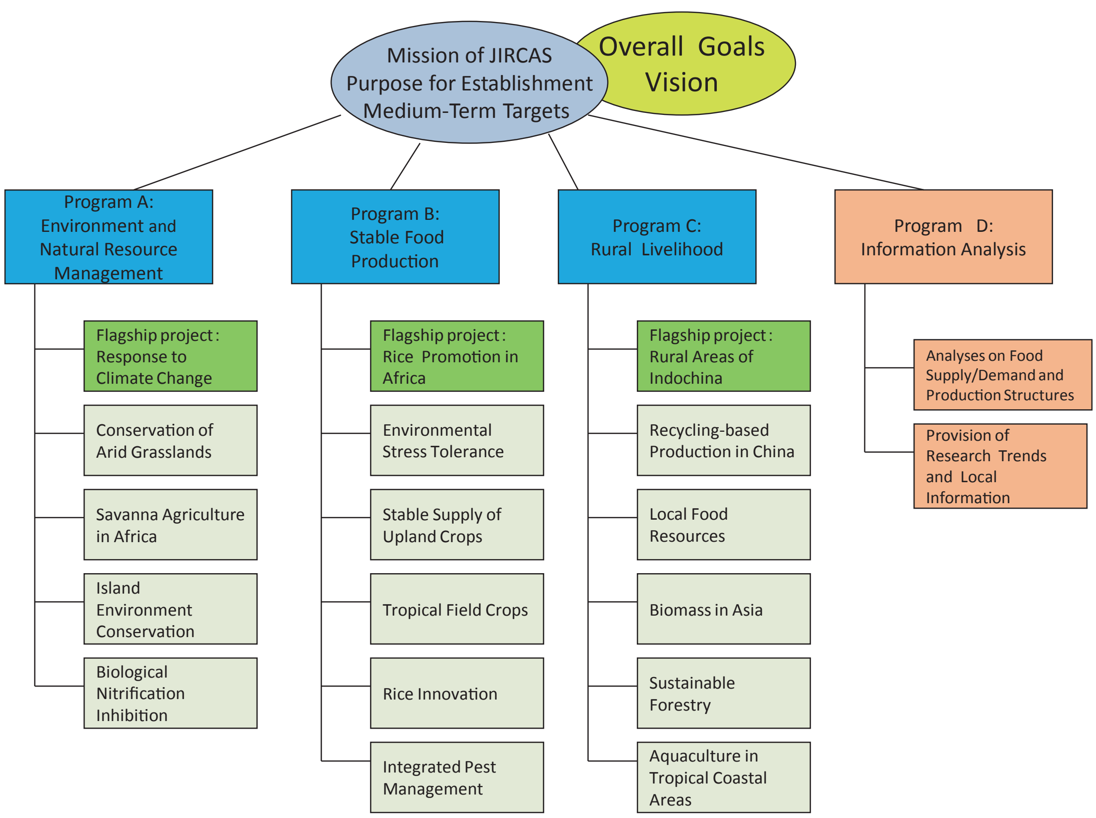


Fig. 1. Program-Project Research Framework

Fig. 2. Locations of our current activities based on 95 MOUs with partner institutions

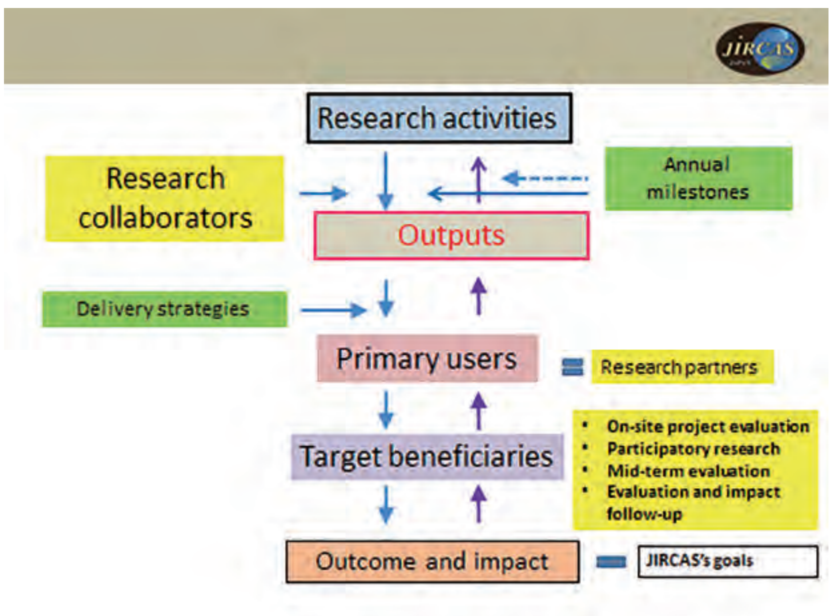


Fig. 3. Impact-oriented research for development (Operational Cycle)

T. Iwanaga

HIGHLIGHTS FROM 2015

JIRCAS International Symposium 2015

Why "Quality" Matters in International Agriculture Research?

JIRCAS International Symposium 2015 under the title "Why 'Quality' Matters in International Agriculture Research?" was held on October 28, 2015 in Tokyo. The symposium was co-sponsored by the United Nations University - Institute for the Advanced Study of Sustainability (UNU-IAS) and supported by the Agriculture, Forestry and Fisheries Research Council Secretariat of the Ministry of Agriculture, Forestry and Fisheries (AFFRC, MAFF), Japan International Cooperation Agency (JICA), Japanese Society of Regional and Agricultural Development, and Japan Forum on International Agricultural Research for Sustainable Development (J-FARD).

On September 25, about a month before the JIRCAS symposium, the United Nations (UN) Summit 2015 was held in New York. Japanese Prime Minister Shinzo Abe attended the summit, where the "2030 Agenda for Sustainable Development," which includes 17 Sustainable Development Goals (SDGs) and 169 targets, was announced and adopted. Specific measures that can contribute to achieving the SDGs, including a novel idea focusing on "質(quality)," were forwarded. Japan, for its part, will pursue various initiatives to achieve an inclusive, sustainable, and resilient "quality growth" for all.

As agriculture researchers, we should always keep in mind the messages from Rachel Carson's "Silent Spring" (1962) and The Club of Rome's "The Limits to Growth" (1972), which still resonate today. According to them, we may have our doubts about growth but we should carry on with our efforts to increase food production through Green Revolution technologies and eradicate poverty through economic development so we can further cope with the global challenges caused by climate change toward the end of the 20th century.

However, despite the UN adopting the new 15-year development goals mentioned above, many challenges remain, and these issues are not resolved by name change alone. On the other hand, we need to supply safe and nutritious food, thus we have to keep our ecosystem healthy by adapting to extreme weather events. Moreover, the increasing pressures to maintain our production systems and further requirements to reduce congestion and improve the quality of land and soil have also made the challenges more complex.

While research expectations have continuously increased, the allotted funds and resources have steadily decreased, reflecting Japan's economic downturn in recent years. For example, CGIAR funds from Japan was USD 37 million in 1996,

JIRCAS International Symposium 2015

but has since fallen to below USD 2 million in 2015.

Under such circumstances, we must change our thinking to something that goes against traditional research designs and approaches, and find a breakthrough to fulfill our responsibilities as agricultural researchers. The term "high quality" was therefore chosen as the theme of this year's JIRCAS symposium to correspond to this situation.

During the symposium, several multifaceted, diverse, and high quality research results were presented in the opening keynote speeches and the following sessions. It was pointed out that project settings should start from the food table and then be related to their output functions. Based on the presentations, the symposium was bookended by a wrap-up session discussing the importance of attitudes when aiming at sustainable and resilient research outcomes, bearing in mind the final beneficiaries and users and the need to bring reforms in agriculture, forestry, and fishery industries.

According to Dr. Shizuka Shirakawa, a scholar of Chinese literature, the Chinese character "質" is a combination of "斤" (an abbreviation of "斧" which means "axe") above and "貝" (an abbreviation of "鼎") below. Hence, the traditional explanation for the character "質" is that "an important contract must be carved with an axe," which means that the terms of a contract (the important part) are the "essence" of a contract. Now you often hear people refer to "質問 (*shitsu･mon* or question)" when they ask others if there are any questions. The "質" in "質問" also has the same meaning.

As researchers, we should always be aware of and impose "質(quality)" on ourselves, and we must make efforts to continuously contribute toward producing high quality, diverse, and ready-to-use research results.

Symposium on "Further Improvement of Sugarcane Productivity and Utilization through Integration of Agriculture and Industry"

The international symposium on "Further Improvement of Sugarcane Productivity and Utilization through Integration of Agriculture and Industry" was held on September 17, 2015 in Khon Kaen, Thailand. The symposium was organized by Japan International Research Center for Agricultural Sciences (JIRCAS) and co-organized by Khon Kaen University (KKU) and Khon Kaen Field Crops Research Center (KKFCRC), Department of Agriculture, Thailand.

To achieve a steady increase in sugarcane production, breeding of new varieties and improvement of agricultural practices as well as development of new utilization methods are needed. Typical examples of combined agricultural and industrial researches, such as the breeding of multi-purpose sugarcane (MPS) with high biomass yield and the development of the Inversion Process, a new type of integrated sugar-ethanol production technique that is also suitable for use with MPS, were reported. In addition,

new technologies related to sugarcane production were introduced, and information was exchanged for future collaboration among companies and research institutes in Japan and Thailand.

The opening remarks were delivered by Dr. Yupa Hanboonsong, an associate professor of the Faculty of Agriculture, KKU, followed by Mr. Shotaro Ando, project leader of JIRCAS, who explained the purpose of the symposium. A keynote speech, entitled “The past, present, and future of sugarcane research in Northeast Thailand,” was presented by Ms. Taksina Sansayawichai, a senior researcher of KKFCRC.

In the first session, improvements in sugarcane production through agronomic and breeding studies were presented by Kumphawapi Sugar Co., Ltd. and JIRCAS, respectively. A new process for producing sugar and ethanol was introduced by Asahi Group Holdings, Ltd.

In the second session, new technologies related to sugarcane production were presented by Toyota Motor Corporation, Shin-Etsu Chemical Co. Ltd., Research Institute for Biological Sciences Okayama, and JIRCAS. After the general discussion, the closing remarks were delivered by Dr. Naruo Matsumoto, the regional coordinator of the Southeast Asian liaison office of JIRCAS.

A day before this symposium, the “JIRCAS-KKU-KKFCRC Collaborative Workshop on Sugarcane IPM (Integrated Pest Management) Project” was held, and the results of the 5-year project were evaluated. A total of 83 participants including 24 Japanese joined the workshop and/or the symposium.

Symposium on “Mitigation technologies for greenhouse gas emissions from enteric fermentation and manure in Southeast Asia”

In Southeast Asia, enteric fermentation is the second most important source of anthropogenic greenhouse gas (GHG) in the agricultural sector, followed by animal manure. Khon Kaen University (KKU, Thailand), Can Tho University (CTU, Vietnam), and JIRCAS have jointly developed monitoring technologies for methane emissions from enteric fermentation, determined methane emissions from cattle production, and evaluated several mitigation technologies under the collaborative project entitled “Establishment of monitoring technologies and development of mitigation technologies for methane emissions from enteric fermentation.”

A symposium was held on October 28, 2015 as part of the 4-day “5th International Conference on Sustainable Animal Agriculture for Developing Countries” at the Dusit Thani Pattaya Hotel in Thailand. The symposium’s aims were as follows: to introduce the technologies, particularly those that were developed during the said JIRCAS project (Session 1); to share knowledge on measurement and mitigation technologies for GHG emissions from cattle manure (Session 2); and finally, to discuss the types of research studies that should be carried out in the future.

Dr. Fuminori Terada (Meiji Feed. Co. Ltd, Japan) started the symposium with a presentation on the possibilities for GHG emissions mitigation from cattle production in Asia. In Session 1, Dr. Osamu Enishi (NARO Institute of Livestock & Grassland (NILGS) introduced the efforts that have been taken to mitigate enteric methane emissions in Japan, followed by Dr. Nguyen Van Thu (CTU) and Mr. Chatchai Kaewpila (KKU), who explained the effects of feed additives on the mitigation of enteric methane emissions. Mr. Takashi Sakai reported the possibility of predicting enteric methane emissions from fatty acid contents in the rumen, and Dr. Tomoyuki Suzuki showed the factors affecting methane conversion factors.

In Session 2, an overview of research activities on the mitigation of GHG emissions from manure in Japan was presented by Dr. Takashi Osada (NILGS). He emphasized that it is important to establish measurement techniques for each country, to develop mitigation technologies, and to improve GHG emission inventories. Following this presentation, the current situation on manure processing and relevant research activities in Thailand and Vietnam were introduced by Dr. Kalaya Boonyanuwat (Division of Livestock Development) and Dr. La Van Kinh (Institute of Animal Sciences for Southern Vietnam), respectively.

The participants had a productive exchange of views, and it was recognized that a comprehensive evaluation of whole GHG emissions from cattle production was necessary because of the interactions between enteric methane emissions and GHG emissions from manure.

2015 Japan International Award for Young Agricultural Researchers

JIRCAS, in cooperation with the Agriculture, Forestry and Fisheries Research Council (AFFRC) Secretariat, presented the Japan International Award for Young Agricultural Researchers for the ninth 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 2015 commendation ceremony was held last October 27 at the U Thant International Conference Hall of the United Nations University (UNU) in Tokyo.

AFFRC Chairman Yoshio Kobayashi welcomed the awardees and guests, and congratulatory remarks were delivered by Tokyo University of Agriculture Professor Takuji Sasaki, UNU Senior Programme Coordinator Akira Nagata, and Japan International Cooperation Agency (JICA) Senior Advisor Tomochika Motomura. Selection Committee Chair Mutsuo Iwamoto explained the selection process.

The seven-member selection committee conducted a document review, with the chairman of the AFFRC determining three winners from among 36 candidates. Each awardee received a testimonial and a USD 5,000 cash prize.

The 2015 awardees and their research achievements are as follows:

Dr. Ani WIDIASTUTI
Nationality: Republic of Indonesia
Institute: Universitas Gadjah Mada
Research achievement: Mechanism, Potency and Practical Application of Heat Shock-Induced Resistance

Dr. Viengsakoun NAPASIRTH
Nationality: Lao PDR
Institute: National University of Laos
Research achievement: Development and utilization of silage technique and agro-industrial by-products for cattle feed for the promotion of sustainable livestock agriculture in Laos

Dr. Atef SWELAM
Nationality: Arab Republic of Egypt
Institute: International Center for Agricultural Research in Dry Areas
Research achievement: Development of a cost-effective raisedbed machine for small-scale farms to inprove land and water productivity in the Nile Delata

The 2015 awardees, members of the selection committee, and other officials

NEW RESEARCH COLLABORATION

New relationships with the National Food Institute of Thailand and the National Center for Applied Research on Rural Development of Madagascar

On November 26, 2015, JIRCAS signed a Memorandum of Understanding (MOU) “for further collaboration to improve food value chains” with the National Food Institute (NFI) of the Ministry of Industry, Thailand The signing at the Hotel New Otani, Tokyo, was witnessed by Her Excellency Mrs. Atchaka Sibunruang, Minister of Industry, Thailand. JIRCAS will conduct research with NFI on food value chains, aimed atcontributing to the increased production of agricultural commodities and improved natural resource management through development of varieties that are resistant to soybean rust pathogens.

On January 28, 2016, JIRCAS also signed an MOU with Madagascar’s National Center for Applied Research on Rural Development (Central National de Recherche Appliquée au Développement Rural [FOFIFA]) at JIRCAS HQ, Tsukuba. JIRCAS will commence its agricultural research project in Madagascar under its new research program from 2016 to 2020.

Photo 1. Signing ceremony with NFI

Photo 2. Signing ceremony with FOFIFA

OPEN RESEARCH FACILITIES AT THE TROPICAL AGRICULTURE RESEARCH FRONT

The Tropical Agriculture Research Front (TARF) is located at Ishigaki Island (24°N, 129°E), which is one of the main southernmost islands in Ryukyu Islands, Japan. TARF takes full advantage of the subtropical natural conditions on this island in order to develop technologies for sustainable agricultural production in other tropical and subtropical regions of the world, particularly islands.

Approximately 21 ha of experimental fields and a series of facilities (Photo 1), including greenhouses, phytotrons, lysimeters, etc., were used to implement JIRCAS research projects and collaborative projects with other research institutes, universities, etc. Among the research projects conducted in 2015 were the following: environment and natural resource management (e.g., conservation agriculture, manuring practice, and biological nitrification inhibition), stress tolerance in rice and soybean, rice blast, improvement of productivity in rice and sugarcane, and research on other tropical field crops including tropical fruit trees, yam, and cowpea.


Photo 1. Facilities at TARF


Photo 2. Outdoor lysimeters (framed plots)


Photo 3. Maize on artificial sloping fields

Open research facilities were constructed at TARF in 2003 to accelerate research activities on mitigating soil erosion and water deterioration, and to increase water use efficiency in tropical island environments. The facilities consist of lysimeters (indoor: $2m^2$ x 1m x 32 frames and outdoor: $12m^2$ x 2m x 14 frames) (Photo 2), three artificial sloping fields (2º, 3.5º and 5º, 15m long x 30m wide) (Photo 3), and artificially constructed waterways. Four frames are also installed outside for weighing lysimeters.

The lysimeters are used for analyzing evapotranspiration, fertilizer and water release, water use by plants, and water quality, among others, by collecting drained water and nutrients from the bottom of the lysimeters. Sensors installed at the lysimeters automatically measure soil environmental parameters such as soil water and temperature. Rooting behavior can be observed with rhizotrons. A certain amount of water is supplied by irrigation pipes installed both at the top and the bottom of the lysimeters.

Each slope of the artificial sloping fields is subdivided into six 4.2m-wide plots. A soil sedimentation container is installed at end of the slopes to measure the amount of soil erosion and surface water runoff. These sloping fields are used for open field experiments, such as those related to soil-loss preservation, to investigate the effects of vegetation or minimum tillage practices on plant growth, soil erosion, and surface water runoff, etc.

The open research facilities are equipped with instruments for soil water status observation, soil physics analysis, water quality and root development measurement, and transpiration as well as plant water measurement.

The facilities are open to researchers working on environmental conservation of agricultural ecosystems, under the condition that they are undertaking collaborative research with JIRCAS. The research themes for the new mid-term period (FY 2016-2020) have already been announced on the JIRCAS website (http://www.jircas.go.jp/). Moreover, past research projects that elucidated the dynamics and leaching of soil nitrogen in islands conditions and analyzed the effects of cover crops on soil erosion were highlighted in JIRCAS Newsletter No.64 (2012).

ACADEMIC PRIZES AND AWARDS

“Prize for Creativity” from the Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Mr. Masato Shimajiri and Mr. Yasuteru Shikina, technical support staff of the Tropical Agriculture Research Front (TARF), received the “Prize for Creativity 2015” from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) for their innovative work titled “Improving the cost-performance and workability of wind-resistant net houses.” The MEXT Awards honor people for contributing to the progress and for promoting public understanding of science and technology. “Prize for Creativity” is one of the categories in the MEXT Awards, and it is conferred when a person provides significant contribution through technical innovation in his/her professional field.

TARF is located in Ishigaki Island, Okinawa, Japan, where several typhoons attack every year, inflicting serious damage not only on farmers’ fields but also on experimental fields. Farmers use wind-resistant net houses in order to protect their crops from severe wind damage. Mr. Shimajiri and Mr. Shikina have developed a low-cost wind-resistant net house (photo below), which retains the robustness and cuts 40% of the cost for construction by re-using old pipes for scaffolding. Since its construction at TARF two years ago, it has been used for tropical fruit tree experiments to reduce the damage caused by typhoons.

The awardees, Mr. Masato Shimajiri and Mr. Yasuteru Shikina, together with JIRCAS staff

The awardees explain the features and applications of the improved net house.

The low-cost, wind-resistant net house constructed within TARF premises

Best Presentation Prize at the International Soil Conference 2015

Dr. Satoshi Tobita, director of the Crop, Livestock and Environment Division, was awarded first place in the oral presentation contest at the International Soil Conference 2015 (ISC2015) held in Cha Am, Thailand, on August 18-21, 2015. In his presentation, titled “JIRCAS achievements in sustainable land management and soil fertility enhancement in Africa,” he introduced the past and current research activities and achievements of JIRCAS towards improving agricultural productivity in Sub-Saharan Africa. The conference, which also used the auspicious occasion to celebrate the “International Year of Soils 2015,” was organized by the Land Development Department (LDD) of the Ministry of National Development, Thailand, to raise awareness for the sustainable use of soils in harmony with food security.

Kinoshita Prize (Journal Award) from the Agricultural Economic Society of Tohoku

On August 28, 2015, Director Kunihiro Doi of the Research Strategy Office received the Kinoshita Prize (Journal Award) from the Agricultural Economic Society of Tohoku. The Kinoshita Prize (awarded for the 32nd time in 2015) was handed out to academic publications that helped provide significant contributions to the development of agriculture in northeastern Japan. Society President and Hirosaki University Professor Chousei Shibuya presented the award certificate during a gathering in Niigata.


表彰状

土居邦弘　殿

貴殿の論文「東日本大震災における政府食料調達のロジスティックスの分析ー食料及び輸送手段調達の遅れの発生についてー」（農村経済研究第32巻第2号）はすぐれた業績と認められます

よってここに東北農業経済学会木下賞（学会誌賞）を贈り之を表彰いたします

平成27年8月28日

東北農業経済学会

会長　澁谷長生

Mr. Doi, who also delivered a separate report titled "Discussion of the food supply risk in the Tokyo Metropolitan Earthquake" during the event, has been receiving high praise for his research on the government's food procurement logistics system, which became a major issue for the victims of the 2011 Great East Japan Earthquake. The research results have provided important guidance for research involving resilient food systems for the future.

JIRCAS scientists receive the 2015 Nikkei Global Environmental Technology Awards Prize for Excellence

For their outstanding contribution to the development of new countermeasures against desertification in West Africa, i.e., the "Fallow Band System" and its derivative technology, Drs. Kenta Ikazaki and Satoshi Tobita, researcher and director, respectively, of the Crop, Livestock and Environment Division, together with two colleagues, received the Excellence Award at the 25th Nikkei Global Environmental Technology Awards hosted by Nikkei Inc. in Tokyo on November 6, 2015.

"Excellence Award" at the 25th Nikkei Global Environmental Technology Awards.
From left to right: Satoshi Tobita, Kenta Ikazaki, Ueru Tanaka (Project Leader, Research Institute for Humanity and Nature), and Hitoshi Shinjo (Associate Professor, Kyoto University)

The research had been implemented mainly as a collaborative project between JIRCAS, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and Kyoto University. 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%. The derivative technology, a fusion of the "Fallow Band System" and diguette (stone line) or *Andropogon* sp. (perennial grass), can be used for controlling desertification caused by water erosion.

The results of the research were obviously superior and the technologies have demonstrated high practicality, thus there is a high possibility of active diffusion to local farmers in West Africa. So far, the "Fallow Band System" has been adopted by more than 89 villages in Niger, West Africa.

JIRCAS receives the "JICA Recognition Award" at the 11th JICA President Commendation ceremony

On October 16, 2015, Dr. Masa Iwanaga, JIRCAS President, accepted the Japan International Cooperation Agency (JICA) "Recognition Award" at the 11th JICA President Commendation ceremony held at the JICA Research Institute in Ichigaya, Tokyo. The JICA Recognition Award is given to individuals, organizations, and groups as an expression of JICA's appreciation for their contribution and cooperation to JICA's Official Development Assistance (ODA) activities. Dr. Shinichi Kitaoka, JICA President, presented the award certificate and the commemorative gift.

JIRCAS is the only Japanese institute that undertakes exhaustive agricultural research in tropical / subtropical areas and other developing regions. JIRCAS has been making great scientific contributions to the Coalition for African Rice Development (CARD) as a steering committee member and as one of the core research institutes since CARD's launching during the Fourth Tokyo International Conference on African Development (TICAD IV). These CARD activities were highly evaluated by JICA, thus the decision to grant the above award to JIRCAS.

JICA President Shinichi Kitaoka presents the award certificate to JIRCAS President Masa Iwanaga.

Group photo of awardees (JICA Recognition Award for 2015)

JIRCAS receives award during Thailand's National Science and Technology Fair 2015

Since 2007, JIRCAS has been attending Thailand's National Science and Technology Fair, an annual event organized by the Ministry of Science and Technology, Royal Thai Government, to stimulate the public's interest in science and technology by highlighting recent advancements and innovations. For its active participation, JIRCAS, together with other supporting agencies, was awarded a trophy of appreciation by Dr. Pichet Durongkaveroj, Minister of Science and Technology, at the opening ceremony on 15 November. An estimated 1 million visitors attended the 12-day event, which ran from 14 to 25 November.

Minister Durongkaveroj viewed JIRCAS's exhibition booth, which featured 14 posters highlighting its collaborative research projects with Thai research organizations in 2015. Research staff explained the results, including a new sugarcane variety (multi-purpose sugarcane, TPJ04-768, registered in February 2015 in Thailand), which was also displayed in a large pot at the exhibit.

Science and Technology Minister Pichet Durongkaveroj awards trophies to supporting agencies.

Science and Technology Minister Pichet Durongkaveroj visits the JIRCAS booth.

Two JIRCAS researchers among Thomson Reuters' 2015 Highly Cited Researchers

On January 14, 2016, Thomson Reuters Corporation, a major multinational mass media and information firm, announced the 2015 Highly Cited Researchers list, which identifies contemporary scientists whose work has significantly influenced others in their field. The list in the category of Plant & Animal Science included two JIRCAS researchers, Drs. Yasunari Fujita and Kyonoshin Maruyama, senior researchers of Biological Resources and Post-harvest Division. The list named over 3,000 scientists from around the world, of which about 80 belong to research institutes in Japan. The selections are based on the number of Highly Cited Papers, defined as those that rank in the top 1% by citations for field and publication year in the Web of Science database, published from 2003 to 2013 across 21 subject categories. - See more at: http://highlycited.com/

"Young Scientist Award" from the Crop Science Society of Japan

Dr. Yasuhiro Tsujimoto, a researcher of the Crop, Livestock and Environment Division, received the "Young Scientist Award" at the conference of the Crop Science Society of Japan on March 28, 2016. Dr. Tsujimoto has continuously devoted his research career to field-based studies through research collaborations in Madagascar, Ghana, and Mozambique. The award was given in recognition of his research achievements on the elucidation of yield-limiting factors and the development of efficient crop management practices adapted to low-input and low-fertility environments in Sub-Saharan African countries.

Dr. Yasuhiro Tsujimoto receiving his award certificate

Dr. Yasuhiro Tsujimoto delivering his award lecture

"Certificate of Appreciation" from the Department of International Cooperation of the Chinese Academy of Agricultural Sciences

On July 16, 2015, the Department of International Cooperation, Chinese Academy of Agricultural Sciences (CAAS), awarded a certificate of appreciation to JIRCAS for "having maintained a longstanding cooperative relationship and correspondingly contributing to sustainable agriculture development in upland farming areas."

JIRCAS and CAAS started their collaborative research activities in 1997, achieving fruitful research results and cultivating a great number of talented professionals through joint projects, including the "Design and Evaluation of Recycling-Based Agricultural Production System in Upland Farming Areas of Northern China." At the end of the acknowledgement letter, CAAS expressed its hope of strengthening its relationship with JIRCAS and enhancing agricultural development in both China and Japan.


ACKNOWLEDGEMENT

Department of International Cooperation
CAAS

JIRCAS project leader awarded an honorary doctorate in biochemistry by King Mongkut's University of Technology Thonburi (KMUTT), Thailand

Dr. Akihiko Kosugi, project leader of JIRCAS (Biological Resources and Post-harvest Division), was awarded an honorary doctorate in biochemistry by King Mongkut's University of Technology Thonburi (KMUTT), Thailand. Dr. Sakarindr Bhumiratana, president of KMUTT, presented the award. The honorary degree was given because of Dr. Kosugi's active leadership in the Asia Biomass project of JIRCAS. His achievements were highly regarded by the KMUTT University Council, which cited his role in building the capacity of KMUTT faculty members and researchers as well as those from other universities in Thailand, Malaysia, and Indonesia, thereby facilitating human resources development through JIRCAS's joint research activities. Her Royal Highness Princess Maha Chakri Sirindhorn of the Thai Royal Family conferred the honorary title on Dr. Kosugi during the KMUTT graduation ceremony on November 11, 2015 at Bangkok International Trade and Exhibition Centre (BITEC).

Honorary doctorate conferred by Her Royal Highness Princess Maha Chakri Sirindhorn on Dr. Akihiko Kosugi

At the award celebration. (Seated from left, 4th-6th: Project Leader Akihiko Kosugi, KMUTT Council Chairman Tongchat Hongladaromp, and KMUTT President Sakarindr Bhumiratana)

Honorary doctorate diploma from KMUTT

Mongolian University of Life Sciences awards the "Golden Gerege" to JIRCAS researchers

On December 3, 2015, Dr. Shunji Oniki, Mr. Takeshi Matsumoto, and Dr. Akira Hirano were awarded the "Golden Gerege" prize—a form of diplomatic passport in Mongolian tradition—by the Mongolian University of Life Sciences (MULS), Mongolia. The prizes were awarded in recognition of their long-standing contributions towards strengthening research facilities and capacity building of young researchers of the university. With this, these three JIRCAS senior researchers were dignified as MULS Ambassadors. Such recognition illustrates the mutual trust gained from working closely together in collaborative research activities

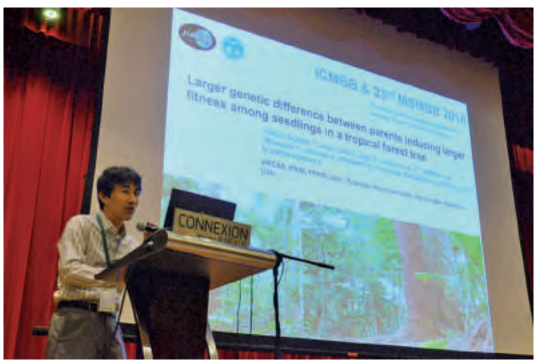
The "Golden Gerege" awarded by the Mongolian University of Life Sciences (MULS), Mongolia, to three researchers of JIRCAS entitling them as MULS Ambassadors and represents a strong foundation for future collaboration.

JIRCAS and MULS had just successfully completed a five-year collaborative research project titled “Development of resilient agro-pastoral systems against the risks of extreme weather events in arid grasslands in Northeast Asia” in March 2016. The project covered a wide range of disciplines and yielded various research outcomes, including the establishment of procedures for preparing pasture carrying capacity maps using satellite data for better pasture resource management, the development of locally workable techniques to use brewer’s grain as animal feed based on a series of state-of-the-art scientific experiments, and the conduct of an in-depth socioeconomic assessment of damages and recovery for better policy making. The research outputs were communicated to the Mongolian society through the local steering committee comprising both central and local government officials of Mongolia as well as delegates from MULS and JIRCAS.

Certificate of appreciation at the International Conference on Molecular Biology & Biotechnology (ICMBB) in conjunction with the 23rd Malaysian Society for Molecular Biology & Biotechnology (MSMBB) Scientific Meeting

On March 9, 2016, Dr. Naoki Tani, senior researcher of JIRCAS, was awarded a certificate of appreciation by the organizing committee of the International Conference on Molecular Biology and Biotechnology (ICMBB) for his contribution as an invited speaker. He delivered his lecture, entitled “Larger genetic difference between parents inducing larger fitness among seedlings in a tropical forest tree,” on day one of the 3-day conference, which was held in conjunction with the 23rd Malaysian Society for Molecular Biology & Biotechnology (MSMBB) Scientific Meeting on March 9-11 at Connexion@Nexus, Kuala Lumpur, Malaysia.

JIRCAS and Forest Research Institute Malaysia (FRIM) have been conducting collaborative research on sustainable tropical forest management since 1991. The partnership has been strengthened through projects, including the ongoing project, which began in 2012, entitled “Evaluation and technology improvement for selective logging protocol in dipterocarps” under the Third 5-year Mid-term Plan. The organizing committee of the ICMBB invited Dr. Tani to give a lecture at the conference after evaluating the research outputs on genetic factors relevant to growth and mortality of dipterocarp seedlings derived from the project.




Certificate of Appreciation

This is to certify that

Dr. Naoki Tani (Invited Speaker)

has participated in the

International Conference on Molecular Biology & Biotechnology (ICMBB)

in conjunction with the

23rd MSMBB Scientific Meeting

9-11th March 2016

Connexion@Nexus, Kuala Lumpur

ICMBB 2016 Chair

ICMBB 2016 Co-Chair

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' Third Medium-Term Goals in FY 2011, including the enhancement of research efficiency and the improvement of the quality of research programs and financial performance. Based on the Third Medium-Term Goals, JIRCAS drafted and began to implement a detailed five-year plan, the Third Medium-Term Plan (FY 2011- FY 2015).

4. Evaluation

The performance and budgeting management of research activities conducted by JIRCAS undergo regular evaluation by the IAA Evaluation Committee established within MAFF. As for the activities of each fiscal year, the Committee investigates and analyzes the progress towards achieving the Medium-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 evaluation of the national research and development (a decision of the Prime Minister in 2008) which require efficient evaluation, JIRCAS has modified the in-house evaluation system in the initial year of the Third Medium-Term Plan. The in-house evaluation in FY 2015 was carried out 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-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, an Executive Advisor and Auditor, the Program Directors and the Directors of each research division) in February 2016.
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 2016.

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 2016.

5. Medium-Term Plan

JIRCAS implements four programs for research activities under the Medium-Term Plan. Each program consists of several projects. Major accomplishments and research highlights of the programs in FY 2015 are described in the following sections. The contents of the Medium-Term Plan are also described in the Appendix.

Table 1. Number of Programs in the Third Medium-Term Plan (FY 2011 - FY 2015)

Program		Projects
A	(Environment and Natural Resource Management)	5
B	(Stable Food Production)	6
C	(Rural Livelihood)	6
D	(Information Analysis)	2

Third Medium-Term Plan (FY 2011 - FY 2015)

[Research Approach 1]
Research and development on agricultural, forestry and fishery technologies geared towards providing solutions to international food and environmental problems

Program A
Development of agricultural technologies based on sustainable management of environment and natural resources in developing regions

Projects:
1. Development of agricultural technologies in developing countries to respond to climate change
2. Development of resilient agro-pastoral systems against the risks of extreme weather events in arid grasslands in Northeast Asia
3. Development of technologies for sustainable agricultural production in the African savanna
4. Development of environment-friendly agricultural production technology in islands
5. Utilization of Biological Nitrification Inhibition (BNI) function for the development of breeding materials and application to cropping systems

Program B
Technology development for increased productivity and stable production of agricultural products in the tropics and other unstable environments

Projects:
1. Development of rice production technologies in Africa
2. Development of genetic engineering technologies of crops with environmental stress tolerance
3. Development of breeding technologies toward improved production and stable supply of upland crops
4. Evaluation and utilization of diverse genetic materials in tropical field crops
5. Rice innovation for environmentally sustainable production systems
6. Development of integrated pest management (IPM) techniques for stabilization of agricultural and livestock production in developing areas

Program C
Technology development for income and livelihood improvement of the rural population in developing regions

Projects:
1. Establishment of sustainable and independent farm household economy in the rural areas of Indochina
2. Design and evaluation of a recycling-based agricultural production system in upland farming areas of Northern China
3. Advanced application of local food resources in Asia
4. Development of biofuel and biomaterial production technologies using biomass resources in Southeast Asia
5. Development of forest management and conservation techniques through sustainable use in Southeast Asia
6. Development of aquaculture technologies for sustainable and equitable production of aquatic products in tropical coastal areas

[Research Approach 2]
Program D
Collection, analyses and dissemination of information for grasping trends of international agriculture, forestry and fisheries

Projects:
1. Collection and analysis of international food supply and demand as well as production systems
2. Dissemination of research trends and local information

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 (JRAs) 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 113 MOUs or JRAs remained in force at the end of FY 2015.

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. In FY 2015, 126 JIRCAS researchers or administrators were dispatched abroad for a total of 556 duties. 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 likewise 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 Third Medium-Term Plan period is summarized in the figure below.

Four Program Directors, whose positions were newly-established, are responsible for the implementation of individual programs during the Third Medium-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 based on sustainable management of the environment and natural resources in developing regions"

The Environment and Natural Resource Management Program focuses on impact analyses and the development of adaptation and mitigation technologies to cope with climate change. The program also deals with sustainable resource management and environmental conservation technologies in regions vulnerable to climate change.

[Response to climate change]

Mitigation of greenhouse gas (GHG) emissions

JIRCAS obtained Certified Emission Reductions (CERs, or carbon credits) in June 2015 for the 446 t of CO_2 reduction realized during the 1st monitoring period (June 2013-May 2014) upon the introduction of 435 biogas digesters (BDs) in Mekong Delta, Vietnam. The introduction of BDs to rural areas of developing countries would accelerate the transition from using costly commercial cooking fuels (firewood and LP gas) to carbon-neutral biogas. It was also clarified that subsidies for technical support were effective in disseminating the BD system. In Paraguay, a guideline was made for the Reforestation Programme Clean Development Mechanism (CDM), which will facilitate application of the results of the preceding JIRCAS reforestation CDM project to broader areas. As to rice cropping, we conducted a triple cropping experiment (for the fourth time) in a farmer's paddy field in the Mekong Delta, where significant effects of the alternate wetting and drying (AWD) water-saving irrigation on mitigating GHG emissions and increasing rice grain yield were reproduced. We applied AWD to farmers' rice fields under different soil environments in four districts of An Giang Province in the Mekong Delta, and confirmed that GHG mitigation is also possible in acidic soil conditions. In the field of livestock research, feeding a total mixed ration (TMR) diet consisting of fermented cassava pulp or fresh brewers grains was effective in decreasing methane emission per digestible dry matter intake. Methane emissions from animals throughout a production period was estimated to be 48% lower in the semi-intensive system with fermented TMR as compared with the grazing-only extensive system. Regarding carbon sequestration in agricultural lands, the application of rice straw compost at 6 Mg ha^{-1} for each crop to a paddy field in Vietnam showed increases in rice yield and carbon storage in the soil as well as a 50% reduction in chemical fertilizer use. In an upland field in Thailand, rice straw mulching increased carbon storage in the soil and maize yield was maintained or improved. In Indonesia, where vegetable farmers tend to overdose on chemical fertilizer, reducing chemical fertilizer application by half of the standard dosage showed no significant yield difference if horse manure was applied at a rate of 10 Mg ha^{-1}.

Adaptation measures to climate change

A quantitative trait locus (QTL) for the spikelet number per panicle (*SPIKE*) was transferred into 5 rice mega-varieties in South and Southeast Asia, and the developed near-isogenic lines with *SPIKE* were analysed for yield improvement. YTH183, an introgression line with promising yield potential at the International Rice Research Institute (IRRI), had significantly higher grain yield than IR64 in local irrigated and rainfed fields in the Philippines, Indonesia, and Lao PDR. A reliable method has been established to correct the data of the global-scale seasonal weather forecast model (SINTE-X) of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), applicable to areas of Central Java in Indonesia and the central and southern provinces of Lao PDR. Using the decision support system developed with the established method, improvement of rice grain yield was confirmed in 5 villages of central and southern provinces in Lao PDR. This system has been published online at the IRRI homepage. With the use of supply and demand models for agricultural products, the impacts of climate change and adaptation technologies were economically simulated. In the case of Bangladesh, if early-morning-flowering rice varieties are disseminated and suffer half yield loss due to high temperature, then the per capita consumption of rice would be increased by 5.0 kg in 2050, and the decrease in the rice consumption would be alleviated by 1.1 kg in the case of a recurrent poor harvest (10-year recurrence interval). Another simulation was ran in Mekong Delta, where the construction of high dykes caused the flooding of paddy fields and the disappearance of 10% of winter rice fields, resulting to a decrease in per capita rice consumption (590 g) and an increase in farm rice price (25 USD/Mt). Furthermore, the simulation, using the world food long-term prediction model, showed that the spread of the high temperature tolerant rice variety would increase yield and consumption of rice in almost all the South and Southeast Asian countries.

[Utilization of Biological Nitrification Inhibition (BNI) function]

On BNI function's contribution as a mitigation strategy against global warming, the field experiments in Colombia elucidated that nitrification inhibitory activity of the field converted from *B. humidicola* grassland may last for at least four years, which resulted in the reduction of nitrogen fertilization. Additionally, it was shown that the release of biological nitrification inhibitors from sorghum roots is regulated at the transcriptional level.

[Resilient agro-pastoral systems in Northeast Asia]

In an attempt to reduce the risks of extreme weather events in the Mongolian grasslands, we have developed a series of operational countermeasures. First, we accomplished a procedure for the prompt creation of pasture carrying capacity maps at the end of the summer grazing season for risk-prone winter. This was accomplished by combining our pasture biomass maps in summer, our field-tested forage intake values, and detailed land use data provided by the government. Second, we proposed an improved supplemental feeding technique during winter by using silage prepared mainly from brewers' grain. The appropriate amount of the supplementation was determined from the results on the growth performance and meat qualities of grazing lambs. Last, econometric models were applied to estimate the relationships between regional and households' characteristics and the risk-coping strategies in the central area of Mongolia. Animal numbers during the disaster were governed by socio-economic factors such as preparation of feeds, emergency movement, and cash income. The initial abundance of animals would chiefly determine the animal number for the recovery period.

[Sustainable agricultural production in the African Savanna]

The possibility of extending the conservation agriculture-based cropping system has been evaluated in different agro-ecological zones of West Africa. The yields of maize/sorghum non-till cropping combined with pigeon pea intercropping were higher than that of conventional monocropping in almost all zones. Furthermore, it has been realized that some farmers accept this cropping system through demonstration farm activities although there were some limitations. In southern Africa, a prototype Decision Support System was developed for smallholder farmers in Northern Mozambique along the Nacala Corridor to decide the planting area for each crop based on profitability, which may vary between sites with different crop yields and socioeconomic conditions. Using this system, the advantages of the developed techniques in the current project, such as the maize-soybean intercropping system, could be evaluated.

[Island environment conservation]

In the Marshall Islands, several sustainable water use methods for Laura Lens were summarized and published by the government. The handbook, titled "Laura Lens Conservation and Management Manual," describes the "safe" daily pump discharge in accordance with the rainfall level and recommends the dispersed pumping method (i.e., increasing the number of intake wells to reduce pumping pressure). It is being used widely by the Drought Committee, among others, in ensuring the sustainable use of a healthy Laura Lens by drought-affected people.

In Negros Island, Philippines, excessive nitrogen (N) application in sugarcane fields is a cause of groundwater contamination through N leaching. A soil-crop model simulation indicated that N leaching can be reduced by more than 70% by halving the basal N application to the recommended amount. In contrast, saving of N topdressing would not be as effective and may negatively affect sugarcane yield. Reduction of the basal N application rate to sugarcane, therefore, can be a technology option for a more sustainable land and resource management in Negros.

Horse manure can replace half the amount of conventional chemical fertilizer application without any yield loss in West Java Highland

West Java Highland, which is underlain by soils derived from volcanic ash, is one of several production centers of temperate vegetables in Indonesia. Previous studies have found that vegetable farmers in this area tend to overdose on chemical fertilizer, thus organic matter application is considered an important option to improve soil fertility. However, the expansion of horticultural production in West Java Highland has caused a shortage of cow dung and chicken manure, which are popular forms of organic matter in the area. Although West Java Province has 14,000 horses (2014 data), horse manure use is very limited. This study, therefore, aimed to develop a technology to reduce chemical fertilizer application in West Java Highland without yield loss by applying horse manure, an underutilized organic resource in the area.

Horse manure is turned into compost by fermentation over a four-week period, with the manure turned over every week (Fig. 1). It contains around 0.7% nitrogen and 0.8% phosphate, which is equal to or higher than those of cow manure. Horse manure has lower C/N ratio than cow manure, which means that it is relatively easily decomposed in soil (Table 1). In field experiments at the Indonesian Vegetable Research Institute (IVEGRI), West Bandung, West Java, reducing chemical fertilizer application by half the standard dosage showed no significant yield difference if horse manure is also applied at an amount equal to 10t/ha (Fig. 2).

A field seminar was held at a village near IVEGRI, with seminar participants listening to explanations about chemical fertilizer reduction by manure application and receiving information leaflets written in the local language (Bahasa Indonesia) (Fig. 3). A questionnaire survey conducted after the seminar revealed that majority of farmers concerned (19 out of 30) were interested in technologies that reduce chemical fertilizer application.

In conclusion, it can be said that there is enough possibility for local vegetable farmers to apply this developed technology using local

Fig. 1. Horse manure production
Horse dung is piled (left) and fermented in a bamboo cage (right).
(Photos courtesy of the Indonesian Soil Research Institute)

Table 1. Nutrient content of horse and cow manure (% wet weight)

	Water (%)	C [*2] (%)	N (%)	C/N	P_2O_5 (%)	K_2O (%)
Horse manure	77.6	5.93	0.67	8.9	0.77	0.74
Cow manure [*1]	66.3	8.93	0.65	13.8	0.18	0.81

*1 Katamine et al. (2000)

*2 Organic carbon in horse manure, total carbon in cow manure

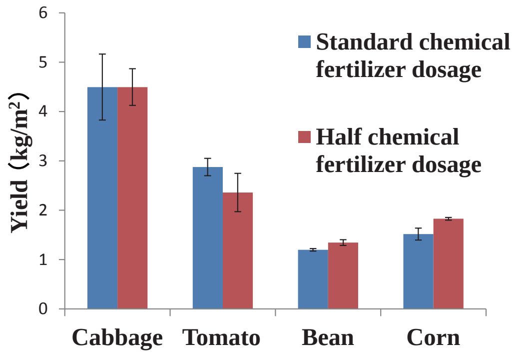


Fig. 2. Vegetable yields after chemical fertilizer application at standard and at half dosage rates in field experiments
Conditions: Horse manure 10t/ha, conventional tillage, average of three replications, error bars mean standard error
Cabbage and tomato: wet season in 2011
Bean: wet season in 2012
Corn: dry season in 2012

Fig. 3. Field seminar participants reading the information leaflet (inset) written in the local language
URL:http://www.jircas.affrc.go.jp/english/manual/horse_manure/horse_manure.pdf

underutilized resources, such as horse manure, to reduce chemical fertilizer application. Horse dung production, which can be estimated from the number of horses in West Bandung, can meet the amount of horse manure necessary to enable the technology to be applied to all cabbage production areas in the region.

(T. Sugino, N. Sumarini [Indonesian Vegetable Research Institute], Suwandi [IVEGRI], R. Rosliani [IVEGRI], D. Setyorini [Indonesian Soil Research Institute], W. Hartatik [ISRI], R. Saraswati [ISRI]

TOPIC 2

Guideline for tackling the decrease in forest resources using the CDM programmes of activities

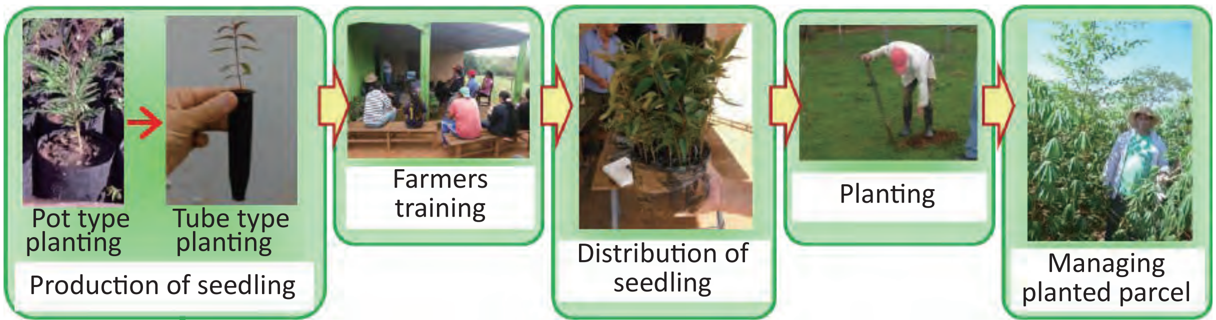
The decrease in forest resources is a pressing problem in Paraguay. One proposed solution to tackle this problem nationwide was to promote reforestation through the implementation of a Clean Development Mechanism (CDM) project. JIRCAS established Paraguay's first CDM project, which was successfully conducted in Paraguarí Department in the eastern part of the country. In order to apply the results of the CDM project to other areas in Paraguay, JIRCAS conducted similar CDM projects in five departments under a Programme of Activities[1], which is a CDM support structure, and tried to form an extendable reforestation programme CDM with governmental bodies in Paraguay. However, specific methodologies and techniques for forming a reforestation programme CDM have yet to be established because there had been no previous registration or track record with the United Nations CDM Executive Board.

Consequently, JIRCAS developed a guideline describing the following: 1) the preparation of a Project Design Document, which is essential for forming the programme CDM; 2) the establishment of a coordinating and managing entity in Paraguay; and 3) the calculation of the volume of greenhouse gases (GHGs) absorbed by planted trees (Table 1).

The guideline also included JIRCAS's recommendations for small-scale farmers on conducting reforestation activities appropriately and efficiently, such as the reduction of seedling weight by changing the planting method from "old-style pot type" to "tube type", and the establishment of a reforestation promotion method consisting of a series of progressive reforestation activities (Fig. 1). Furthermore, to improve the livelihood of small-scale farmers, JIRCAS evaluated the profitability of eucalyptus planting and developed indicators for nurturing

Table 1. The main structure and contents of the guideline

Introduction		Background and Objectives, Summary of activities, Structure and Content of Guideline and Use of Guideline
Chapter 1	Overview of the Reforestation Programme CDM	Overview of the Programme CDM, CDM flow, Role of the coordinating and managing entity, Contents and Organization of Project Design Document
Chapter 2	Efforts to form a Reforestation Programme CDM in Paraguay	Methodology and typology of the adopted CDM, Selection of Project boundaries, Formation of the Programme of Activities and Component of Project Activity (Establishment of Coordinating and Managing Entity, How to plan and implement the reforestation promotion method)
Chapter 3	Methods for Calculating Anthropogenic GHG removals	Applied CDM methodologies (AR-AMS0007ver03.1), Calculation of Anthropogenic GHG Removals
Chapter 4	Profitability Analysis	Profitability Analysis Procedures and Care Study

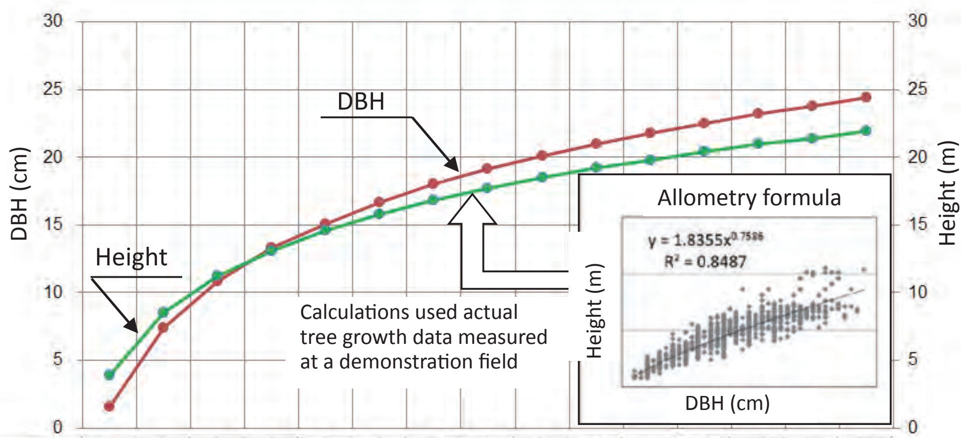


Box a) Pot type planting: Diameter 10cm, Height 13cm, and Volume 1000cm^3

Tube type planting: Diameter at the top (2.5cm) and bottom (1.0cm), Height 12cm, and Volume 60cm^3

* The change of planting type resulted to weight reduction, saving of production space, and improved distribution of seedlings.

Fig. 1. The Reforestation Promotion Method



Tree age (years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IRR (%)					10.8	11.7	13.6	14.3	14.4	14.2	13.8	13.4	13.0	17.6	16.7
NPV (US$)					14	40	112	161	196	215	219	213	205	748	704

Note) IRR that can guarantee profitability is 10% based on the interest rate for deposits in Paraguay Central Bank (10% in 2004)

IRR: Internal Rate of Return

NPV: Net Present Value

DBH: Diameter at Breast Height

Conditions for calculating IRR, etc:
- Reforestation interval 4m*2.5m (1,000 trees / hectare)
- Annual average growth volume 31m^3/ha
- No thinning, large-scale felling of trees after 5 years
- Price Reduction Rate = 10% of NPV

Fig. 2. Indicators for nurturing forests and desired IRR to ensure the profitability of eucalyptus planting

forests to ensure the profitability (Fig. 2). The feasibility of the reforestation promotion method has already been verified by officials of the National Forestry Institute of Paraguay.

The guideline is expected to be utilized for the preparation of Nationally Appropriate Mitigation Actions (NAMAs), which promote GHG emissions reduction in developing countries and whose national target for GHG emissions reduction in Paraguay was submitted for compulsory action to the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC). To ensure the accuracy and reliability of GHG emission reduction calculations, they need to follow a series of actions such as measurement, report, and verification when they create a NAMA. Accordingly, this guideline, which is based on CDM methodologies and in line with the strict rules of the United Nations, has satisfied the appropriate standard.

It is possible for surrounding countries to utilize the guideline because Spanish, Portuguese, and English versions have also been prepared. This guideline can be viewed and downloaded from the JIRCAS website through http://www.jircas.affrc.go.jp/english/manual/manual_index.html

(M. Watanabe, S. Shiraki)

TOPIC 3

Forage intake of grazing sheep in Mongolian winter grassland is 20% higher than the UNDP index

Mongolia has been experiencing increases in livestock number in recent years, which in turn have led to an increased risk of climate-related disasters. To reduce the risks, it is necessary for the grassland to be managed appropriately using scientific data such as carrying capacity calculated from aboveground biomass and forage intake by animals. However, the method for calculating the index is not always clearly documented; therefore, the scope of application of the index is difficult to define. The forage intake of sheep was estimated to obtain basic information for calculating the carrying capacity of the Mongolian forest steppe and steppe grassland during autumn and the next spring.

Research data showed that aboveground biomass was lowest in February, and that the reduction rates of aboveground biomass in forest steppe and steppe from September 2011 to February 2012 were 70.9 and 82.6%, respectively. The dominant plant species were *Stipa* spp., *Cleistogenes squarossa*, and *Artemisia frigid* in the forest steppe, and *Stipa* spp., *Carex pediformis*, and *Agropyron cristtumn*. in the steppe. The body weight of sheep in forest steppe and steppe decreased by 13.6% and 8.7%, respectively, between November 2011 and February 2012 (Fig. 1). Daily fecal outputs in forest steppe and steppe were 0.475-0.665 and 0.467-0.550 kg DM, respectively. During the same period, fecal output in the forest steppe decreased significantly (Fig. 2, Table 1). Forage digestibilities determined from acid detergent lignin in pasture plants and in feces at forest steppe and steppe were 51.8-63.8 and 63.2-70.9%, respectively, and there were significant differences among

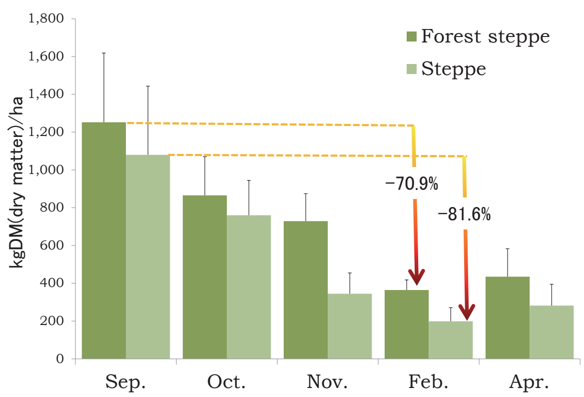


Fig. 1. Seasonal changes of aboveground biomass

Fig. 2. Fecal bag attached to the sheep

Table 1. Calculation of intake and other parameters measured in forest steppe and steppe

		2011			2012		ANOVA	
		Sep.	Oct.	Nov.	Feb.	Apr.	S.D.	P
Forest steppe								
Body weight	(kg)	41.8 ab	45.5 a	45.7 a	39.5 b	37.9 b	4.42	***
Fecal output	(kg DM/day)	0.557 abc	0.600 ab	0.665 a	0.500 bc	0.475 c	0.094	***
Digestibility	(% DM)	58.1 bc	51.8 d	63.8 a	62.2 ab	56.5 c	4.07	***
Intake	(kg DM/day)	1.33 b	1.25 b	1.89 a	1.34 b	1.10 b	0.33	***
	(% BW/day)	3.16 b	2.80 b	4.09 a	3.40 ab	2.91 b	0.62	***
Steppe								
Body weight	(kg)	53.8	57.5	56.4	51.5	51.0	5.66	*
Fecal output	(kg DM/day)	0.467	0.550	0.469	0.489	0.471	0.080	ns
Digestibility	(% DM)	70.5 a	68.2 ab	70.9 a	65.1 bc	63.2 c	2.89	***
Intake	(kg DM/day)	1.60 ab	1.73 a	1.64 ab	1.41 ab	1.30 b	0.30	**
	(% BW/day)	2.97	3.02	2.91	2.76	2.54	0.49	ns

Annual average temperature and precipitation in 2011-2012 were the same as normal. n=12
S.D.: Pooled standard deviation. ***: P<0.001, **: P<0.01, *: P<0.05, ns: P>0.05
a, b, c: Means within the same row with different letters are significantly different (P<0.05)

seasons (Table 1). Forage intake calculated from the fecal output and forage digestibility at forest steppe and steppe were 1.10-1.89 kg DM/day (2.91-4.09% BW/day) and 1.30-1.73 kg DM/day (2.54-3.02% BW/day) (Table 1). A comparison of the forage intake during summer, autumn, winter, and spring showed experimental data values of 1.6, 1.8, 1.1, and 1.1 kg DM/day, respectively, which was 20% higher than the prevalent index data (which was determined by UNDP, 2007) for winter (February). Therefore, the carrying capacity in winter, as calculated from experimental data, is lower than the prevalent index.

In the future, it would be possible to extensively compare the carrying capacities by estimating the forage intakes on different regions and grazing environments. Forage digestibility is affected by seasonal differences and vegetation composition, and must be considered in the calculations. Also, it is recommended that feed intake expressed in terms of body weight (%BW/day) be calculated for the comparison.

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TOPIC 4

Laura Lens Conservation and Management Manual

The Majuro Atoll, which contains the capital city of Majuro in the Republic of the Marshall Islands (RMI) in the Pacific Ocean, has a population of about 28,000. Freshwater in particular is a fragile resource because there are no rivers or lakes. People in the Majuro Atoll depend on Laura Island’s freshwater lens (Laura Lens) for domestic and irrigational use. Laura is an island village situated on the western edge of Majuro Atoll, with an area of 1.8 km^2, an average altitude of a few meters, and a population of approximately 2,300. As a result of population growth in Majuro Atoll, water demand on the atoll is expected to rise and put increasing pressure on Laura Lens. Moreover, the presence of El Niño in the Pacific region often causes droughts in the RMI. There is also a concern that climate and meteorological changes caused by global warming may expand drought areas or cause them to shift. Thus, Laura Lens is in a critical state. Normal water-pumping rates can result in saltwater upconing (i.e., partial upward intrusion of saline water) at the Laura Lens boundary if monthly rainfall is reduced even slightly below normal levels.

In order to develop a method for conserving Laura Lens, a numerical simulation was performed using the SEAWAT model. To analyze

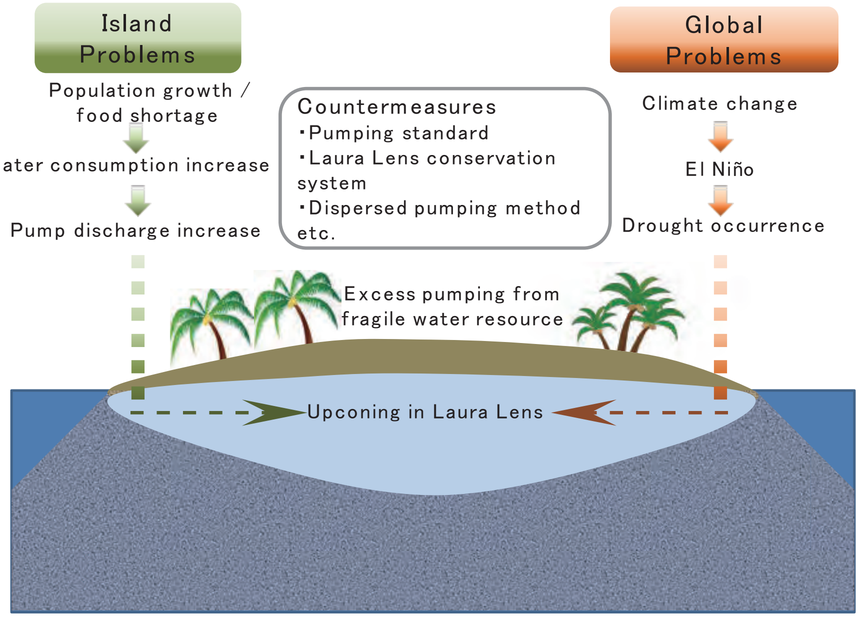

Fig. 1. Problems and Countermeasures in terms of Water Use

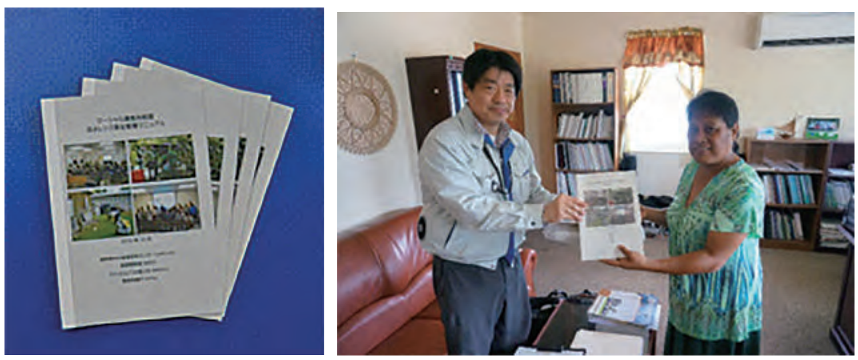

Fig. 2. Laura Lens Conservation and Management Manual

Table of Contents

Fig. 3. Table of Contents

water usage, numerical experiments were carried out in which monthly rainfall and daily pump discharge were set under varied boundary conditions. Saltwater upconing, which should not reach the shaft (lateral well), was simulated to obtain the sustainable daily pump discharge for Laura Lens. This manual, therefore, describes the “safe” daily pump discharge in accordance with the rainfall level, and recommends the dispersed pumping method (i.e., increasing the number of intake wells to reduce pumping pressure on one location) to maintain a healthy Laura Lens based on scientific findings.

To conserve the freshwater lens, it is important that the daily pumping discharge be reduced as the monthly rainfall decreases. It is thus desirable to devise a new groundwater intake system in which the wells are being pumped at low intensities. On February 3, 2016, a state of emergency was declared in the RMI because of the drought caused by El Niño. This manual is serving its purpose as it is being widely used by the Drought Committee, among others, in ensuring the sustainable use of a healthy Laura Lens by drought-affected people.

(K. Koda and T. Kobayashi)

TOPIC 5

Lowering of rhizosphere soil pH is a relevant factor on biological nitrification inhibition in sorghum

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major food crops in the world. To date, most studies on biological nitrification inhibition (BNI) in sorghum have been performed on plants grown in hydroponic systems. To determine whether or not sorghum inhibits nitrification in fields, this current study was conducted in an area underlain by alfisols, which is a typical soil in semi-arid and sub-humid tropics, with the aim of clarifying the mechanism that results in the inhibition of soil nitrification in the field. Nitrification activity in the rhizosphere of sorghum, i.e., the soil (of a few millimeters thick) surrounding the roots, was measured and compared with those in the adjacent bulk soil.

Sweet sorghum (CSH 22SS, NTJ 2, 675x700, ICSV 25263, ICSV 25274, ICSV 93046) and grain sorghum (CSH 16, PVK 801, HTJH 3201) were cultivated in four alfisol fields in the semi-arid tropical region of India during the 2010 and 2011 rainy seasons. Soil samples were collected three times during the growing

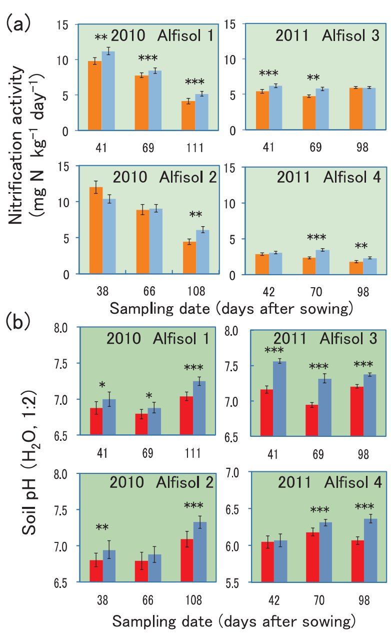

Fig. 1. Average nitrification activities (a) and average pH (b) in the rhizosphere soils (■, ■) and bulk soils (■, ■) in each sampling

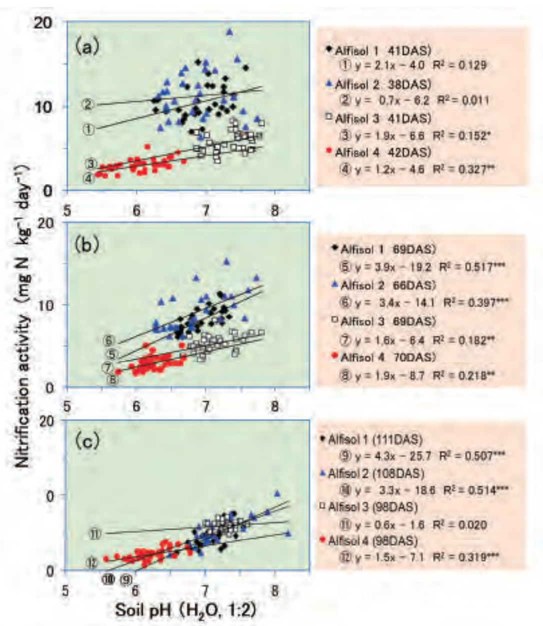

Fig. 2. Relationship between nitrification activity and soil pH (H_2O, 1:2) of rhizosphere soil in each sampling (early (a), middle (b), and late (c) stage of growth)

DAS: days after sowing

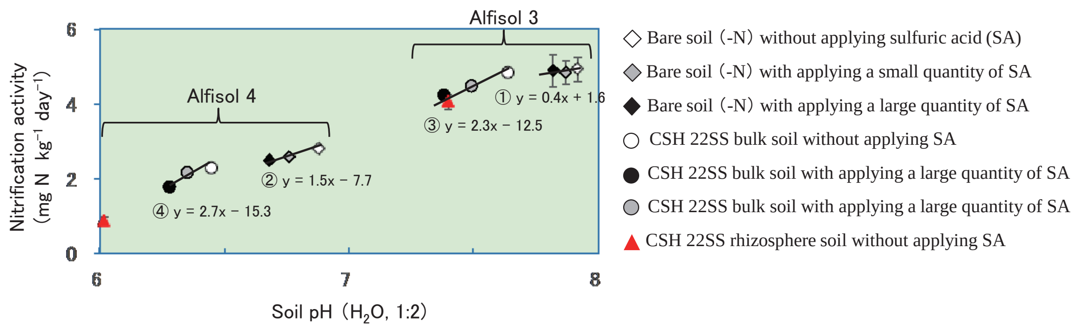

Fig. 3. Effects of soil pH modification on nitrification activity.
Each nitrification activity of soils with modified soil pH by applying sulfuric acid was measured.

season. Nitrification activity in the rhizosphere soil was significantly lower than that in the bulk soil in 8 out of 12 samplings (Fig. 1a), while the pH (H_2O, 1:2) of the rhizosphere soil was significantly lower than that of the bulk soil in 10 out of 12 samplings (Fig. 1b). The nitrification activities and soil pH showed significant positive correlation for Alfisols 3 and 4 except for Alfisol 3 at 98 days after sowing, whereas the nitrification activity and soil pH had significant positive correlation for Alfisols 1 and 2 collected during the mid and late growth stages in the four fields (Fig. 2). Acidification of the soil by sulfuric acid decreased the nitrification activity to a comparable extent, as observed in the rhizosphere soils (Fig. 3).

These results indicate that acidification of soil around roots would be one of the main causes of nitrification inhibition by sorghum in the field. Although our study showed that acidification of soil would be the main driving force for nitrification inhibition in the rhizosphere, root exudates such as sorgoleone may also enhance BNI simultaneously. Due mainly to technical difficulties involving soil, which contains numerous and wide-ranging organic compounds, it remains unclear whether specific compounds exudated from plants inhibit nitrification in the soil-plant system. Further studies are necessary to clarify the contribution of root exudates to BNI activity in the field.

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TOPIC 6

The release of biological nitrification inhibitors from sorghum root is regulated at the transcriptional level

Sorghum (*Sorghum bicolor*) roots release biological nitrification inhibitors (BNIs) to suppress soil-nitrifier activity and soil-nitrification. The presence of NH_4^+ in the rhizosphere stimulates the release of BNIs from roots and is hypothesized to be functionally linked to plasma membrane (PM) H^+-ATPase activity. However, whether the H^+-ATPase is regulated at the transcriptional level, and if so, which iso-forms of H^+-ATPases are involved in BNIs release are not known. Also, the stimulation of BNI release, whether it is due to NH_4^+ uptake or its assimilation in roots, is unclear, and it would be subsequently addressed by this study.

NH_4^+ concentrations up to 1.0 mM positively stimulated both PM H^+-ATPase activity and BNI release from sorghum roots; but at higher concentrations (>1.0 mM), NH_4^+ did not further increase BNI release and a decline in PM H^+-ATPase activity was observed (Fig. 1a, b). Vanadate, an inhibitor of H^+-ATPases, suppresses BNI release from intact sorghum plants (Fig. 1c). Twelve PM H^+-ATPase genes (iso-forms, designated as *SbA1 to SbA12*) were identified in sorghum genome; however, only five H^+-ATPase genes were stimulated by NH_4^+ in the rhizosphere. They have a similar expression pattern and is consistent with the observed variation in H^+-ATPase activity (Fig. 2). Methyl-ammonium (MeA), a non-metabolizable analogue of NH_4^+, had no

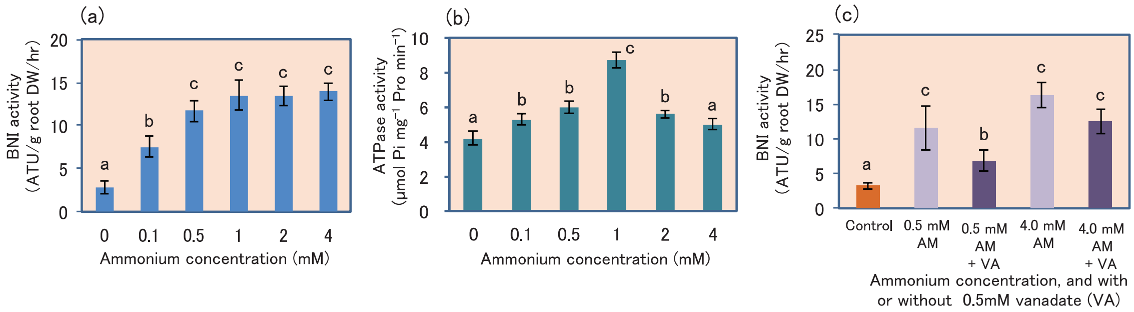

Fig. 1. The effects of ammonium (AM) on biological nitrification inhibitor (BNI) release from sorghum roots (a) and the plasma membrane (PM) H^+-ATPase activity in the roots (b), and the effect of vanadate (VA), an ATPase inhibitor, on BNI release from the roots (c)

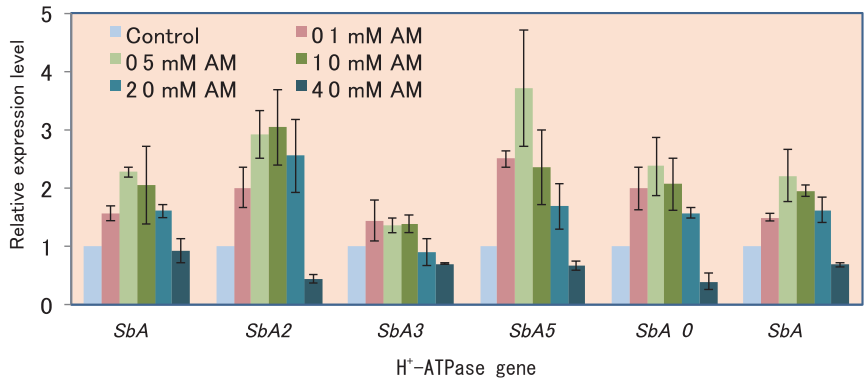

Fig. 2. The expression of six sorghum PM H^+-ATPase genes in response to NH_4^+ (AM) nutrition

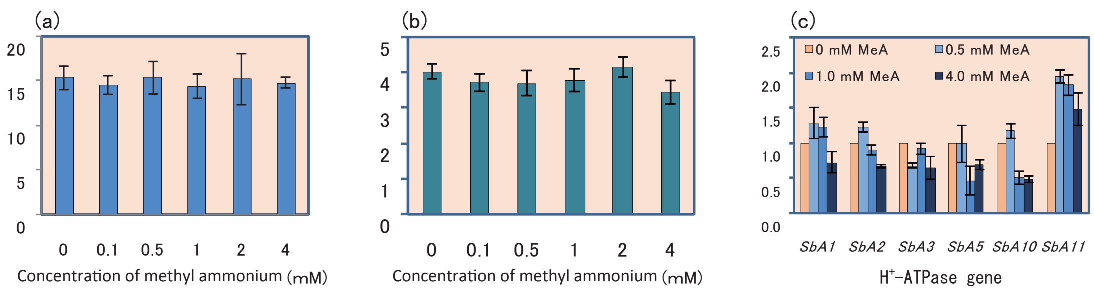

Fig. 3. The effect of methyl-ammonium (MeA), a non-metabolizable analogue to NH_4^+, on BNI release (a), the H^+-ATPase activity (b), and the expression of the H^+-ATPase genes in sorghum roots (c)

significant effect on BNI release, H^+-ATPase activity, or the expression of H^+-ATPase genes (Fig. 3). These results suggest that the functional link between PM H^+-ATPase activity and BNI release is operational only at NH_4^+ concentrations of ≤1.0 mM in the rhizosphere. The variation in PM H^+-ATPase activity by NH_4^+ is due to transcriptional regulation of five iso-forms of H^+-ATPases. The stimulatory effect of NH_4^+ on BNI release is functionally associated with NH_4^+ assimilation and not from NH_4^+ uptake alone.

A mechanistic understanding of BNI release in sorghum helps in choosing suitable agro-ecological niche production systems where BNI function is expressed to its genetic potential for controlling soil nitrification. In addition, the use of slow-release N-fertilizers can allow soil ammonium levels ≤1.0 mM. This, coupled with the development of genetically modified crops with accelerated PM H^+-ATPase activity, can further improve BNI release from sorghum root systems to make production systems low-nitrifying and low-N_2O emitting with improved nitrogen-use efficiency, which in turn will be ultimately beneficial to human society and the environment.

(G. V. Subbarao, H. Zeng, T. Di, Y. Zhu [Nanjing Agricultural University])

PROGRAM B
Stable Food Production

"Technology development for increased productivity and stable production of agricultural products in the tropics and other unstable environments"

The Stable Food Production Program is aimed at developing technologies that will improve and sustain productivity through collaborative research with local institutions and international research centers, especially for areas under adverse environments such as those found in tropical regions. Research outcomes are expected to contribute to global food security and help reduce starvation and malnutrition, which remain serious problems in developing regions. 'Research Highlights 2015' of Program B are introduced as 'Topics' at the latter half of this article.

[Development of rice production technologies in Africa]

The program's flagship project, "Development of rice production technologies in Africa," tries to fulfill the main target of the Coalition for African Rice Development (CARD) to double rice production in Sub-Saharan Africa within ten years (by 2018). To meet the target, various approaches were used. One of several genes that enhance nitrogen uptake, *qRL6.1*, was introduced to popular varieties such as upland NERICA 1 in West Africa. The lines with upland NERICA1 background showed a significant increase in dry matter production and panicle weight but not much difference in heading date compared to the original upland NERICA1 planted under upland conditions in Tsukuba. Experimental data suggested that *qRL6.1* is effective in increasing productivity in rice with the genetic background of upland NERICA1. The phosphorous deficiency tolerance gene (*Pstol1*), on the other hand, was introduced to upland NERICA4, and some lines showed better yields than the original, which were grown under upland conditions in Tanzania. Also, a simple protection method for irrigation canals was examined for applicability, cost, and service life. The draft manual was prepared after consolidating the results of studies, and helpful tips for utilizing the methods were included. Among the 27 varieties /lines, four lines (Amankwatia, Bodia, and Sakai as cultivars in Ghana and IRBL9-W[RL], which was developed under an IRRI-JIRCAS collaboration) were identified as suitable for floodplain conditions in Ghana. Aiming to strongly set out JIRCAS's contribution to the CARD initiative, a practical guideline-table clearly expressing correspondence between developed technologies and their suitable recipients under diverse ecological and social conditions for rice production in Africa was prepared in order to spread the research outcomes efficiently.
[Topic 1]: High-yielding and stable rice varieties in the flood plains of Upper Volta River in Ghana

[Rice innovation for environmentally sustainable production systems]

A low-input and environment-friendly variety of rice and a new cultivation technology in Asia that ensures stable productivity in poor environmental conditions will be advanced. On a related note, the JIRCAS project, "Blast Research Network for Stable Rice Production," has progressed. This research focuses on the development of a differential system for blast pathogen and resistance genes in rice varieties in Asia and Africa. The application of the differential system for blast resistance developed for each country was confirmed and the research situation regarding genetic improvement in promising cultivars using it was clarified.

Differentiation of blast races at the global level was clarified, and the genetic diversity in Japan was found to be lower than those of other countries in Asia and Africa. Moreover, it corresponded with low genetic variation in the resistance of rice cultivars in Japan. The allele-specific DNA markers for the phosphoric acid uptake gene (*Pup1*) were developed, novel quantitative trait loci (QTLs) for phosphoric acid use efficiency were detected, and donor cultivars were selected.
[Topic 2]: Unmasking novel loci for internal phosphorus utilization efficiency in rice germplasm through Genome-Wide Association Analysis
[Topic 3]: Co-differentiation of blast races and rice varieties in Japan

[Development of genetic engineering technologies of crops with environmental stress tolerance]

The development of genetic engineering technologies as tools to improve crop cultivation in developing countries is important, especially in areas under unstable environments where drought or poor natural conditions affect stable crop production.

Abscisic acid (ABA) accumulates in leaves, inducing leaf senescence in response to environmental stress. We found that *SNAC-A* subfamily genes are mainly involved in ABA-induced leaf senescence. We also revealed that GLK transcription factors have important roles for ozone tolerance through the regulation of stomatal closure. Controlling these genes may contribute to the improvement of drought tolerance in crops. We have succeeded in improving the transformation efficiency of Brazilian soybean cultivars and were able to establish the transformation method using *Agrobacterium*. We obtained transgenic events having *AREB1* stress-tolerance gene of *Arabidopsis* using *Agrobacterium* methods. The transgenic events showed drought tolerance in the greenhouse.

[Topic 4]: Improving the drought tolerance of a Brazilian soybean variety using *Agrobacterium*-mediated transformation

[Topic 5]: Discovery of genes related to leaf senescence during long-term dry stress

[Development of breeding technologies toward improved production and stable supply of upland crops]

In South America, soybean production has been threatened since the early 2000s by Asian soybean rust (ASR) caused by *Phakopsora pachyrhizi*. ASR, along with drought, is currently the most serious threat to stable soybean production. To cope with ASR, we evaluated its pathogenicity and are developing resistant soybeans using backcrossing and marker-assisted selection. Six and four lines resistant to ASR have been developed in Paraguay by line breeding using the cultivar Aurora and the line YG as recurrent parents, respectively. Their agricultural performance is under evaluation at several locations. Moreover, we have isolated a salt tolerance gene *Ncl* from soybean. The *Ncl* gene can be utilized to improve salt tolerance in soybean.

[Topic 6]: Map-based cloning of a salt tolerance gene *Ncl* and its utilization for improvement of salt tolerance in soybean

[Evaluation and utilization of diverse genetic materials in tropical field crops]

This project aims to develop effective evaluation and breeding techniques for better utilization of a wider range of germplasm for genetic improvement in tropical field crops.

Yam (*Dioscorea* spp.) is a traditional staple crop of economic and socio-cultural importance in West Africa. Genome analysis and improved molecular techniques, if incorporated into the breeding program, would tremendously facilitate germplasm characterization as well as genetic mapping and tagging, thus effectively establishing its scientific bases. Out of 90 newly developed simple sequence repeat (SSR) markers, 30 were selected as a useful set for studying the genetic variation and relationships of five popular *Dioscorea* species in Africa. The markers can also be useful for cultivar identification, gene/QTL mapping, etc. in breeding programs in West Africa. Furthermore, simple and effective criteria and techniques for analyzing major yam tuber traits were developed and preliminarily adopted to a set of diverse yam accessions to confirm its practical usefulness for further evaluation of the extensive yam germplasm.

Cowpea (*Vigna unguiculata*) is traditionally important as a good source of protein and minerals and of cash income for small-scale farmers in Sub-Saharan Africa. Therefore, the development and deployment of cowpea varieties with adequate quality and nutritional value that meet the needs of consumers should enhance cowpea consumption and production in the region. To monitor local prices and consumer preference for cowpea grain, monthly surveys were conducted and completed over a 3-year period in 19 local markets in Nigeria. To further understand the consumers' preferences in detail, the 23 most popular local varieties identified through the survey were investigated for basic agronomic traits and grain protein content. We also evaluated 240 germplasm accessions for various grain quality-related traits and the results were organized as an open access database to be used by cowpea breeders to improve grain quality and nutrition that meet the needs of farmers and consumers.

Characterization and preliminary evaluation of JIRCAS's tropical fruit germplasm collections are steadily ongoing, and distinctive germplasm accessions are progressively being utilized in our activities. A promising passion fruit breeding line with large fruit size, high soluble solid-acid ratio, and bright skin color even under high temperature conditions was selected. Based on the test performance over 3 seasons, JIRCAS applied to MAFF for official variety registration in Japan.

Sugarcane is widely cultivated as a food and energy source in the tropics. However, inferior environmental conditions such as poor soil and rainfall deficiency hinder stable production. We are attempting to utilize a wild relative, *Erianthus*, to improve the biomass productivity of sugarcane even under unfavorable environments. With the selected 41 SSR markers, genetic diversity analysis of 150 accessions of the Thai *Erianthus* germplasm was performed. The obtained information, including morphological and agronomic traits, will be organized into an open access database to enhance the utilization of this wild relative toward sugarcane improvement. To promote utilization of *Erianthus* as a bioenergy crop, a new variety with improved mechanical harvesting efficiency was developed. JIRCAS and NARO jointly applied to MAFF for official variety registration in Japan.

[Topic 7]: Development of SSR markers for diversity studies on Yam (*Dioscorea*) genetic resources

[Topic 8]: Evaluation of genetic diversity in quality-related traits of cowpea genetic resources for the development of an open access database

[Topic 9]: JEC1, a new variety of *Erianthus* with higher mechanical harvesting efficiency

[Development of integrated pest management techniques for stabilization of agricultural and livestock production in developing areas]

Multi-purpose sugarcane (MPS), which was developed during JIRCAS's Second Medium-Term Plan period, is expected to help address global food and energy issues because it can be used for both food (sugar) and energy (ethanol) production purposes. Three varieties of MPS, TPJ03-452, TPJ04-713, and TPJ04-768, were registered in Thailand. However, a phytoplasma disease, sugarcane white leaf (SCWL), is an obstacle to field production in developing areas. A simulation model for risk assessment of infectious SCWL disease transmission was developed. The results of risk assessment suggested that multiplication of healthy seed cane in a large field might be possible by reducing the invasion risk of SCWL disease at the inside of a large field.

[Topic 10]: New sugarcane varieties using wild sugarcane and collaboratively bred in Thailand

[Topic 11]: Movement ability of vector insects of sugarcane white leaf disease

We carried out a follow-up investigation of the 2012 Research Highlights report titled "Guideline on salt damage mitigation measures in fields under high groundwater level conditions." The guidelines manual had already been distributed and is being utilized by appropriate beneficiaries such as farmers in Uzbekistan where lands suffer from salt damage. Research findings and updates were presented regularly through seminars by the Ferumeru council and local government agencies, leading to greater awareness by the farmers and agencies concerned. Moreover, part of the results have been used as training materials. Thus far, certain impacts have been alleviated and positive development have been observed.

TOPIC 1

High-yielding and stable rice varieties in the flood plains of Upper Volta River in Ghana

Rice consumption is drastically increasing in West Africa; however, domestic production has not matched the increase in consumption. Moreover, the increasing cost of imported rice is putting the squeeze on the national budget. The utilization of fertile flood plains is thus being eyed as one solution to increase rice production in the region.

The fertility of flood plains changes drastically according to the distance from rivers. In addition, there is a large annual environmental variation in the areas where crops are grown.

We tried to screen suitable rice varieties for the flood plains. The experiments, which used 28 varieties, were conducted at 4 places (Fig. 1), each experiencing different flood conditions from 2012 to 2014 (Table 1). The result of cluster analysis showed the yield responses of four genotypes across three environments.

G-2 (Genotype-2) had the highest yield in E-3 (Environment-3) but showed lower yields in other environments (Fig. 1). A genotype showing high yield only in a particular environment is not adequate for flood plains because the environment undergoes large changes every year. On the other hand, G-3 showed moderate yields and was stable under different environments. Meanwhile, G-4 showed the highest yield in E-1 and relatively higher yields in other environments. Therefore, G-4 was considered

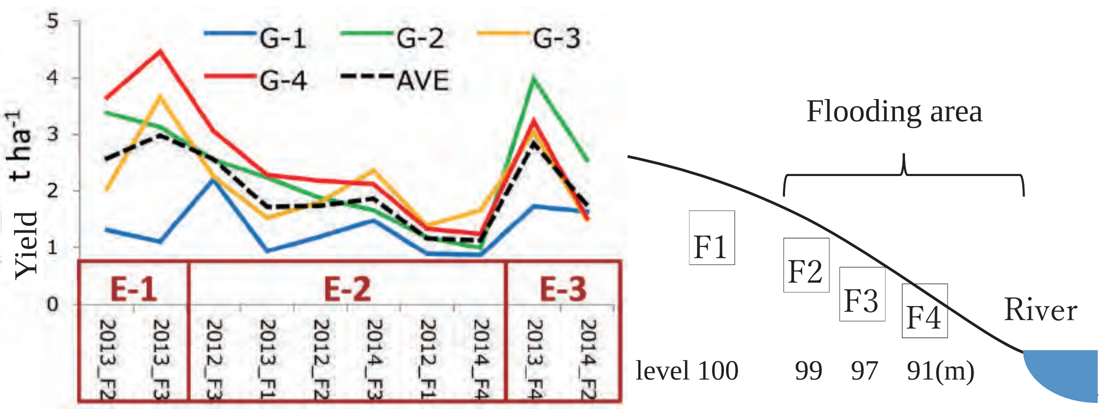

Fig. 1. Average yields of genotype groups across environment groups.
G : Genotype by cluster analysis, E : Environment group

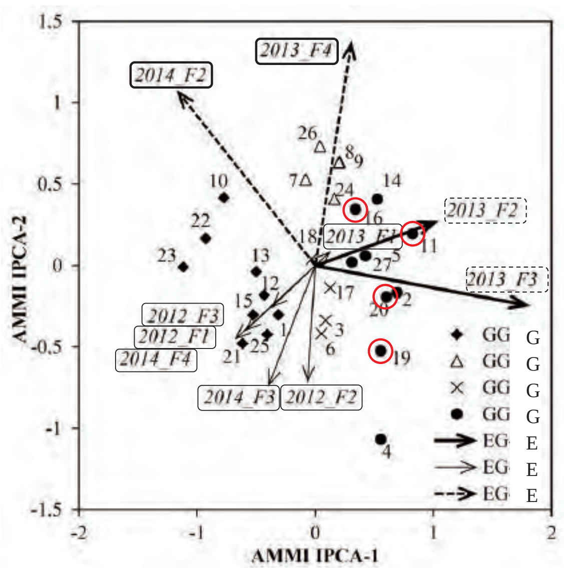

Fig. 2. Feature of each variety by AMMI analysis

Table 1. Average yields of the sampled varieties

No.	Genotype	Species	Yield	Character
G-1 (Very stable but low yield)				
1	CK40	*O. sativa*	1.91	Lowland
10	IR73020-19-2-B-3-2B	*O. sativa*	1.74	Submergence
12	N22	*O. sativa*	0.78	Upland
13	Nylon	*O. sativa*	1.38	Deepwater
15	Vandana	*O. sativa*	0.90	Upland
21	CG14	*O. glaberrima*	1.42	Lowland
22	Mala Noir IV	*O. glaberrima*	1.19	Deepwater
23	Yélé 1A	*O. glaberrima*	1.08	Deepwater
25	Séidou Bayebeli	*O. glaberrima*	1.66	Upland
G-2 (High yield in E-3)				
7	IR71700-247-1-1-2	*O. sativa*	2.12	Lowland
8	IR72431-5B-18-B-10-1	*O. sativa*	2.66	Elongation
9	IR73018-21-2-B-2-B	*O. sativa*	2.35	Submergence
24	Douboutou II	*O. glaberrima*	2.30	Lowland
26	Saligbeli	*O. glaberrima*	2.37	Deepwater
G-3 (Standard)				
3	IR07F323	*O. sativa*	2.01	AG + *Sub1*
6	IR67520-B-14-1-3-2-2	*O. sativa*	2.09	Submergence
17	Jasmin85	*O. sativa*	2.15	Lowland
18	Sikamo	*O. sativa*	2.25	Lowland
G-4 (High yield especially in E-1)				
2	IR07F297	*O. sativa*	2.39	AG + *Sub1*
4	IR42	*O. sativa*	2.76	Irrigated
5	IR11141-1-6-1-4	*O. sativa*	2.30	Elongation
11	IRBL9-W[RL]	*O. sativa*	2.61	*Sub1*
14	PSBRC80	*O. sativa*	2.18	Lowland
16	Amankwatia	*O. sativa*	2.75	Lowland
19	Bodia	*O. sativa*	2.60	Lowland
20	Sakai	*O. sativa*	2.59	Lowland
27	WAB1159-2-12-11-6-10	NERICA	2.44	Lowland

Varieties in red letters are in the top 20% (>2.5t) in terms of yield.

the most favorable genotype in flood plains. We can see which varieties are favorable in flood plains by performing AMMI (additive main effect and multiplicative interaction) analysis. Varieties that are stable in any environment are plotted near the origin. The tested varieties, IRBL9-W[RL] (Japan-IRRI Project; https://www.jircas.affrc.go.jp/kankoubutsu/seika/seika2011/pdf/2011-10.pdf), in addition to some local varieties such as Amankwatia, Bodia, and Sakai, are among the top 20% in terms of yield (Fig. 2). IR42 (No.4) had the highest yield on average; however, it was not stable.

Our results showed that planting early-maturing varieties to avoid drought is not effective. We believe that this information will be useful in designing breeding strategies for rainfed rice in flood plains. We also hope that our results will contribute to achieving the goal of CARD (Coalition for African Rice Development), which targets rainfed lowlands for increased rice production.

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Unmasking novel loci for internal phosphorus utilization efficiency in rice germplasm through Genome-Wide Association Analysis

Phosphorus (P) is an essential element needed for plant growth, but it is deficient in many cropping systems worldwide, leading to low grain yields. In addition, the depletion of non-renewable rock phosphate reserves and increase of P fertilizer prices have renewed interest in breeding P-efficient cultivars. Internal P utilization efficiency (PUE), or how efficiently the P that is taken up is utilized to accumulate either grain yield or vegetative biomass, is of prime interest because there has been no progress to date in breeding for high PUE.

We have characterized the genotypic variation for PUE present within the rice gene pool by using a hydroponic system that assured equal plant P uptake. This experiment was performed with a single dose of 800 µg P as the low-P treatment. All genotypes therefore had comparable P content and PUE was estimated as total biomass per amount of P available (P supplied and seed P).

Genotypes Mudgo, Yodanya, Santhi Sufaid, and DJ123 had higher estimated PUE values, while modern varieties such as IR64, Taichung, and Koshihikari had lower values. The loci controlling PUE were mapped via a Genome-Wide Association Study (GWAS), which included 292 diverse *Oryza sativa* accessions from 82 countries. The main loci associated with PUE were mapped on chromosomes 1 and 11 (Fig. 1A). The highest PUE was associated with a minor *indica*-specific haplotype on chromosome 1 and a rare *aus*-specific haplotype on chromosome 11 (Fig. 1A). Comparative variant and expression analysis for genes contained

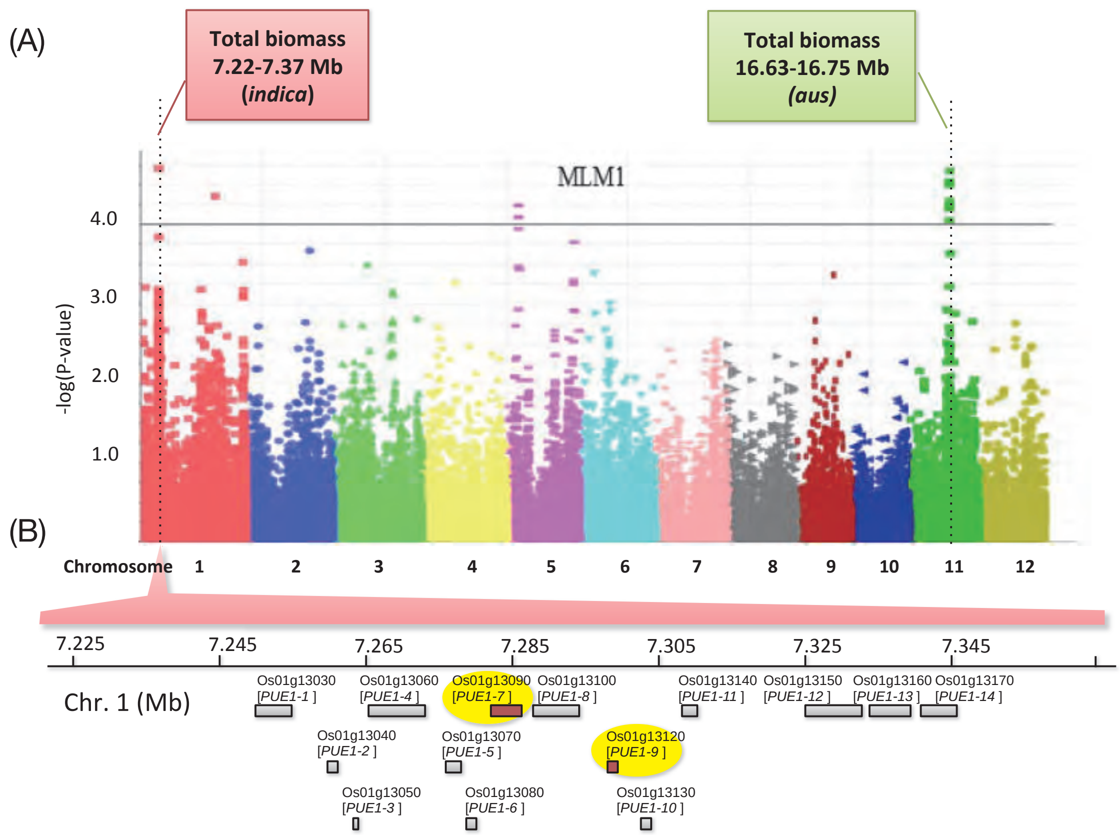


Fig. 1. Manhattan plots for PUE
(A) Dotted lines indicate two major QTL of PUE on chromosome1 and 11. They are involved in PUE for total biomass (shoot and root). The peak of chromosome 5 is associated with PUE for root biomass.
(B) *PUE* loci on chromosome 1 (7.247-7.343 Mb). The two candidate genes showed different gene expression patterns in low P conditions.

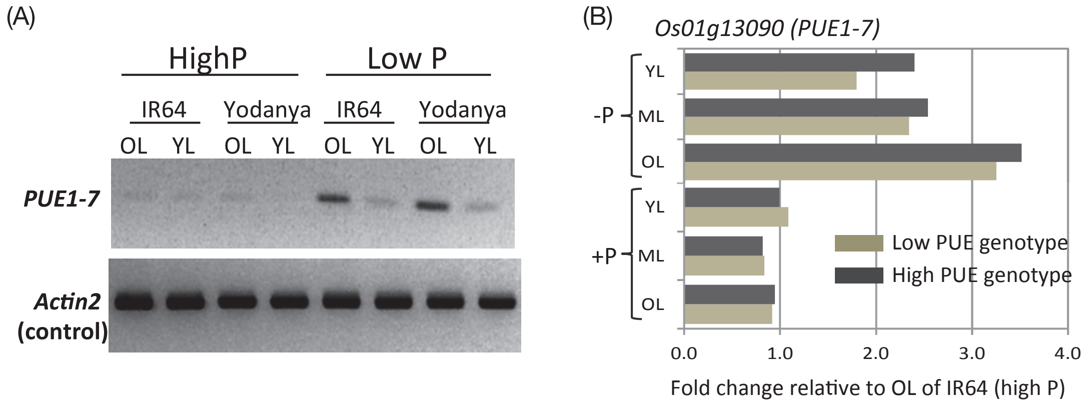


Fig. 2. Gene expression analysis for candidate gene (PUE1-7) of the PUE locus on chromosome 1 (A) Semi-quantitative RT-PCR (B) qPCR for candidate gene PUE1-7. Gene expression was compared in old leaves (OL, beginning to senesce), intermediate leaves (ML, typically the two leaves below the youngest fully expanded leaf) and young leaves (YL, >50% developed).

within the chromosome 1 haplotype identified two high priority candidate genes: *PUE1-7* and *PUE1-9* (Fig. 1B). In terms of *PUE1-7*, there is no difference in gene expression pattern, while differences in coding regions between genotypes of contrasting haplotypes suggest that functional alterations for two predicted proteins are likely causative for the observed differences in PUE.

The loci reported here are the first identified for PUE in any crop that is not confounded by differential P uptake among genotypes. Importantly, modern rice varieties were found to lack haplotypes associated with superior PUE and would thus benefit from targeted introgressions of these loci from traditional donors to improve plant growth in phosphorus-limited cropping systems.

(K. Kondo, J. Pariasca-Tanaka, M. Wissuwa, TJ Rose [Southern Cross University])

TOPIC 3

Co-differentiation of blast races and rice varieties in Japan

JIRCAS, through its project titled "Blast Research Network for Stable Rice Production," has clarified the diversity of blast (*Pyricularia oryzae* Cavara) races and the genetic variation of resistance in rice (*Oryza sativa* L.) cultivars of Asia and Africa.

To develop a durable protection system against blast disease, which has caused serious damage to rice production in all rice cultivation areas of the world, the diversities of blast races and the variations of resistance in rice cultivars were examined. This is important for understanding and defining the relationships between the races and cultivars in order to provide basic information.

In Japan, we found multiple evidence of co-differentiation of blast races and rice cultivars, based on pathogenicity studies of blast isolates collected and genetic analysis for resistance of rice cultivars in each region.

The pathogenicity of 310 blast isolates was evaluated based on the reactions to 23 differential varieties, which harbor a single resistance gene in each genetic background and susceptible control, Lijiangxintuanheigu(LTH). It was then classified into three cluster groups, I, IIa and IIb. Blast isolates in group I were mainly virulent to resistance genes of *Pik* alleles, and were distributed with higher frequencies in Hokkaido, Tohoku, Kanto and Hokuriku, compared with the other regions. Those in group IIa did not show virulence to *Pik* alleles' genes, and were distributed in all regions of Japan. Those in group IIb were not virulent against *Pik* alleles' genes

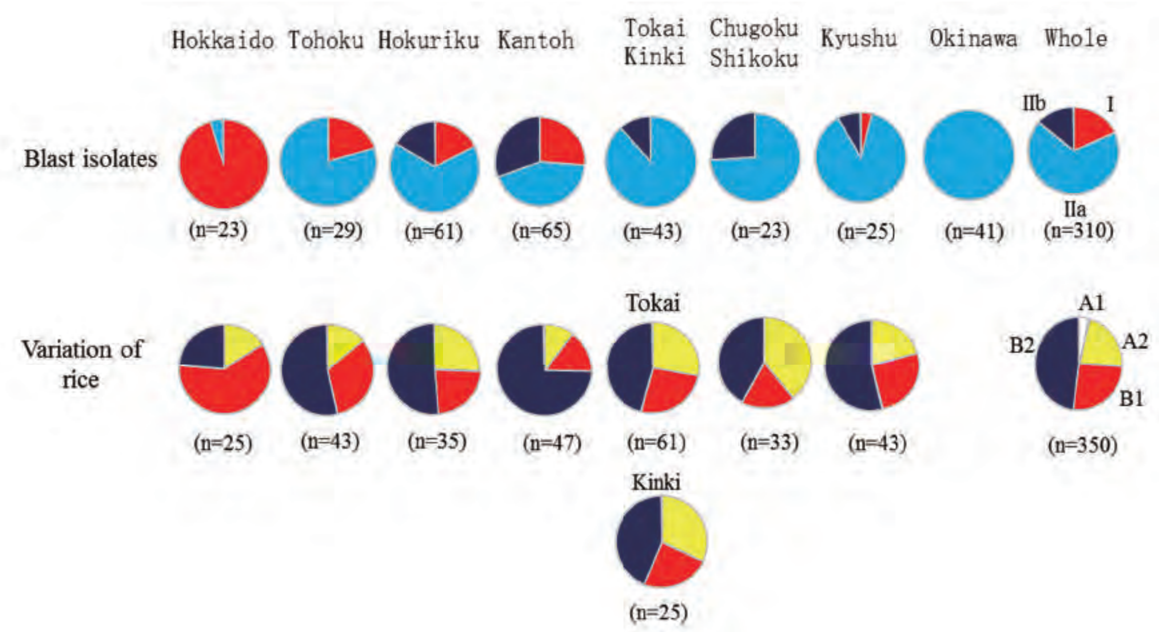


Fig. 1. Genetic variation of blast races and resistance in rice cultivars in each region of Japan.
Virulent blast isolates for resistance genes of *Pik* alleles, which were classified into cluster group I (red color), were dominant in Hokkaido and Tohoku regions. These *Pik* alleles' genes were included mainly in the rice cultivar's group blast isolates (BI), and higher frequencies were shown in Hokkaido and Tohoku compared with the other regions.
These data on blast races and rice accessions were modified from Kawasaki-Tanaka et al. (2016, Plant Disease 100: 816-823) and Kawasaki-Tanaka and Fukuta (2014, Breeding Science 64: 183–192), respectively.

and *Pii*, *Pi3* and *Pi5*(t), and the distributions were limited to Hokuriku, Tokai, Chugoku/ Shikoku and Kyushu.

A total of 350 rice accessions were classified into four cluster groups, A1, A2, B1 and B2, based on the resistance reactions to blast isolates from Japan and the Philippines. A1 was the most susceptible among the four groups, and included differential varieties and LTH only. The most resistant group was B2 followed by B1 and A2. Many accessions of group B1 were expected to harbor the *Pik* alleles' genes in the genetic backgrounds, and these were cultivated with higher frequencies in Hokkaido and Tohoku than in other regions. The highest resistance group B2 was found with high frequency in Kanto region.

Blast races and resistance of rice accessions varied in each region of Japan, and the differentiations of blast races corresponded with the variations of rice varieties in each region. In particular, the relationships between virulent blast races for *Pik* alleles' genes and rice accessions with *Pik* alleles' genes were found in Hokkaido and Tohoku regions. These results indicated that blast races were differentiated on the basis of resistance genes in rice varieties.

(Y. Fukuta, S. Yanagihara, N. Hayashi [National Institute of Agrobiological Sciences], A. Kawasaki-Tanaka [Tottori University])

Improving the drought tolerance of a Brazilian soybean variety using *Agrobacterium*-mediated transformation

Brazil is the second-largest soybean producing country in the world. However, severe droughts have affected production in Brazil, thus the development of drought-tolerant soybean is required. For soybean, it has been difficult to produce transformants because the transformation efficiency is very low. Although transformation of Brazilian soybean varieties BR-16 using bio-ballistic had been reported, there is no report of *Agrobacterium*-mediated transformation of the Brazilian varieties. As the plants transformed by *Agrobacterium* generally have low copy numbers of transgenes, the establishment of an *Agrobacterium*-mediated transformation method will make it easier to obtain transformants stably expressing a gene of interest and allow the rapid fixation of inserted gene in transgenic plants.

We succeeded in improving the transformation efficiency of Brazilian soybean cultivars and were able to establish the transformation method using *Agrobacterium* (Fig. 1a-b). The transformation

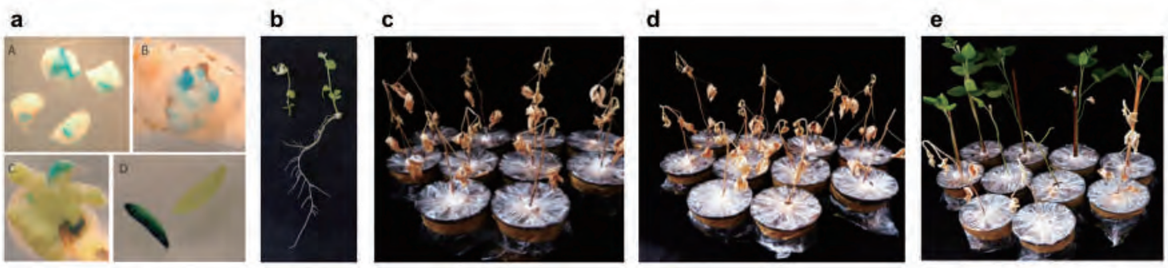


Fig. 1. Establishment of the transformation method applied to Brazilian soybean variety BR16 using *Agrobacterium*, and drought tolerance of a transgenic soybean expressing *AREB1* gene in the greenhouse.

a) GUS activity in the tissues of soybean after being infected by *Agrobacterium* carrying a binary vector with BAR and GUS genes. **A:** transient *gus* gene expression around the embryonic tip region after 5 days of co-cultivation; **B:** stable expression in meristems of embryonic tip cultured on shoot elongation medium for 1 week; **C:** stable expression in regenerated adventitious shoot cultured on shoot elongation medium for 2 weeks; **D:** leaflets with (left) GUS activity from a transgenic plant or without (right) from a non-transgenic plant. The figures were from Kanamori et al. (2011).

b) Root elongation of transgenic soybean plant. A differentiated shoot (left) developed roots (right) on a rooting medium. The figure was from Kanamori et al. (2011).

c-e) Survival rates of soybean plants of the genotypes 1Ea15 and 1Ea2939 transformed with 35S:AtAREB1 and non-transgenic BR 16 after 17 days of withholding irrigation followed by 7 days of rewatering. **c:** BR 16; **d:** 1Ea15; **e:** 1Ea2939. Figures **c**, **d**, and **e** were adapted from Marinho JP et al. (2015).

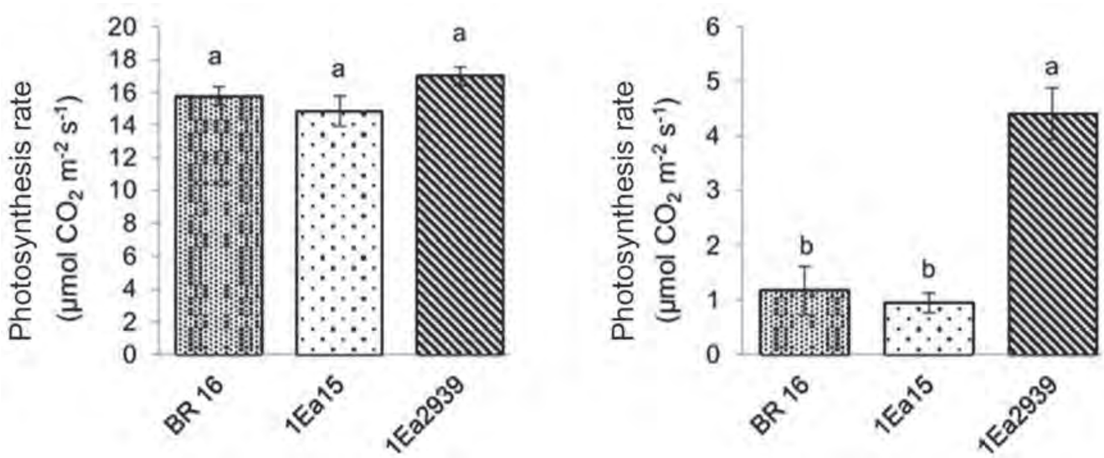


Fig. 2. Photosynthetic rate of soybean transgenic lines 1Ea15 and 1Ea2939 transformed with 35S:AtAREB1 and non-transgenic BR 16, grown under well-watered conditions (left) and under water deficit (right). Values represent mean± standard error; n=9 replicates. In each water condition, means followed by the same lowercase letters do not differ by the Tukey test ($p \leq 0.05$). The figures were adapted from Marinho JP et al. (2015).

efficiency was 1.74% when we used the reporter *GUS* (β-*glucuronidase)* gene for the transformation. This efficiency can enable us to produce the transgenic soybean varieties at a practical level. We confirmed that the copy numbers of the transgene are low. Stress-inducible AREB (ABRE (ABA- responsive element)-binding factor) transcription factors play important roles in regulating stress responses and tolerances. We obtained transgenic events having *AREB1* stress-tolerance gene using *Agrobacterium* methods. The transgenic events showed drought tolerance in the greenhouse (Fig. 1c-e, Fig. 2).

We are conducting an evaluation of transgenic soybean lines in the field. We expect to produce transgenic soybean varieties with high yield under drought conditions in the future. In addition, we expect to produce transgenic soybean varieties with various kinds of useful genes using the *Agrobacterium*-mediated transformation methods.

1) Kanamori N, et al. (2011) JIRCAS Working Report 71:75-79.
2) Marinho JP*, Kanamori N*, et al. (2015) Plant Mol. Biol. Rep. (Marinho JP and Kanamori N contributed equally to this work)

(N. Kanamori, Y. Fujita, K. Nakashima, K. Yamaguchi-Shinozaki [The University of Tokyo], J. Marinho [Embrapa Soybean], A. Nepomuceno [Embrapa Soybean])

TOPIC 5

Discovery of genes related to leaf senescence during long-term dry stress

Extreme weather events frequently occur around the world, causing crop damage. The damage caused by droughts is extensive and has become a serious global problem. Leaf senescence occurs as the late stage of leaf development and in response to environmental stress. Ethylene is a major plant hormone inducing leaf senescence. Recent studies have shown that abscisic acid (ABA) also induces leaf senescence. The elucidation of the mechanism of leaf senescence during long-term dry stress is important to enable stable food production under drought via development of crops. However,

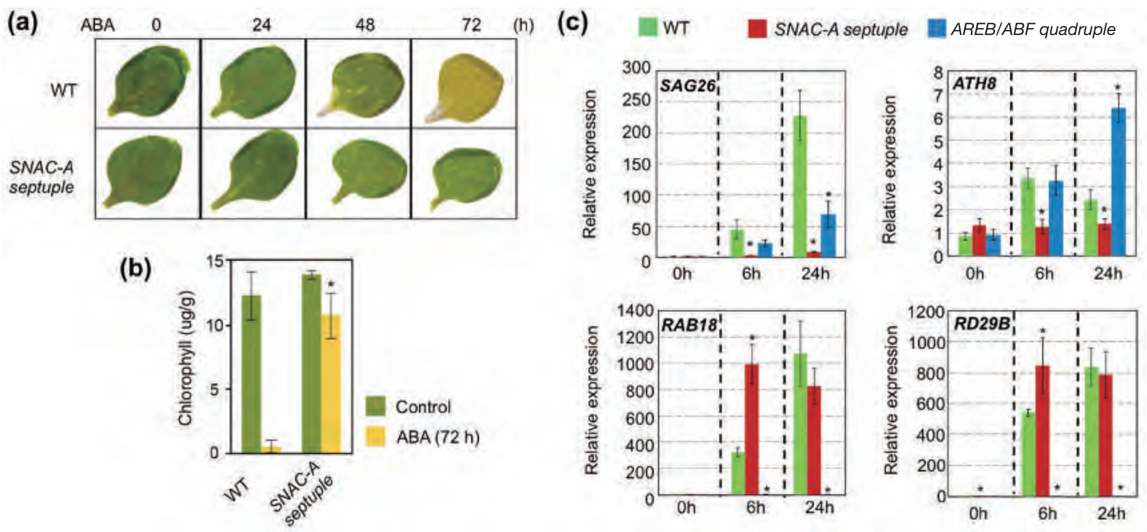


Fig. 1. Chlorophyll degradation and gene expression in ABA-treated wild-type and ABA-treated mutant leaves.
(a) Reduced sensitivity to ABA in chlorophyll degradation in ABA-treated wild-type (WT) and mutant (SNAC-A *septuple*) leaves. Each number indicates the time after 100 μM ABA treatment.
(b) The change in chlorophyll content in ABA-induced senescence. First rosette leaves of wild-type and mutant plants were grown on GM agar plates with or without treatment with 100 μM ABA for 72 h. Student's t-test: *$P < 0.05$. Each value represents mean±SD (n = 4).
(c) ABA-responsive gene expression in the SNAC-A septuple and AREB/ ABF quadruple mutants. Expression profiles of downstream genes of AREB/ABF and SNAC-A transcription factors. Two-week-old seedlings grown on GM agar plates were transferred to GM agar plated with 100 μM ABA for 6 and 24 h. Total RNA was isolated from seedlings.
The figures were adapted from Takasaki *et al*. (2015).

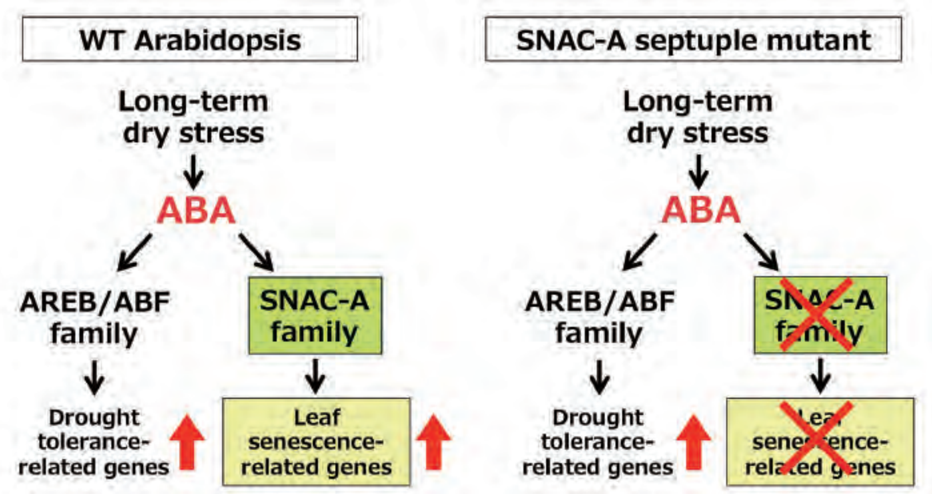


Fig. 2. Molecular mechanism of leaf senescence during long-term dry stress.
SNAC-As induce ABA-inducible genes related to senescence during stress, and SNAC-As induce a different set of ABA-inducible genes from those mediated by AREB/ABFs.

the detailed mechanisms of ABA-induced leaf senescence remain unclear. We focused on the A subfamily of stress-responsive NAC (SNAC-A) transcription factors, the expression of which is induced by abiotic stresses, particularly ABA.

Gene expression analysis revealed that seven SNAC-A genes (ANAC055, ANAC019, ANAC072/RD26, ANAC002/ATAF1, ANAC081/ATAF2, ANAC102 and ANAC032) were induced by long-term treatment with ABA and/or during age-dependent senescence. The SNAC-A septuple mutant clearly showed retardation of ABA-inducible leaf senescence (Fig. 1a-b). Microarray analysis indicated that SNAC-As induce ABA- and senescence-inducible genes. In addition, comparison of the expression profiles of the downstream genes of SNAC-As and ABA-responsive element (ABRE)-binding protein (AREB)/ABRE-binding factor (ABF) (AREB/ABFs) indicates that SNAC-As induce a different set of ABA-inducible genes from those mediated by AREB/ABFs (Fig. 1c). These results suggest that SNAC-As play crucial roles in ABA-induced leaf senescence signaling (Fig. 2).

Our results indicate that the SNAC-A subfamily genes are mainly involved in ABA-induced leaf senescence. Controlling gene expression will enable researchers to regulate leaf senescence during stress responses, and thus contribute toward improving the yield of stress-tolerant crops.

1) Nakashima K et al. (2012) Biochimica et Biophysica Acta 1819: 97–103
2) Takasaki H et al. (2015) Plant J. 84: 1114-1123

(K. Nakashima, K. Maruyama, H. Takasaki [RIKEN, The University of Tokyo], T. Yoshida, K. Yamaguchi-Shinozaki [The University of Tokyo], F. Takahashi, M. Fujita, F. Myouga, K. Toyooka, K. Shinozaki [RIKEN]

TOPIC 6

Map-based cloning of a salt tolerance gene *Ncl* and its utilization for improvement of salt tolerance in soybean

Soybean [*Glycine max* (L.) Merr.] is the world's primary crop source for protein and oil. Its cultivation is conducted in a wide range of environments and is exposed to many biotic and abiotic stresses that influence the sustainability of soybean production. Salt stress inhibits soybean growth and reduces grain yield. Genetic improvement of salt tolerance is essential for sustainable soybean production in saline areas. In this study, we isolated a quantitative trait locus (QTL) for salt tolerance using the map-based cloning strategy from a Brazilian soybean cultivar FT-Abyara to facilitate its use in soybean breeding.

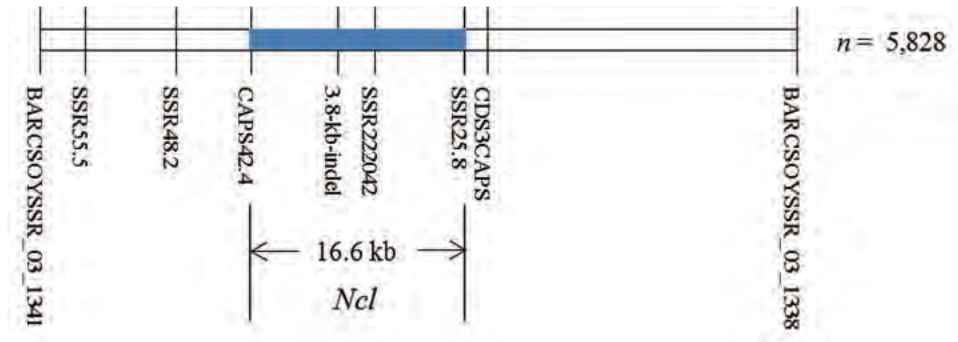


Fig. 1. Fine mapping (n = 5,828) delimits *Ncl* to a 16.6-kb region between markers SSR25.8 and CAPS42.4 on chromosome 3.

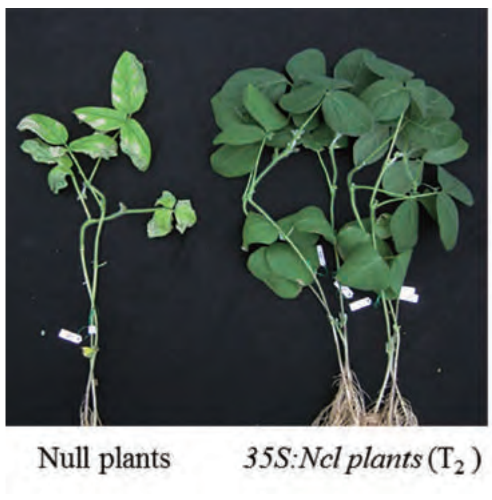


Fig. 2. Overexpression of *Ncl* in transgenic soybean lines enhanced its salt tolerance.

Fig. 3. Introgression of *Ncl* into a salt-sensitive variety "Jackson" by marker-assisted selection (MAS) produced an improved salt tolerance line.

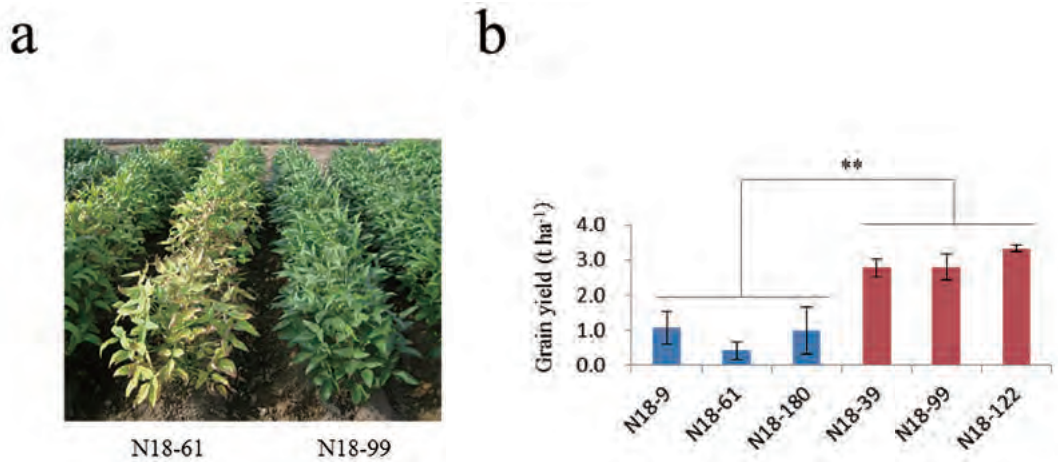


Fig. 4. Field performances of *Ncl* near isogenic lines (NILs) in a saline field condition in Miyagi Prefecture, Japan. (a) Top view of N18-61 and N18-99 grown in a salt stress field in 2012. (b) Grain yield results of the NILs in a salt stress field in 2012. N18-39, N18-99, and N18-122 are lines carrying the tolerant allele of *Ncl*, whereas N18-9, N18-61, N18-180 are lines that had the sensitive allele. Data are shown as mean ± s.d. from three replicates. **: Significant difference (P < 0.01) based on ANOVA (Tukey's multiple comparison test).

To identify the gene that conditioned the salt tolerance QTL, we conducted fine mapping using 5,828 plants derived from F9 residual heterozygous plants, and delimited the QTL to a 16.6-kb interval between markers SSR25.8 and CAPS42.4. Since only one predicted gene, *Glyma03g32900*, existed within the 16.6-kb region (Fig. 1), *Glyma03g32900* was thus determined as the causal gene underlying the salt tolerance QTL (*Ncl* locus). The salt-tolerant soybean lines showed higher expression of the salt tolerance gene *Ncl* in the root and resulted in lower accumulations of Na+, K+, and Cl− in the shoot under salt stress. We transformed *Ncl* full-length cDNA driven with 35S promoter (*35S:Ncl*) into a Japanese soybean cultivar Kariyutaka using the *Agrobacterium*-mediated transformation method, and significantly enhanced its salt tolerance (Fig. 2). To determine the usefulness of *Ncl* in conventional soybean breeding, we conducted introgression of *Ncl* into a salt-sensitive variety Jackson through continuous backcross, followed by DNA marker-assisted selection (MAS) using primers Satt339, SSR222042, and SSR112166 in each generation, and finally produced an improved salt tolerance line (Fig. 3). This result demonstrated that the DNA markers around *Ncl* could be used for introgression of *Ncl* into a salt-sensitive cultivar for developing a soybean variety with high salt tolerance. To determine the effect of *Ncl* in salt stress field conditions, we evaluated the *Ncl* near isogenic lines (NILs) in a salt stress field condition. The field experiments, which were conducted over three years, showed that *Ncl* could increase soybean grain yield by 3.6–5.5 times in saline field conditions (Fig. 4).

Our study suggests that using *Ncl* in soybean breeding through transgenic or MAS would contribute to sustainable soybean production in saline-prone areas.

(D. T. Do, H. Chen, H. T. T. Vu, A. Hamwieh, T. Yamada [Hokkaido University], T. Sato [Tohoku University], Y. Yan [Xinjiang Academy of Agricultural Sciences, China], H. Cong [Xinjiang Academy of Agricultural Sciences, China], M. Shono, K. Suenaga, D. Xu)

TOPIC 7

Development of SSR markers for diversity studies on yam (*Dioscorea*) genetic resources

Yam (*Dioscorea* spp.) is a tuber crop widely cultivated in Africa, Asia, and South America. This traditional staple crop is very important for regional food security and income generation especially in West Africa (Fig. 1). However, yam breeding is constrained by the crop's inherent attributes, including a long growth cycle, being inconsistent or non-flowering, polyploidy, and high heterozygosity. The use of advanced genetic tools and genomic resources in this crop has remained slow and difficult mainly because very little is known about yam genetics. Moreover, the available yam genetic resources are poorly characterized, limiting the utility of the existing

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

Table 1. SSR markers (among the six *Dioscorea* species) considered effective for phylogenetic studies

Marker	*D. cayenensis*	*D. rotundata*	*D. alata*	*D. dumetorum*	*D. esculenta*	*D. bulbifera*
YM002	++	++	++	−	−	+
YM003	++	++	++	−	−	−
YM005	++	++	++	−	−	−
YM006	++	++	−	−	−	−
YM009	++	++	++	−	−	−
YM010	++	++	++	−	−	−
YM011	++	++	−	−	+	−
YM012	++	++	++	−	−	−
YM013*	++	++	++	++	+	++
YM021	++	++	++	−	−	+
YM023	++	++	++	−	−	−
YM024	++	++	++	++	−	−
YM032	++	++	++	−	−	+
YM033	++	++	++	−	−	−
YM036	++	++	++	−	−	−
YM037	++	++	++	−	−	−
YM044	++	++	++	−	−	−
YM045	++	++	++	−	+	−
YM053*	++	++	++	+	+	+
YM055*	++	++	++	++	+	−
YM065	++	++	++	+	−	−
YM066*	++	++	++	++	−	+
YM071	++	++	++	++	−	−
YM074*	++	++	++	+	+	+
YM075	++	++	++	−	−	−
YM078	++	++	++	−	+	−
YM080*	++	++	++	++	+	++
YM084	++	++	−	−	−	−
YM087	++	++	++	−	−	−
YM089	++	++	++	−	−	−

++: amplified (polymorphic), +: amplified (monomorphic), -: no amplification
Symbols highlighted in yellow: showed species-specific polymorphisms
*: Markers showed amplification in > 5 species

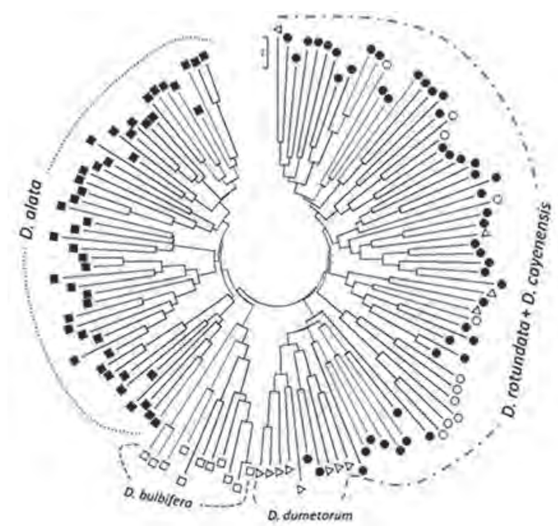


Fig. 2. Dendrogram of yam genetic resources generated based on the genetic distances of six cross-amplified SSR markers.
■: *D. alata*, □: *D. bulbifera*, ●: *D. rotundata*, ○:*D. cayenensis*, △: *D. dumetorum*

diversity in yam improvement programs. In this study, effective Simple Sequence Repeat markers (SSRs) were developed to demonstrate their effectiveness in estimating genetic diversity and in understanding the phylogenetic relationships of the genetic resources. The results of the study will serve as guide for implementing their use in yam breeding for the region.

A total of 90 SSRs were developed from an enriched genomic library of yellow Guinea yam (*D. cayenensis*). The number of SSRs developed in this study exceeds the total number of SSRs developed in the previous studies (67 SSRs in the seven reports). Cross-amplification revealed that 85 (94.4%) and 51 (56.7%) of these SSRs could be successfully transferred to the other two major cultivated species of *D. rotundata* and *D. alata*, respectively. A total of 30 markers were selected based on stable amplification in six important species, i.e., *D. cayanensis*, *D. rotundata*, *D. alata*, *D. dumetorum*, *D. esculenta* and *D. bulbifera*, for the analysis of phylogenetic relationships among *Dioscorea* species (Table 1). Among these 30, the six marked with * were considered to be useful marker sets for phylogenetic studies for their polymorphisms and high level of transferability over five species. Clustering based on these six SSRs among *D. cayenensis*, *D. rotundata*, *D. alata*, *D. dumetorum* and *D. bulbifera* detected groups consistently and reflected their taxonomic relationships as demonstrated by previous studies, e.g., *D. alata* and *D. bulbifera* were clearly separated, and *D. rotundata* and *D. cayenensis* were closely related to each other (Fig. 2).

These developed SSR markers can be used as handy markers not only for genetic diversity analysis but also for cultivar identification, gene/QTL mapping, and authentication of progenies obtained from genetic crosses particularly for the modestly equipped national agricultural research systems located in major yam-growing regions.

(S. Yamanaka, H. Takagi, M. Tamiru [Iwate Biotechnology Research Center], R. Terauchi [Iwate Biotechnology Research Center])

TOPIC 8

Evaluation of genetic diversity in quality-related traits of cowpea genetic resources for the development of an open access database

Cowpea [*Vigna unguiculata* (L.) Walp.], a traditionally important grain crop in Sub-Saharan Africa, is an affordable source of protein and minerals as well as cash income, especially for small-scale farmers who have limited options for food and cash crops. It also retains tremendous potential for improving nutritional balance and livelihoods in the region. Africa has been experiencing rapid economic growth in recent years; thus, in addition to improving “quantity” in the production, more attention would be placed on “quality” to boost utilization and consumption, and to further promote the crop through “value addition”. In this study, we sought possible strategies for value-addition using the rich genetic resources available, and we evaluated the genetic diversity especially in various grain quality-related traits and the relationships among these traits in cowpea.

Wide genetic variation and strong correlations among crude protein and Fe and Zn contents suggest the possibility of improving the concentrations of these nutritional factors simultaneously in 240 accessions evaluated (Table 1). Also, low associations among physical and nutritional properties of grain indicate the possibility of introgressing favorable traits utilizing identified genetic resources.

From these 240 accessions, a set of 20 accessions retaining the diversity in physical and basic nutritional properties were selected and further analyzed to create a detailed profile of the grain’s physical, nutritional/anti-nutritional, and functional properties (Table 2). Based on the observed narrow variation in amino acid (AA) composition, a reliable nitrogen-to-protein conversion factor of 5.45 was proposed for the estimation of crude protein content. We identified several improved breeding lines, such as IT93K-452-1, IT90K-277-2, and IT98K-205-8, with low concentrations of flatulence-causing oligosaccharides together with various favorable agronomic traits and nutrient contents. Also, TVu-12802 and TVu-467 were nominated as potential parental lines due to their high amounts of micronutrients and low phytic acid/Fe and phytic acid/Zn molar ratios.

The obtained results were organized into an

Table 1. Phenotypic (upper diagonal) and genotypic (lower diagonal) correlations among major agronomic traits and physical and nutritional properties

	Dflow[a]	Dharv[b]	Byield[c]	Gyield[d]	CP[e]	Fe	Zn	Mn	Cu	Gweight[f]
Dflow		0.45 *	0.30 *	0.02	0.05	0.02	−0.01	0.08 *	−0.14 *	0.08
Dharv	0.44 *		0.10 *	0.09 *	−0.10 *	−0.13 *	−0.10 *	0.15 *	0.12 *	0.44 *
Byield	0.57 *	0.19 *		0.49 *	0.22 *	0.17 *	−0.01	−0.09 *	−0.15 *	0.04
Gyield	0.10	0.32 *	0.57 *		0.07	0.03	−0.23 *	−0.05	−0.01	0.17 *
CP	0.10	−0.15	0.25 *	−0.11		0.47 *	0.36 *	−0.02	0.07	−0.19 *
Fe	0.05	−0.22 *	0.16	−0.23 *	0.70 *		0.33 *	−0.03	0.04	−0.24 *
Zn	0.00	−0.25 *	−0.07	−0.38 *	0.70 *	0.68 *		0.05	0.13 *	−0.14 *
Mn	0.24 *	0.42 *	0.32 *	0.53 *	0.13	0.04	0.18		0.19 *	0.15
Cu	−0.30 *	0.17 *	−0.27 *	0.02	0.11	0.06	0.16	0.22		0.00
Gweight	0.13	0.53 *	0.06	0.35 *	−0.28 *	−0.39 *	−0.25 *	0.07	0.00	

* indicates $P<0.05$
[a] Dflow=Days to 50% flowering; [b] Dharv=Days to harvest; [c] Byield=Biomass yield;
[d] Gyield=Grain yield; [e] CP=Crude protein; [f] Gweight=100-grain weight

Table 2. Profile of the grain's physical, nutritional/ anti-nutritional and functional properties

Traits	Average	Highest	Lowest	S.D.
Grain size[a)]				
100 seed wt (g)	11.7	18.7	4.0	2.9
Width (mm)	5.3	6.8	3.7	0.6
Length(mm)	7.2	9.7	4.8	0.9
Protein (%)[a,b)]	20.4	24.1	17.0	1.3
Micronutrient (mg/kg)[a)]				
Fe	53.1	66.3	41.4	5.0
Zn	39.6	47.3	32.1	2.9
Mn	25.3	39.4	14.7	3.8
Cu	4.8	7.3	3.4	0.7
Dietary fibre (g/100g)[c)]				
Insolble	15.7	20.6	9.0	2.7
Solble	1.2	3.4	N.D.	0.9
Oligosaccharide (mg/g)[c)]				
Stachyose	31.5	43.8	24.1	3.9
Sucrose	15.4	39.3	9.2	7.8
Raffinose	3.4	4.5	1.7	0.7
Phytic acid (mg/g)[c)]	28.3	37.0	21.8	4.6
Polyphenol (mg/g)[c)]	4.4	48.8	0.1	10.7
DPPH IC_{50} (mg/g)[c)]	416.7	1403.9	28.8	376.8
Cooking time (min)[c,d)]	97.0	160.0	60.0	23.9

[a)] Data obtained in 240 genotypes
[b)] Calculated with N-P conversion factor of 5.45
[c)] Data obtained in selected 20 genotypes
[d)] Time to reach adequate hardness (2 - 4 N) as boiled bean

Fig. 1. Various cowpea grains

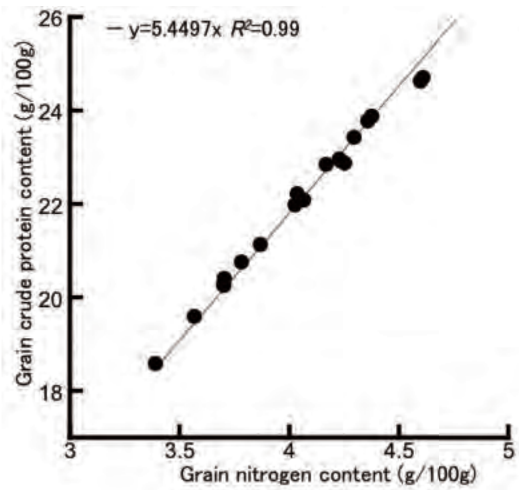


Fig. 2. Relationship between grain nitrogen and grain crude protein contents

open access "EDITS-Cowpea" database (http://www.jircas.go.jp/database/edits-cowpea) that enables all cowpea breeders and researchers to identify the potential germplasm resources to use to facilitate their work.

These findings suggest potential and possible uses of identified genetic resources with key quality-related traits which may stimulate breeding activities towards promotion and value-addition of the crop. Also, the developed open access database will enhance the utilization of cowpea's wide genetic diversity. These outputs are expected to link the primal elements needed for grain quality improvement, and facilitate the development and deployment of cowpea varieties with improved nutrition and quality that meet the needs of farmers and consumers. This, in turn, should enhance cowpea consumption and production in the region.

(S. Muranaka, M. Shono, H. Takagi, T. Myoda [Tokyo University of Agriculture])

TOPIC 9

JEC1, a new variety of *Erianthus* with higher mechanical harvesting efficiency

The enhancement of production and utilization of bioenergy crops as energy sources would play an important role in reducing CO_2 emissions, improving local energy production, and stimulating local economy. *Erianthus* (*E. arundinaceus*), a wild relative of sugarcane, is a perennial tall herb of Gramineae with C_4 photosynthesis. Because of its high biomass productivity, it is considered a good candidate as feedstock for bioenergy production in Japan especially in sub-tropical areas. To realize practical utilization of *Erianthus*, the development of new varieties that will enable low cost production is indispensable. Thus, in 2014, the Japan International Research Center for Agricultural Sciences (JIRCAS) and the National Agriculture and Food Research Organization (NARO) registered JES1 (Japanese *Erianthus* Seed 1) as its first *Erianthus* variety. JES1 is a variety that can be propagated by botanical seeds. Although it improves the propagation efficiency of *Erianthus*, the stools are relatively less uniform in their growth, which leads to lower mechanical harvesting efficiency. Since mechanical harvesting cost is a major portion of total costs in biomass production, we developed this new variety, JEC1 (Japanese *Erianthus* Clone 1). JEC1 can

Table 1. Major characteristics of JEC1 (Kumamoto Pref., NARO)

Characteristics[1]	JEC1[2]	JES1[3]	KO2-erect[3]	note
Plant type	5.1	3.0	5.5	(1 : erect - 9 : prostrate)
Leaf sheath hairiness	5.3	3.9	5.9	(1 : absent - 9 : very many)
Early growth (2nd year)	7.3	6.3	6.4	(1 : poor - 9 : very robust)
Plant length (cm)	418 a	396 a	371 b	2nd year (2013)
Culm diameter (mm)	14.8 a	14.2 a	14.3 a	2nd year (2013)
Stalk no. (no./a)	4751 a	4777 a	4959 a	2nd year (2013)
Dry matter yield (t/10a)	3.16 a	3.22 a	2.71 a	2nd year (2013)
Dry matter content (%)	42.6 a	39.1 a	50.4 b	2nd year (2013)
Ash content (%)	7.7 a	7.3 a	6.2 b	1st year (2012)
First heading date	10/8 a	10/18 b	9/30 c	2nd year (2013)
Germination rate[4] (%)	9.4	0.1	11.9	2nd year (2013)

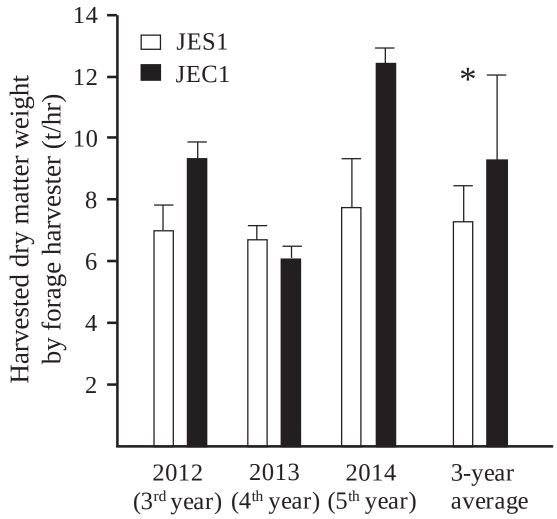
1) Different alphabets indicate significance at 5% level by Tukey's HSD.
2) Materials under test were propagated by tissue culture.
3) Check variety and clone
4) Calculated from the number of germinated florets over the total number of florets (Total floret number of JEC1, JES1 and KO2-erect was 1451, 1352 and 1264, respectively.)

Fig. 1. JEC1 vs JES1

Table 2. Coefficient of variance in stalk number and dry matter weight per stool

Year	Variety[1]	Stalk no.			Dry matter weight		
		no. /stool	CV		g /stool	CV	
1st year	JEC1	133	18		1630	27	
	JES1	86	38		1378	47	
2nd year	JEC1	89	46		5923	50	
	JES1	90	67		6031	80	
Two-way ANOVA[2]	*df*	*F*	*P*		*F*	*P*	
Variety (JEC1 vs JES1)	1	9.34	0.016	*	31.70	0.008	**
Year (1st vs 2nd)	1	16.46	0.004	**	27.98	0.006	**
Variety x Year	1	0.03	0.875	*ns*	5.50	0.499	*ns*
Error	8						

1) Results from 1st and 2nd year data of the performance test field planted on June 2012.
2) Data were collected from 5 stools in each replication (3 rep.).
3) Results of two-way ANOVA for calculating the coefficient of variance of each trait. * and ** indicate the significance at 0.01<P<0.05 and P<0.01, respectively. ns = not significant.



1) Harvested dry matter weight per hour by forage harvester ''CHAMPION 3000''
2) Data were collected from 3rd, 4th, and 5th year experimental fields planted in June 2010.
3) The drivers of the forage harvester were different in 2012 and 2013, 2014.
4) * indicate the significance at 5% level between varieties by two-way ANOVA (variety and year as factors of variation).

Fig. 2. Mechanical harvesting efficiency of JEC1

be propagated vegetatively and demonstrates improved mechanical harvesting efficiency over the previous variety, JES1.

JEC1 was selected from the open pollinated population of JW4, a Japanese *Erianthus* germplasm accession that exhibits late flowering and an erect growth habit. Vegetative propagation of JEC1 was done by stem cutting or rhizome division. Its heading was in early October, 10 days earlier than JES1, and the germination rate of florets was 9.4% in Kumamoto Prefecture (Table 1). The plant had a relatively prostrated growth habit compared with JES1 (Table 1, Fig. 1), and the dry matter yield in the 2nd year was 3.16t/10a, which was almost equivalent to JES1. The coefficient of variance of stalk number and the dry matter weight per stool in JEC1 were significantly lower than in JES1 (Table 2); as a result, a significantly higher machine harvesting efficiency of 9.3t/hr was achieved, compared with the efficiency of JES1 which was 7.3t/hr (Fig. 2). It should be noted that JEC1 produces fertile seeds in the southern part of Japan, therefore cultivation of this variety in Ogasawara and Nansei Islands is not recommended due to the risk of weed invasion. However, cultivation poses no problem for the northern part of Kyusyu mainland.

In Japan, the utilization of bioenergy crops is still under study phase. JEC1 is being considered for use as a pioneer material in technical development, empirical research, and pilot projects leading to the practical utilization of *Erianthus*.

(Y. Terajima, M. Gau [NARO], N. Uwatoko [NARO], A. Sugimoto)

TOPIC 10

New sugarcane varieties using wild sugarcane and collaboratively bred in Thailand

Along with an increasing world population, tight food and energy supplies have become a problem. In areas where agricultural productivity is low, urgent measures are required to increase crop productivity in the fields and to enhance food and energy production. Sugarcane was among those identified as important candidate crops because it can produce food and energy from its sugar and fiber. Therefore, we tried to develop new sugarcane varieties that provide high yields of both sugar and fiber in Northeast Thailand, where sugarcane productivity is low because of severe drought, infertile soil, and sugarcane white leaf disease. Sugar is a food component and can also be a source of bio-ethanol, whereas electricity can be generated from bagasse, a byproduct of sugarcane fiber.

Interspecific hybridization between commercial cultivars of sugarcane and *Saccharum spontaneum* (wild sugarcane) clones, which were collected from all over Thailand, was carried out and F_1 populations were obtained.

Table 1. History of new sugarcane varieties

Name of variety	Mother plant	Father plant
TPJ03-452	Uthong1	F_1 interspecific hybrid (K84-200 x *S. spontaneum*)
TPJ04-713	CP72-5028	F_1 interspecific hybrid (88-2-401 x *S. spontaneum*)
TPJ04-768	94-2-128	F_1 interspecific hybrid (88-2-401 x *S. spontaneum*)

Except for *S. spontaneum*, names of commercial cultivars or lines are indicated.

Table 2. Millable cane yield, sugar yield, and fiber yield of new sugarcane varieties per hectare

Name of variety	Millable cane yield (t/ha)				Sugar yield (t/ha)				Fiber yield (t/ha)			
	1st year	2nd year	3rd year		1st year	2nd year	3rd year		1st year	2nd year	3rd year	
TPJ03-452	105.1	76.0 (72)	58.7 (56)	a	10.7	10.4 (97)	4.6 (43)	a	19.7	12.1 (62)	9.4 (48)	a
Khonkaen3	91.4	64.9 (71)	36.5 (40)	a	13.2	9.7 (73)	4.4 (33)	a	10.8	7.8 (72)	3.4 (32)	b
K88-92	92.9	58.9 (63)	39.0 (42)	a	10.9	7.9 (73)	4.0 (37)	a	9.7	5.5 (56)	3.6 (37)	b
TPJ04-713	76.8	77.2 (101)		a	6.6	6.8 (103)		a	9.6	9.3 (97)		ab
TPJ04-768	77.1	79.5 (103)		a	8.9	10.1 (113)		a	13.3	11.9 (89)		a
Khonkaen3	84.0	61.9 (74)		a	12.2	8.6 (70)		a	8.8	7.0 (80)		b

Results at the Tha Phra branch of Khon Kaen Field Crops Research Center (KKFCRC) are shown in the upper table. Sugarcane was planted in March 2008 with two replications; the planting cane of the first year was harvested in February 2009, the first ratoon cane of the second year was harvested in January 2010, and the second ratoon cane of the third year was harvested in December 2010. Results at the KKFCRC were shown in the lower table. Sugarcane was planted in May 2013 with four replications; the planting cane of the first year was harvested in March 2014, and the first ratoon cane of the second year was harvested in March 2015. Sugar yield (Commercial cane sugar (CCS) yield) = millable cane yield x CCS (%) /100. CCS (%): % of calculated recoverable sugar from millable cane. Fiber yield = millable cane yield x fiber content (%) /100. Figure in parentheses indicates the relative yield of the second or the third year to the yield of the first year. The varieties with same letter in the column are not significantly different according to the Tukey's method at P = 0.05 in two-way analysis of variance among varieties and years.

Table 3. Characteristics of new sugarcane varieties

Name of variety	No. of millable cane (/ha)	Length of millable cane (cm)	Diameter of millable cane (cm)	Brix (%)	CCS (%)	Fiber (%)
TPJ03-452	66026 a	293 a	2.18 c	20.4 a	13.9 a	15.8 a
Khonkaen3	61058 a	172 a	2.62 b	23.2 a	14.4 a	12.2 ab
K88-92	49519 a	223 a	3.13 a	19.5 a	13.5 a	9.3 b
TPJ04-713	62179 a	269 b	2.63 a	17.5 b	9.0 b	12.1 b
TPJ04-768	51282 ab	342 a	2.22 b	22.4 a	12.7 a	15.0 a
Khonkaen3	42468 b	240 b	2.84 a	22.9 a	14.0 a	11.3 b

Results at the harvest of the first ratoon cane of the second year in the field experiments of Table 2 are shown in Table 3. Brix (%): weight % of soluble matter. CCS (%): % of calculated recoverable sugar from millable cane. The varieties with same letter in the column are not significantly different according to the Tukey's method at P = 0.05 in one-way analysis of variance.

Fig. 1. TPJ03-452 (left) and TPJ04-768 (right) planting canes. Photos taken in October 2013.

F_1 hybrids were crossed with commercial cultivars of sugarcane and BC_1 populations were obtained. From the BC_1 population, TPJ03-452, TPJ04-713, and TPJ04-768 were selected and registered as new varieties of sugarcane by the Department of Agriculture, Thailand on February 5, 2015 (Table 1). The sugar yields of TPJ03-452 and TPJ04-768 were at a comparable level with those of commercial cultivars, Khonkaen3 and K88-92, but the fiber yields were higher than those of Khonkaen3 and K88-92. Total fiber yield of TPJ03-452 in three years was about 1.9 times more than that of Khonkaen3 and total fiber yield of TPJ04-768 in two years was about 1.6 times more than that of Khonkaen3 (Table 2). Cane yield, sugar yield, and fiber yield of the first ratoon cane of Khonkaen3 decreased a lot from those of the planting cane but in the case of TPJ04-768, the decrease was less than those by Khonkaen3 (Table 2). TPJ03-452 and TPJ04-768 had thinner stalks and higher fiber content than Khonkaen3 and K88-92. TPJ04-768 had longer stalks than Khonkaen3 (Table 3 and Fig. 1).

Ratooning is a labor-saving and a low cost method of cultivating sugarcane. TPJ04-768 can produce sugar at a comparable level to commercial cultivars, and the decrease of cane yield from the planting cane to the ratoon cane is small. Multiple ratoon cultivation of this variety is expected in Northeast Thailand, which has a long and severe dry season. It will be supplied to farmers and sugar mills for field tests in order to become a recommended variety. A harvester will be needed because the stalks are thin and the leaves are difficult to remove. However, unlike commercial cultivars, these new varieties have high fiber content, thus new methods may need to be developed to produce sugar and ethanol.

(S. Ando, Y. Terajima, S. Tagane, M. Sato, K. Ishiki, M. Matsuoka, Y. Takagi, A. Sugimoto, W. Ponragdee [Khon Kaen Field Crops Research Center, Department of Agriculture Thailand (KKFCRC)], T. Sansayawichai [KKFCRC], A. Tippayawat [KKFCRC])

TOPIC 11

Movement ability of vector insects of sugarcane white leaf disease

Sugarcane White Leaf Disease (SCWLD) is a dominant limiting factor of sugar production in Thailand, the world's second largest sugar-exporting country. This disease is transmitted by the planting of infected seed-cane and the migration of two insect species, *Matsumuratettix hiroglyphicus* and *Yamatotettix flavovittatus* (Fig. 1). A good knowledge of the movement ability of vector insects is thus required to establish control techniques. However, it is difficult to estimate the insects' movement ability by visual observation because the vectors are tiny species and they hide at the lower part of the sugarcane stalk. Therefore, we carried out mark-recapture experiments at a sugarcane field to evaluate the movement ability of the vector insects.

We made sticky plastic traps based on the vector insects' color preferences. The traps were distributed in a stellate pattern, radiating from a common center to 50m outwards (Fig. 2). The marked vectors were released from the center, and we counted the number of trapped specimens every two days. We stopped the experiment after 20 days because no vector insects were trapped by the 20th day. The experiment was replicated three times for *M. hiroglyphicus* and the number of released specimens was 1980, 1200 and 800, respectively. In the case of *Y. flavovittatus,* the experiments were replicated two times and the number of released specimens was 2700 and 2100, respectively. On the first experiment, the specimens were trapped most frequently at the nearest trap (for both species) (Fig. 3, left). On the other hand, the percentage of trapped

Fig. 1. The vector insects of sugarcane white leaf disease.
Left: *Matsumuratettix hiroglyphicus* (body length: 4mm)
Right: *Yamatotettix flavovittatus* (body length: 5-6mm)

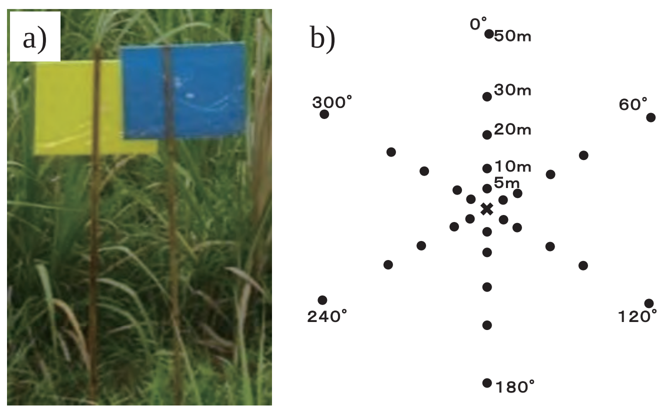


Fig. 2. Details of the sticky trap and the layout.
a) One set of sticky traps made from blue and yellow plastic plates (about 40 x 50cm).
b) The traps were distributed in a stellate pattern at 5, 10, 20, 30, and 50-m intervals from the center. The height was same as the plant height.

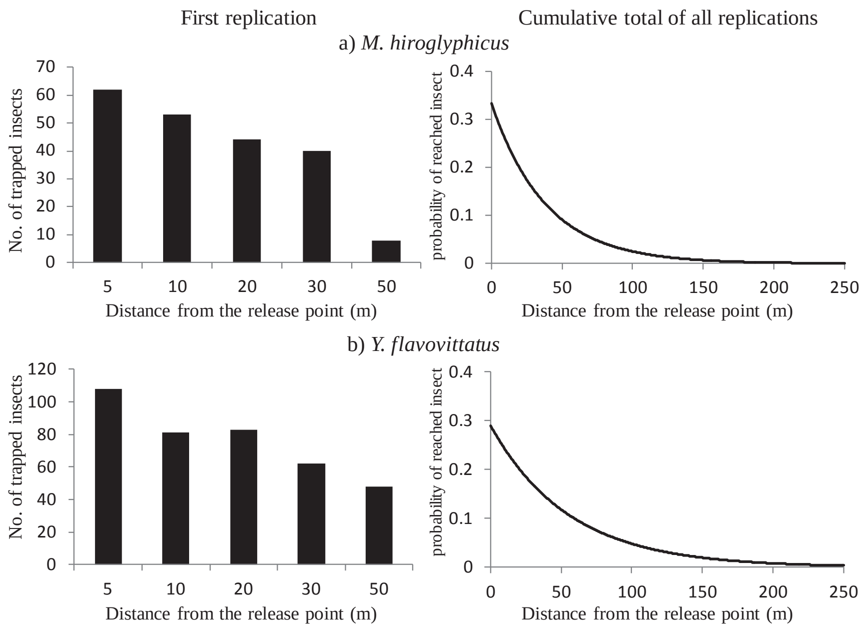


Fig. 3. Frequency-distance graphs of trapped vector insects from the release point (left) and the probability distribution of reached distance (right).
Left: Results from the first replication. 1,980 *M. hiroglyphicus* and 2,700 *Y. flavovittatus* specimens were released.
Right: The probability distributions were calculated using a cumulative total of 20 days. The underestimation was corrected. The data from all replications were pulled.

M. hiroglyphicus at the farthest trap from the release point was only 3.9%. The trapping percentages of the vectors calculated from the cumulative total of all replications were about 10% for *M. hiroglyphicus* and about 13% for *Y. flavovittatus*. These values were deemed sufficient for evaluation of movement abilities. The probability distribution of the reached distance by each species on the 20th day was calculated (Fig. 3, right). We corrected the underestimation caused by trapping and moving out of the trapping range using Yamamura's method (Yamamura, 2003). Based on the probability distance, the estimated average movement distance after 20 days was 162.1m for *M. hiroglyphicus* and 387.5m for *Y. flavovittatus*.

In SCWLD-infested areas, the risk of disease invasion to newly established healthy seed-cane production fields by the vector insects is high. Our results suggest that if we establish a large field and treat it with pesticides, the infection risk inside the field will be low because the movement ability of the vector insects is not high. It means that we probably can produce healthy seed-cane in a SCWLD-infested area. Our results will also be helpful in establishing control techniques when SCWLD occurs in Japan. It must be noted, though, that the specimens in our experiments were forced to move at least once because they were released from plastic boxes that did not have food. Thus, our estimated movement distance values were possibly overestimated compared with actual values using wild vector insects.

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

PROGRAM C
Rural Livelihood

"Technology development for income and livelihood improvement of the rural population in developing regions"

The Rural Livelihood Program supports the sustainable development of agriculture, forestry and fisheries, and the development of technologies that generate income and improve living conditions in developing regions. Research activities have been carried out mainly in Lao PDR, Thailand, Malaysia, Philippines, and China. The technologies that have been developed are being transferred to the farmers, industry workers, and local government officers.

[Sustainable and Independent Farm Household Economy in IndoChina Project]

In this project, various research activities related to socio-economy and biodiversity, as well as lowland and upland systems, were conducted at the study site in Laos. The direction of technology development was clarified on the basis of current trends in crop production at the target village, and the role of biodiversity in dietary habits was implied by the survey on the dependency of food resources in natural ecosystems.

In lowland areas, several technologies represented by a) an irrigation system with reservoir water for paddy rice and for non-rice crop production, b) the selection of a rice cultivar resilient to delayed transplanting, c) the use of bat guano to overcome soil constraints, and d) fish culture to improve rice yields, were developed to improve productivity and intensify lowland systems.

In upland areas, significant outputs were delivered from the viewpoint of appropriate land use and utilization of forests, e.g., a) appropriate crop arrangement based on environmental response, b) demonstration of fruit production, c) cropping systems with low labor competition, and d) clarification of diversity and economic value of NTFPs. Moreover, a new forage crop was introduced for livestock production.

In addition to the above researches, outreach activities such as village meetings, exhibition of research results at the District Agriculture and Forestry Office, and demo farm exhibition in the target village were actively conducted.

[Recycling-based Agricultural Production in China Project]

The possibility of adopting a water-saving irrigation technique while achieving increased crop yield has been shown from the results of minimum tillage wheat cultivation as a recycling-based production technology in an intensive cereal cropping zone in China. Furthermore, in order to support recycling-based agricultural production systems, we have clarified the factors that cause the low utilization of crop residue by conducting a survey of farmers' awareness and attitudes. The cultivation of a mini pumpkin that utilizes local resources has been legalized as the "Utility Model" and has had major implementations, including the establishment of a technical manual. This project has been highly evaluated by the Chinese Academy of Agricultural Sciences.

[Food Resource Utilization Project]

Under the framework of the Asian Food Resource Network (AFRN), a workshop titled "Advanced application of local food resources in China 2015" was held in Shaanxi, China, where discussions were made about the direction of future joint research. A research group composed of scientists from JIRCAS and China Agricultural University found that the treatment of legume seeds by slightly acidic electrolyzed water improves the productivity of sprouts. Furthermore, the database of traditional fermented foods in Thailand was updated based on new findings on fermentation bacteria obtained from a joint research between JIRCAS, Thailand, and Laos. The research team also found the mechanism that causes certain fermented rice noodles to have a characteristic elastic texture. In addition, a "preliminary study of fruit preferences in Thailand" had been done as a consignment research by the Ministry of Agriculture, Forestry and Fisheries.

[Asia Biomass Project]

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 waste water. To demonstrate energy production through our technologies, we carried out a feasibility study with Japanese companies in Malaysia and the Philippines.

These achievements are good examples of our technologies being utilized in many practical applications.

[Sustainable Forestry Production Project]

Technology development was implemented to achieve sustainable management and conservation of forest resources. In Malaysia, a comparison of seed production between selectively logged and natural forests showed that healthy seed production was maintained by the amount of dispersed pollen to mother trees, thus regulating the exclusion of selfed immature seeds. In Thailand, a soil suitability map for teak plantation had been developed for two provinces. The technical methodology was transferred to the Thai side and they applied this knowledge to expand the map coverage. This ongoing approach has led to the publication of soil suitability maps for 6 provinces, covering 40% of Northeastern Thailand's land area and contributing to the dissemination of teak plantations in Thailand.

[Tropical Coastal Aquaculture Project]

Development of environment-friendly aquaculture technologies was conducted in coastal waters of Southeast Asia. In Thailand, the effects of co-cultured seaweed and snails on the growth of giant tiger shrimp were evaluated. In the Philippines, the newly developed Integrated Multi-trophic Aquaculture (IMTA) system was demonstrated by collaborating with fishermen. In Malaysia, the decrease in cockle culture production was attributed to low mud supply, which diminished sediment stability in mudflats, and the deterioration of water quality in rivers.

Lastly, future applications of the seed production technology for whiteleg shrimp were explored. Molecular markers were established as indicators of gonadal maturation stage, and molecular biological techniques were successfully employed in controlling the levels of vitellogenesis-inhibiting hormone.

TOPIC 1

Late transplanting caused by water shortage leads to yield reduction in plot-to-plot fields in Central Laos

Irrigation systems in the semi-mountainous areas of Laos (officially the Lao People's Democratic Republic) are not well-developed. Most farmers do not have direct access to irrigation water, thus they depend mainly on plot-to-plot irrigation and rainwater. Fields in the upper parts of the system have priority, and there is low flexibility in water use especially in the lower parts, including the target area at N Village in the northwestern part of Vientiane Province. This study aims to clarify the location of low productivity fields, identify the constraints to crop yield, and propose measures to increase yield, in the hope of making a contribution to improve lowland rice productivity.

As noted during the 2013 crop season, transplanting of rainy season rice started at the beginning of July and was completed in mid-August. However, even as transplanting went on in the upper and middle parts of the lowland area in mid-July, the lower fields still had not received water and had not even began plowing. In such fields, transplanting started from the beginning of August (Fig. 1). After transplanting, there was no serious water shortage in the entire lowland field areas. Fields with yields greater than 4.0 t ha^{-1} were mainly located in the upper and middle parts; in contrast, fields with low yields (less than 2.0 t ha^{-1}) were located in the lower part of the area. A relational analysis of the yield at 137 plots showed that grain yield was significantly higher in fields that had early ponding (before 20 July) and early transplanting (in July) than in fields that had late ponding (after 21 July) and late transplanting (in August) (Table 1). There was no correlation between soil fertility and rice grain yield (total nitrogen: R^2=0.004, available phosphorus: R^2=0.08). Field experiments also indicated that grain yield in early transplanted field (in July) was higher than in late transplanted field (unpublished data). The results suggested that late transplanting caused by water shortage led to yield reduction in the lower fields of the plot-to-plot irrigated area. In order to increase grain yield in the lower fields, transplanting

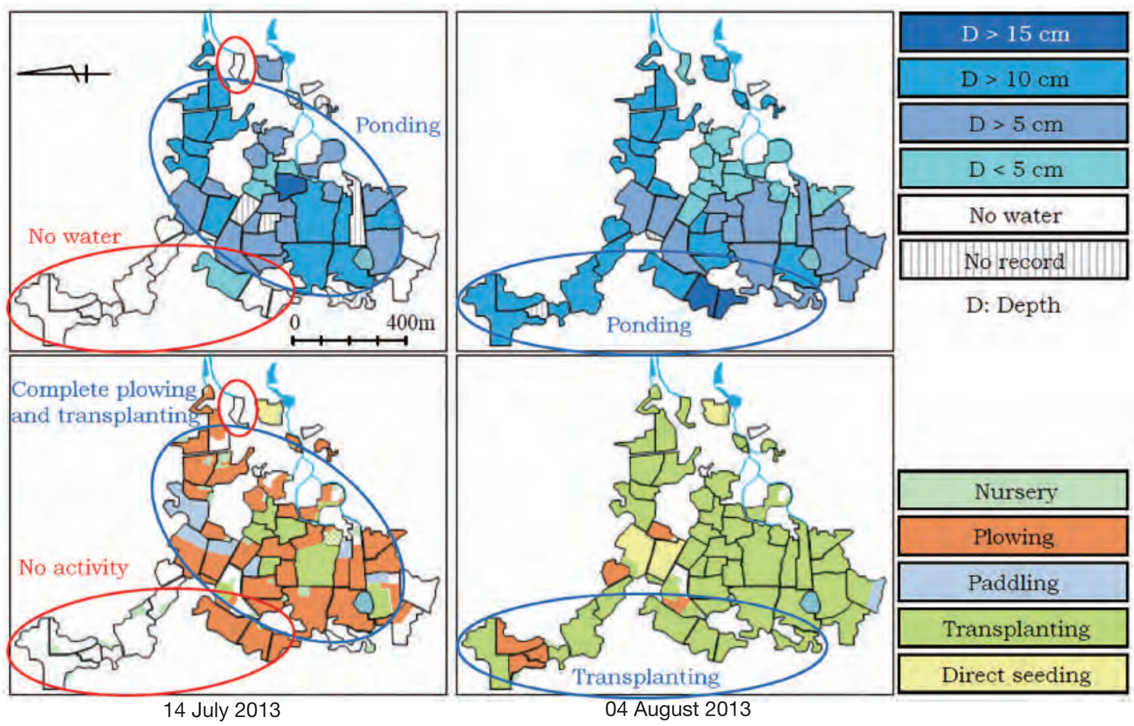


Fig. 1. Surface water depth (upper) and practiced farming activities (lower) in each field

Table 1. Relationship between grain yield and start times of ponding/ transplanting

Classification		N*	Avg. grain yield t ha^{-1}	Note
Start time of ponding	Before 20 Jul	108	3.87^{a}	Significant difference between a and b at $p < 0.05$ according to t test
	After 21 Aug	29	2.22^{b}	
Start time of transplanting	Before 14 Jul	28	4.20^{a}	Significant difference between a and b at $p < 0.05$ according Tukey-HSD test
	15 Jul – 28 Jul	64	3.68^{a}	
	29 Jul – 11 Aug	45	2.88^{b}	

* Sampling quadrats (1 m × 1 m) were installed in 47 field blocks as shown in Fig. 1. Three large field blocks were divided into two parts, and three quadrats were installed for each (in total 150 plots in 50 blocks). The relationship between yield and times of field ponding and transplanting were analyzed. The 13 samples (4 plots harvested by farmers before sampling and 9 plots in direct seeding field) were excluded from the analysis (n = 137).

should be completed by the middle of July, and early irrigation or increasing irrigation amount in the upper fields are necessary to accelerate water supply to the lower fields.

In order to share water resources to the lower fields, a consensus on water allocation among villagers is essential. The head of N village or a local government staff should play the role of coordinator. Farmers' working schedules should also be arranged to avoid labor conflicts caused by the change in transplanting time. In addition, water resource development and irrigation facility improvements are necessary to increase the capacity according to expanding water demand from mid-June to early July. Irrigation facilities are not developed in 73% of agricultural lands in the five countries of Indochina, which means that most fields are irrigated plot-to-plot. The results of this research, therefore, can contribute to such plot-to-plot fields.

(H. Ikeura, S. Phongchanmixay [Agricultural Research Center, National Agriculture and Forestry Research Institute, Laos], S. Phonsagon [Institute Technology Bandung], S. Inkhamseng [National University of Laos])

TOPIC 2

Techniques for collecting black soldier fly eggs year-round for use as a promising feed material for fish culture

In rural areas of Laos, fish culture development is strongly encouraged for stabilizing food self-sufficiency as well as animal protein supply. However, feed cost occupies a large portion of total cost in fish culture operations and needs to be reduced. The black soldier fly (BSF, *Hermetia illucens*) is distributed over Laos, and its larvae (Fig. 1) could be a promising feed material for fish culture because of its high protein content. By using the larvae, the feed cost for fish culture is expected to be largely reduced because they can be reared with food residues and livestock manure. Although people in Laos commonly consume a wide range of insects as food, BSF is not included, which means that it has exploitable potential. This study, therefore, aimed at the development of a year-round egg collection technique that can be applied by small-scale farmers. The following findings were obtained:

1. The larvae of BSF contain considerable nutrients (e.g., protein and fat) (Table 1) and are valuable as feed material for fish culture.
2. BSF adults are attracted to outdoor oviposition traps throughout the year; however, the oviposition incidence has large fluctuations, thus periods with scarce oviposition were observed during seasonal occurrence (Fig. 2).
3. Although some reports mentioned that around 1,000 newly-emerged BSF adults must be released in a large net cage (about 2 m on all sides) to obtain fertilized eggs of BSF, it was also observed that oviposition can occur in a smaller-scale system, with 100 adults in a small net cage (27 cm on all sides) as performed in the present study (Fig. 1).
4. Although previous reports mentioned that sunlight and/or a large incandescent lamp, in addition to the large cage, were necessary for oviposition of BSF, the oviposition was observed using other smaller illuminants, e.g., a 40W fluorescent light or a 20W LED light, like in the present study (Table 2). The

Table 1. Crude protein, crude fat, and ash contents (% dry weight) in black soldier fly (BSF) larvae and in general commercial feed for fish culture in Lao PDR

Constituent	Content (%)	
	BSF	Fish feed*
Crude protein	67.1	32.0
Crude fat	6.9	4.0
Ash	6.5	-
Others	19.5	74.0

*manufactured by Centago, Thailand

Fig. 1. A female BSF (upper left), larvae (upper right) and adult BSF in a rearing and egg collection cage made of polyethylene (lower photo)

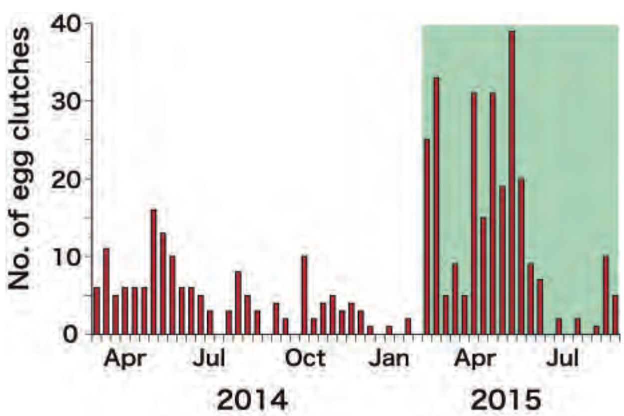


Fig. 2. The number of egg clutches collected at outdoor traps in Laos. (The part shaded in green showed a marked improvement.)

Table 2. Life-history parameters of adult *Hermetia illucens* under different light sources

Life-history parameter	Supplemental light source (mean ± SE)		
	LED lamp only	LED lamp + 2 h sunlight1)	
Pre-oviposition period (days)	4.6 ± 0.3	4.4 ± 0.3	
Oviposition period (days)	7.6 ± 0.8	9.4 ± 0.8	
No. of clutches/female	0.43 ± 0.04	0.39 ± 0.04	
No. of hatched clutches/female	0.05 ± 0.03	0.15 ± 0.03	*
Hatchability (%)2)	11.2±9.1	39.5±6.3	*
No. of eggs/female	289.0 ± 27.0	240.2 ± 31.6	
No. of hatched eggs/female	43.7 ± 35.8	84.4 ± 19.0	
Male longevity (days)	12.8 ± 0.2	14.1 ± 0.3	*
Female longevity (days)	12.3 ± 0.2	12.7 ± 0.2	

* Difference was significant between light sources (ANOVA, $p<0.05$)
1) Exposed to sunlight between 1000 and 1200 for the first 15 days after emergence as adults (14 out of 15 days had clear weather).
2) Number of hatched clutches/total number of clutches

pre-oviposition periods were 4–5 days, and the oviposition periods lasted approximately 7 days under artificial lights and about 9 days under sunlight/artificial light. The fertilization rates under the latter were relatively higher.

5. Stable production of BSF larvae that is low-cost and space-saving became more feasible with application of the above-mentioned system.

In addition to the above findings, the following observations were noted:

1. Fruit rinds (e.g., water melon) are efficient as attractants, resulting to an influx of incoming BSF adults to the oviposition traps.
2. It is necessary to clarify the number of ovoposition events / mating frequency of BSF adults during its lifetime to improve the collection of fertilized eggs.
3. The mechanism of enhancing egg fertilization under the sunlight should be studied.
4. This system is applicable not only in Laos but also in other areas / countries.

(S. Nakamura, S. Morioka)

TOPIC 3

Specific tree species preferred for use as firewood in Central Laos

The villagers of Laos harvest non-timber forest products (NTFPs) from forests for daily use. One of the many NTFPs obtained from forests is firewood, their main fuel source. Based on a survey in N village, each farming household consumes approximately 1.94 tons per year or a total of 272 tons per year for the village's 140 households. This is equivalent to 16 hectares of forest area. Villagers prefer two species in particular, and this has had a major influence in decreasing the number of forest trees in central Laos.

Firewood harvesting areas at the target villages in Vientiane Capital were also surveyed. The areas are about 30-60 minutes by foot from the village center and the villagers largely focus on hilly areas where timber harvesting is permitted. A single harvest requires about three to four hours. Besides leftovers from slash-and-burn operations, firewood also comes from living trees that have been cut down (Fig. 1).

Firewood is used mostly as cooking fuel and for adjusting feed for livestock (pigs, chickens). The difference in usage per household is small. On average, a household uses about 1.94 tons (dry weight) per year, thus the amount of firewood consumed by the whole village's 140 households comes to about 272 tons per year.

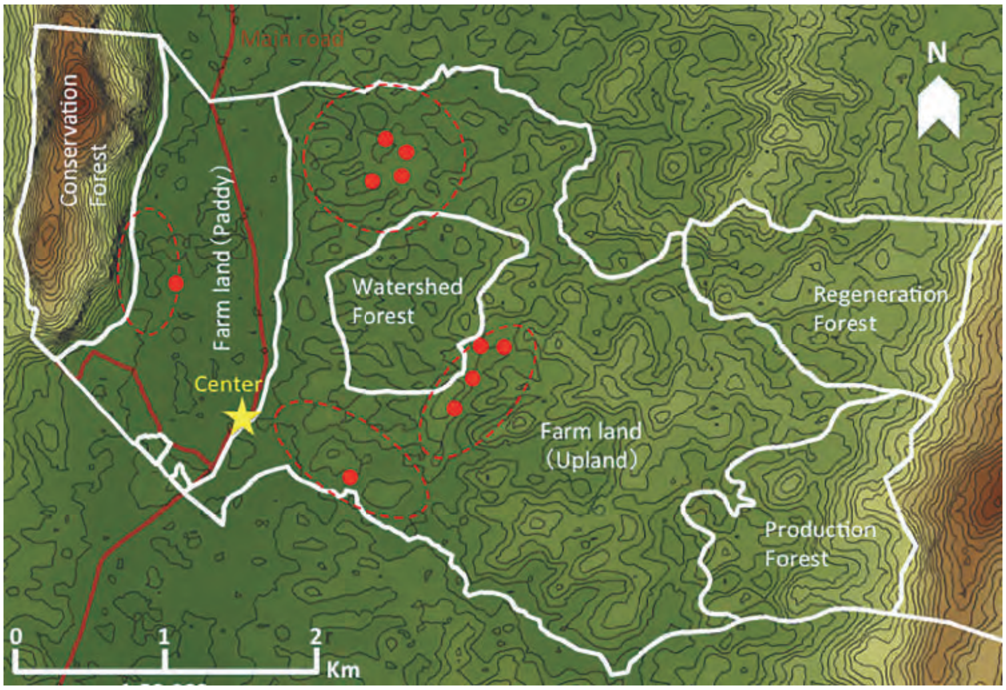


Fig. 1. Firewood harvest locations of target survey villages in Vientiane Capital. Red dashed lines are harvesting lands as indicated by farmers. Red dots are actual 2013 harvesting sites. Contour interval is 20m.

Fig. 2. Villagers prefer these tree species for firewood use. (Left: *Cratoxylum sp*., Right: *P. dasyrachis*)

A survey was also conducted to calculate the vegetation of firewood harvesting areas (5-year fallow) and forest areas using the biomass estimation equation for slash-and-burn fallow forests. Results showed that the village's yearly consumption is equivalent to 16 hectares of felled trees. Areas where firewood harvesting is permitted total to about 800 hectares.

About 50 tree species, including bamboo, are used as firewood. Of those consumed, people prefer the two species, *Cratoxylum* sp. (Hypericaceae), which is preferred by survey respondents, and *Peltphorum dasyrachis* (Fabaceaae) (Fig. 2). People prefer these two species because of their burning efficiency and heat retention qualities. The potential yield of *Cratoxylum* and *Peltphorum* is 0.12 and 0.28 ton per hectare, respectively. The demand for these two particular species is especially high, thus planting these tree species will expectedly reduce the amount of labor for harvesting firewood and ensure a stable fuel supply.

Projects in the forestry field, like those implemented under REDD+, are aimed at obtaining basic information upon investigation of the amount of firewood taken from forests.

Because forest vegetation changes depending on the region or fallow length, carrying out a vegetation survey of the applicable region is necessary in order to estimate forest area from firewood consumption information.

Due to the high demand for these tree species, setting up a community forest where members can harvest firewood is suggested. In particular, 'white' charcoal produced by burning *Cratoxylum* fetches a higher price than black charcoal, thus higher added value can be expected if this species is selected for planting. Furthermore, community forestry of *Cratoxylum* sp. is expected to not only positively affect labor hours but also improve everyday rural life.

(K. Kimura, R. Yoneda, Bounpasakxay Khamphumi [Forest Science Research Center], Singkone Xayalath [FSRC])

TOPIC 4

A Laotian tree database including useful varieties in secondary forests after slash-and-burn agriculture

The inhabitants of rural Laotian villages harvest various non-timber forest products (NTFPs) from their forests, hence basic information on these plants is necessary for the preservation and management of the forests as well as for dendrology (study of woody plants) and NTFP studies. However, in Laos, where national development began late, there has been no progress as regards the maintenance of illustrated plant references and related materials. *Forests and Trees of the Central Highlands of Xieng Khouang, Lao PDR* (Lehmann, L., Greijmans, M. & Shenman, D., 2003), despite its information being limited to the arboreal varieties of only a single region, is one of the precious few such volumes about Laos. Unfortunately, it is out of print and there are no existing plans for a second edition, which means that there are currently (as of 2015) no illustrated reference books available at places like bookstores. In order to assist forest investigations by researchers, forest preservation administration officers, and NGO personnel, among others, we began constructing a database of trees and shrubs as foundational information for the maintenance of harvested leaf specimens.

We prepared leaf specimens taken from over 300 tree samples gathered in post-slash-and-burn second-growth forests (fallow forests) in the investigated central Laotian villages. We have finished identifying 120 of them (Table 1) and assigned code numbers to the identified samples so we can look them up. The samples were then collected and maintained for browsing at the leaf sample repository in Laos Forest Research Center.

In samples captured with a CMOS sensor, information necessary for identification, such as the presence or absence of fine hairs, is lost from the image. In order to make a detailed observation of harvested leaf specimens on a computer screen, high-resolution images were

Table 1. Compiled database showing some of the trees appearing after slash-and-burn agriculture

Local Name	Local Name	Scientific Name	Family Name
ຄັບ	khup	*Maesa ramentacea* Wallich	Loganiaceae
ຕອງຕາແວນ	Tong ta van	*Mallotus paniculatus* Mull.	Euphorbiaceae
ສົ້ມພົດ	Som phot	*Rhus chinensis* Mill.	Anacardiaceae
ເໝືອດ	Muat	*Aporosa villosa* (Lindl). Baillon	Euphorbiaceae
ຕິ້ວຂົນ (ໜາມ)	Tiew khon (Nam)	*Cratoxylum maingayi* Dyer	Hypericaceae
ນ້ຳກ້ຽງ	Nam kieng	*Gluta usitata* (Wall.) Ding Hou	Anacardiaceae
ກະເບົາ	Ka bao	*Hydnocarpus ilicifolia* King	Achariaceae
ນົມຍານ	Nom nhan	*Barringtonia annamica* Gagnep.	Lecythidaceae
ໝາກກໍ່	Mark Kor	*Castanopsis* sp.	Fagaceae
ສະຄາມ	Sa kham	*Peltophorum dasyrrhachis (Miq.)*	Fabaceae

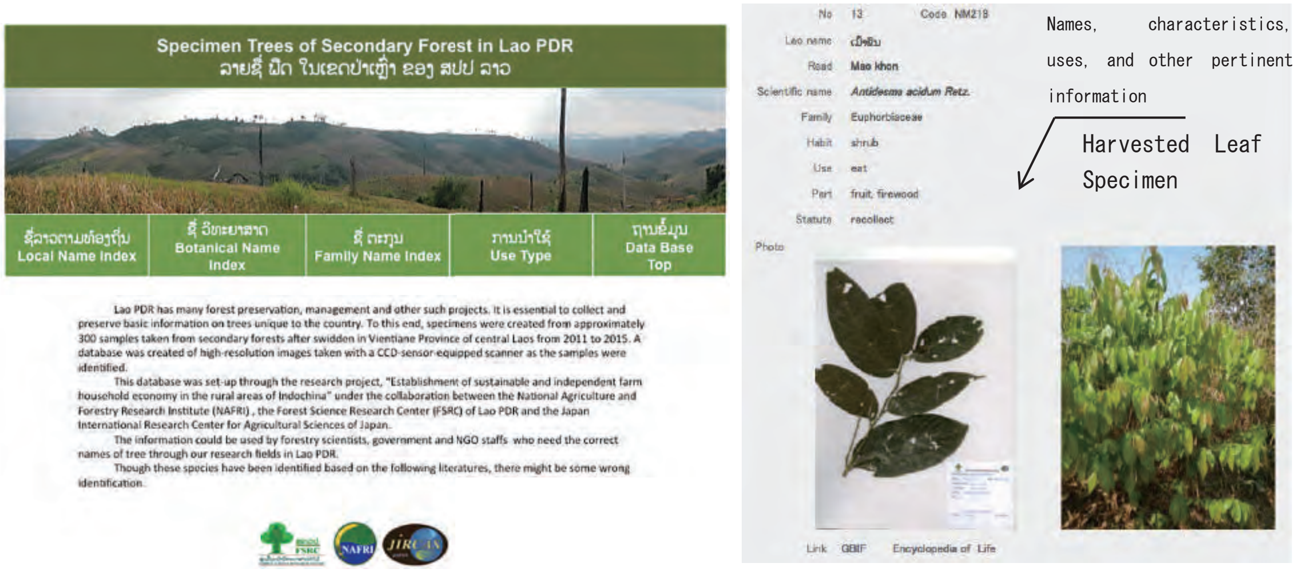


Fig. 1. Database of trees appearing in slash-and-burn secondary forests (left: lookup screen, right: tree classification information screen)
URL: http://www.jircas.go.jp/database/secondarytreelaos/

captured using a CCD sensor. At present, we are processing approximately 70 high-resolution images.

The specimen images can be browsed on the newly-created internet database titled "Specimen Trees of Secondary Forests in Lao PDR." In this database, local names, scientific names (genus and species), usage (in Laos), photographs, specimen images, specimen collection locations, specimen codes, and links to existing databases aside from JIRCAS are included. It is also possible to look up the local names in Laotian (Fig. 1). Furthermore, we have linked our data to the GBIF (Global Biodiversity Information Facility) and the EoL (Encyclopedia of Life) databases.

Several forest-related projects are underway in Laos, and we expect that our results will be useful to the project staff, the Laotian government and universities, and so on. In particular, several REDD+ projects are in preparation within Laos, and they are expected to make use of this database.

We will continue adding new information to the published databases in order to hasten the identification of as yet unidentified tree varieties. Moreover, because our focus has been on specimens collected from the slash-and-burn fallow forests of central Laos, it will hereafter be necessary to compile specimens and local names from other Laotian regions.

(K. Kimura, Singkone Xayalath [Forest Science Research Center], Bounpasakxay Khamphumi [FSRC])

TOPIC 5

Improving the productivity of bean sprouts with slightly acidic electrolyzed water

Sprouts are among the most popular and favorite vegetables in Japan and other countries. They are easy to produce and contain many nutrients that benefit human health. During the germination of seeds and the growth of sprouts, watering at a regular time is needed; however, if the surrounding environment is humid and warm, it will provide a suitable condition for microbial reproduction. Once high microbial populations exist on the sprouts, it will have a negative impact on the shelf life of sprouts and ultimately on human health. Sprouts are often used as ready-to-eat vegetables, thus measures should be taken to control microbial contamination on the sprouts, and a successful seed decontamination treatment must be performed to inactivate microbial pathogens while preserving seed viability, germination, and vigor.

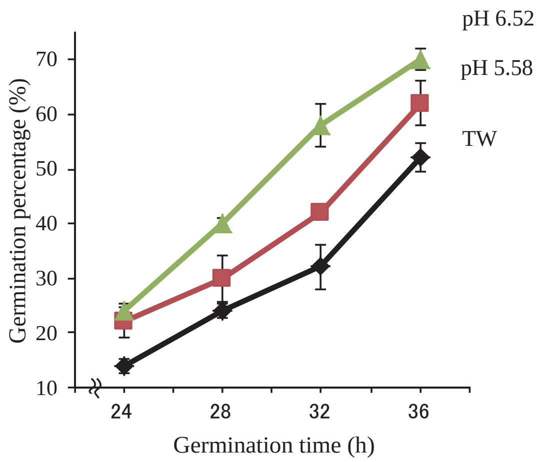


Fig. 1. Effect of slightly acidic electrolyzed water (ACC 10 mg/L) on the germination percentage of soybean seeds
TW: Tap water (pH 7.35 and ACC not detected)

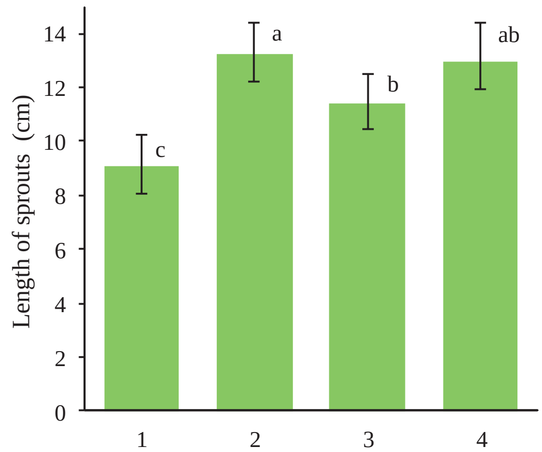


Fig. 2. The length of soybean sprouts treated by slightly acidic electrolyzed water (SAEW) after five days of germination
1-soaked and watered during germination by TW
2-soaked and watered by SAEW
3-soaked in SAEW and watered by TW
4-soaked in TW and watered by SAEW
Different letters mean statistically significant difference (P<0.05).

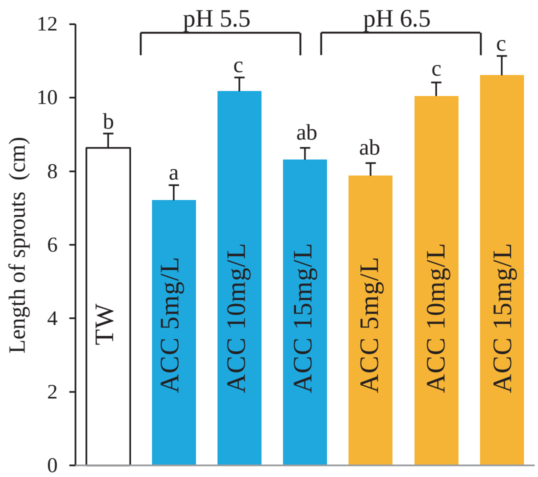


Fig. 3. The length of soybean sprouts treated by TW and SAEW after five days of germination
Different letters mean statistically significant difference (P<0.05).

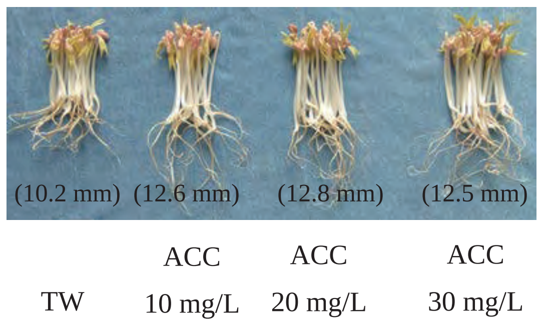


Fig. 4. The effect of SAEW on mungbean sprouts after 108 hours of germination
The length of mungbean sprouts is written in parentheses.

Slightly acidic electrolyzed water (SAEW), which has a near-neutral pH and contains available chlorine concentration (ACC), can be generated by electrolyzing dilute hydrochloric acid. SAEW has many advantages: 1) It is a kind of high-efficiency disinfection agent; 2) It is converted to normal water after use, so it is environmentally friendly; 3) It physically kills microorganisms, and prevents microorganisms from acquiring resistance; and 4) It functions at room temperature, so SAEW does not result in changes in ingredients, texture, scent, or flavor which often occur after heat treatment. In this study, SAEW was applied in producing bean sprouts and the effects of SAEW on germination, sprout growth, and physiological activity of bean seeds were evaluated.

Results demonstrated that SAEW with available chlorine concentration (ACC) of around 10 mg/L could greatly improve germination percentage (Fig. 1). Sprout length of soybean seeds soaked and then watered during germination period by SAEW was significantly longer than that of tap water (TW) control (P<0.05). Also, using SAEW instead of TW in either soaking or germination period could enhance sprout length (Fig. 2).

Results also indicated that soybean soaked in SAEW prior to germination greatly affected the later growth of sprouts. The length of soybean sprouts after five days of germination treated by TW or SAEW with different pH and ACC are shown in Figure 3. Furthermore, both pH and ACC of SAEW can affect the growth of soybean sprouts. Figure 4 shows the effect of SAEW on the length of mungbean sprouts. Mungbean sprouts treated with SAEW of ACC 10, 20 and 30 mg/L grew longer than TW control by 23.87, 25.81 and 23.04%, respectively, after soaking procedure.

In Japan, SAEW has been an authorized food additive since 2002 and a specified agricultural chemical since 2014 because of its proven biological safety and effectiveness as a bactericide even at a low ACC of 10–30 mg/L and pH of 5.0–6.5. SAEW shows promise as a kind of disinfectant for seed sprouts, not only by reducing microorganism populations and prolonging shelf life but also by promoting sprout growth.

(E. Tatsumi, S. Nirasawa, H. Liu [China Agricultural University], R. Liu [CAU])

TOPIC 6

Construction of "The Traditional Fermented Foods of Thailand" Database

Various fermented foods that are produced and utilized in Thailand have been influenced by its neighboring countries. This research, therefore, looked at the possibility of adding more economic value to local food resources by employing traditional production technologies, specific fermentation microorganisms, and characteristic components. A review of existing literature revealed that only a few materials containing comprehensive information on traditional fermented foods of Southeast Asia have been collected. Kasetsart University of Thailand had once published such a book, entitled "The traditional fermented foods of Thailand" (Bhithakpol et al., 1995), but it is difficult to obtain today. With this in mind, JIRCAS constructed and opened an electronic database on traditional fermented foods of Thailand on the web, with recently obtained information from the results of microbiological studies in JIRCAS.

The database (https://www.jircas.affrc.go.jp/DB/DB11/) is composed of articles featuring 86 kinds of foods (26 fishery products, 8 animal

Fig. 1. An example of fermented food in East and SE Asia (fermented rice noodle)

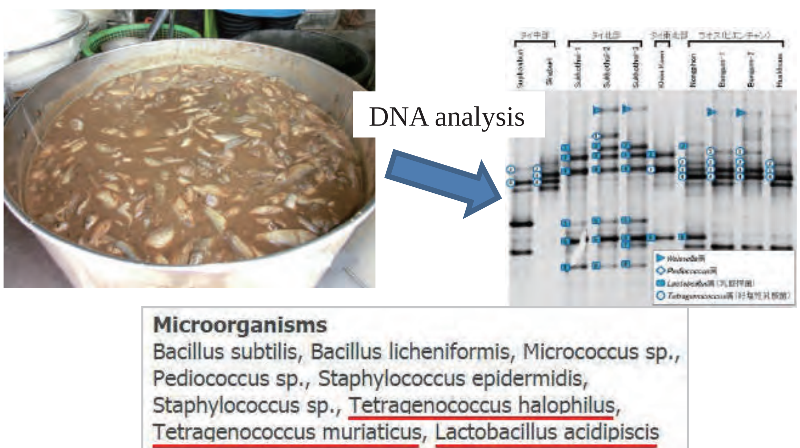


Fig. 2. Newly identified lactic acid bacteria from fermented fish

Chemical composition

Moisture (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	NaCl (%)	Total invert sugar (%)	Acidity as lactic acid (%)	pH	a_w
69.3	5.6	1.1	0.9	0.7	0	0.1	0.2	4.0	0.92

Fig. 3. A sample database page (General nutritional information for fermented rice noodle)

Fig. 4. Database homepage

products, 17 fruits, 23 vegetables, 6 rice products, 4 soybean products, and 2 others). Each article contains the local names in Thailand, ingredients, fermentation process, microorganisms, conditions, ways of eating, general nutritional information and pictures. They also show recent information on microorganisms, such as lactic acid bacteria in fermented fish, which have been identified by JIRCAS researchers. The articles have been organized by material and are easy to search.

Various traditional foods in East and Southeast Asia have many common characteristics and employ similar production technologies. By sharing information, it is expected that the production practices and quality of food in each of the countries are improved, and that newly designed food products would be developed in the future based on traditional technologies.

(K. Nakahara, J. Marui, W. Panthavee [Kasetsart University], G. Trakoontivakorn , [KU] P. Tangkanakul [KU])

TOPIC 7

Discrimination of old oil palm trunks to maximize production of fermentable sugars in sap: A promising source of sugars for biofuels and biomaterials

Oil palm (*Elaeis guineensis*) is widely planted for its edible oil in tropical countries such as Malaysia and Indonesia. In general, the palm starts bearing oil-contained fruits 2.5 years after planting, but its productivity becomes lower after 20-25 years, making it necessary to cut the old palms and replant new seedlings at plantation sites.

In Malaysia, an estimated 120,000 hectares of oil palm were replanted annually (from 2006 to 2010) to maintain oil productivity (1, 2). When replanting, old palms are cut and most of them are discarded or burnt at the plantation site. Efficient ways of utilizing oil palm trunks (OPT) are desired for an ideal oil palm plantation and a sustainable palm oil industry, thus we investigated the amount and

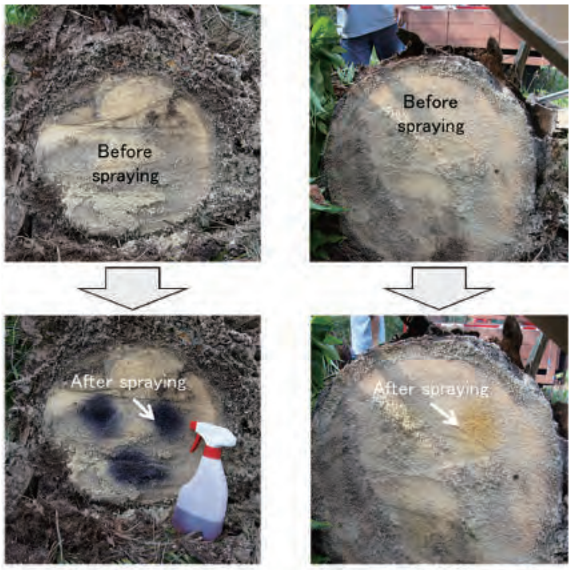


Fig. 1. Spray tests using iodine solution for felled oil palm trunk (OPT). OPT was obtained from a commercial oil palm plantation in Selangor, Malaysia. The starch content of OPT was measured using a total starch kit before the spray tests were carried out. The starch concentration of OPT containing high and low starch contents was 46.8% (w/w dry) and 7.1% (w/w dry), respectively.

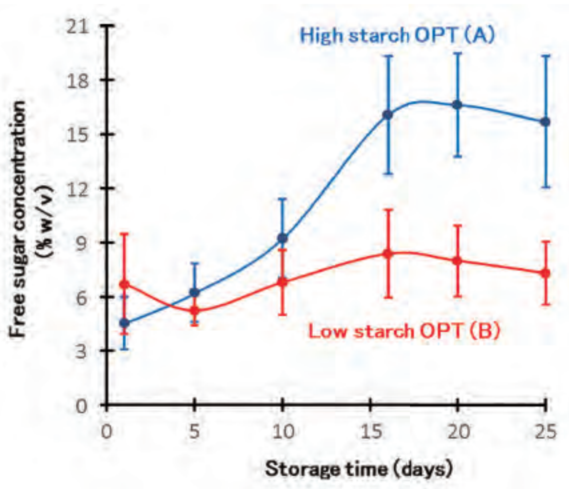


Fig. 2. Storage tests using high starch OPT (A) and low starch OPT (B). Free sugar was measured by high-performance liquid chromatography (HPLC) using squeezing sap of trunk samples obtained from each storage time. The total amount of glucose, fructose, and sucrose shows as free sugar in the sap.

composition of sugars in the sap squeezed from felled trunks together with moisture content. We also examined the effects of storage of the felled trunks on sugars in the sap (1,2).

Free sugar content in OPT sap is at maximum level at 30-60 days of storage after logging, thus the sap should be squeezed during this period to obtain the highest sugar concentration for further utilization (2). In addition, there was an accumulation of free sugars depending on starch concentration in OPT, as observed by an increase in sugar content in OPT with high starch content, though it decreases after a certain period of storage (3). Thus, starch concentration in OPT is useful as a key indicator to discriminate OPTs that exhibit increasable fermentable sugars in the oil palm sap during storage of the trunks after logging. On the other hand, it may be difficult to discriminate an OPT that has high starch content from its appearance.

In this study, we reported a method to discriminate a promising OPT among felled OPTs using iodine solution. To easily determine the starch content in felled OPT, iodine solution was sprayed to its cross section. When iodine solution was sprayed to the cross section of OPT containing high starch content, a dark blue color immediately appeared on the surface of the cross section. In contrast, when felled OPT containing low starch content was sprayed with iodine, the color of the cross section did not change.

To confirm whether OPT with high starch content increases its free sugars in the sap during storage, the sugar concentration in sap was compared to sap from OPT with low starch content during storage. Results have shown that the increase of free sugar in sap was observed only in OPTs with high starch content, indicating that this phenomenon depends on starch content in OPT. This method, in which iodine solution is sprayed on OPT cross-section, is useful in the discrimination of promising OPTs that exhibit increasable free sugar content during storage.

(1) Kosugi et al. (2010), J Biosci Bioeng. 110:322-325.doi:10.1016/j.jbiosc.2010.03.001.
(2) Yamada et al. (2010), Biomass Bioenergy 34:1608-1613
(3) Abdul Hamid et al. (2015), Int. J. Green Energy, doi.org/10.1080/15435075.2014.910786

(A. Kosugi, T. Arai, S. Nirasawa, Z. A. Abdul Hamid [Universiti Sains Malaysia], O. Sulaiman [USM], R. Hashim [USM])

TOPIC 8

Evaluation of the economic viability of ethanol production from palm sap with low sugar concentration

Some palm saps extracted from old oil palm trunks have low sugar content due to differences in species or in plant physiology. Here, we condensed palm sap with low sugar content by flat membrane filtration, then fermented the condensed palm sap at a high temperature using the thermotolerant yeast, *Kluyveromyces marxianus*. The input energy required to concentrate the palm sap and the output energy that could be generated from the ethanol were calculated. The condensation of sugar in sap from palm trunk required for an economically viable ethanol production was evaluated.

Experiment results showed that when palm sap squeezed from oil palm trunk (MC 80%, 30kg) had 3.1% sugar content, the energy required to condense up to 9.6% by flat membrane filtration was 10.9MJ (Fig. 1). The energy required for squeezing and fermentation was 5.8MJ and 0.85MJ, respectively. Total input energy for ethanol production was 17.6MJ when the energy for condensation (10.9MJ) was added (Fig. 1).

When ethanol production was conducted using thermotolerant yeast, ethanol (0.0454kg/L and 0.32L) was produced from 9.6% sugar content in palm sap. The output energy from produced ethanol was 6.7MJ (Fig. 2). Consequently, the energy balance between input and output was calculated and plotted. When sugar concentration in palm sap reached 6.1% or more, output energy became higher than input energy in palm sap (i.e., output energy turned to positive based on the plot between input and output energy) (Fig. 3). The energy required for sugar condensation from 3.1% to 9.6% was in proportion to sugar concentration in palm sap.

A simple method to distinguish high-sugar trunk from low-sugar trunk is reported in another research highlight report. This result

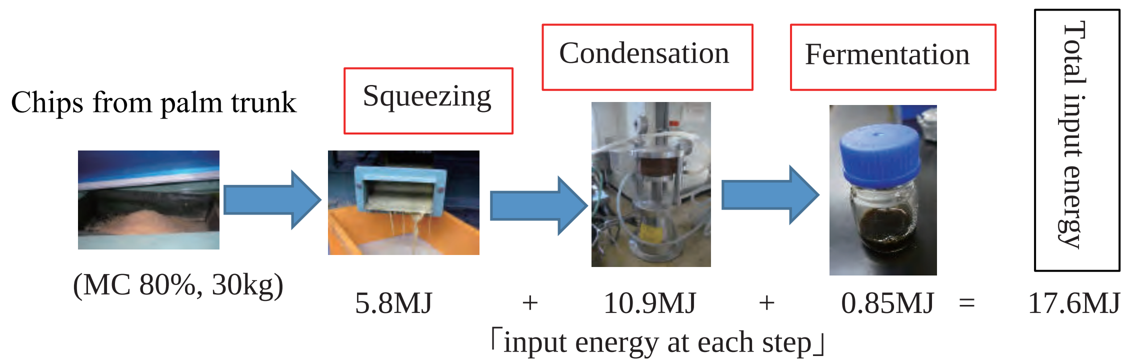


Fig. 1. Total energy required for squeezing, condensation, and fermentation from chips of oil palm trunk (17.7MJ)

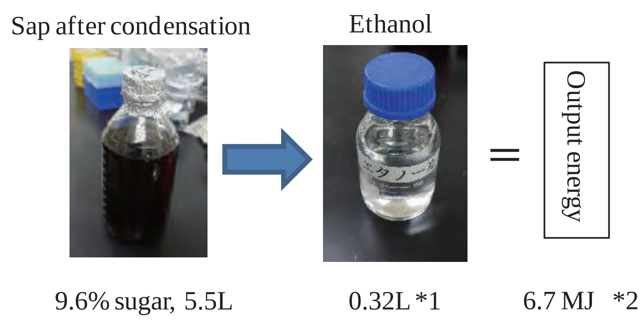


Fig. 2. Calories in ethanol from fermentation of palm sap (Output energy)
*1. Ethanol (L) produced from palm sap 5.5L was calculated from following equation: (0.0454kg/L x 5.5L)/0.789kg/L *2 calories of ethanol = 21.2MJ x 0.32L

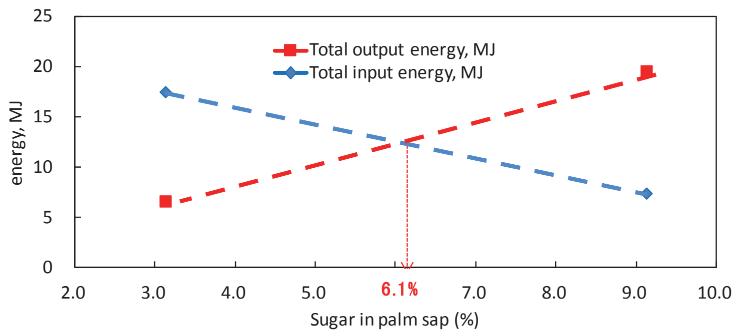


Fig. 3. The energy balance turns positive when the sugar in palm sap is more than 6.1%.

only provides information to get appropriate sugar content in palm sap before ethanol production. Even if sugar in palm sap is less than 6.1%, it is still possible to use heat energy from the residue after squeezing the sap. The output energy, however, is reduced when fermentation efficiency is less than 90%.

(Y. Murata, T. Arai, A. Kosugi)

TOPIC 9

Characterization of oil-palm trunk residue degradation enzymes from the isolated fungus, *Penicillum rolfsii*

Oil palm (*Elaeis guineensis*) used in palm oil production must be replanted at 20 to 25-year intervals in order to maintain oil productivity. Consequently, the felled palm trunks represent one of the most important biomass resources in Malaysia and Indonesia. Oil-palm trunk biomass consists of a complex network of cellulose, hemicellulose, and lignin, the major constituents of which are celluloses and hemicelluloses.

To utilize the felled palm trunks specifically for bioethanol and bioplastic production, and to exhibit the advantages of hydrolysis compared to using commercial enzymes, we characterized the crude ligno-cellulolytic enzyme of the fungal isolate *P. rolfsii* c3-2(1) IBRL utilizing oil-palm trunk residues.

We were able to show that the mesophilic fungus *P. rolfsii* c3-2(1) IBRL produces high activity enzymes (P. rolfsii) including xylanase, laminarinase, and arabinase. P. rolfsii

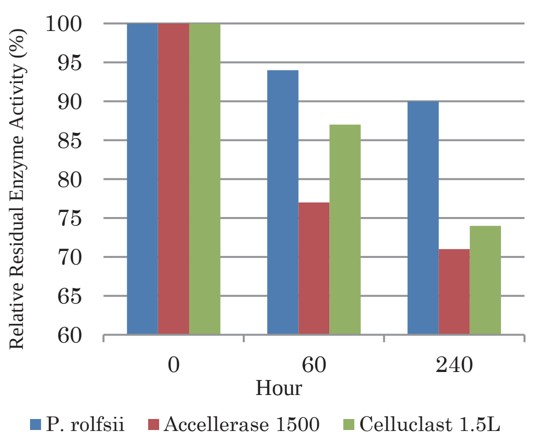


Fig. 1. Residual activity expressed as a percentage of the maximum oil-palm trunk residue activity by P. rolfsii c3-2(1)

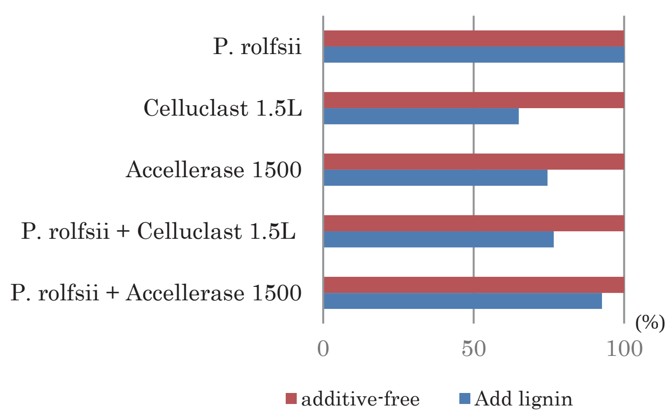


Fig 2. Absorption of P. rolfsii c3-2(1) IBRL enzymes and commercial enzymes on Klason lignin residues after 1.5 h at 4°C

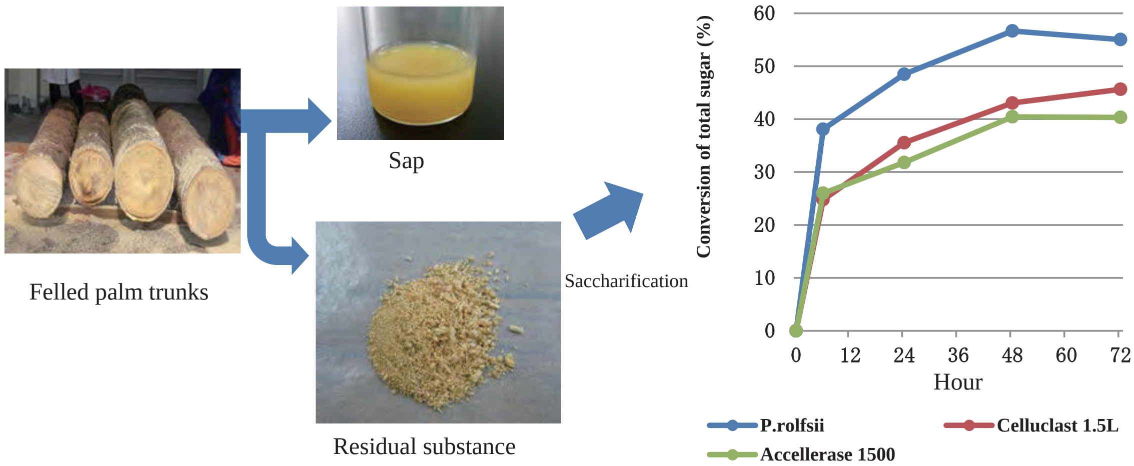


Fig. 3. Time course for the hydrolysis of oil-palm trunk residues using P. rolfsii c3-2(1) IBRL enzyme and commercial enzymes based on the hydrolysis of total sugar conversion (%)

displayed higher thermal stability compared with commercial enzymes, Celluclast 1.5 L and Acellerase 1500 (Fig. 1). The effects of isolated lignin residual on biomass saccharification revealed that P. rolfsii possesses weak 'lignin-binding' enzymes that may contribute to their higher hydrolysis efficiency on oil-palm trunk residues (Fig. 2). The hydrolysis efficiency of P. rolfsii is 1- to 1.5-fold higher than that of commercial enzymes following 48–72 h of biomass saccharification (Fig. 3). These findings suggest that *P. rolfsii* c3-2(1) IBRL is a fungal strain isolate that can potentially be used as a microbial factory for ligno-cellulolytic enzyme production. Furthermore, *P. rolfsii* c3-2(1) IBRL may represent an alternative for biomass utilization, such as oil-palm trunk residues. The high performance of ligno-cellulolytic enzymes produced by *P. rolfsii* c3-2(1) IBRL deserves significant attention as an alternative to other commercial enzymes for the production of second-generation biofuels and bioplastic.

(T. Arai, K. Lee [Universiti Sains Malaysia], D. Ibrahim [USM], Y. Murata, A. Kosugi)

TOPIC 10

Identification of factors that promote CSR activities by Indonesian palm oil companies

Since 1977, the Indonesian Government has been implementing the oil palm estate development program called the Nucleus Estate Smallholders (NES), whose major objective is to promote benefit-sharing between estate companies and rural communities. The NES is a kind of land allocation agreement between small-scale farmers and estate companies. When companies develop new oil palm estates, they are obliged to allocate a part of the estate to small scale farmers, called "plasma farmers." In addition to the NES program, palm oil companies have also taken an increased interest in Corporate Social Responsibility (CSR). Although the primary objective of NES is profit making, it is believed that NES also promotes CSR activities by estate companies because collaborations with local communities under the NES program lead to a better understanding of rural societies by the companies. This study aimed to identify the factors that promote CSR activities by Indonesian palm oil companies through an analysis of questionnaire survey results answered by 132 member companies of the Indonesian Palm Oil Association (GAPKI), which is the sole association of Indonesian palm oil producers.

The results of the questionnaire survey showed that all but two respondents were aware that their companies have been implementing CSR activities. Out of 16 CSR activities that were listed, "Infrastructure development" was

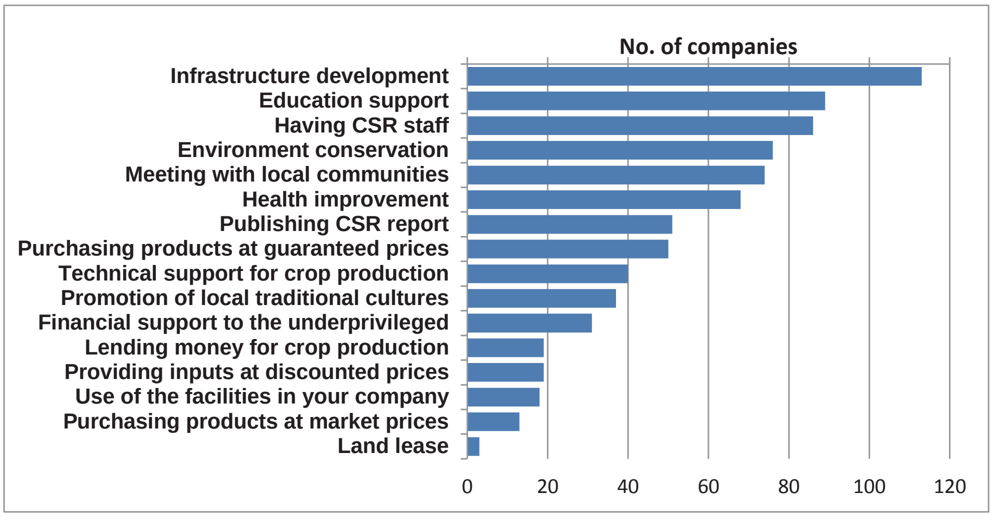


Fig. 1. Number of companies devoted to CSR activities (n=132, Multiple answers allowed)

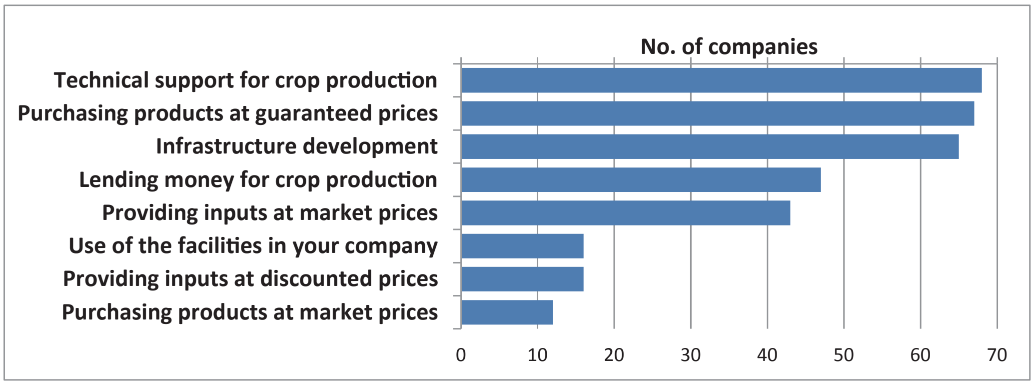


Fig. 2. Implementation of eight programs in the NES scheme (n=91, Multiple answers allowed)

Table 1. Summary results of regression analysis (n=115)

	Standardized partial regression coefficient (P value)
X_1	0.2973 *** (0.0001)
X_2	0.4653 *** (0.0000)
X_3	0.2896 *** (0.0001)
PS	0.0744 (0.3113)
RF	-0.0615 (0.4551)
PD	-0.1235 (0.1363)
RG	-0.0906 (0.2494)
Constant	6.9594
Adjusted R^2	0.4341
P value	(0.0000) ***
AIC	229.4

***: (P<0.01)

$Y = f(X_1, X_2, X_3, PS, RF, PD, RG)$
where
Y: The degree of CSR activities
X_1: The size of the company evaluated by FFB production in metric tons
X_2: A composite variable representing the company's efforts in the NES scheme [a)]
X_3: A composite variable representing the extent to which the company thinks each activity/concept will be effective in establishing better relationships with local communities [b)]
PS: The share of plasma farmers in terms of farmland area in the company
RF: Annual rainfall (mm)
PD: Population density in the province
RG: Regional Gross Domestic Product per capita in the province
a) The score of each sample on the first principal component of Primary Component Analysis (PCA) about variables of the programs in the NES scheme
b) The score of each sample on the first principal component of PCA about variables of component regarding the activities/concepts of the companies for contributing to establish better relationships with local communities

the most common, followed by "Education support", "Having CSR staff" and "Environment conservation" (Fig. 1). According to the basic procedures of the NES scheme as stipulated by the Indonesian Ministry of Agriculture, estate companies are required to provide support activities such as "Technical support for crop production", "Purchasing products at a guaranteed price", and "Infrastructure development" to plasma farmers. However, among companies that implemented the NES scheme, only around 70% answered that they already provide these three support programs to plasma farmers (Fig. 2). The results of regression analysis performed on data from the questionnaire survey concluded that the performance of the NES scheme, the size of the company, and the perception of relationships with local communities are major driving forces that stimulate participation in CSR activities (Table 1). A previous study found that the NES scheme can improve the fresh fruit bunch yield of plasma farmers by promoting appropriate fertilizer use and providing high quality seedlings (JIRCAS Research Highlights in 2014). The results of the present study indicated that the NES scheme can also promote CSR activities by palm oil companies.

When the NES scheme was launched in 1977, the government strongly supported it with subsidies. However, recent policies have resulted in decreased direct support for the scheme. The findings of this study can be used as evidence for the government to create a more supportive environment to promote the NES scheme.

(T. Sugino, H. Mayrowani [Indonesian Center for Agriculture Socio Economic and Policy Studies], H. Kobayashi [Graduate School for Horticulture, Chiba University])

TOPIC 11

Maintenance of outbred seraya seed production by selectively excluding inbred seeds in natural hill dipterocarp forests

Maintaining forest regeneration is essential for sustainable forest management when timber and other forest materials are extracted. Nearly all unprotected forests in the humid and sub-humid tropical regions should be regarded as disturbed rather than truly primary forests because timber has been selectively logged from them. It has been widely believed that forests have sufficient resilience to recover from selective logging, and selective logging regimes have been widely applied in management programs for tropical forests. However, selective logging may threaten the pollination and sexual reproduction systems of tropical tree species, and hence ultimately the regeneration of healthy cohorts of seeds, seedlings, and saplings of timber trees required for sustainable forest management. Consequently, outcrossing restrictions can markedly increase the proportions of unhealthy offspring through inbreeding depression. Generally, pollination and subsequent outcross mating are susceptible to reductions in population density for tropical tree species, which depend on weak flyer insects for pollination. In particular, tree species of the family Dipterocarpaceae are widely distributed and dominant in Southeast Asian tropical rain forests.

The pollination of tree species belonging to section *Mutica* of genus *Shorea* (Dipterocarpaceae), including our study species, *Shorea curtisii* (seraya in local language), depends mainly on weak flyer insects such as thrips. This in turn leads to lower mature seed production and decreased outcross mating, which have been reported to be associated with low population density. It has also been unveiled how tropical forest species maintain outcrossing at a high level. Outcross mating is maintained not only by the relative amount of self vs. outcross-pollen landing on the stigma but also by some biological processes, such as partial self-incompatibility and inbreeding depression, which can reduce the amount of self-mating. Therefore, we revised our modeling of pollen dispersal and male fecundity (See Tani et al. 2011 in JIRCAS Research Highlights) by incorporating a parameter expressing the biological processes to exclude self-mating, namely partial self-incompatibility and/or inbreeding depression until seed maturation, and simultaneously estimated the parameters of pollen dispersal, male fecundity, and the biological process by hierarchical Bayesian method. We compared parameters expressing the biological processes to exclude self-mating between natural and selectively logged forests. The estimated parameter showed that fertilization

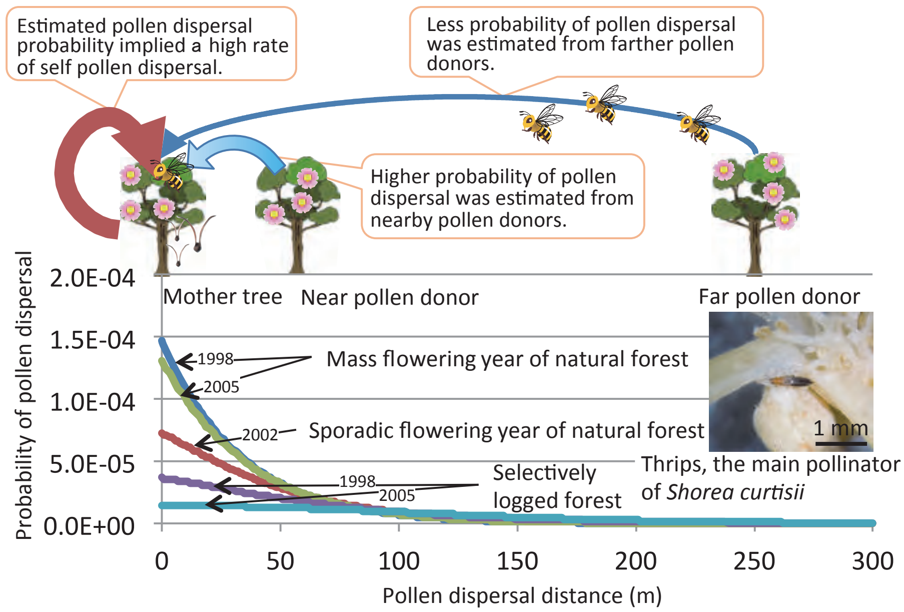


Fig. 1. Probability of pollen dispersal with distance between mother tree and pollen donors.

Pollen dispersal probability was estimated using paternity of 1,492 seeds collected in three synchronized flowering years at a natural forest and paternity of 728 seeds collected in two synchronized flowering years at a selectively logged forest. Self-pollen should be dispersed to each mother tree with higher probability even in the natural forest.

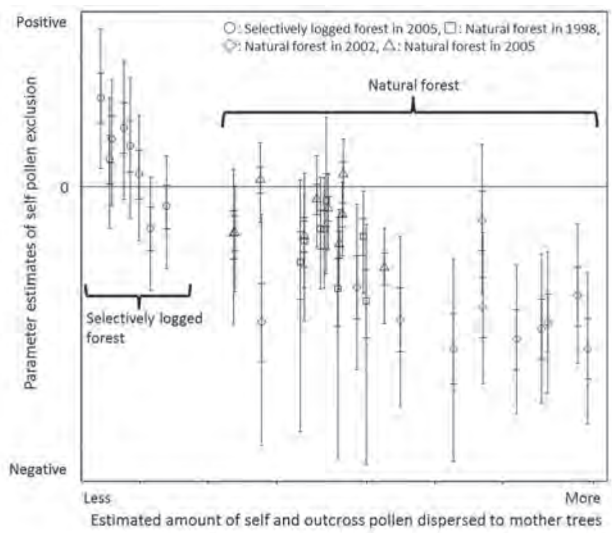


Fig. 2. Relationship between parameter estimates of self-pollen exclusion to total pollen amount dispersed to each mother tree.

The short and long ranges of vertical bar indicate 50% and 95% Bayesian credibility intervals, respectively. When the bar does not cross over zero and is in a negative area, self-pollen and/or selfed seeds were excluded by the biological processes.

of the ovules of self-fertile mother trees was not restricted and that self-fertilized seeds grew into maturity in the selectively logged plot. In contrast, the estimated parameter showed that higher outcrossing in the natural forest was caused by the exclusion of large amounts of self-pollen due mainly to biological processes. Mother trees with higher amounts of total pollen indicated exclusion due to biological processes during seed maturation. These mother trees also showed large female fecundity, which implied that the higher fecund trees tend to exclude self-pollen and/or abort immature selfed seeds.

(N. Tani, M. Norwati, S. L. Lee, C. T. Lee, [Forest Research Institute Malaysia], Y. Tsumura [University of Tsukuba])

TOPIC 12

Improving the production of giant tiger prawn using an unidentified species of *Chaetomorpha* having euryhaline nature

For three decades, giant tiger prawn (*Penaeus monodon* Fabricius) has been an important aquatic export product of Southeast Asian countries, providing income support to shrimp aquaculturists. However, giant tiger prawn production has recently been decreasing due to pond eutrophication and/or shrimp diseases caused by high-density and intensive aquaculture systems. We have been developing a closed co-culture system incorporating giant tiger prawn and unexploited benthos, *Chaetomorpha* sp., under an international collaboration project between King Mongkut's Institute of Technology Ladkrabang (KMITL) and Japan International Research Center for Agricultural Sciences (JIRCAS).

Chaetomorpha species (Fig. 1) found at the coast of central Thailand is considered to be an unidentified species from the results of morphological observation, ecological monitoring, and phylogenetic molecular sequencing analysis. Field surveys revealed this alga to be abundant throughout the year in stagnant coastal ponds and irrigation channels with salinity of 3.4–90 psu. Its highest mean specific growth rate of approximately 60% day^{-1} (2 mm particle became 20 cm within one week) was observed in laboratory experimental trials at salinities of 20–30 psu at 30 °C (Fig. 2). This seaweed contained 20.4%

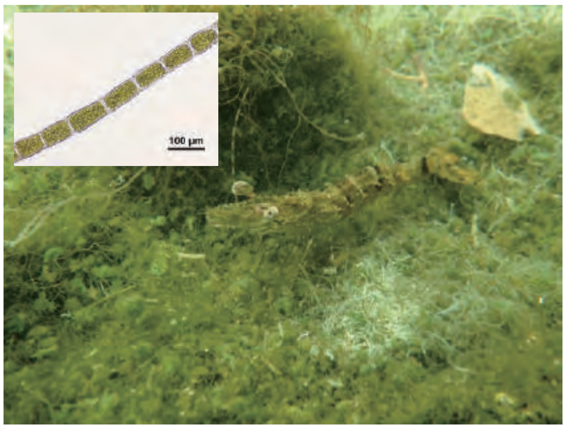


Fig. 1. *Chaetomorpha* sp. and giant tiger prawn. Inset photo (upper left corner) shows microscopic photograph of *Chaetomorpha* sp.

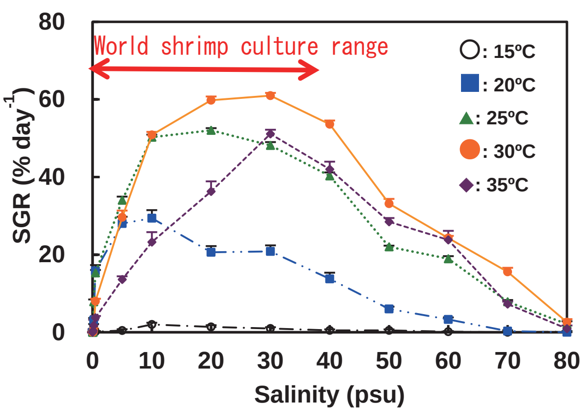


Fig. 2. Mean specific growth rates (SGR) of *Chaetomorpha* sp. under different salinities and water temperatures

Table 1. Growth performance, SGR, and FCR of giant tiger prawn juveniles in a monoculture and in co-culture with *Chaetomorpha* sp.

	Monoculture	Co-culture
Mean initial weight of individual shrimp (g)	0.39 ± 0.03 ^{a}	0.39 ± 0.03 ^{a}
Mean terminal weight of individual shrimp (g)	7.15 ± 1.28 ^{a}	11.20 ± 0.65 ^{b}
Final weight difference compared with control (%)	100	157
SGR of shrimp (% day^{-1})	4.14 ± 0.27 ^{a}	4.79 ± 0.08 ^{b}
FCR of shrimp	2.39 ± 0.28 ^{a}	1.46 ± 0.62 ^{b}
FCR reduction rate compared with control (%)	100	61

Values are shown as mean ± standard deviation from triplicate data. Different superscript labels within the same row indicate significant difference between means (Tukey-Kramer HSD test, $p < 0.05$).

protein and 64.8% carbohydrates, and giant tiger prawn preferably grazed this alga even when provided artificial feed pellets. When giant tiger prawn was co-cultured with *Chaetomorpha* sp., shrimp growth and feed conversion ratio (FCR*) improved by approximately 57% and 39%, respectively, compared with monocultured prawn (Table 1).

It is expected that this alga can be easily applied to intensive shrimp aquaculture ponds worldwide due to its wide tolerance to salinity. However, experimental data at earthen pond level is needed for practical use of this co-culture system. An analysis of consumers' preferences, such as shrimp color, taste, etc., also needs to be undertaken in anticipation of product distribution.

* An index indicating the feed quantity necessary to increase the specific weight of fisheries animals. Lower value shows greater efficiency.
  FCR = feed given (dry weight) / weight increase in fisheries animals (wet weight)

(I. Tsutsui, D. Aue-mneoy [King Mongkut's Institute of Technology Ladkrabang])

PROGRAM D
Information Analysis

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

Under the Third Medium-Term Plan of JIRCAS, activities for the collection, analysis, and dissemination of information for identifying trends related to international agriculture, forestry, and fisheries were separately specified from their research and investigation activities. These activities were divided into two main subjects: A) the analyses of the current situation and forecasts concerning food supply and demand and the production structure of agriculture, forestry, and fisheries in foreign countries, and B) the collection, analysis, and dissemination of information and materials related to the international food situation, to the agricultural, forestry, and fishery industries as well as to rural areas.

Subject A was made in order to contribute to the solution of global food and environmental problems. Subject B was made in order to formulate and conduct research and other projects related to agriculture, forestry, and fisheries in developing regions.

Information was collected in a regular, institutional, and systematic manner through collaboration with related organizations in Japan and overseas, and through long-term dispatch of staff to priority areas of activities. The respective information and materials were provided to a broad range of researchers, government agencies, and private companies.

Evaluation of fiscal year 2015 accomplishments showed that Program D performed well in comparison with the original annual implementation plan. Below is a summary of Program D's outputs, among others.

Under Subject A, JIRCAS developed a standard econometric model framework for assessing food supply-demand situation at country level through the ASEAN Food Security Information System (AFSIS) Project. A workshop was held to disseminate the model and to distribute the manual to member countries. This was achieved in collaboration with AFSIS, which is being implemented by the ASEAN Secretariat, the Statistics Department of the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, and the UN FAO's Regional Office for Asia and the Pacific through its Technical Cooperation Program (TCP). A prospective analysis of African rice cultivation area and yield trend was conducted as a provision for further project consideration. Continuous efforts were also made to collect information on agricultural market projections through participation in meetings, such as the World Outlook Conference, where subject-matter experts congregate. Information on agriculture and water was also collected and cooperation with water-issue organizations such as the World Water Council and the International Commission on Irrigation and Drainage. In addition, a staff member of JIRCAS has been sent on a long-term assignment to the International Renewable Energy Agency (IRENA) to conduct bio-energy resources and supply cost assessments. The results were utilized in updating the "REmap 2030" report, assessing the environmental impacts, and creating project guidelines.

Under Subject B, JIRCAS actively participated in the Global Rice Science Partnership (GRiSP), a Consultative Group on International Agricultural Research (CGIAR) research program, and the Coalition for African Rice Development (CARD), playing an important role in contributing to technology development and in connecting related national and international stakeholders. JIRCAS participated in G20-related networks for agricultural research, such as the Meeting of Agricultural Chief Scientists (MACS), the Wheat Initiative (WI), the Asia-Pacific Association of Agricultural Research Institutions (APAARI), and the Tropical Agricultural Platform (TAP), and contributed to international consensus building on agricultural development. Using an internal competitive fund known as the "President's Incentive Budget," various innovative activities were carried out. In particular, a comprehensive feasibility study was carried out to formulate and evaluate new projects in preparation for the next medium to long-term plan.

In October 2015, JIRCAS organized an international symposium titled "Why 'Quality' Matters in International Agriculture Research?" at the U Thant International Conference Hall, United Nations University, Tokyo. During the symposium, several multifaceted, diverse, and high quality research results were presented in the opening keynote speeches and the following sessions. It concluded with a discussion on the importance of attitudes when aiming at sustainable and resilient research outcomes, bearing in mind the final beneficiaries and users and the need to bring reforms in agriculture, forestry, and fishery industries.

Furthermore, JIRCAS continuously gathered local information on agricultural research priorities in Southeast Asia and Africa by maintaining liaison offices. Regional representatives also attended various meetings and events to exchange ideas on current and future collaborations.

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 Incorporated Administrative Agencies (IAAs). 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. Seven individual visits to JIRCAS were made during FY 2015 under the Administrative Invitation Program. Invited administrators and their home institutions are listed below.

Administrative Invitations, FY 2015

Nteranya Emmanuel Sanginga	International Institute of Tropical Agriculture (IITA), Nigeria	Apr. 5-12, 2015
Rose Fiamohe	Africa Rice Center (AfricaRice), Benin	Oct. 23-30, 2015
Yuji Niino （新野有次）	Regional Office for Asia and the Pacific, Food and Agriculture Organization of the United Nations, Thailand	Oct. 26-29, 2015
Patcharee Tungtrakul	Institute of Food Research and Product Development, Kasetsart University, Thailand	Oct. 26-29, 2015
Margaret Ann Tutwiler	Bioversity International, Italy	Oct. 26-29, 2015
Aimé Lala Razafinjara	National Center of Applied Research for Rural Development (FOFIFA), Madagascar	Jan. 27-30, 2016
Md. Ismail Hossain	Agricultural Statistics Division, Bangladesh Rice Research Institute (BRRI), Bangladesh	Feb. 14-20, 2016

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 IAAs, 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. Eighteen researchers were invited under this program during FY 2015. Invited researchers, their affiliated research organizations, and their research activities are summarized below.

Counterpart Researcher Invitations, FY 2015

Nguyen Xuan Loc	College of Environment & Natural Resources, Can Tho University, Vietnam	Study on the mitigation of greenhouse gas emission from paddy fields of the Mekong Delta by the introduction of water-saving irrigation	May 31-Jun. 14, 2015
Singkone Xayalath	Botany and Forest Ecology Unit, Forest Science Research Center, Lao PDR	Clarification of forest products use in livelihood and development of the measures to manage forest through sustainable use	Jun. 15-24, 2015
Chanaporn Trakunjae	Kasetsart Agricultural and Agro-Industrial Product Improvement Institute (KAPI), Kasetsart University, Thailand	Development of thermotolerant yeast suitable for cassava pulp fermentation	Jul. 1-Nov. 27, 2015
Pradipta Ranjan Pradhan	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India	Development of methodology to detect genetic differences on biological nitrification inhibition of sorghum for N_2O emissions in soil.	Aug. 2-Nov. 27, 2015
Yoshiaki Ueda	Institute of Crop Science and Resource Conservation (INRES), Plant Nutrition, University of Bonn Germany	Evaluation of candidate genes associated with tolerance to Zn deficiency and elevated ozone	Oct. 1, 2015-Mar. 15, 2016
Phatsalakone Manivong	Agricultural Research Center (ARC), National Agriculture and Forestry Research Institute (NAFRI), Lao PDR	International training course for Plant Genetic Resources in Asia (PGRAsia) 2015, Japan	Oct. 19-Nov. 9, 2015
Jaehak Jeong	College of Agriculture & Life Sciences, Texas A&M University, USA	Participation in the MARCO Satellite International Workshop 2015, Japan	Oct. 18-24, 2015
Daophaseng Lorsavanh	National Agriculture and Forestry Research Institute (NAFRI), Lao PDR	Management of the project on Establishment of a sustainable and independent farm household economy in the rural areas of Indo China	Oct. 23-31, 2015
Chen Yinjun （陈印军）	Institute of Agricultural Resources and Regional Planning (IARRP), Chinese Academy of Agricultural Sciences (CAAS), P.R.China	Economic evaluation of organic matter input	Nov. 24-28, 2015
Yi Xiaoyan （易小燕）	Institute of Agricultural Resources and Regional Planning (IARRP), Chinese Academy of Agricultural Sciences (CAAS), P.R.China	Economic evaluation of organic matter input	Nov. 24-28, 2015

Fang Linna （方琳娜）	Institute of Agricultural Resources and Regional Planning (IARRP), Chinese Academy of Agricultural Sciences (CAAS), P.R.China	Economic evaluation of organic matter input	Nov. 24-28, 2015
Wilson Dogbe	Northern Region Farming Systems Division, CSIR-Savanna Agricultural Research Institute, Ghana	World-wide network for the field monitoring to estimate the effect of climate changes on rice yield	Nov. 20-28, 2015
Saidou Simpore	Institute of Environment and Agricultural Research, Natural Resources Management and Production System Department, Burkina Faso	Development of conservation agriculture based cropping system and evaluation of its effects on soil conservation and on productivity increase	Dec. 18, 2015-Jan. 20, 2016
Julio César García Rodríguez	Las Huastecas Experimental Station, National Institute of Forestry, Agricultural, and Livestock Research (INIFAP), Mexico	Investigation of pathogenic variation of soybean rust pathogen and development of resistant soybean varieties in Mexico	Jan. 11-Mar. 9, 2016
Yang Xiaomei （楊暁梅）	Institute of Agricultural Resources and Regional Planning (IARRP), Chinese Academy of Agricultural Sciences (CAAS), P.R.China	Development of recycling technology for organic material inputs in corn-wheat cropping system	Jan. 11-Feb. 6, 2016
Md Rejwan Bhuiyan	Plant Pathology Division, Bangladesh Rice Research Institute (BRRI), Bangladesh	Pathological and breeding studies for blast disease in rice (*Oryza sativa L.*)	Jan. 18-Mar. 23, 2016
Jinbo Zhang （張　金波）	Institute of Crop Germplasm Resources, Xinjiang Academy of Agricultural Sciences, P.R. China	Evaluation of soybean for environmental stress tolerance in field conditions and development of soybean elite breeding lines	Feb. 15-21, 2016
Hua Cong （叢　花）	Institute of Crop Germplasm Resources, Xinjiang Academy of Agricultural Sciences, P.R. China	Evaluation of soybean for environmental stress tolerance in field conditions and development of soybean elite breeding lines	Feb. 15-21, 2016

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. Fifty three invited researchers implemented their programs during FY 2015 as listed below.

Project Site Invitations, FY 2015

Woldetensai Gebreyohannes Girmay	Department of Land Resource Management and Environmental Protection, Mekelle University, Ethiopia	Attendance to the 18th International Soil Conservation Organization Conference, United States of America	May 29-Jun. 8, 2015
Antonio Juan Gerardo Ivancovich	Estación Experimental Agropecuaria Pergamino, Instituto Nacional de Tecnología Agropecuaria (INTA-EEA Pergamino), Argentina	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 21-26, 2015
Adrian Dario De Lucia	Estación Experimental Agropecuaria Cerro Azul, Instituto Nacional de Tecnologia Agropecuaria (INTA-EEA) , Argentina	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Monica Isabel Heck	Annual Crops Department, Estación Experimental Agropecuaria-Cerro Azul, Instituto Nacional de Tecnologia Agropecuaria (INTA-EEA Cerro Azul), Argentina	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Ruti Scholz	Centro de Investigación Capitán Miranda (CICM), Instituto Paraguayo de Tecnología Agraria (IPTA), Ministerio de Agricultura y Ganadería (MAG), Paraguay	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Anìbal Morel Yurenka	Centro de Investigación Capitán Miranda (CICM), Instituto Paraguayo de Tecnología Agraria (IPTA), Ministerio de Agricultura y Ganadería (MAG), Paraguay	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Gabriela Morel	Centro de Investigación Capitán Miranda (CICM), Instituto Paraguayo de Tecnología Agraria (IPTA), Ministerio de Agricultura y Ganadería (MAG), Paraguay	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Miori Uno Shimakawa	Fundacion Nikkei-Cetapar (Cetapar), Republica del Paraguay	Annual project meeting on “Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection” (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015

Rafael Moreira Soares	Embrapa-Soja, Brazil	Annual project meeting on "Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection" (at Foz de Iguaçu), Brazil	Sep. 22-24, 2015
Silvina Stewart	Instituto Nacional de Investigacion Agropecuaria (INIA)-La Estanzuela, Uruguay	Annual project meeting on "Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection" (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Marcelo Julian Rodriguez Alonzo	Instituto Nacional de Investigacion Agropecuaria (INIA)-La Estanzuela, Uruguay	Annual project meeting on "Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection" (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Christian Dujak	Program Breeding-MAS, Instituto Paraguayo de Tecnologia Agraria (IPTA-CICM), Paraguay	Annual project meeting on "Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection" (at Foz de Iguaçu), Brazil	Sep. 22-25, 2015
Fabio Centurion	Fundacion Nikkei-Cetapar (Cetapar), Republica del Paraguay	Annual project meeting on "Monitoring *Phakopsora pachyrhizi* populations in South America and Development of resistant cultivars by marker-assisted selection" (at Foz de Iguaçu), Brazil	Sep. 24, 2015
Lei Cailin	Institute of Crop Sciences, Chinese Academy of Agricultural Sciences (ICS-CAAS), P.R. China	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Nguyen Thi Minh Nguyet	Agricultural Genetics Institute (AGI), Vietnam	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Hoang Hoa Long	Department of Molecular Plant Pathology, Agricultural Genetics Institute (AGI), Vietnam	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Nguyen Thi Nhai	Agricultural Genetics Institute (AGI), Vietnam	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015

Jonathan M. Niones	Philippine Rice Research Institute (PhilRice), Philippines	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Juliet P. Rillon	Philippine Rice Research Institute (PhilRice), Philippines	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Phetmanyseng Xangsayasane	Agricultural Research Center (ARC), National Agriculture and Forestry Research Institute (NAFRI), Lao PDR	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Phoumy Inthapanya	National Agriculture and Forestry Research Institute (NAFRI), Lao PDR	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Sathya Khay	Cambodian Agricultural Research and Development Institute (CARDI), Kingdom of Cambodia	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Bo Zhou	International Rice Research Institute (IRRI), Philippines	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Kshirod Kumar Jena	International Rice Research Institute (IRRI), Philippines	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015
Dwinita Wikan Utami	Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD), Indonesia	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project "Rice innovation for environmentally sustainable production systems", P.R. China	Sep. 27-Oct. 1, 2015

Aris Hairmansis	Indonesian Center for Rice Research (ICRR), Indonesia	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Thanapa Somjai	Ubon Ratchathani Rice Research Center, Rice Department, Thailand	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Acharaporn Na Lampang Noenplab	Phitsanulok Rice Research Center, Rice Department, Thailand	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Mohammad Abdul Latif	Plant Pathology Division, Bangladesh Rice Research Institute (BRRI), Bangladesh	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Md. Abdul Kader	Plant Breeding Division, Bangladesh Rice Research Institute (BRRI), Bangladesh	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Nguyen Thi Lang	Cuu Long Delta Rice Research Institute, Vietnam	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Vo Thi Tra My	Cuu Long Delta Rice Research Institute, Vietnam	Participation in the Annual Meeting and Workshop for the Blast Research Network for Stable Rice Production, under the JIRCAS research project “Rice innovation for environmentally sustainable production systems”, P.R. China	Sep. 27-Oct. 1, 2015
Baboucarr Manneh	Sahel Regional Station, Africa Rice Center, Senegal	Participation in the “Workshop on Research Output of Collaboration in Ghana 2011-15 and Future Prospect”, Ghana	Oct. 7-9, 2015
Isaac Kofi Bimpong	Sahel Regional Station, Africa Rice Center, Senegal	Participation in the “Workshop on Research Output of Collaboration in Ghana 2011-15 and Future Prospect”, Ghana	Oct. 7-10, 2015

Chatchai Kaewpila	Faculty of Agriculture, Khon Kaen University, Thailand	Participation in the JIRCAS-hosted Symposium on “Mitigation technologies for greenhouse gas emissions from enteric fermentation and manure in Southeast Asia”, Thailand	Oct. 27-29, 2015
Nguyen Van Thu	Department of Animal Sciences, College of Agriculture & Applied Biology, Vietnam	Participation in the JIRCAS-hosted Symposium on “Mitigation technologies for greenhouse gas emissions from enteric fermentation and manure in Southeast Asia”, Thailand	Oct. 27-29, 2015
Kritapon Sommart	Faculty of Agriculture, Khon Kaen University, Thailand	Participation in the JIRCAS-hosted Symposium on “Mitigation technologies for greenhouse gas emissions from enteric fermentation and manure in Southeast Asia”, Thailand	Oct. 27-29, 2015
La Van Kinh	Institute of Animal Sciences for Southern Vietnam, Vietnam	Participation in the JIRCAS-hosted Symposium on “Mitigation technologies for greenhouse gas emissions from enteric fermentation and manure in Southeast Asia”, Thailand	Oct. 27-29, 2015
Nakamanee Ganda	Nakhonratchasima Animal Nutrition Research and Development Center, Department of Development of Livestock, Thailand	Attendance to the 23rd International Grassland Congress (23rd IGC), India	Nov. 19-25, 2015
Baasanjalbuu Bayaraa	School of Animal Science and Biotechnology, Mongolian University of Life Sciences (MULS), Mongolia	Presentation at the 23rd International Grassland Congress (23rd IGC), India	Nov. 19-26, 2015
Chuluunbat Gantumur	School of Animal Science and Biotechnology, Mongolian University of Life Sciences (MULS), Mongolia	Presentation at the 23rd International Grassland Congress (23rd IGC), India	Nov. 19-25, 2015
Du Fulin	College of Economics and Management, Inner Mongolia Agricultural University, P.R. China	Participation in the GrassRisk Project Workshop at Mongolian University of Life Sciences and field study in Tov Province, Mongolia	Nov. 30-Dec. 6, 2015
Nerissa Diaz Salayo	Southeast Asian Fisheries Development Center (SEAFDEC), Aquaculture Department (AQD), Philippines	Participation in the JIRCAS Workshop on “Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas”, Thailand	Dec. 1-4, 2015
Maria Junemie Hazel Lebata-Ramos	Southeast Asian Fisheries Development Center (SEAFDEC), Aquaculture Department (AQD), Philippines	Participation in the JIRCAS Workshop on “Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas”, Thailand	Dec. 1-4, 2015
Alias bin Man	FRI Kampung Acheh, Fisheries Research Institute, Malaysia	Participation in the JIRCAS Workshop on “Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas”, Thailand	Dec. 1-4, 2015

Ibrahim Bin Johari	FRI Batu Maung, Fisheries Research Institute, Malaysia	Participation in the JIRCAS Workshop on "Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas", Thailand	Dec. 1-4, 2015
Wan Norhana Binti Md. Noordin	FRI Batu Maung, Fisheries Research Institute, Malaysia	Participation in the JIRCAS Workshop on "Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas", Thailand	Dec. 1-4, 2015
Noor Hasmayana Binti Yahaya	Selangor State Fisheries Department, Malaysia	Participation in the JIRCAS Workshop on "Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas", Thailand	Dec. 1-4, 2015
Chong Ving Ching	Institute of Ocean and Earth Sciences (IOES), University of Malaya, Malaysia	Participation in the JIRCAS Workshop on "Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas", Thailand	Dec. 1-4, 2015
Lee Soon Loong	Institute of Biological Sciences, Faculty of Science, University of Malaya, Malaysia	Participation in the JIRCAS Workshop on "Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas", Thailand	Dec. 1-4, 2015
Emmanuel Dugan	Soil Fertility Chemistry And Plant Nutrition Division, CSIR-Soil Research Institute, Ghana	Participation in the "Final Workshop on Development of Conservation Agriculture Based Cropping System for Sustainable Soil Management in West Africa" and the "7th International Conference of the African Soil Science Society", Burkina Faso	Feb. 3-12, 2016
Roland Nuhu Issaka	Soil Fertility Chemistry And Plant Nutrition Division, CSIR-Soil Research Institute, Ghana	Participation in the "Final Workshop on Development of Conservation Agriculture Based Cropping System for Sustainable Soil Management in West Africa" and the "7th International Conference of the African Soil Science Society", Burkina Faso	Feb. 3-12, 2016
James M. Kombiok	CSIR-Savanna Agricultural Research Institute, Ghana	Participation in the "Final Workshop on Development of Conservation Agriculture Based Cropping System for Sustainable Soil Management in West Africa" and the "7th International Conference of the African Soil Science Society", Burkina Faso	Feb. 3-12, 2016

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 (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, which aims to promote collaborative research that address various problems confronting countries in the developing regions. In FY 2006, these fellowship programs were modified and merged into one. In FY 2015, a total of three researchers were invited to conduct research at JIRCAS HQ.

JIRCAS Visiting Research Fellowships at Tsukuba (October 2015-March 2016)

Cao Dong	Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, P.R. China	Identification of environmental stress tolerance genes in soybean and their application to soybean improvement	Oct. 16, 2015-Feb. 9, 2016
Junjarus Sermsathanaswadi	Chemical Technology, Suan Dusit Rajabhat University, Thailand	Development of biological saccharification technology using alkali-thermophilic, cellulolytic and anaerobic bacteria	Oct. 9, 2015-Mar. 31, 2016
Wichittra Bomrungnok	Department of Food Science and Technology, School of Science and Technology, University of the Thai Chamber of Commerce, Thailand	Development of a highly efficient bioplastic production technology using felled oil palm trunk	Oct. 11, 2015-Mar. 31, 2016

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 2015, one researcher was invited to Mongolia. The fellow and his research subject are listed below.

For inquiries on the JIRCAS Visiting Research Fellowship Program, please contact the Research Coordination Section (Tel. +81-29-838-6335; Fax +81-29-838-6337; e-mail: irs-jircas@ml.affrc.go.jp)

JIRCAS Visiting Research Fellowship at Project Site (October 2015-March 2016)

Chuluunbat Gantumur	School of Animal Sciences and Biotechnology, Mongolian University for Life Sciences (MULS), Mongolia	Development of a technique for processing and conservation of underutilized feed resources and its effects on the meat quality in Mongolia	Oct. 1, 2015-Mar. 31, 2016

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 post-doctoral 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 IAAs affiliated with MAFF. The visiting scientists who resided at JIRCAS in FY2015 are listed below.

JSPS Postdoctoral Fellowship for Overseas Researchers (April 2015 to March 2016)			
Amrit Kaur Nanda	Australian National University, Australia	Characterizing candidate genes to improve rice performance on zinc-deficient soils	Sep. 8, 2014- Sep. 7, 2016
Josefine Nestler	University of Bonn, Germany	Investigation of root traits and candidate genes associated with P uptake efficiency	Apr. 1, 2014- Mar. 31, 2016
Mohammad Ashik Iqbal Khan	Bangladesh Rice Research Institute, Bangladesh	Study for co-differentiation of blast races and resistance genes in rice	Nov. 1, 2014- Oct. 31, 2016
Vincent Pujol	Australian National University, Australia	Influence of the rhizosphere and root microbiome on phosphorus uptake in rice	Sep. 8, 2014- Sep. 7, 2016
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

JSPS Invitation Fellowship for Research in Japan (April 2015 to March 2016)			
Short-Term			
Eric Wajnberg	French National Institute for Agronomic Research, France	Comparative studies on hymenopterous and dipterous parasitoids for efficient biological control	Mar. 20, 2015- Apr. 10, 2015

WORKSHOP

Workshop on "The establishment of a sustainable and independent farm household economy in Lao PDR

The JIRCAS-NAFRI collaborative workshop, titled *The establishment of a sustainable and independent farm household economy in Lao PDR* was successfully held at the Lao Plaza Hotel in Vientiane, Lao PDR, on June 4, 2015, with more than 80 people in attendance.

Dr. Phouangparisack Pravongviengkham, vice minister (now minister) of Agriculture and Forestry (MAF), Lao PDR, together with three others, delivered the opening remarks. He also presented Dr. Masa Iwanaga, president of JIRCAS, with an award for JIRCAS's contribution on capacity building and on improving the research facility through project activities.

Mr. Savanh Harnphon, deputy director general of the Planning and Cooperation Department, MAF, gave a keynote speech, titled "Overview of agriculture and future direction in Lao PDR," followed by Dr. Masayoshi Saito, program director of JIRCAS, who stated the objectives of the workshop and the priority areas in the upcoming phase.

In the first session, Japanese and Lao researchers presented 11 topics discussing the results of studies on several research subjects. In the second session, Mr. Vongvilay Vongkhamsao, deputy director of Planning and Cooperation Division, NAFRI, and Dr. Vanthong Phengvichith, deputy director general of NAFRI, gave presentations titled "Significance of the project and the remaining problems" and "MAF strategy focusing on the agricultural research in Lao PDR", respectively.

In the general discussion, the importance of employing a comprehensive and systematic approach to improve household economy in the semi-mountainous areas of Indochina was discussed, and methods of transferring the developed technologies effectively to the villagers were explained. The workshop concluded with JIRCAS, NAFRI, and NUOL agreeing to build closer relations with each other.

Workshop on collaborative research activities of the JIRCAS project titled "Development of rice production technologies in Africa (DeriptA)": Research output of collaboration in Ghana 2011-2015 and future prospect

A workshop was held in Accra, Ghana, on October 8, 2016 to review the collaborative research activities between JIRCAS and national research institutes in Ghana, and between JIRCAS and Africa Rice Center concerning the "Development of rice production technologies in Africa (DeriptA)" project of JIRCAS. A total of 36 participants gathered at the venue, including staff from the Ministry of Food & Agriculture (MOFA), Council for Scientific and Industrial Research (CSIR), Savanna Agricultural Research Institute (CSIR-SARI), University for Development Studies (UDS), Kwame Nkrumah University of Science & Technology(KNUST), Japan International Cooperative Agency (JICA), Ohayo Ghana Foundation, and JIRCAS.

There were four main sessions during the workshop. Session I covered the following topics, namely, "The diversity in pathogenicity among rice blast races collected from East and West Africa," "Rice blast resistance and phosphorus deficiency tolerance among African rice germplasm and breeding materials," and "Yield performance of breeding materials

developed for Asian condition under African field conditions." All these activities have led to the formulation of some strategies for breeding rice for Africa. Session II had two sub-sessions: Session II-1 covered the following topics, titled "Preparation of manuals for improving rice production in Africa" and "Improving soil fertility in lowland rice ecologies in Ghana funded by MAFF." It also discussed "Low life cycle cost paddy infrastructure technologies." Session II-2 showed the "Installation of supplemental irrigation system for rainfed lowland funded by MAFF." Session III tackled the topic, titled "Developing technologies to utilize flood plains along the river for rice cultivation with low-input," which is highly suitable to Africa. Methods of suppressing weeds and selection of suitable varieties were discussed. The last session provided an "Analysis of conditions for effective dissemination of technologies" that have been developed through other sub-projects. Baseline information on farmers and the role of farmer based organizations (FBOs) were discussed. The participants exchanged views and opinions regarding the topics during post-session discussions, thus contributing to the success of the workshop.

Workshop on collaborative research activities of the JIRCAS project "Development of agricultural technologies in developing countries to respond to climate change " - JIRCAS-CTU Climate Change Project Workshop 2015 –

JIRCAS, together with Can Tho University (CTU), organized the "JIRCAS-CTU Climate Change Project Workshop 2015" on 22 December 2015 at CTU in Can Tho City, Vietnam. The workshop provided an opportunity for project participants, including researchers from institutes in Japan, the CTU and Cuu Long Delta Rice Research Institute (CLRRI) in Vietnam, and Khon Kaen University in Thailand, to share the results of research activities conducted in Mekong Delta, Vietnam, under the JIRCAS project entitled "Development of agricultural technologies in developing countries to respond to climate change." Future activities for the next midterm plan of JIRCAS were also discussed.

A total of 51 participants gathered for the workshop, with 34 attendees from Vietnamese institutions including CTU, CLRRI, the Institute of Animal Sciences for Southern Vietnam (IASVN), and the Southern Institute of Water Resources Research (SIWRR), and 17 from Japanese institutions including JIRCAS, University of Miyazaki, Ishikawa Prefectural University (IPU), Yamagata University (YU), Chiba University (CU) and Nagoya University (NU).

The workshop was opened by Dr. Ha Thanh Toan, Rector of CTU, and Dr. Akinori Oshibe, Program Director of JIRCAS. After self-introductions by each participant, representatives of JIRCAS, CLRRI, CTU, NU, YU, IPU, and SIWRR reported the results of the 5-year project focusing on the mitigation of greenhouse gas (GHG) emissions in Mekong Delta, based on research studies on rice paddy systems, livestock raising, and biogas digester (BD) use. The results of impact evaluation and the challenges of adapting to future environmental variations in Mekong Delta were also reported and discussed. In addition, Prof. Kazuyuki Inubushi of CU introduced his research on methane emissions mainly from brackish waters.

The project achievements, on the whole, received positive comments. A general explanation relating JIRCAS's ongoing activities with the programs and projects planning for the next midterm plan was given by Program Director Oshibe and Director Nobuyoshi Fujiwara of the Rural Development Division. Some research proposals were described, and there were discussions highlighting the importance of linkages and the sharing of results already obtained in rice, livestock and BD studies, as well as examining the usefulness of satellite information.

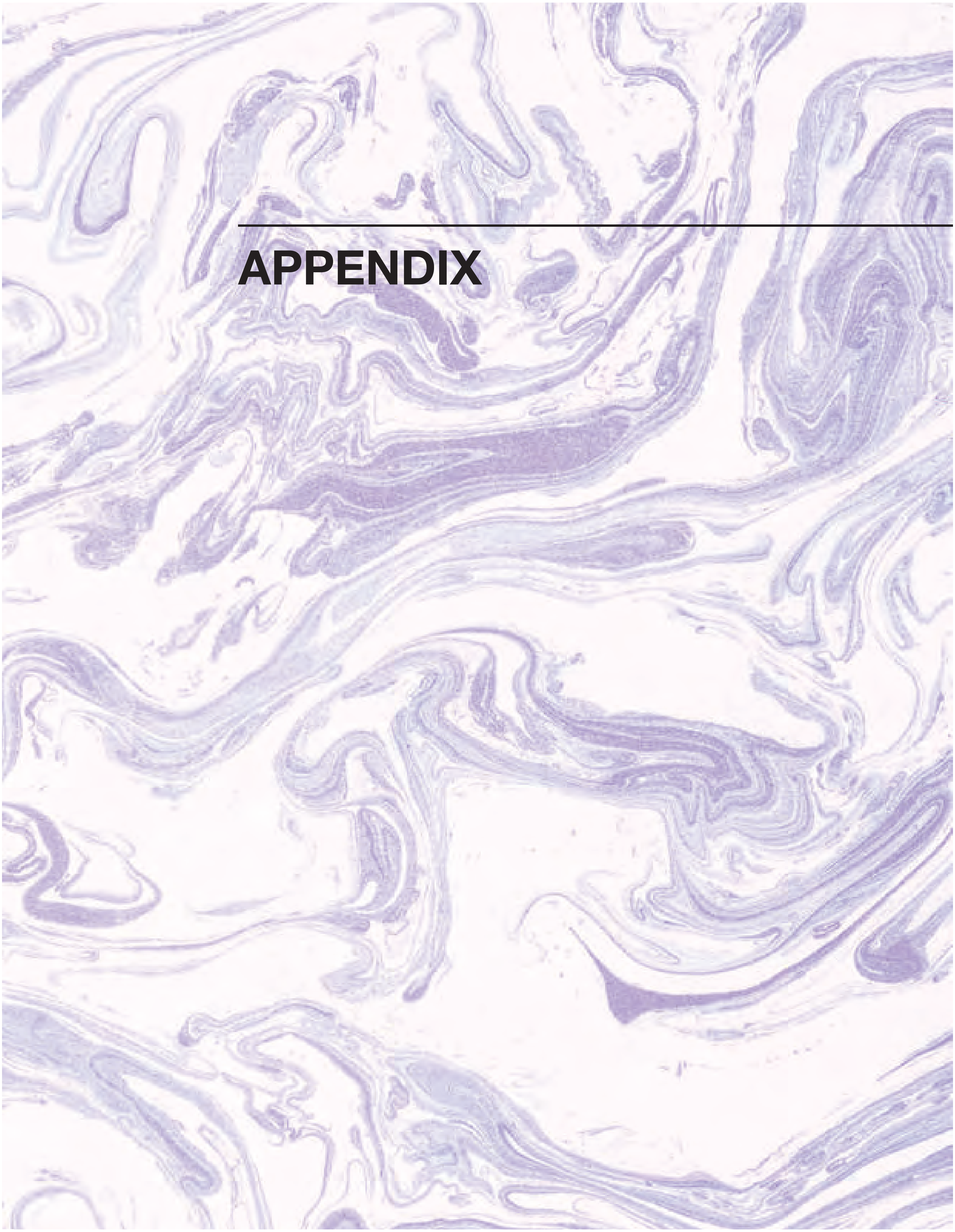
On the next day, 23 December, several participants, including 16 visitors from Japan, visited the experimental and farmers' paddy fields (including at the CLRRI), stock farms (including at the Hoa An Campus of CTU), and BD installations (in Can Tho City and Hau Giang Province) to deepen their understanding of the discussion from the previous day.

Participants of the "JIRCAS-CTU Climate Change Project Workshop 2015" held on 22 December at Can Tho University in Can Tho City, Vietnam

International Symposiums and Workshops, FY 2015			
1	JIRCAS-NAFRI collaborative workshop on "The Establishment of a Sustainable and Independent Farm Household Economy in Lao PDR"	June 4, 2015	Vientiane, Laos
2	JIRCAS-KKU-KKFCRC collaborative workshop on "Sugarcane IPM (Integrated Pest Management) Project"	September 16, 2015	Khon Kaen, Thailand
3	Symposium on "Further Improvement of Sugarcane Productivity and Utilization through Integration of Agriculture and Industry"	September 17, 2015	Khon Kaen, Thailand
4	Annual meeting of the "Blast Research Network for Stable Rice Production" and workshop on "New rice breeding research using gene pyramiding and networks	September 28-30, 2015	Kunming, China
5	Workshop on "Impacts of Climate Change on Agriculture and Adaptation to Extreme Events in Bangladesh"	October 5, 2015	Gazipur, Bangladesh
6	Workshop on the JIRCAS collaborative research project, "Development of rice production technologies in Africa" - Research output of collaboration in Ghana 2011-15 and future prospect -	October 8, 2015	Accra, Ghana
7	Research seminar on "Advanced application of local food resources in China 2015"	October 15-16, 2015	Ryo Yang, China
8	MARCO Satellite International Workshop 2015: Adoption and adaptation of SWAT for Asian crop production systems and water resource issues	October 20-23, 2015	Tsukuba, Japan
9	JIRCAS International Symposium 2015: Why "Quality" Matters in International Agriculture Research?	October 28, 2015	Tokyo, Japan
10	Symposium on "Mitigation technologies for greenhouse gas emissions from enteric fermentation and manure in Southeast Asia"	October 28, 2015	Chonburi, Thailand
11	MARCO Satellite International Workshop 2015	November 24-26, 2015	Tsukuba, Japan
12	Final workshop of the GrassRISK Project	December 2, 2015	Ulan Bator, Mongolia
13	Workshop on "Development of Aquaculture Technologies for Sustainable and Equitable Production of Aquatic Products in Tropical Coastal Areas"	December 2-3, 2015	Bangkok, Thailand
14	4th Steering Committee Meeting of the GrassRISK Project	December 3, 2015	Ulan Bator, Mongolia
15	Annual Meeting 2015: GM Drought Tolerance Project	December 11, 2015	Tsukuba, Japan

16	Workshop on Improvement of Utilization Techniques of Forest Resources to Promote Sustainable Forestry in Thailand	December 15, 2015	Bangkok, Thailand
17	Final workshop of the “Establishment of Sustainable Rural Society with Low GHG Emission in Tigray Region, Ethiopia’’ Project	December 15, 2015	Mekele, Ethiopia
18	JIRCAS-CTU Climate Change Project Workshop 2015	December 22-23, 2015	Can Tho, Vietnam
19	Workshop on “Improvement of Selective Logging Techniques in Dipterocarp Forests to Achieve Sustainable Forest Management in Peninsular Malaysia”	January 27-28, 2016	Genting Highlands, Malaysia
20	KNUST-JIRCAS Workshop on “Effective development of paddy field in Ghana - Development of Low Cost Irrigation Facility applicable to Africa (DLCIFA) -	February 10, 2016	Kumasi, Ghana
21	2nd Technical Committee Meeting on “Study on Improvement of Micro Reservoir Technologies for Enhancement of Rice Production in Africa (IMRT for Rice)	February 23, 2016	Kumasi, Ghana
22	Workshop on the “Recycling-based agricultural production system in upland farming areas of Northern China” joint project	March 2, 2016	Beijing, China
23	IAARD-JIRCAS Seminar: Effect of Organic Matter Application on Vegetable Yield and Soil Organic Carbon Content on a Volcanic Ash Soil in West Java, Indonesia -Summary of IAARD-JIRCAS collaborative study in FY2006-2015-	March 3, 2016	Lembang, Indonesia
24	Research Seminar: How many non-timber forest products do villagers use in Lao PDR?	March 4, 2016	Vientiane, Laos
25	Debrief meeting on the JIRCAS-KKFCRC Collaborative Research Project for Sugarcane Improvement (EDITS-Cane: 2011-2015)	March 14, 2016	Khon Kaen, Thailand
26	Final Workshop on “Development of ‘Conservation Agriculture’-based cropping system for sustainable soil management in West Africa”	March 14, 2016	Kumasi, Ghana
27	5th Steering Committee Meeting of the GrassRISK Project	March 16, 2016	Ulan Bator, Mongolia
28	Steering Committee Meeting between NAFRI and JIRCAS on the Rural Indochina Project	March 23, 2016	Vientiane, Laos
29	Workshop: JIRCAS Research on Measures against Salinizaton	March 24, 2016	Tashkent, Uzbekistan
30	Stakeholder briefing on the Rural Indochina Project in 2015	March 25, 2016	Vientiane, Laos

APPENDIX



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English	
1) JARQ (Japan Agricultural Research Quarterly)	
	Vol. 49 No. 3, No. 4
	Vol. 50 No. 1, No. 2
2) Annual Report 2014	
3) JIRCAS Newsletter	No.75, No.76, No.77, No.78
4) JIRCAS Working Report Series	
	No. 83 The Weather-Rice-Nutrient Integrated Decision Support System (WeRise)
	No. 84 Development of Agricultural Technologies in the Mekong Delta to Respond to Climate Change

Japanese	
1) JIRCAS News	No.75, No.76, No.77, No.78
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THIRD MEDIUM-TERM PLAN OF THE JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

The Japan International Research Center for Agricultural Sciences (JIRCAS) has been contributing to the improvement of technologies for agriculture, forestry, and fisheries, in tropical and subtropical areas as well as other overseas developing regions (hereinafter referred to as “developing regions”), by performing technical trials and research activities.

During the First Medium-Term Goal period (FY2001 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 U.N. Millennium Development Goals for the eradication of poverty and hunger in the world.

During the Second Medium-Term Goal period (FY2006 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 activities as projects at JIRCAS. In fiscal 2008, JIRCAS took over international activities from the dissolved Japan Green Resources Agency and strengthened its field activities.

Based on the outcomes of JIRCAS’s research strategy 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 30, 2010), three research agendas have been identified over the course of this Medium-Term Goal period, namely: (1) the development of agricultural technologies in developing regions, based on sustainable management of resources, (2) the development of technology for increased productivity and stable production of agricultural products in the tropics and other unstable environments, and (3) the development of technology for income and livelihood improvement of the rural population in developing regions. Research resources will be allocated to these agendas on a priority basis, and a system that will allow the research results to be to put into practice most effectively in developing regions will be established. To best understand the highly diverse subjects and goals of technological development in developing regions, JIRCAS will also strengthen its capability related to the collection, analysis, and dissemination of information on international agriculture, forestry, and fisheries.

Through this series of activities, JIRCAS is committed to fulfill its responsibilities as Japan’s only research institution mandated to carry out comprehensive international research in agriculture, forestry, and fisheries, and to contribute to the enhancement of food security in the country by solving global food problems.

I MEASURES TO BE TAKEN TO ACHIEVE THE GOAL OF EFFICIENT BUSINESS MANAGEMENT

A) Cost reduction

1. Reduction in costs such as general and administrative expenditures

a) 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. The general and administrative expenditures will be thoroughly examined and reviewed to determine whether there is any further room for cost reduction.

b) With regard to pay standards, the salaries including allowances for directors and staff will be carefully scrutinized in light of the general pay standards for government employees. As JIRCAS’s payment level for fiscal 2009 was 104.7 against a base figure of 100 for government employees (for administrative/technical personnel, age considered), its pay standards will be reviewed and reduced to the equivalent level for government employees by fiscal 2011; and in succeeding years the payment level will be in accordance with the pay regulations for government officials. The results of the assessment and progress of implementation will be made public. With regard to total personnel expenses, ongoing cost reduction efforts of more than 5% over a period of five years from fiscal 2006, according to the Act on Promotion of Administrative Reform for Realization of Small and Efficient Government (Act No. 47 of 2006), are to be consistently maintained through fiscal 2011. The reduction target for JIRCAS's total personnel expenses for this fiscal year (excepting retirement allowances, welfare expenditures [legal and non-legal welfare expenditures], and salaries revised in accordance with the recommendation of the National Personnel Authority) is more than 6% with respect to the fiscal 2005 level. Based on the Treatment Related to Salary Revisions for Government Officials (determined at the Cabinet meeting on November 1, 2010), and in accordance with the government's personnel cost-cutting efforts, JIRCAS will conduct a rigorous review of its personnel expenses as part of the planned fundamental review of the incorporated administrative agency (IAA) system. Personnel expenses related to staff taken on from the Japan Green Resources Agency, which had already achieved a personnel expenses reduction of more than 5%, are not subject to the current personnel expenses reform, in accordance with the Treatment of Across-the-board Personnel Cost Cuts for Organizations such as Incorporated Administrative Agencies Which Cooperate in Accepting Staff from Dissolved Agencies (notice of June 9, 2008 from the Administrative Reform Promotion Office, and other government departments, to personnel in charge at the ministries).

Personnel expenses related to the following permanent staff are not included in the reduction targets:
(i) Fixed-term staff employed by means of competitive or contracted research funds, or external funds from the private sector for collaborative work.
(ii) Fixed-term researchers (a) employed by means of government commission fees or subsidies; or (b) engaged in important research agendas (strategically important science and technologies designated in the Third Basic Program for Science and Technology [determined at the cabinet meeting on March 28, 2006],in line with national policy), who are employed by means of operational grants; or (c) 37 years of age or younger as of the end of fiscal 2005.

2. Review of Contracts

a) According to the Promotion of Activities for Rationalization of Procurement at Incorporated Administrative Agencies (determined by the Minister of Internal Affairs and Communications on May 25, 2015) and other related policies, from a viewpoint of realizing appropriate, speedy and efficient procurement with fair and transparent procedures, a procurement rationalization plan will be established, and an improvement of procurement in priority fields and through governance on procurement, and other related measurements will be steadily implemented.
b) Contract methods (such as the use of multi-year vs. single-year contracts) will be reviewed from a cost-saving viewpoint, with reference to other IAAs.
c) With regard to contracts with organizations deemed to be in close relation to JIRCAS, information provision will be reviewed to enhance transparency.

B) Implementation and feedback from evaluations and checks

1. To ensure work priority and transparency, JIRCAS will conduct evaluations and checks on its operations and research activities in a fair manner by utilizing external specialists prior to annual evaluation by the IAA Evaluation Committee. To allocate research resources on a priority basis, JIRCAS will clarify the basic policy and specific methods of supplying the respective results, along with the results from the IAA Evaluation Committee, to the administrative management. Research activities in particular will be reviewed on a flexible basis, with their necessity and progress taken into account. Evaluation and feedback results will be made available on JIRCAS's website.

2. For the purpose of evaluating research activities, a process sheet enumerating the annual goals will be prepared prior to the start of research. The process sheet is important for two main reasons: First, it ensures the improvement of technologies concerning agriculture, forestry, and fisheries in developing regions to address their food problems, thereby contributing to Japan's food security; Second, it becomes the basis for conducting evaluations at high international standards. Numerical goals and specific indicators will be set wherever possible. Research resource input and obtained results will be analyzed and utilized to evaluate research activities.

3. JIRCAS will endeavor to streamline and upgrade its evaluation methods by ensuring the mutual utilization of data needed for a multiple evaluation system. It will also improve this evaluation system where necessary.

4. Based on third-party evaluation, including that of administrative departments, each of the 10 or more research outcomes which are useful to developing regions will be designated as a 'Major Outcome for Dissemination' within the Third Medium-Term Goal period. The dissemination and use of such designated and other research results will be understood, analyzed, and utilized for the improvement of administrative management.

5. JIRCAS will make performance evaluations of its personnel and appropriately integrate the results into their treatment.

C) Effective use, improvement, and upgrading of research resources

1. Research funds

a) Research activity evaluation results will be appropriated into budget allocations for the effective and efficient promotion of the Medium-Term Goals research programs supported by operational grants.
b) To further promote research and development, efforts will be made to obtain external funds, such as funds for commissioned projects and competitive funds, and to utilize them more efficiently.

2. Research facilities and equipment

Research facilities and equipment are classified into three categories based on their age-related condition and JIRCAS' research prioritization, as follows: (i) facilities that will not conduce to research promotion without renovation and upgrading, (ii) facilities that will hamper the progress of research without renovation due to their severe age-related condition, and (iii) facilities required to be renovated by law or regulations. Planned renovation and upgrading of facilities essential to research promotion will be implemented while the use of such facilities will be promoted to increase the rate of utilization. With regard to the Island Environment Technology Development Laboratories, which are open facilities located at Tropical Agriculture Research Front, research proposals will be made to other research centers and publicity activities will be augmented to encourage the use of the facilities.

3. Organization

To achieve the Third Medium-Term Goals, the administrative and research organizations will be reviewed in a flexible manner, based on research evaluation results, to promote collaborative work with other IAAs in the agricultural field.

4. Improvement of staff qualifications and development of human resources

a) JIRCAS will revise its human resource development program in accordance with the Act on Enhancement of Research and Development Capacity and Efficient Promotion of Research and Development by Advancement of Research and Development System Reform (Act No. 63 of 2008), as well as changes in the surrounding environment of research and development, and other factors.
b) Efforts will be made to improve the qualifications of researchers who play key roles in international collaborative research, by dispatching them abroad and conducting collaborative studies with invited overseas researchers.
c) JIRCAS will create a competitive and cooperative environment for research personnel, provide them with effective incentives, develop their career path by utilizing a range of employment systems, conduct effective personnel exchanges with other research organizations including IAAs, and promote various forms of human resource exchange with governmental departments. JIRCAS will

also cooperate with other agricultural IAAs in developing the international skills of their staff.

d) JIRCAS will make efforts to improve its personnel's qualifications by mandating that administrative and technical staff actively participate in various training sessions organized and implemented by external organizations or other IAAs. Efforts will also be made to improve the system that allows technical staff to engage positively in research support.

e) The management ability and leadership of research project leaders will be improved through the implementation of various training systems.

D) Improvement, upgrading, and promotion of the efficiency of the research support sector

1. Research support work will be streamlined wherever possible by conducting work in conjunction with other agricultural IAAs, such as the joint implementation of training programs and joint creation of manuals.

2. The work of the General Affairs Section will be reviewed to ensure efficiency in the operational system. The efficiency of clerical management will be promoted by speeding up and simplifying clerical procedures.

3. JIRCAS will provide efficient local support to researchers dispatched abroad when they perform experimental and accounting work.

4. Efforts will be made to streamline, upgrade and enhance technical support activities by reviewing work and focusing on areas that require highly specialized technology and knowledge that meet the needs of advanced experimental and research work.

5. The Ministry of Agriculture, Forestry and Fisheries Research Network (MAFFIN) will be utilized to streamline, upgrade and enhance work on the collection and dissemination of research information; and efforts will be made, both to promote information-sharing across JIRCAS and to streamline operations, through the use of groupware.

6. Efforts will also be made to rationalize research support staffing by reviewing overall support work and continuing to promote outsourcing.

E) Promotion and enhancement of collaboration and cooperation between industry, academia, and government

1. To further promote collaborative research and researcher exchange, efforts will be made to improve information exchange and alliances with national and public research organizations, universities, and the private sector.

2. JIRCAS will actively support alliances and cooperation with other agricultural IAAs, including personnel exchanges, keeping in mind the division of roles.

3. Cooperation will be provided to the National Agriculture and Food Research Organization (NARO), as necessary, in implementing breeding research and other work.

II MEASURES TO IMPROVE THE QUALITY OF SERVICE AND EXECUTION OF OTHER DUTIES RELATING TO THE PUBLIC

A) Research and investigations

1. Priority research promotion

The research activities described in the attachment will be promoted on a priority basis.

a) To fulfill JIRCAS's responsibilities as Japan's only research institution mandated to carry out comprehensive international research in agriculture, forestry, and fisheries for developing regions, efforts will be made to improve information exchange and alliances with related organizations in Japan, through close coordination with the Japan Forum for International Agricultural Research for Sustainable Development (J-FARD) and other organizations for sustainable development. JIRCAS will also actively strive to make international contributions, utilizing Japan's technology in these areas by collaborating with developing and developed nations, international research institutes, private organizations such as NGOs, and international research networks, to effectively promote international collaborative work. Questionnaires on joint research will be sent to related overseas research institutes to further the effective performance of such activities.

b) To ensure the prompt and practical application of research results, JIRCAS will make efforts to encourage the beneficiaries of technologies and research results to participate in research projects from the planning stages, and to conduct such research activities focusing on the utilization, diffusion, and commercialization of research results.

c) At least 525 collaborative researchers and research managers will be invited from agricultural, forestry, and fisheries research organizations in developing regions during the Third Medium-Term Goal period to conduct collaborative research or improve the capability of the researchers concerned. At least 85 effective Memoranda of Understanding (MOUs) will be maintained per year.

d) Collaborative research utilizing research resources owned by respective organizations will be promoted efficiently by further strengthening alliances with other IAAs in the field of agricultural research and development.

e) As a sub-bank in the NIAS Genebank Project implemented by the National Institute of Agrobiological Sciences (which serves as the central bank), JIRCAS will efficiently collect, store and characterize gene resources in close cooperation with the central bank.

2. Collection, analysis and dissemination of information for identifying trends related to international agriculture, forestry and fisheries

a) To help solve global food and environmental problems, JIRCAS will analyze the current situation and make forecasts concerning food supply and demand and the production structure of agriculture, forestry, and fisheries in foreign countries.

b) To contribute to research and other projects related to agricultural, forestry, and fisheries in developing regions, JIRCAS will collect, analyze, and disseminate information and materials related to the international food situation, to the agricultural, forestry, and fishery industries as well as to rural areas. It will be carried out in a regular, institutional, and systematic manner, through collaboration with related organizations in Japan and overseas, and through the long-term dispatch of staff to priority areas. The respective information and materials shall be provided to a broad range of researchers, government agencies, and private companies.

3. Flexible response to government needs

JIRCAS will flexibly respond to government needs that will arise during the Third Medium-Term Goal period, and carry out necessary research and development in a consistent manner.

B) Reinforcement of ties with government departments

1. JIRCAS will appropriately reflect the opinions of the departments of the Ministry of Agriculture, Forestry and Fisheries in its research activities and dissemination of research outcomes. At every stage during development, from research design to dissemination of outcomes and practical applications, JIRCAS will make efforts to seek a common awareness of issues with related governmental departments, through close exchange of information, and will welcome them to participate in annual meetings to examine research results and plans. Alliances with government departments will be assessed on a yearly basis with the respective departments' participation, and the results will be utilized to further strengthen ties.

2. Keeping in mind the division of roles with other IAAs, JIRCAS will provide technical information and dispatch experts to governmental departments and related committee meetings, including emergency response, and will hold symposiums and other forums.

C) Promotion of the release and dissemination of research results

1. Securing interactive communication with the public

a) To fulfill accountability to the public, JIRCAS and its researchers will make efforts to secure interactive and continuous communication with the public by effectively utilizing various forms of information media.
b) The research staff will actively pursue community outreach activities such as open lectures for citizens, and their efforts will be conscientiously evaluated.
c) JIRCAS will seek the understanding of residents in areas where research is implemented, through cooperation with research partners and local governments concerned.

2. Promotion of utilization of research results

JIRCAS regards PR and the dissemination of new knowledge and technologies, along with their integration into government policy, as important activities. Researchers and related departments will make efforts to promote such activities.

In light of these aims, JIRCAS will first combine research results obtained during the Third Medium-Term Goal period with those already obtained in the previous Medium-Term Goal period, compile them in a database, and create manuals for proper utilization. At the same time, JIRCAS will conduct PR activities in countries where research facilities are located and actively promote the dissemination and utilization of research outcomes in developing regions by conducting collaborative research with international research or cooperation institutions.

3. Public relations and the release of research results

a) Research results will be released at academic meetings in Japan and overseas. At least 560 refereed papers will be published in academic journals and bulletins during the period covered by the Medium-Term Goals. In addition, at least 35 international symposiums and workshops will be held during that period, and the respective research results will be widely released in Japan and overseas.
b) Details of research results and other activities will be released on JIRCAS's website and through exhibitions. JIRCAS will also issue more than 11 press releases of major research results during the period covered by the Medium-Term Goals.

4. Acquisition of intellectual property rights and promotion of their utilization

a) JIRCAS considers important the generation of results beneficial to the entire world, transcending national and regional borders (global public goods). When promoting practical application and utilization of research results, special attention will be paid to find balance between contributing to the progress of developing regions and promoting Japan's industries, including agriculture.

b) JIRCAS will implement intellectual property management to promote research and development, with the ultimate aim of promoting practical application and utilization. Obtaining rights to research results and handling licenses will be carried out in an integrated manner, from the design stage of research and development onwards.
c) JIRCAS will aim to win patent rights in a strategic manner, including filing and licensing overseas, for possible patent licensing in the future or for the protection of research results. JIRCAS will file at least 20 patent applications in Japan and abroad during the period covered by the Third Medium-Term Goals.
d) JIRCAS will review its own patents, as needed, in light of licensing and the development of alternative technologies. It will waive rights to less important patents.
e) Bred materials applicable to Japan will be registered in the Registry of Plant Varieties to promote their dissemination and utilization.
f) JIRCAS will grant at least three licenses for domestic or international patents each year within the Third Medium-Term Goal period.
g) JIRCAS will actively provide information related to patent rights to outside parties, and strengthen efforts necessary for technological transfer.
h) JIRCAS will review its own Basic Intellectual Property Policy as necessary, in line with the Strategy for Agricultural, Forestry and Fisheries Intellectual Property (decided by the Agriculture, Forestry and Fisheries Research Council in March 2007).

D) Other social contributions in specialized fields

1. Analyses and appraisals

On request from the government, relevant organizations, or universities, JIRCAS will perform analyses and appraisals that require its highly specialized knowledge and/or are difficult for other organizations to carry out.

2. Training sessions and seminars

a) JIRCAS will hold training sessions and seminars as often as possible, and actively cooperate in events sponsored by the government and other organizations.
b) JIRCAS will actively welcome participants and trainees from other IAAs, universities, national and public institutions, and the private sector, to develop human resources, raise technical standards, and disseminate technical information. JIRCAS will also welcome trainees from abroad.
c) JIRCAS will dispatch young researchers of universities to overseas countries, and promote the development of researchers engaged in international agriculture, forestry, and fisheries research.

3. Cooperation with international organizations and academic societies

a) As an organization that carries out 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. It will also provide domestic and overseas technical information on request.
b) JIRCAS will plan and hold international symposiums jointly with international organizations, with the aim of contributing to the development of agriculture, forestry, and fisheries in developing regions.
c) JIRCAS will implement a commendation program for young researchers at agricultural, forestry, and fisheries research organizations in developing regions.

[Attachment] Directions related to research and investigations

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

To overcome current global environmental problems, as well as maintain and expand the agricultural, forestry, and fishery industries in developing regions, JIRCAS will aim to develop sustainable resource management and environmental conservation technologies in relevant areas through collaboration with local and international research centers. More specifically, the following priority research projects will be carried out:

a) Projects addressing global warming including (1) the development of global warming mitigation technologies such as those for the reduction of greenhouse gas emissions from livestock and agricultural land and by soil carbon sequestration, (2) the development of adaptation technologies such as nutrient management technology to reduce stresses imposed by climate change, (3) the assessment and analysis of global warming impacts (and its countermeasures) on the food market by employing a global food supply and demand model, and (4) the development of a sustainable rural community model with low GHG emission by employing clean development mechanism (CDM) project activities.

b) JIRCAS will establish a sustainable farming system for dry and semi-dry areas by developing antidesertification technologies and by optimizing soil and grazing management as well as employing a cropping system that conserves soil in agriculture (conservation agriculture) through the use of non-tilling farming and cultivation of cover crops suitable to the African Savanna. JIRCAS will also develop water-saving cultivation and groundwater resource conservation technologies on islands in developing regions which are highly susceptible to abnormal climate conditions caused by global warming.

c) JIRCAS will strive to develop technologies that will enhance nitrogen use efficiency by utilizing the biological nitrification inhibition function of certain crops, thereby promoting sustainable agricultural systems and resource management.

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

This program seeks to develop technologies to improve and sustain productivity through collaborative research with local institutions and international research centers, in specific research fields wherein Japan has shown predominant comparative advantage, focusing especially on adverse environments such as those found in tropical regions. The program also aims to reduce starvation and malnutrition, which remain serious problems in developing regions, and to contribute to food security in the world and in Japan. More specifically, the following priority research will be carried out:

a) To help fulfill the goal of the Coalition for African Rice Development (CARD) to double rice production in Africa by 2018, JIRCAS, as the implementing institute for the flagship project "Development of rice production technologies in Africa", will evaluate rice genetic resources, introduce biotic/abiotic stress tolerance into rice strains suitable to African environmental conditions, develop an Asian-type low life-cycle cost paddy infrastructure technology, and establish a cultivation system for low-input rice production in flood plains which have previously been considered unsuitable for rice production.

b) Stable crop productivity shall be attained in unstable environments by overcoming adverse factors such as drought, submergence, salinity, diseases, and pests. This research will be done by (1) establishing genetic engineering technologies to develop crops suitable to developing regions, (2) developing breeding technologies and materials to secure sustainable production against factors that inhibit the production of main upland crops such as soybean, (3) developing technologies for the evaluation and utilization of diverse genetic materials and breeding lines in tropical field crops such as sugarcane, (4) improving Asian-type rice cultivation by utilizing low-input/high-yield cultivation technology and greater genetic diversity, and (5) developing integrated pest management techniques to stabilize agricultural and livestock production in developing regions.

3. Technology development for income and livelihood improvement of the rural population in developing regions

This program aims to improve income in rural areas by (i) promoting their appropriate development in line with the respective natural conditions and cultural background, and (ii) evaluating the multilateral values of various agricultural, forestry, and fishery products. To achieve this objective, JIRCAS will develop key production technologies for sustainable agriculture, forestry, fisheries, and rural development. JIRCAS will also develop modern processing, distribution, and storing technologies through collaborations with local and international research centers to effectively utilize the products. More specifically, the following priority research projects will be carried out:

a) In rural areas in Indochina, JIRCAS will establish stable production systems for rice and field crops, livestock, forest, and fish culture, which can adapt to diverse geographical environments (forests, open fields, rice fields, and rivers), to encourage self-sufficiency, eradicate poverty, and enhance the economic independence of farmers.

b) In East and Southeast Asia, where the structures of food supply/demand and rural communities are changing due to rapid economic growth, JIRCAS will examine and propose measures to support sustainable agriculture, forestry, and fisheries. The project aims to develop food processing technologies by utilizing varied traditional food resources in these areas, as well as biofuel production technologies that do not compete with food production by utilizing the unused biomass resources in Southeast Asia. To help boost the forestry and fisheries industries in Southeast Asia, JIRCAS will develop techniques for the sustainable use of forest resources by taking advantage of forest multi-functionality. JIRCAS will also develop sustainable aquaculture technologies while preserving habitats through co-culture techniques.

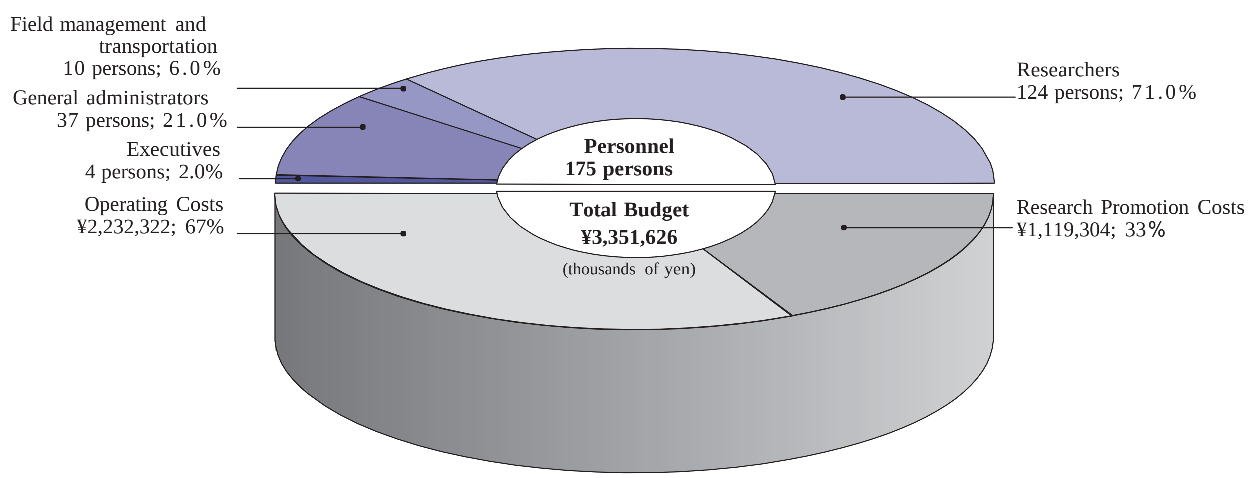
FINANCIAL OVERVIEW

Fiscal Year 2015

	thousands of yen
TOTAL BUDGET	**3,351,626**
OPERATING COSTS	**2,232,322**
Personnel (175)	1,916,572
President (1), Vice-President (1), Executive Advisor & Auditor (2)	
General administrators (37)	
Field management (10)	
Researchers (124)	
* Number of persons shown in ( )	
Administrative Costs	315,750

RESEARCH PROMOTION COSTS	**1,119,304**
Research and development	450,515
Overseas dispatches	228,727
Research exchanges/invitations	5,877
Collection of research information	107,341
International collaborative projects	313,318
Fellowship programs	13,526

Budget FY 2015 (Graph)



MEMBERS OF THE EXTERNAL EVALUATION COMMITTEE

Members of the JIRCAS External Evaluation Committee

Hiroto ARAKAWA	Former Special Advisor, JICA Research Institute
Kiyoko IKEGAMI	Professor, Graduate School of Social and Cultural Studies, Nihon University
Hiroko ISODA	Director, Alliance for Research on North Africa, University of Tsukuba
Toshihiko KOMARI	Vice President, Corporate Strategy Division, Japan Tobacco Inc.
Shin-ichi SHOGENJI	Professor, Graduate School of Bioagricultural Sciences, Nagoya University

JIRCAS STAFF in FY 2015

President

Masa Iwanaga

Vice-President

Osamu Koyama

Executive Advisor & Auditor

Hisaya Kakiuchi
Mari Inoue

Research Strategy Office

Kunihiro Doi, Director

Research Coordinator
Tomohide Sugino, Development Economics
Shun-ichi Nakada, Bioenergy Policy

Regional Representative for Southeast Asia or Africa
Naruo Matsumoto, Representative of Southeast Asia Office (Thailand)
Haruyuki Dan, Representative of Africa Office (Ghana)

Researcher
Eiichi Kusano, Agricultural Economics
Sakiko Shiratori, Agricultural economics

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Takeshi Kano, Program B: Stable Food Production
Masayoshi Saito, Program C: Rural Livelihood

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Research Planning and Management Office
Yukiyo Yamamoto, Head

Research Planning Section
Takeshi Watanabe, Head

International Relations Section
Kunimasa Kawabe, Head

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
Tokichi Kojima, Head

Research Coordination Section
Kaoru Watanabe, Head
Keiko Ikeda, Assistant Head
Katsunori Kanno, Coordination Subsection Head
Yoshihiko Sumomozawa, International Relations Subsection Head

Research Support Section
Akira Urushibara, Head
Toshiki Kikuchi, Budget Subsection Head
Koichi Fuse, Support Subsection 1 Head

Information and Public Relations Office
Shinsuke Morioka, Head

Senior Researcher
Masaki Morishita, Rural Development

Public Relations Section
Yumiko Arai, Head

Technology Promotion Section
Yuzou Manpuku, Head

Publications and Documentation Section
Masahiro Maeda, Head
Hiromi Miura, Network Subsection Head
Takanori Hayashi, Managing Subsection Head (Librarian)

Intellectual Property Expert
Akira Hirokawa

Safety Management Office
Yasuyuki Nakanishi, Head

Senior Researcher
Mie Kasuga, Plant Molecular Biology

Administration Division

Toshiyuki Kawaura, Director

General Affairs Section
Takayoshi Takeda, Head
Shin-ichiro Takada, General Affairs Assistant Head
Takashi Oosato, Personnel Management Assistant Head
Sachiyo Tatebe, General Affairs Subsection Officer

Kazuyo Kadowaki, Welfare Subsection Head
Gaku Takeda, Personnel Subsection 1 Head
Kumi Ehara, Personnel Subsection 2 Head

Accounting Section
Toshinori Baba, Head
Kazuo Miyajima, Accounting and Examination Assistant Head
Toru Shimura, Procurement and Asset Managing Assistant Head
Takeshi Usuku, Financial Subsection Head
Jun-ichi Irino, Accounting Subsection Head
Ryoichi Mise, Overseas Expenditures Subsection 1 Head
Takayuki Yamamoto, Overseas Expenditures Subsection 2 Head
Yuka Takatsuto, Audit Subsection Officer
Hifumi Takahashi, Procurement Subsection 1 Head
Masayoshi Takanashi, Procurement Subsection 2 Head
Gen-ichiro Hanaoka, Supplies/Equipment Subsection Officer
Kazuya Fujikawa, Facilities Subsection Head

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Takashi Ichimi, General Affairs Subsection Head
Hiroe Nagatomo, Accounting Subsection Head

Audit Office

Norio Tadokoro, Head

Rural Development Division

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Hideki Furihata, Agricultural Engineering
Koichi Takenaka, Rural Development Forestry
Hiroshi Ikeura, Irrigation

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Naoki Horikawa, Hydrology
Takeshi Matsumoto, Grassland Management
Kazuhisa Kouda, Agricultural Engineering
Shinji Hirouchi, Agricultural Engineering
Mamoru Watanabe, Rural Development
Kenji Ishido, Agricultural Engineering
Taro Izumi, Rural Development
Masakazu Yamada, Rural Development
Keisuke Omori, Soil Salinization in Dryland
Naoko Oka, Agriculture Water Management
Shutaro Shiraki, Rural Development
Ken-ichiro Kimura, Forest Chemistry
Katsumi Hasada, Rural Development
Junya Onishi, Irrigation
Chikako Hirose, Agricultural Engineering

Researcher
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Jun Furuya, Agricultural Economics

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Kazuo Nakamoto, Agricultural Economics
Shunji Oniki, Agricultural Economics
Akira Hirano, Geographic Information Systems
Shintaro Kobayashi, Agricultural Economics

Biological Resources and Post-harvest Division

Takeshi Urao, Director

Project Leaders
Hiroko Takagi, Plant Breeding
Kazuo Nakashima, Plant Molecular Biology
Masayasu Kato, Plant Pathology
Kazuhiko Nakahara, Food Chemistry
Seiji Yanagihara, Rice Breeding
Akihiko Kosugi, Molecular Microbiology

Senior Researchers
Tamao Hatta, Mineralogy and Geology
Xu Donghe, Plant Molecular Genetics
Eizo Tatsumi, Food Chemistry
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
Takamitsu Arai, Molecular Microbiology
Mitsuhiro Obara, Plant Physiology and Genetics
Tsutomu Ishimaru, Plant Breeder
Toshiyuki Takai, Crop Science and Genetics

Researchers
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Yukari Nagatoshi, Plant Molecular Biology
Kaori Fujita, Crop Science and Food Engineering

Crop, Livestock and Environment Division

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Yasuo Ando, Plant Microbiology
Fujio Nagumo, Soil Science
Yasukazu Hosen, Soil Science
Seishi Yamasaki, Animal Nutrition

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Tomoyuki Suzuki, Animal Nutrition
Keiichi Hayashi, Soil Management

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Guntur V. Subbarao, Crop Physiology and Nutrition
Matthias Wissuwa, Physiology and Genetics
Sada Ando, Animal Nutrition
Tetsuji Oya, Crop Science
Takayuki Ishikawa, Plant Physiology
Yoshiko Iizumi, Hydrological Science

Researchers
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Hidetoshi Asai, Crop Science
Kenta Ikazaki, Soil Science

Forestry Division

Iwao Noda, Director

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Daisuke Hoshino, Silviculture
Reiji Yoneda, Silviculture
Masazumi Kayama, Tree Physiology

Fisheries Division

Tetsuo Fujii, Director

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Toru Shimoda, Marine Chemistry
Marcy N. Wilder, Crustacean Biochemistry
Tatsuya Yurimoto, Aquatic Biology
Tsuyoshi Sugita, Fish Nutrition and Fish Physiology
Masashi Kodama, Marine Chemistry
Tomoyuki Okutsu, Aquatic Animal Physiology

Researchers
Isao Tsutsui, Aquaculture
Bong Jung Kang, Aquatic Animal Physiology

Tropical Agriculture Research Front

Kazuhiro Suenaga, Director
Koshun Ishiki, Public Relations Officer

Project Leaders
Yoshimichi Fukuta, Rice Breeding
Shotaro Ando, Soil Science

Senior Researchers
Mariko Shono, Plant Physiology
Hide Omae, Crop Science
Tsutomu Fushimi, Food Analysis and Oil Crops
Shinkichi Gotoh, Soil Science
Shinsuke Yamanaka, Molecular Biology
Takuma Ishizaki, Plant Molecular Biology
Yoshifumi Terajima, Sugarcane Breeding
Youichi Kobori, Entomology
Naoko Kozai, Pomology

Researchers
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Shin-ichi Tsuruta, Molecular Genetics

Technical Support Section
Tatsushi Ogata, Head
Koji Yamato, Machine Operator
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

THE JAPANESE FISCAL YEAR AND MISCELLANEOUS DATA

The Japanese Fiscal Year and the Annual Report 2015

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) 2015 covers the period from April 1, 2015 through March 31, 2016. The Annual Report 2015 summarizes the full extent of JIRCAS activities that occurred during this period. The subsequent Annual Report will detail events and programs from April 1, 2016 through March 31, 2017 (FY 2016).

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 JIRCAS' symbol mark (shown on front/back cover): The mark was conceived by Takayuki Ishikawa of the Crop Production and Environment Division, and Toshifumi Murakami, former Senior Researcher in the Research Planning and Coordination Division. The Earth enveloped in a revolving swirl of clouds represents the dynamics of international research and JIRCAS' aim to target all world areas. The star was added to serve as a polestar for international agricultural research and to represent the importance of cooperation.

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