Japan International Research Center for Agricultural Sciences

Annual Report 2005

(April 2005-March 2006)

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JIRCAS 2005 ANNUAL REPORT

Message from the President

President
Dr. Shinobu Inanaga

My first year in office saw the conclusion, on March 31, 2006, of JIRCAS' First 5-year Medium-Term Plan. Most of the general achievements and activities during this period were detailed in last year's 2004 Annual Report.

I would now like to describe the main research activities covered in the First Medium-Term Plan.

1. The JIRCAS research group which is working on stress-tolerance of plants has made a pioneering breakthrough with the discovery of dehydration-responsive element binding protein (DREB) genes using the model plant *Arabidopsis thaliana*. The DREB genes control the expression of specific genes responsible for tolerance to unfavorable environments, such as drought, salt damage and low temperatures. Introduction of DREB gene constructs into important agricultural crops, such as tobacco, rice and other plants produced transformants that showed strong tolerance to these adverse environments under greenhouse conditions. JIRCAS has started implementing collaborative projects with international research institutes that include several Consultative Group on International Agricultural Research (CGIAR) Centers such as the International Rice Research Institute (IRRI), the International Maize and Wheat Improvement Center (CIMMYT), the International Center for Agricultural Research in Dry Areas (ICARDA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), with the aim of developing novel, stress environment-tolerant varieties of rice, wheat and legumes.
2. JIRCAS has developed a simple analytical method and a micro quantifying technique for 2-acetyl-1-pyrroline, an aromatic compound found in fragrant rice, and a technology for measuring the viscoelasticity of rice noodles. Using these evaluation techniques, it was established that the amount of 2-acetyl-1-pyrroline varied depending on the cultivated area and that this difference is drought stress-induced.
3. To remedy the problems facing aquaculture of giant freshwater prawn juveniles in the Mekong River Delta in Vietnam, JIRCAS has developed a phytoplankton-based Green Water System that gives a higher juvenile survival rate and is more economical than the traditional water recirculation system. To disseminate this technology to local farmers, Vietnamese-language videotapes of the technical manual for the system were produced and distributed.
4. In the vegetable-producing areas of the West Java highlands, JIRCAS discovered that a yearly three-crop rotation very effectively reduced the incidence of clubroot disease of cabbage, Chinese cabbage and other vegetables.
5. JIRCAS examined the invasion pattern of the citrus psyllid, the vector of citrus greening disease, a very prevalent citrus disease in Vietnam, to find out how the invasion of new orchards by this vector could be prevented. The results formed the basis of a proposal for appropriate timing of pesticide application.
6. JIRCAS demonstrated that the newly introduced direct seeding system of rice in the uplands is an effective means of dealing with unreliable rainfall and the labor shortage for transplanting in the rainfed paddy fields in Northeast Thailand. The yield obtained from directly seeded rice fields is similar to that obtained from traditional transplanting cultivation and if combined with the no-tilling technique, provides effective weed control.

On the international cooperation front, last year was an active year for JIRCAS, since we were engaged in several mission-oriented activities.

In September 2000, the United Nations declared the U.N. Millennium Development Goals to further global efforts to eliminate extreme poverty and starvation and secure environmental sustainability. Japan, in responding to this call, joined the rest of the world in doing its share to contribute to the achievement of these goals. Towards this end, JIRCAS and the Japan Forum on International Agricultural Research for Sustainable Development (J-FARD) jointly organized an international symposium entitled ***"Perspectives of R&D for Improving Agricultural Productivity in Africa - What and how can Japan contribute to Africa?"*** at the United Nations University (UNU) in July 2005. The symposium aimed to address the economic and food security concerns of Africa and to serve as a venue for the formulation of policies and guidelines for future strategic research activities of J-FARD and JIRCAS in the African region. It was a major success, as reflected by the attendance of many distinguished guests and stakeholders in African agriculture. This symposium was co-sponsored by the Japan International Cooperation Agency (JICA), UNU and the Food and Agriculture Organization of the United Nations Liaison Office in Japan (FAOLOJA), under the auspices of CGIAR, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of Foreign Affairs (MOFA).

JIRCAS also organized a workshop entitled ***"Research and Development for Sustainable Dryland Agriculture in West Asia"*** and the Hokkaido University / JIRCAS Seminar *"Improvement of Crop Root Systems Adapted for*

Dry Regions," held at Hokkaido University on December 13-14, 2005. These activities are part of the MAFF-commissioned JIRCAS project entitled "Strategic study on sustainable production in dryland agriculture of West Asia."

To reduce human suffering caused by food-borne diseases as well as to improve the food hygiene situation in Asia, JIRCAS, in cooperation with the National Food Research Institute (NFRI) and MAFF, organized the ***"Asian Food Hygiene Network Symposium"*** which was held at JIRCAS HQ on March 7-8, 2006. The symposium was attended by experts and researchers working on food-related fields in various Asian countries.

To attain the ultimate end of improving global agricultural productivity and sustainability, it is of great importance to develop the skills of foreign counterpart researchers working in the agricultural field. To meet this need, JIRCAS invited about 20 young researchers from the developing world for one-year collaborative studies in Japan under the JIRCAS Visiting Research Fellowship Program, which has been in place since the early 1990s.

With the aim of expanding its activities globally, every year JIRCAS sends over 10 researchers to the CGIAR Centers to take part in collaborative research. The CGIAR Headquarters, in recognition of JIRCAS's achievements and contributions to CGIAR's mission, designated JIRCAS as a Focal Point Institution in 2004.

In 2004, MAFF commissioned JIRCAS to implement the Japan-CGIAR Fellowship Program, which is designed to support young Japanese researchers in expanding their expertise in international research for development while strengthening international partnerships. Last FY 2005, JIRCAS sent 11 Japanese graduate students and post-doctoral researchers to seven CGIAR Centers for a period of two to three months each.

JIRCAS also places great importance on its cooperation with JICA, and to reinforce it, JIRCAS has sent its staff overseas for the preliminary surveys, management guidance and implementation of several JICA projects. JIRCAS-JICA liaison meetings were also held regularly to discuss specific measures for cooperation.

JIRCAS's efforts and contributions have been highly commended by our collaborative research partner countries.

The Embassy of the People's Republic of China in Japan praised JIRCAS's collaborative research in China, implemented from 1997 to 2003, and expressed great hopes and expectations on China's part for the new collaborative research project, started in 2004, which focuses on stabilizing food supply systems to mitigate the fluctuations in production and markets in China.

JIRCAS Main Building

In February 2006, the Southeast Asian Fisheries Development Center (SEAFDEC) awarded JIRCAS a plaque of commendation for our significant contribution to the improvement of production techniques for juvenile tropical fish species in Southeast Asia.

In March 2006, JIRCAS received a Certificate of Appreciation from the Brazilian Minister of Agriculture, Livestock and Food Supply for our collaborative research with Brazilian research institutes spanning a period of over ten years.

JIRCAS has just commenced the Second Medium-Term Plan, which covers the period from April 1, 2006 to March 31, 2011. It has been formulated to carry out two major programs: first, the research and development of agricultural, forestry and fisheries technologies aimed at solving global food and environmental problems, and second, the collection, analysis and publication of information aimed at grasping trends in international food, agriculture, forestry, fisheries and farming systems. The first major program deals with the following three sub-programs.

1. Developing applicable technologies for stable production and multiple applications of biological resources under adverse environmental conditions
2. Development of environmental resources and suitable production management technology for sustainable agriculture, forestry and fisheries
3. Elucidation of the impact of global environmental changes on agriculture, forestry and fisheries and the development of mitigating technologies

JIRCAS will strive to achieve the goal of becoming a research organization that caters both to domestic needs and to the demands of the international community.

Finally, I wish to thank the members of the Editorial Board of this Annual Report for making this year's publication possible.

稲永忍

HIGHLIGHTS FROM 2005

IMPORTANT NEW DEVELOPMENTS

Certificates of Recognition for International Research Cooperation

JIRCAS received two Plaques of Recognition from SEAFDEC in February 2006

The Southeast Asian Fisheries Development Center (SEAFDEC), which has been conducting comprehensive collaborative research with JIRCAS on sustainable fishery production systems in brackish mangrove areas, conferred on JIRCAS two Plaques of Recognition for our significant contribution in joint research aiming at improvement of seeds and seedling production technology for tropical fish species in Southeast Asia.

Plaques of Appreciation from SEAFDEC to JIRCAS.

In March 2006, a Certificate of Appreciation was presented by Brazil's Agriculture Minister in recognition of more than 10 years of soybean research cooperation

Our research collaboration with Brazil, which started in 1972 and has been implemented through a series of comprehensive projects since 1996, has aimed at achieving environment-friendly, sustainable soybean production by integrating agro-pastoral systems into conventional soybean cultivation. Research outputs for soybeans that are tolerant to drought and resistant to rust will contribute solutions to the current major problems on soybean production in South America. Brazil has commenced a program wherein they plan to improve 22 million ha of degraded grasslands during a 10-year period, using the agro-pastoral system that is one of the major outputs of our collaboration. Dr. Luis Carlos Guedes Pinto, Executive

Certificate of Appreciation from Brazil's Minister of Agriculture to JIRCAS.

JIRCAS senior administrators pose for group photograph at the JIRCAS front entrance. Front row: T. Ono, M. Yasunaka, S. Inanaga, A. Noguchi, S. Matsui, Back row: M. Tada, O. Koyama, Y. Mori, O. Ito, S. Oshio, T. Kumashiro

A. Fujimoto

S. Nakamura

S. Kitamura

T. Senboku

Secretary of the Ministry of Agriculture, Livestock and Food Supply (Ministerio da Agricultura, Pecuaria e Abastecimento), visited JIRCAS on March 18, 2006. He commended JIRCAS's contribution to the agriculture of Brazil and the importance of further collaboration and then presented a Certificate of Appreciation in the name of the Minister of Agriculture to honor JIRCAS's research cooperation over the years.

J-FARD/JIRCAS International Symposium on "Perspectives of R&D for Improving Agricultural Productivity in Africa: What and how can Japan contribute to Africa?"

The Japan Forum on International Agricultural Research for Sustainable Development (J-FARD) and the Japan International Research Center for Agricultural Sciences (JIRCAS) organized an International Symposium on "Perspectives of R&D for Improving Agricultural Productivity in Africa: What and how can Japan contribute to Africa?" on July 14-15, 2005 at the U Thant Conference Hall, United Nations University in Tokyo, Japan. This was attended by a total of 320 international participants. The Symposium was co-sponsored by the Japan International Cooperation Agency (JICA), the United Nations University (UNU), Food and Agricultural Organization of the United Nations Liaison Office in Japan (FAOLOJA), under the auspices of the Consultative Group on International Agricultural Research (CGIAR), the Ministry of Foreign Affairs of Japan (MOFA) and the Ministry of Agriculture, Forestry and Fisheries (MAFF).

Organizers and participants recognized that as a member of the international community, Japan has a responsibility to do its share towards improving the stability and sustainability of developing countries in Sub-Saharan Africa, where many countries face economic stagnation, low income and are especially threatened by food insecurity. Likewise, the Japanese Government is seeking to define its direction in which to demonstrate its commitment towards supporting African agricultural development in pursuance of the policy set forth in the G8 Summit at Gleneagles.

On the first day (July 14), Mr. Kimio Fujita, former President of the JICA made a historical review of Japan's international cooperation efforts for developing countries. Mr. Ian Johnson, Chairman of the CGIAR and Vice-President of the World Bank, addressed the fact that a new era of cooperation in science-for-development is needed to meet the enormous development challenges confronting Sub-Saharan Africa.

Finally, Dr. Monty Jones, (Executive Secretary, FARA) and Dr. Kanayo F. Nwanze, (Director-General, WARDA) who originally developed the New Rice for Africa (NERICA) stated that NERICA will become more crucially important in the future and emphatically proposed that the Japanese government and researchers should provide African researchers with more comprehensive technical assistance to carry out rice experiments. They likewise recognized the impressive Japanese track record of technical cooperation on the development of NERICA.

During the panel discussion (July 15), Mr. Nobuo Kishi, a member of the House of Councilors, noted the importance of the role of Japan and its contribution to international cooperation activities. He also commended the current international collaborative and strategic research activities with research

The speakers and panelists of the Symposium.

centers affiliated with the CGIAR. Several directors-general from CGIAR Research Centers also reported on the various problems plaguing African farmers, such as scarcity of water supply, the small scale of farmlands and the vulnerability of small domestic markets to pressures from developed countries to liberalize local agricultural markets.

DREB Meeting with International Research Institutes in Rome

Aiming at the development of environmental stress-tolerant crops through transformation, JIRCAS has been conducting collaborative research with a number of International Research Institutes in the CGIAR (Consultative Group on International Agricultural Research) group. DREB (Dehydration Responsive Element Binding protein) genes, which are proprietary technologies generated through JIRCAS internal research, have been delivered to these International Research Institutes on the basis of a material transfer agreement.

To further strengthen collaboration and to share technical information as well as technical problems encountered during research, the first meeting on DREB was held in Rome on October 2, 2005, following the international conference on drought (Interdrought II). Key scientists conducting DREB transformation in the International Research Institute such as the International Rice Research Institute (IRRI), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Agricultural Research in the Dry Areas (ICARDA), the International Center for Tropical Agriculture (CIAT), and the International Maize and Wheat Improvement Center (CIMMYT) were present.

The meeting began with scientists from JIRCAS describing the recent status of JIRCAS internal research projects to elucidate the molecular mechanism of crops' abiotic stress tolerance. Recent results on expression analysis of downstream genes activated by a transcriptional factor, DREB1, the identification of a number of stress-inducible promoters through microarray assay, and the isolation and characterization of a new transcriptional factor, DREB2, were presented.

Following this introduction of the current status at JIRCAS, each International Research Institute described its progress achieved so far. IRRI emphasized the importance of the use of high-throughput transformation systems in finally identifying an elite transformant of rice. CIAT described their experiences with the transformation of South American rice, and future plans for further evaluation of these transformants. Concerning wheat, CIMMYT succeeded in generating many primary transformants of wheat. With regard to legumes, ICRISAT has been successfully transforming groundnuts, and ICARDA is working on lentils. Furthermore, a representative of the Brazilian Agriculture Research Corporation (EMBRAPA) described their research into transforming Brazilian soybean varieties using the particle bombardment method.

After the presentations from each institute, a number of technically important issues were identified and discussed. These included the selection and identification of a suitable gene construct, a reliable and universal evaluation method for stress tolerance of the transformants, the importance of analysis of expression profiles or strengths of the introduced transgenes, and the importance of appropriate data collection for preparation for regulatory clearance. Regarding management aspects, all of the participants agreed to renew the existing material transfer agreement, which will be executed between the representatives of each institute.

This first meeting focusing on DREB was constructive and fruitful even from just the viewpoint of information sharing. By holding meetings on a regular basis, further acceleration of progress can be expected in the development of elite transformants in each target crop.

DREB meeting with International Research Institutes held in Rome.

NEW RESEARCH COLLABORATION

New MOUs initiated in Fiscal Year 2005

JIRCAS signs MOU with the Ministry of Science and Technology (MOST) of the Republic of the Sudan

The Ministry of Science and Technology (MOST) of the Republic of the Sudan is tasked with spurring the country towards building a competitive knowledge-based economy. It is committed to maintaining efficient and sustainable technology and to expand knowledge to infrastructures to promote the productivity needed to compete in the global market.

With great hope and interest in establishing collaborative relations with JIRCAS, a five-member Sudanese delegation, led by Prof. El Zubair Beshir Taha, the Minister of MOST, visited JIRCAS on Sept 15, 2005. The other members of the delegation were Prof. Isam Abd El Majid, Director, Sudan Academy of Science; Dr. Eisa El Gaali, Director, Commission for Biotechnology and Genetic Engineering; Dr. Azhari Muh Eldin, Director, Industrial Research and Consultation Center and Dr. Musa M. Omal, Ambassador, Embassy of the Republic of the Sudan. The delegation met and exchanged views with several senior JIRCAS officials on various relevant topics of mutual interest to both JIRCAS and MOST. Their visit culminated in the signing of an MOU for collaboration in agricultural research, affirming the desire of both institutions to engage in collaborative research programs and exchanges.

Thus far, JIRCAS has entered into and has signed MOUs with several CGIAR (Consultative Group on International Agricultural Research) research centers based in Africa, such as the Africa Rice Center (WARDA), the International Institute for Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI). Furthermore, in West Africa, JIRCAS has been carrying out collaborative research work on stable rice production technology with WARDA in Nigeria and the Agricultural Research Institute of Guinea (Institut de Recherche Agronomique de Guinée: IRAG) in Guinea. It has also implemented a collaborative research project with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on **"Improvement of fertility of the sandy soils of semi-arid West Africa"** in Niger. In East Africa, collaborations had been undertaken with ILRI and ICIPE. To date however, JIRCAS had not yet undertaken any research collaborations with North Africa, and thus, this recently concluded MOU between JIRCAS and MOST of Sudan marks the first step in this direction. As a research strategy for the 21st century, JIRCAS places great emphasis on collaborative research for Africa, with its Research Strategy Office playing a lead role in the planning and implementation of research strategies.

Agreement on Research Collaboration with XinJiang Academy of Agricultural Sciences

The Province of XinJiang, in China, is characterized by its dry weather throughout the year. Annual precipitation is less than 200 mm. Although the weather conditions are harsh, the people are able to farm very prosperously, producing a wide range of agricultural products. This is due to the well-designed and long-established irrigation system utilizing snowmelt from mountain regions. This province thus offers an ideal natural environment for screening crops for drought tolerance.

XinJiang Academy of Agricultural Sciences, with its head institute located in Urumqi, has been conducting a wide range of research programs to further improve the province's agricultural production. In particular, it has a long history of evaluation of soybean varieties adapted to local environments using many research stations spread throughout the province.

Evaluation of soybean lines in a field at XinJiang Academy of Agricultural Sciences in Urumqi.

JIRCAS is currently placing a higher priority on the development of abiotic stress tolerant crops, including soybeans. To develop abiotic stress-tolerant soybeans using the conventional approach, a reliable screening system is clearly necessary. Meanwhile, XinJiang Academy of Agricultural Sciences is planning to further strengthen screening for drought tolerance of soybean germplasm.

Because JIRCAS's and the XinJiang Academy of Agricultural Sciences' interests complement each other, on November 1, 2005, both decided to enter into an agreement on collaborative research for three years to screen stress-tolerant soybean germplasm. Through this collaborative research, which will provide the most reliable screening, we anticipate being able to identify drought-tolerant soybean germplasm.

Memorandum of Agreement signed for a new collaborative research project with the International Rice Research Institute (IRRI)

The new IRRI-Japan collaborative research project, entitled "Development of Integrated Rice Cultivation System under Water-saving Conditions" was initiated in August 2005 through funding by the Government of Japan to IRRI. The project aims at developing breeding materials with unique agronomical traits suited to water-limited conditions, evaluation of existing water-saving irrigation techniques, and newly developed breeding materials from the viewpoint of environmental impact and development of a rice-cropping system with high water productivity and low environmental load through integration of water saving techniques, soil and crop management, and newly developed materials. JIRCAS seconded at IRRI two scientists with backgrounds of breeding and soil science to support the project's implementation. To facilitate and harmonize collaboration between IRRI and JIRCAS, both institutes have reached a mutual agreement to compose and sign a Memorandum of Agreement (MOA) that should be placed under the existing MOU.

New projects

On April 1, 2006, the Japan International Research Center for Agricultural Sciences (JIRCAS) commenced implementation of research programs and administrative operations according to the second Medium-Term Plan (April 2006–March 2011) approved by the Ministry of Agriculture, Forestry and Fisheries (MAFF).

JIRCAS Medium-Term Plan (April 2006–March 2011)

《Research Activities》

【A.】 Research and development on agricultural, forestry and fisheries technology geared towards providing solutions to international food and environmental problems

Note: " ・ " indicates individual project

1) Development of technologies to utilize biological resources for stable production and multi-purpose applications under adverse environments.

(1) Elucidation of mechanism of tolerance to abiotic stress and production of tolerant crops
- Development of abiotic stress-tolerant crops
- Elucidation of molecular mechanisms of abiotic stress tolerance and improvement of stress tolerance in model plants

(2) Improvement of abiotic stress tolerance of rice in Africa
- Improvement of drought and submergence tolerance of rice in Africa

(3) Identification of pathogenic races for important diseases and selection of resistant germplasm in major crops
- Blast research network for stable rice production
- Identification of stable resistance to soybean rust for South America
- Molecular analysis of resistance mechanisms to Fusarium head blight in wheat

(4) Development of biomass utilization technology suited to Southeast Asia
- Development of technologies to utilize biomass resources in Southeast Asia

(5) Elucidation of the functionality and quality

parameters of traditional food and agricultural products in Asia and development of effective utilization technology
- Value addition to Asian agricultural products

(6) Effective utilization of genetic resources in tropical and subtropical crops
- Development of the stress-tolerant *Vigna* legumes in tropical and subtropical regions
- Development of breeding materials to diversify sugarcane utilization
- Genetic improvement of vegetable soybean and mungbean for the tropics and subtropics

(7) Sustainable utilization of tropical and subtropical marine resources and development of aquaculture technology
- Technology to control reproduction in commercially important shrimp and prawn species
- Research into suitable stock management in tropical/subtropical areas
- Development of aquaculture technology suited to Southeast Asia

2) Development of management technologies of environmental resources and production systems for sustainable agriculture, forestry and fisheries

(1) Development of sustainable management technologies for tropical soils
- Improvement of the fertility of sandy soils in the semi-arid zones of West Africa through organic matter management
- Good Soil Care (GSC) in the tropics

(2) Integrated management system for improved water utilization aiming at increasing economic options and reducing environmental impact
- Improvement of water utilization and diversification of agricultural production through a participatory approach in rainfed agricultural areas of Indochina
- Development of integrated rice cultivation system for reduced water availability

(3) Improvement of feeding technology for livestock in the tropics and the subtropics and establishment of sustainable agro-pastoral systems in Asian dry areas
- Development of a sustainable agro-pastoral system in dry areas of Northeast Asia
- Establishment of feeding standard for beef cattle and feedstuff database in Indochina
- Production of *Brachiaria* forage grasses with improved quality and drought tolerance for efficient beef production in the tropics
- Verification of the effectiveness of the agro-pastoral system and development of supplemental feed

(4) Elucidation and exploitation of biological nitrification inhibition (BNI)
- Characterization and exploitation of biological nitrification inhibition

(5) Development of environmental management technology for sustainable crop production in tropical and subtropical islands
- Development of environmental management technology for sustainable crop production in tropical and subtropical islands

(6) Development of nurturing techniques for beneficial indigenous tree species in Southeast Asia
- Development of techniques for nurturing beneficial indigenous tree species and combined management of agriculture and forestry in tropical monsoon regions
- Improvement of selective logging techniques for conservation of genetic diversity in the Dipterocarp forests of Peninsular Malaysia

(7) Development of productive low-input cultivation technology for fruit trees in the tropics
- Development of techniques for low tree height-cultivation and year-round production of tropical fruits such as durian, mangosteen, etc., in Southeast Asia

3) Elucidation of the impact of global environmental changes on agriculture, forestry and fisheries and development of mitigating technologies

(1) Developing an impact assessment model and formulation of a food supply stabilization plan
- Stable food supply systems for mitigating the fluctuations in production and markets in China
- Water supply fluctuations in Indochina

(2) Utilization of Geographic Information System (GIS) for development of a land information monitoring technology in developing regions
- Enhancement of GIS applications for agricultural land information on local to regional scales

(3) Developing pest control management technology for major pests in the tropics and subtropics
- Development of management techniques for Citrus Greening disease in severely affected areas
- Biological control of invasive insect pests

on coconut trees

【B.】 Collection, analyses and dissemination of information to grasp trends related to international food, agriculture, forestry and fisheries and rural areas

(1) Collection and dissemination of information related to global food, agriculture, forestry and fisheries

(2) Elucidation of the direction of technology development in developing regions and analysis of socioeconomic conditions of the development in rural areas

- Developing technology assessment methods to determine factors that influence technology diffusion in Southeast Asia
- Impact analyses of economic integration on agriculture and policy formulation towards alleviation of rural poverty in East Asia

ACADEMIC PRIZES AND AWARDS

JIRCAS is pleased to note that many of its staff members have been recipients of academic prizes and awards from scientific societies and other organizations. The following is a brief summary of achievements which we are proud to include in the Highlights of Annual Report 2005.

Dr. Marcy N. Wilder, Senior Researcher in the Fisheries Division, received "The 2005 Japan Prize in Agricultural Sciences, Achievement Award for Young Scientists," given by the Foundation of Agricultural Sciences of Japan, for her work, "Basic physiological research and the development of seed production and aquaculture technology for economically important prawn species." This award is presented annually to scientists who have contributed outstandingly to progress in the agricultural sciences. In her research concerning the physiology of reproduction and osmoregulation in individual prawn species, Dr. Wilder developed a method of maturity evaluation for the purpose of selecting suitable female spawners in prawn seed production. In collaboration with Vietnam's Cantho University, she also established a "Green water methodology" as a system for commercial rearing of freshwater prawn larvae using phytoplankton cultivated within the rearing tanks. Application of these above methods to freshwater prawn culture in Vietnam has led to a rapid increase in annual production levels, exceeding 10,000 tons as of 2003. Dr. Wilder's work has greatly contributed to the development of the freshwater prawn culture industry in Vietnam.

Dr. Yoshimi YONEMOTO, Head of the Tropical Fruit Crops Laboratory at the Okinawa Subtropical Station, received the Research Encouragement Award of the Tropical Agriculture Research Association of Japan on March 26, 2006.
This award is given to Association members who are innovators in their field with significant research achievements in tropical agriculture research.
In his work, Dr. Yonemoto has investigated the physiological effects, especially the pomological and ecological effects, of the cultivation techniques of several tropical fruit cultivars.
Dr. Yonemoto introduced outstanding cultivars of tropical/subtropical fruit trees and has established cultivation techniques for temperate zones, as well as adding significantly to knowledge of the characteristics of tropical/subtropical fruit tree cultivars. He has made an important contribution to practical cultivation techniques.

RESEARCH STRUCTURE AND EVALU

(THE FIRST Medium-Term TARGET PERIOD (April 2001–March 2006))

Research structure at JIRCAS

JIRCAS is located in Tsukuba Science City, approximately 60 km northeast of Tokyo. Many of the Incorporated Administrative Agencies (IAAs) affiliated to the Ministry of Agriculture, Forestry and Fisheries (MAFF) are also located in Tsukuba, which itself is home to numerous other research institutions and experimental facilities. JIRCAS, as of January 1, 2006, has 158 staff members, including research scientists and administrators. Thirty-four of these staff members are located at the JIRCAS Okinawa Subtropical Station on Ishigaki Island in the southernmost region of Japan. JIRCAS is headed by a President and Vice-President, in addition to an Executive Advisor and Auditor who oversee the utilization of institutional funding and all matters related to budgeting and finance. The Research Planning and Coordination Division oversees seven research divisions which are comprised of the Development Research Division, Biological Resources Division, Crop Production and Environment Division, Animal Production and Grassland Division, Food Science and Technology Division, Forestry Division, and Fisheries Division, as well as the five laboratories at the Okinawa Subtropical Station. The Administration Division is responsible for general administrative affairs. JIRCAS's organizational structure is delineated in Fig. 1.

Research Planning and Coordination Division

The Research Planning and Coordination Division itself does not act as a research division, but rather serves to oversee and support the activities of the seven Research Divisions and the Okinawa Subtropical Station. The Division consists of four sections: the Research Planning Section, Research Coordination Section, International Relations Section, and Publication and Documentation Section. In addition, several International Research Coordinators and a Public Information Officer are assigned to the Division. To promote the implementation of research programs both overseas and in Japan, the first three sections listed above are responsible for the overall planning of JIRCAS research projects, dispatching of researchers on long- or short-term bases, implementation of programs for the invitation of researchers and administrators, and liaison and coordination with international and domestic institutions and agencies. The Publication and Documentation Section is responsible for the collection, classification and provision of bibliographic materials from both overseas and domestic sources, as well as the release of public relations materials. The International Research Coordinators are responsible for overseeing some JIRCAS projects. The Public Information Officer oversees the planning, revision, and release of all JIRCAS publications and is responsible for promoting public understanding of the institution's research activities. In addition, the Division is responsible for coordinating the organization of various meetings and workshops, including JIRCAS's International Symposia.

Administration Division

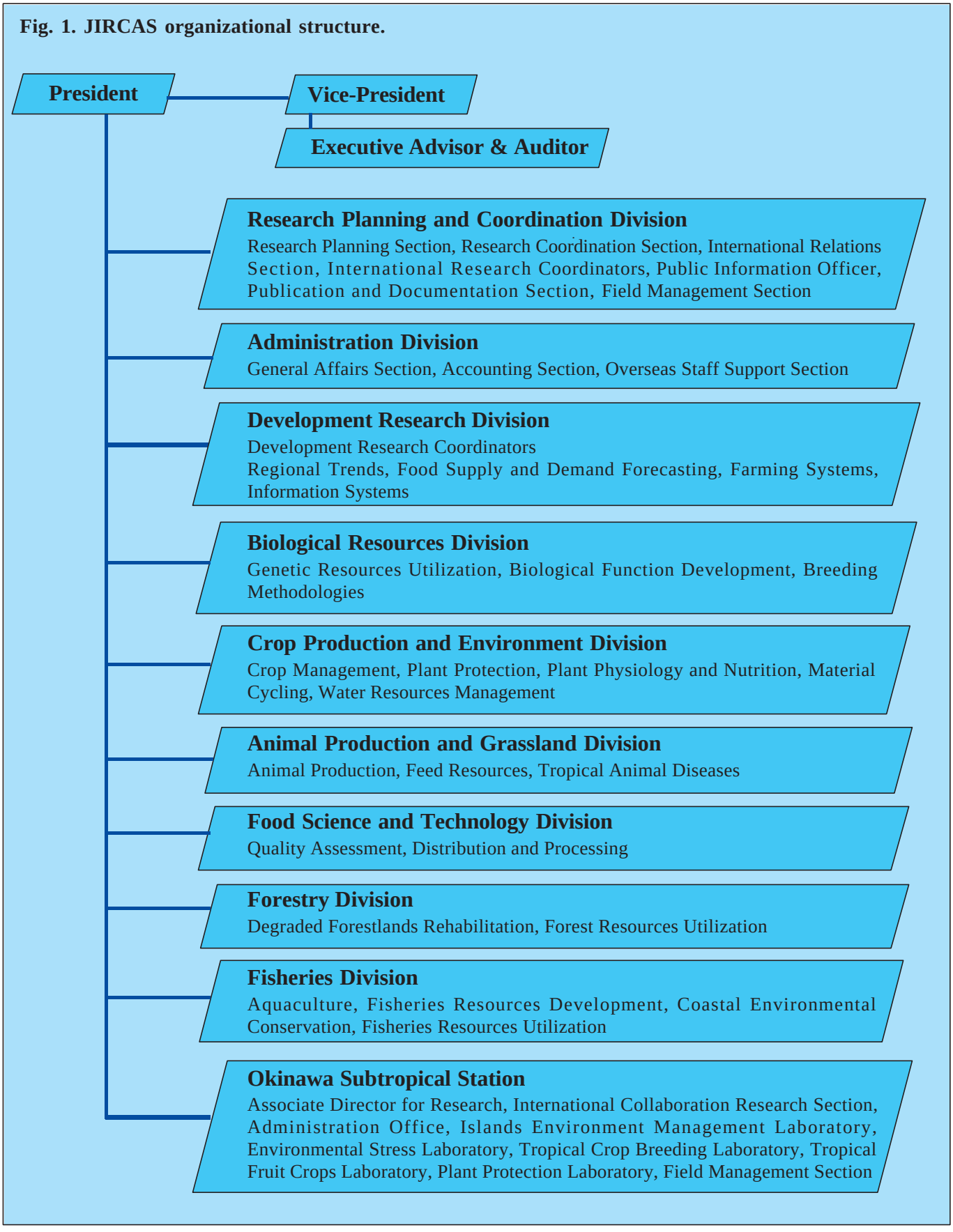
The Administration Division consists of three sections: the General Affairs Section, Accounting Section, and Overseas Staff Support Section. The General Affairs Section is responsible for the management of official documents, personnel-related matters, and social affairs pertaining to JIRCAS staff. The Accounting Section handles overall accounting, auditing, budgeting, settlements and wage distribution. The Overseas Staff Support Section is in charge of all matters pertaining to JIRCAS's overseas operations, including general international affairs, overseas expenditures, and overseas shipments of equipment and materials.

Other

The Okinawa Subtropical Station has an administrative office that is overseen by the aforementioned Administration Division (Fig. 1). Additionally, JIRCAS has two Field Management Sections that oversee JIRCAS's experimental fields; one section is directly under Okinawa Subtropical Station management, and the other is attached to the Research Planning and Coordination Division.

ATION AT JIRCAS

Fig. 1. JIRCAS organizational structure.



Domestic institutional support of JIRCAS international collaborative research

JIRCAS's primary mission is to promote sustainable development of agriculture, forestry and fisheries that is compatible with preservation of the environment in developing regions of the world through integrated, collaborative research programs. Towards this objective, JIRCAS endeavors to play an active role in the international research community. Its collaborative projects in developing countries adopt a multidisciplinary approach that includes the evaluation of the socio-economic conditions in the target countries. In this way, JIRCAS and its counterpart specialists carry out "comprehensive research" in an effort to address the region's most urgent and important agricultural issues. Domestic research at JIRCAS in Japan, the JIRCAS visiting fellowship program, and cooperation with international research institutions all contribute towards and support these overseas research efforts. To orchestrate a project, JIRCAS first systematically collects and analyzes data from a variety of sources, including food supply and agricultural research in developing regions, and then proposes international collaborative research strategies and policies tailored to the specific needs of the target country. In this capacity, by devising comprehensive research and policy proposals, JIRCAS essentially functions as a think tank. Next, JIRCAS utilizes existing technologies, policies, and research to expand its role in the initiation of research programs that effectively confront such pressing matters as sustainable agricultural development, food security, and environmental problems. Currently, JIRCAS is conducting eight comprehensive projects around the world in countries and regions such as Southeast Asia, China, South America, and Africa. Each project is guided and administered by a working group generally composed of the participating scientists, international research coordinators, and JIRCAS directors, who make the necessary adjustments as the project evolves. JIRCAS maintains a formal staff of over 100 researchers, approximately 40 of whom are on long-term research assignments abroad. In addition, JIRCAS's international collaborative research projects receive substantial support from the Ministry of Agriculture, Forestry and Fisheries' seven other affiliated Incorporated Administrative Agencies (IAAs) and their 2,700-strong research staff. For example, when a project requires additional human resources, JIRCAS can request the dispatch of researchers from other IAAs on short-term bases, typically lasting a few weeks to one month. JIRCAS researchers who are not on long-term assignment abroad are located in Tsukuba or at the Okinawa Subtropical Station; these staff support international collaborative projects by conducting project-related domestic research that cannot be accomplished in the target countries. They are also dispatched abroad on short-term bases to promote JIRCAS's projects.

JIRCAS as an Incorporated Administrative Agency

On April 1, 2001, under the Government of Japan's administrative reforms facilitating the reorganization of government-affiliated research organizations, JIRCAS became an Incorporated Administrative Agency (IAA) under the jurisdiction of MAFF. The most distinctive feature of an IAA is its semi-autonomy, with limited prior control from external authorities and an *ex post facto* evaluation system by which it evaluates its own performance. The results of the evaluation are then applied to subsequent activities. Under this new system, MAFF defined JIRCAS's five-year Medium-Term objectives in April 2001, including the enhancement of research efficiency and the improvement of the quality of research programs and financial performance. Based on these objectives, JIRCAS drafted and implemented a detailed five-year plan (see Medium-Term Plan and in-house evaluation system below and Appendix). The performance and budgeting management of research activities conducted by JIRCAS will periodically undergo evaluation by the IAA Evaluation Committee established within MAFF, which is composed of experts from the private sector, universities, and other research organizations. During each fiscal year, the Committee will investigate and analyze progress towards achieving the midterm objectives, and the results of this evaluation will be applied as necessary to structural modifications of the operational and financing systems for subsequent fiscal years. Comprehensive assessment of JIRCAS's performance will contribute towards enhancing the quality of research programs as well as towards more efficient utilization of

financial resources for promoting collaborative research in developing regions. To meet the requirements of this rigorous evaluation, JIRCAS has established an in-house evaluation system, which is described in the following sections.

The Japanese government's basic concepts of science and technology evaluation

Under the 2001 "Science and Technology Basic Plan" which is reflected in the Japanese government's relevant policies, the Japanese community's acceptance of science and technology is extremely important. Research organizations that have become IAAs must clearly identify their research objectives and the implementation of research and development must be enhanced while utilizing funds in an efficient, cost-effective manner. IAAs are also responsible for explaining and communicating their performance in both research and administrative operations to the Japanese people through various information channels that are accessible to the public. To achieve these goals, it is necessary to establish an evaluation system that clearly defines the methodology and orientation of research activities in a manner that will meet public expectations. Along these lines and in order for JIRCAS to accomplish its objectives, appropriate evaluation of the institution's research and administrative operations are to be conducted from quantitative and qualitative viewpoints based on an objective evaluation system.

JIRCAS Medium-Term Plan and in-house evaluation system

JIRCAS conducts its research activities based on Medium-Term and annual plans (Table 1), with the results and efficiency of outcomes evaluated by the aforementioned IAA Evaluation Committee. This evaluation system is best characterized as a bilateral process by which feedback is exchanged between JIRCAS and the Committee. As shown in Fig. 2, under JIRCAS's in-house evaluation system, individual research themes outlined in the Medium-Term Plan and Annual Plan are first evaluated at the division or station level by each Director during internal review meetings attended by JIRCAS administrators and directors. These meetings are conducted from mid-December through early January. Concurrently, evaluation of the management and administration of JIRCAS's operations is jointly conducted by the Research Planning and Coordination Division and the Administration Division. The Research Divisions and the Okinawa Subtropical Station evaluate JIRCAS's research and outcomes, and examine the effectiveness of the dissemination of research

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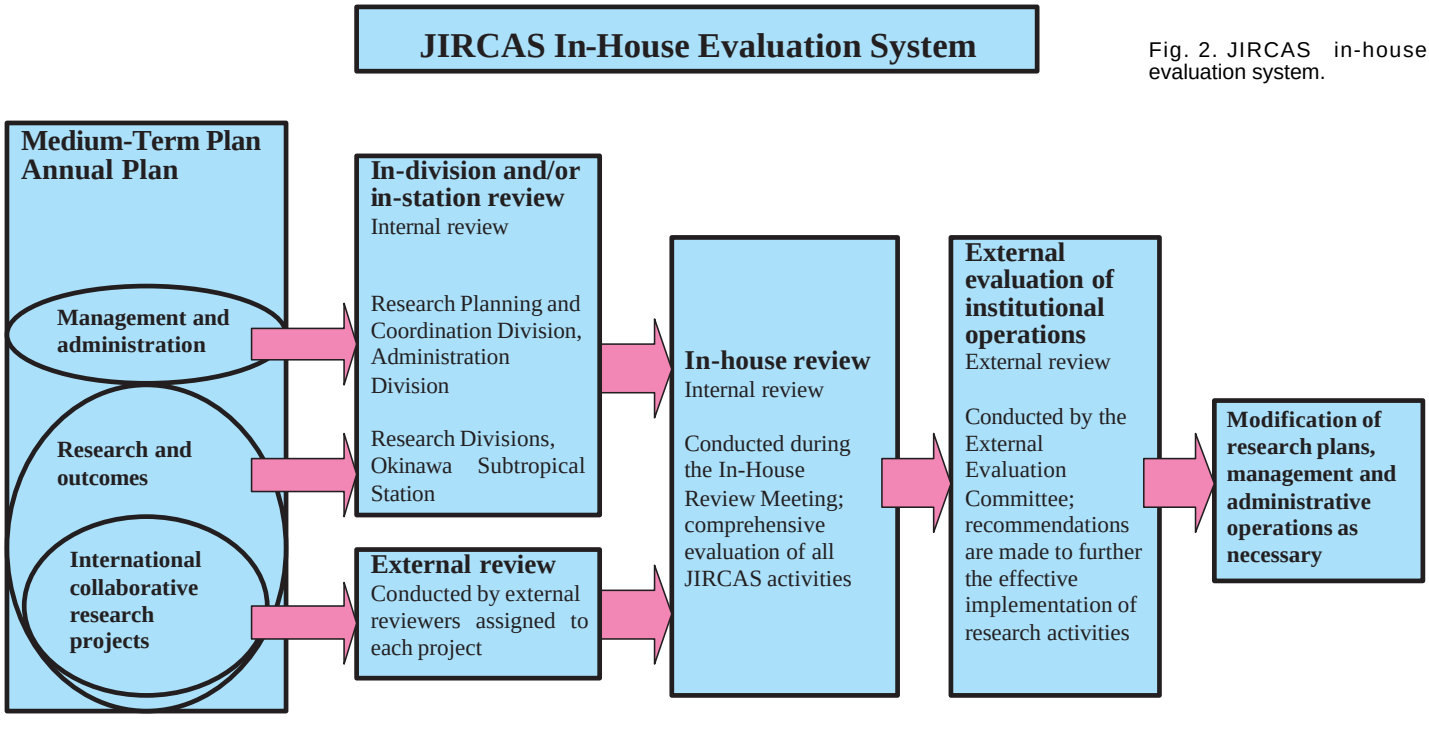


Fig. 2. JIRCAS in-house evaluation system.

Table 1.

JIRCASMedium-Term Plan (April 2001-March 2006) Experiments, research, and investigations	Stable food supply systems in China
A. Improvement of food supply and demand in the developing regions	
1) World food supply and demand and collaborative research strategy	
(1) Analysis for JIRCAS research strategy building	●
(2) World food supply and demand model, particularly for China	●
2) Characteristics and direction of development related to food supply and the environment	
(1) Major constraints on development in Indonesia, West Africa, Vietnam, and other developing regions	
(2) Trends in the development of sustainable farming systems in Indonesia, Vietnam, Thailand, South America, and other regions	●
B. Research in to sustainable development	
1) Sustainable production technology for agriculture, forestry and fisheries commodities in harmony with environmental preservation	
(1) Evaluation of nutrient cycling in diversified cultivated ecosystems and soil amelioration	
(2) Low-input production technology for rice and upland crops in Thailand, Vietnam, China, Indonesia, South America, West Africa, and other developing regions	
(3) Major diseases and insect pests of rice, soybean, and other crops in Southeast Asia, South America, and China	
(4) Local forage resources suitable for agro-pastoral systems	
(5) Physiological characteristics of livestock and of prevalent animal diseases in Thailand, Vietnam, and other developing regions	
(6) Supplementary natural regeneration of valuable tree species in tropical forests	
(7) Environment-friendly methods of aquaculture for aquatic organisms	
2) Quality evaluation, distribution, and processing of agriculture, forestry and fisheries commodities in developing regions	
(1) Quality parameters including appearance and aroma of food resources in Southeast Asia	
(2) Processing technology and prevention of quality deterioration of aromatic rice and other crops	

* Incorporated Administrative Agencies

						●	●	●	●			●						Soybean production and utilization in South America	INTERNATIONAL COLLABORATIVE RESEARCH PROJECTS
																		Control of citrus HLB in Southeast Asia	
																		Utilization of biomass resources in Southeast Asia for sustainable development	
				●								●						Agroforestry technology for tropical forests	
			●									●						Production systems in brackish mangrove areas	
					●			●				●						Increasing economic options in rainfed agriculture in Indochina through efficient use of water resources	
								●	●									Improvement of soil fertility in West Africa	
●	●		●	●		●	●	●	●			●	●		●	●		DOMESTIC PROJECTS	MISCELLANEOUS PROJECTS
●				●	●				●			●			●			DOMESTIC PROJECTS SUPPORTED BY MAFF	
															●			**RESEARCH COMMISSIONED BY OTHER GOVERMENT AGENCIES**	
●			●		●			●	●				●		●			**RESEARCH COMMISSIONED BY MAFF AND ITS AFFILIATED IAAs***	

Table 1.

JIRCAS Medium-Term Plan (April 2001-March 2006) Experiments, research, and investigations	Stable food supply systems in China
(3) Uses for underutilized wood resources such as oil palm residue	
(4) Uses for underutilized aquatic resources in China	
3) Genetic resources and biological functions in developing regions	
(1) Genetic engineering and mechanisms of resistance to environmental stresses	
(2) Evaluation of resistance to disease and pests of rice, wheat and other crops, and development of breeding materials	
(3) Collection, evaluation and preservation of genetic resources of vegetables, fruit trees, and various crops in tropical and subtropical regions	
4) Environmental resources and biodiversity in developing regions	
(1) Environmental resources related to agricultural production and land use	●
(2) Regeneration of tropical forests and introduction of agro-forestry technology	
(3) Aquatic resources in coastal and brackish water mangrove ecosystems in Southeast Asia	
5) Research programs in Okinawa	
(1) Characterization of heat and salinity resistance of snap beans and rice	
(2) Evaluation and utilization of characteristics of sugarcane and root crops	
(3) Regulation of tree form and eating quality of fruits and mass propagation of tropical fruit trees, including mango and papaya	
(4) Incidence of major pests and diseases, such as citrus greening disease, in the tropics and subtropics	
(5) Meteorological and soil factors which cause instability in crop production on tropical and subtropical islands	
(6) Adjustment of variations in heading traits for the generational advancement of rice, wheat, and other crops	

* Incorporated Administrative Agencies

												●	●				Soybean production and utilization in South America
		●															Control of citrus HLB in Southeast Asia
																●	Utilization of biomass resources in Southeast Asia for sustainable development
								●									Agroforestry technology for tropical forests
							●										Production systems in brackish mangrove areas
				●					●								Increasing economic options in rainfed agriculture in Indochina through efficient use of water resources
																	Improvement of soil fertility in West Africa
●	●	●	●	●	●				●			●	●		●	●	DOMESTIC PROJECTS
●	●								●			●	●				DOMESTIC PROJECTS SUPPORTED BY MAFF
													●			●	**RESEARCH COMMISSIONED BY OTHER GOVERMENT AGENCIES**
●	●		●						●		●	●	●		●	●	**RESEARCH COMMISSIONED BY MAFF AND ITS AFFILIATED IAAs***

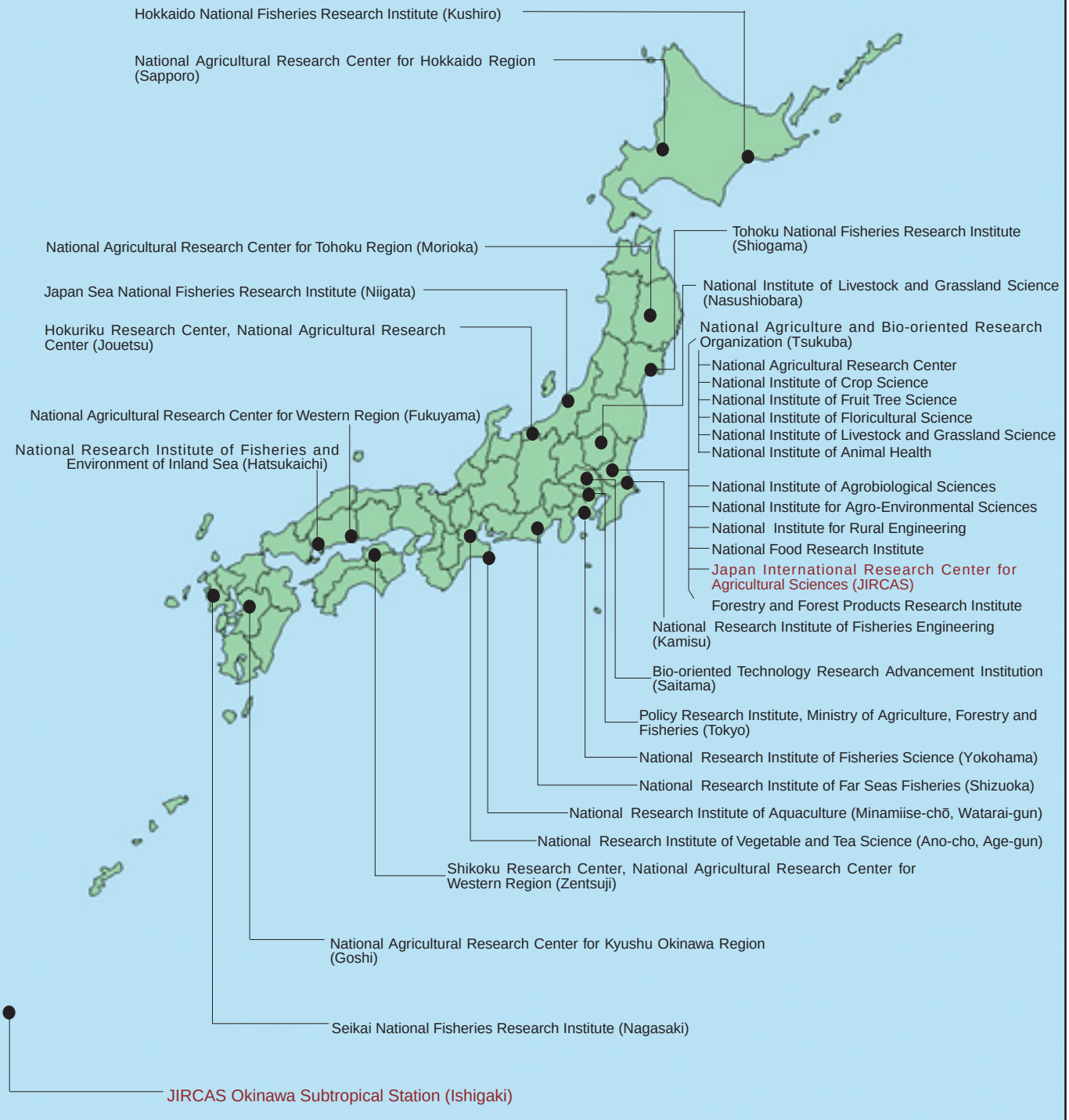
INTERNATIONAL COLLABORATIVE RESEARCH PROJECTS

MISCELLANEOUS PROJECTS

Fig. 3. Incorporated Administrative Agencies affiliated to the Ministry of Agriculture, Forestry and Fisheries.

The eight Incorporated Administrative Agencies (IAAs) involved in research and development for the Ministry of Agriculture, Forestry and Fisheries (MAFF) consist of six agriculture institutions, one forestry institution, and one fisheries institution (Figs. 3 and 4). Of note, the National Agriculture and Bio-oriented Research Organization consists of twelve satellite research institutes and the Fisheries Research Agency consists of nine. In addition, as a national research institute, the Policy Research Institute is attached to MAFF. The Agriculture, Forestry and Fisheries Research Council, an organizational body linking MAFF and the IAAs, promotes comprehensive research efforts in Japan.

Fig 4. Location Map.



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results. For efficient implementation of the individual research components of the Medium-Term Plan and Annual Plans, most of the components are organized into international collaborative research projects that focus on specifically targeted geographical or topical areas. Prior to in-house review, external reviews are conducted annually for individual international collaborative research projects by Japanese and foreign scientists, and administrators and officers from the public sector who are appointed by the President of JIRCAS. Several reviewers are assigned to each project. Based on the above three types of evaluation, a comprehensive in-house evaluation of all of JIRCAS's activities takes place during the In-house Review Meeting held in early February, which is attended by all administrators, directors, and International Research Coordinators. In March, the outcomes and conclusions of the In-house Review Meeting are presented to the External Evaluation Committee appointed by JIRCAS's President for the evaluation of all aspects of institutional operations. These external reviewers evaluate the overall achievement of objectives defined in JIRCAS's Medium-Term Plan and Annual Plans and make recommendations as necessary for the more effective implementation of JIRCAS's research activities. Experiments, research, and investigations conducted according to the JIRCAS's Medium-Term Plan are shown in Table 1. The tenets of the Medium-Term Plan are detailed in the Appendix.

For reference

The new research structure at JIRCAS in the Second Medium-Term Target Period (April 2006–March 2011) is briefly described in Fig. 5. Newest information on the research activities is available on the Web at http://www.jircas.affrc.go.jp/index.html

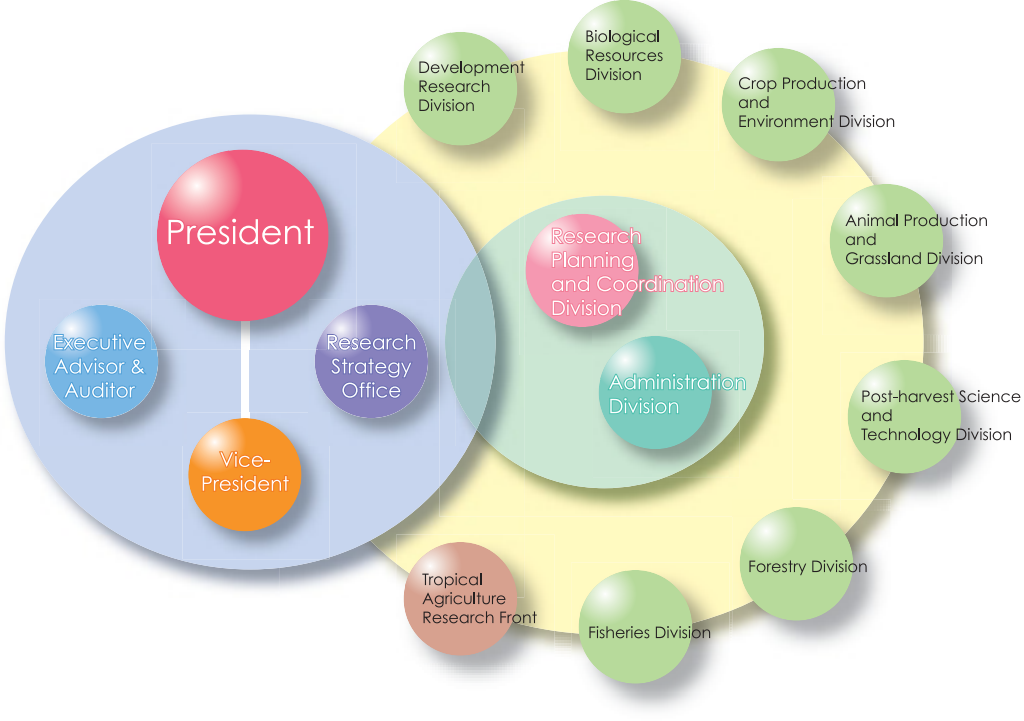


Fig. 5. New Organization (from April, 2006).

RESEARCH OVERVIEW

INTERNATIONAL RESEARCH AT JIRCAS

International collaborative projects at JIRCAS encompass all fields of agriculture, forestry and fisheries and are carried out in association with various other institutions, including international research centers, other Incorporated Administrative Agencies (IAAs), and universities. When the Tropical Agricultural Research Center (TARC) was restructured to create JIRCAS, a series of comprehensive projects was launched that focused on responding to various agricultural problems such as developing sustainable agricultural systems and addressing food supply and environmental issues, all of which confront today's developing countries. Our projects combine research in both the natural and social sciences. Within the scope of a given project, JIRCAS dispatches long- and short-term researchers to developing countries and often sponsors research-related conferences and workshops with the partner country. In addition to these comprehensive projects, JIRCAS continues to promote specific, focused, unidisciplinary projects.

The following section presents recent developments in JIRCAS's ongoing comprehensive projects. In 2005, JIRCAS was involved in eight comprehensive projects in the People's Republic of China; South America including Brazil, Argentina, and Paraguay; Southeast Asia including Malaysia, Thailand, Vietnam, and the Philippines; and West Africa, including Niger. These projects have been divided into three classifications: "Site-specific comprehensive projects," "Country-based comprehensive projects," and "Multinational comprehensive projects." Site-specific comprehensive projects first systematically analyze the agricultural, forestry and fisheries issues faced by a specific region through focused research on the relationships between various factors such as natural resources, the environment, technology, and administration. These projects then draw upon multidisciplinary research to address the needs of the region. Projects in Vietnam, Thailand, Malaysia, and the Philippines are examples of site-specific projects. Country-based comprehensive projects identify the most significant food supply and agricultural problems of the partner country and then select several representative research fields and themes in which JIRCAS can best contribute toward the resolution of those problems. In addition, the projects promote comprehensive joint research through collaboration with the government of the partner country. Multinational comprehensive projects incorporate researchers in many fields over a wide region, encompassing multiple countries in a cooperative effort to resolve strategically important issues. The projects in South America and West Africa are multinational projects. Each comprehensive project has a project leader who organizes and oversees collaboration among researchers in participating research divisions. During the planning stages of these comprehensive projects, socio-economic studies are conducted to identify research priorities in counterpart countries. A complete listing of comprehensive projects undertaken by JIRCAS researchers can be found at the end of this section.

SOUTH AMERICA: Comprehensive studies on the development of sustainable soybean production technology in South America

The soybean is an important staple crop. Soybeans are a major source of food, oil, and protein-rich livestock feed. Production of this valuable crop has increased substantially in the past three decades in comparison with other major grains. Currently, Brazil, Argentina, and Paraguay (all MERCOSUR countries) account for half of global soybean production, placing them among the leading soybean exporters. Recent high market prices for soybeans have motivated farmers to engage in continuous soybean production and to rapidly expand soybean cultivation into environmentally vulnerable areas, such as arid and acid soils characterized by low fertility. Continuous cropping may result in serious outbreaks of diseases and pests such as soybean rust and cyst nematode. The recent frequent occurrence of drought may also adversely affect future soybean production. Comprehensive and multinational research efforts to develop sustainable and more efficient systems of soybean production in South America are an important way of addressing these concerns.

The project framework consists of three primary themes: 1) Development of breeding

technologies for soybeans and grasses, 2) Agro-ecological and physiological characterization in agro-pastoral systems, and 3) Improvement of agro-pastoral systems. These research projects have been implemented by collaboration with several South American (MERCOSUR) and Japanese research organizations, including the Brazilian Agricultural Research Corporation (EMBRAPA) in Brazil, the Ministry of Agriculture and Livestock (MAG) in Paraguay, the National Institute of Agricultural Technology (INTA) in Argentina, the Japan International Cooperation Agency (JICA), the National Federation of Agricultural Cooperative Associations for Colonization (JATAK), and other Japanese research institutes and universities.

The two major threats to current soybean production in South America are drought and soybean rust. Drought is now occurring more frequently. Development of a drought-tolerant soybean is one of the major targets of the project. In collaboration with Centro Nacional de Pesquisa de Soja (CNPSo), EMBRAPA, soybeans transformed with the DREB (Dehydration Responsive Element Binding Protein) gene have been obtained and have shown increased drought tolerance under greenhouse conditions. These soybeans will be further analyzed for gene expression and evaluated under field conditions using 'rain-out shelters.'

Soybean rust has become the most serious disease since its first outbreak in Paraguay and Brazil in 2001. Patho-ecological studies have continued in collaboration with CNPSo, who have identified considerable variations between pathogens collected from different locations in Brazil.

The JIRCAS nematologist based at Instituto Agronomico Nacional (IAN), MAG, Paraguay, has identified the dominant race of cyst nematode in Paraguay as being Race 3.

A large-scale field experiment conducted at Centro Tecnológico Agropecuario en Paraguay (CETAPAR), JICA, resulted in higher yields of soybeans in agro-pastoral plots than in continuous soybean cropping plots. The yield advantage of the agro-pastoral system has been observed over the past three consecutive seasons. Soybean by-products used as winter supplements for grazing beef cattle in the northeastern area of Argentina have been shown to be effective in improving weight gain during winter.

This project was terminated at the end of FY2005; however, several research topics, such as drought-resistant soybeans, soybean rust, and biological nitrification inhibition will be continued as independent projects during the 2nd Medium-Term (FY2006 to FY2010).

Soybean farmer's field in Paraguay.

MALAYSIA: Development of agroforestry technology for the rehabilitation of tropical forests

In FY2000, the Forestry Division initiated a joint research project entitled "Development of agroforestry technology for the rehabilitation of tropical forests," aiming to mitigate agriculture-forestry conflicts as well as to promote environmental conservation and sustainable management of forest resources. The project was implemented mainly in collaboration with the Forest Research Center (FRC) of the Forest Department of the State Government of Sabah, Malaysia.

The following four research topics have been the main focus of this project: technological development to enable the establishment of a favorable environment for agroforestry production; environmental evaluation in the context of agroforestry production; development of technologies to create efficient methods of growing both arboreal and non-arboreal crops under forest canopies; and finally, socio-economic analysis of agroforestry activities.

During FY2005, two JIRCAS researchers specializing in silviculture and soil science have conducted the project at the FRC as long-term visiting scientists. JIRCAS also dispatched three short-term researchers to the

FRC. One was dispatched in the field of silviculture in November 2005, one in soil science in September 2005, and the last in the socio-economic analysis of agroforestry in October 2005.

Under the Counterpart Researcher Invitation Program, Mr. Ricky Alisky Martin, the head of the Social Agroforestry Section, the Forestry Department of the State Government of Sabah, was invited to JIRCAS in February 2006 to exchange opinions and review the progress made under the project.

Since the experimental plots were originally set up at several FRC plantation research stations in February 2003, the project has monitored the growth of various plants cultivated under canopies of planted *Acacia mangium* forests. Among cultivated crops, *noni* (*Morinda citrifolia*) has been identified as a promising cash crop that can be grown on the dim forest floor. To introduce this medicinal plant successfully to the agroforestry system, the project has just recently directed the target of research activities towards the development of its cultivation techniques.

Under this agroforestry project, the sub-project entitled "Studies on the establishment of cover forest for logged-over tropical forests in the Philippines" was implemented in collaboration with the University of the Philippines Los Banos and the Southern Luzon Polytechnic College. To publicize the research work conducted on reforestation and agroforestry in the Philippines, JIRCAS has published a book entitled "Agroforestry Systems in the Philippines: Experiences and Lessons Learned in Mt. Banahaw, Hanunuo Mangyan and some Community-based Forestry Projects."

Noni, a medicinal plant (*Morinda citrifolia*) has been traditionally used by local people in Sabah.

INDOCHINA: Increasing economic options in rainfed agriculture in Indochina through efficient use of water resources (Rainfed Agriculture)

It is now four years since the project started in 2002, with the target area being the lowland-upland boundary zones that extend over Northeast Thailand and Laos, where small-scale mixed farming predominates. The project consists of three main themes: 1) assessment of regional water availability and identification of factors limiting the more efficient use of water in existing farming systems, 2) development of crop production technologies for more effective water use, and 3) the adaptation and integration into farming systems of new technologies through participatory methods.

Following the guidelines for project management at JIRCAS, a workshop and Medium-Term evaluation meeting were organized on 4 and 5 July 2005 respectively, to publicize the research results so far obtained and to critically review past accomplishments and future directions. Based on presentations made at the workshop, the proceedings were published as 27 papers written by both JIRCAS scientists and their counterparts in Thailand.

One of the approaches adopted for the project from its start is a site-based approach, in which Nong Saen Village, 40 km south of Khon Kaen City, was selected for multidisciplinary research. Some of the research highlights obtained this year are as follows. 1) To explore possibility of using groundwater, which is regarded as an important water resource in the area, a survey was conducted through a farmers' meeting to canvass views on groundwater utilization. The farmers feel that it is virtually impossible to drill boreholes, mainly due to the costs involved, suggesting the need to set up a farmer's group for shared use of groundwater within the farm community. 2) Work has started on demonstrations of farming diversification processes through integration of individual technology and the development of a methodology for scaling up and publicizing activities that have been carried out in Nong Saeng village. A specialist in farmer-participatory approach was seconded to Khon Kaen in May 2005 for this work. 3) Concerning the development of water-saving technology by efficient use of residual soil

moisture, to scientifically confirm the previous findings that tomatoes can be grown in fields with only 5 mm of irrigation throughout their growth period, work was started on elucidation of water balance under water-saving conditions and normalization of water-saving technology to the local environmental conditions. 4) In slash-and-burn agricultural areas for upland rice cultivation in the northern Lao PDR, soil has been losing its intrinsic fertility due to erosion. Another project site, Houayyen Village, which has 57 households, has been set up near Luang Prabang City. A risk analysis of erosion and estimation of erosion rate was conducted through soil profile observation, water permeability measurement and quantification of γ-rays from ^{137}Cs, originating in radioactive fall-out, as a tracer. Coarse core development was widely observed in soils in the investigated area. It was speculated from the coefficient of water permeability, confirmed to be greater than 10^{-3} cm s^{-1}, that water percolates smoothly into the subsoil without causing surface runoff, even during heavy rainfall. However, data from ^{137}Cs γ-ray analysis predicts that soil erosion will occur in sloping areas.

Farmers evaluating the growth of vegetables in one of their participatory experiments.

WEST AFRICA: Improvement of the fertility of sandy soils in the semi-arid zones of West Africa through organic matter management

The Sahel, the southern periphery of the Sahara Desert, is frequently afflicted by devastating droughts and famines. The sandy soils of the Sahel are very poor and infertile. The farmers in this region produce their staple foods in what appear to be the most marginal lands in the world. Millet/sorghum-based farmers have traditionally developed close cooperative ties with cattle herders to survive in these harsh environments. They utilize domestically available organic resources such as cattle dung, household waste and crop residues, or keep the land fallow for several years, to maintain and restore the productivity of their farms. However, crop production cannot keep up with the rapid increase in population, making food security currently the most critical issue in the Sahel. JIRCAS initiated a five-year collaborative research project in 2003 with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) located in Niger for improving the fertility of sandy soils in the Sahel.

This project has set its goal as developing an integrated system composed of technologies for the improvement of soil fertility that can be adopted in Sahel agro-ecosystems. Socio-economical and geographical investigations of existing resources in the Sahel have been a part of the research activities of the project, as well as the evaluation of local agricultural knowledge and technologies related to soil fertility management. The project aims at elucidating the degradation process and kinetics of soil-improving organic matter in the Sahel environment, to estimate the nutrient-holding capacity of the sandy soils as affected by organic matter amendment both on a short- and long-term basis, and to identify the synergic interaction and agronomic significance of combinations of organic and inorganic fertilizers. The project also evaluates plant genetic resources, emphasizing the positive introduction of legume crops to the cropping system in the Sahel. Indigenous and exotic plants are also evaluated for possible functions in soil fertility preservation, such as biomass production, prevention of soil erosion, biological nitrogen fixation, and solubilization of immobile nutrients. Based on the results from these research activities, advanced

Participants to the Symposium on "Improvement of Soil Fertility through Organic Matter Management," held at ICRISAT, Niamey, Niger, on September 10, 2005.

techniques for maintenance and improvement of sandy soil fertility will be proposed and verified through repeated on-farm trials in close collaboration with ICRISAT and national programs in Niger and the Sahel countries.

Now in its third year, the project has carried out every activity defined in the overall work plan. The following are items of note this year.

- A survey on the villages in the project site (Fakara region) revealed that indigenous soil fertility management practices are associated with distance between farmers' fields and their houses: that is, farms near villages commonly utilize household waste and farmyard manure as organic fertilizers, while more distant farms are characterized as being managed only by letting them lie fallow, and give lower millet yields.
- Farmers in the Fakara region were interviewed on their preferences as to cowpea varieties, the most popular leguminous crop in the Sahel. The results indicated that dual-purpose varieties that are high yielding in both grain and fodder are the most favored.
- A field evaluation reconfirmed higher productivity in six breeding lines of cowpea, which had been selected for better adaptation to the Sahel environment in previous field trials.
- "The Fakara Plants" database has been constructed and linked to the JIRCAS Homepage (http://www.jircas.affrc.go.jp/project/africa_dojo/Fakara_plants/Fakara_Plants_home.html). It shows the native plant species in the Sahel, and gives descriptions of their growth habitat, local importance and other valuable information.
- A unique soil management system employing fallow land has been postulated, which features a patch or band inside the croplands to capture wind-carried fertile materials. This physical role of the fallow system is verified to be of significance in the nutrient budget in agro-ecosystems in the Sahel.

Since this year corresponds to the middle of the project term, a symposium and a medium-term evaluation meeting were held at ICRISAT in Niamey on September 10 and 12, respectively. The symposium, titled with the name of this project, attracted 53 scientists, technical officials, students and others not only from Niger but also from neighboring countries, who participated in very fruitful and constructive discussions.

The medium-term evaluation meeting, followed by the symposium and field trip, was also successful. The evaluation committee has pointed out that overall research activities during the last two years have been executed exactly as agreed in the original work plan, so no modification will be necessary for the future general research plan. The committee also commented that for the sake of generalization of the project outputs, the potential should be examined for deploying the outputs in other regions than the project site, starting from the mid-stage of the project.

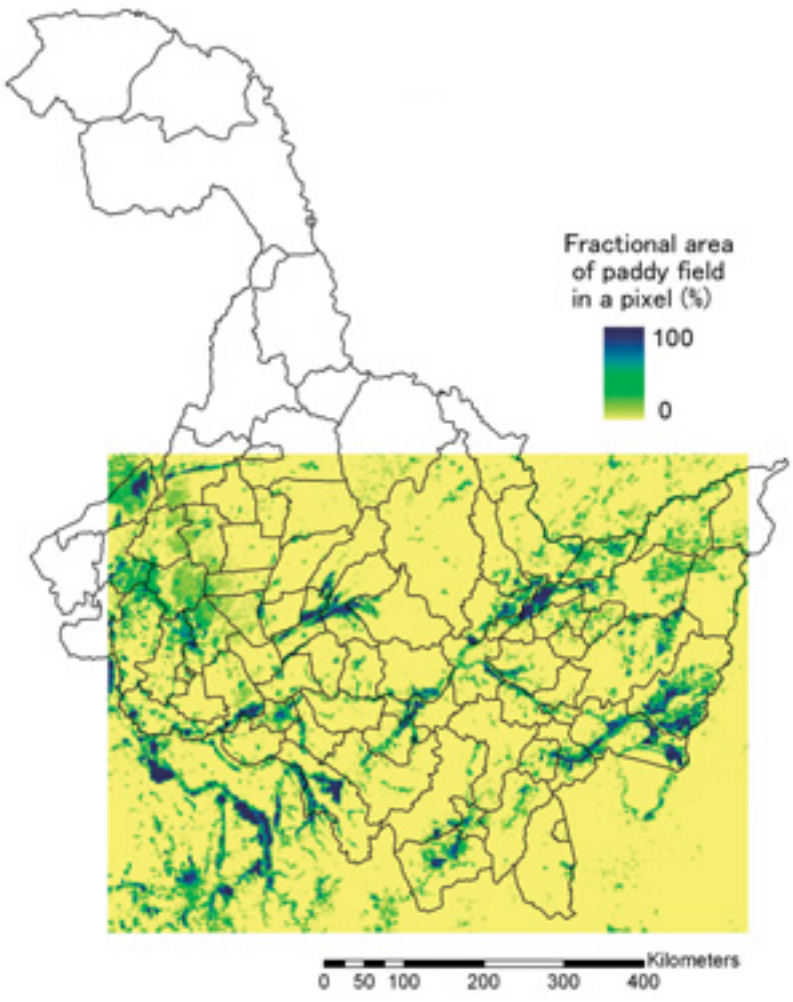
CHINA:
Studies on stable food supply systems for mitigating the fluctuations of production and markets in China

The project, officially initiated in July 2004, aims to study how to stimulate and stabilize the farm and rural economy in China, particularly in the inland and northeastern regions such as Heilongjiang Province, by developing stable food supply systems for mitigating the fluctuations in food production and markets caused by both natural and economic phenomena.

Rice is a major grain food crop that is extensively cultivated from tropical to cool climate zones. Heilongjiang Province, located in a cool climate zone, is one of China's major rice production areas. In the last year, as the second year of the project, we attempted to develop a method for rapidly estimating the

area of paddy fields in Heilongjiang Province using satellite remote sensing data. We estimated the distribution of paddy fields in selected counties where the influence of clouds was minimal. Field servers were deployed at Heilongjiang Academy of Agricultural Science and Hebei Agricultural University, and we tested the data-transfer and sensors' functions. Daily mesh meteorologies of Heilongjiang for mean, maximum and minimum temperature datasets were created at a spatial resolution of 5' x 5' (8 km x 8 km) by the simple statistical interpolation method, enabling comparison between the damage from cool weather year and year of non-damage from cool weather. Moreover, we designed an early warning system for cool weather damage to rice production in Heilongjiang. The system has four components: weather data, mesh weather data, a developmental model and a yield model. We defined the parameters of the crop developmental model based on leaf age at six sites, and built in a meteorological data map generator and created time series graphs of key meteorological data.

We also conducted surveys on farmers' management on different scales, which revealed that combinations of two or more rice varieties held promise as a preventative measure against cool weather damage. We carried out a simple examination to check and obtain the necessary data for the resistance of rice to low temperatures. Moreover, a policy proposal based on the site survey in Jiangxi and Heilongjiang was made for farmers' collaborative organizations, agrotechnology-promoting organizations, and farm insurance. The state-owned farms play key roles in rice farming in Heilongjiang. These were shown as a model for farm insurance and distribution, etc. An analysis was carried out on the rice supply and demand trends, and the price trends, especially in Heilongjiang, and the problems with rice production and consumption were identified. Our survey in Zhejiang, Fujian and Guangdong showed that Heilongjiang's share of rice production is increasing.



Estimated distribution of paddy fields in Heilongjiang Province using MODIS data (2003).

We held a workshop entitled "Development of Early-Warning Systems for Mitigating the Risk Caused by Climate Disasters through Technological Enhancement of Resource Monitoring and Crop-Model Simulation" last November at Tsukuba. Another workshop, "Situation of Rice Distribution System and Agricultural Social Services system in China" was held in Beijing in March of this year.

VIETNAM: Development of new technologies for the control of citrus huanglongbing (HLB) in Southeast Asia

Citrus greening (CG), 'Huanglongbing' (HLB) in Chinese, is one of the most important diseases affecting citrus production in tropical and sub-tropical areas worldwide, including the Mekong Delta. HLB is induced by a bacterial pathogen, *Candidatus* Liberibacter asiaticus, which is transmitted between citrus trees by an insect vector, *Diaphorina citri* (the Asian citrus psyllid). In 2004, in a move to overcome this obstacle, JIRCAS launched a project entitled 'The

development of new technologies for the control of citrus HLB in southeast Asia' in collaboration with the Southern Fruit Research Institute (SOFRI) of Vietnam. Basic techniques for the promotion of research were developed in this project. For example, loop-mediated isothermal amplification and quantitative PCR were successfully applied to the efficient detection and quantification of the DNA of the pathogen. The effective marking method of the vector was also developed for the ecological study of the vector.

Concurrent with the start of JIRCAS's new medium-term plan, the project has been re-designed and started from 2006 as a new five-year project, 'Development of management techniques for citrus greening disease in severely affected areas,' collaborating with SOFRI and the Ving Long provincial government of Vietnam. In this new project, making the best use of achievements in the last 2 years, we aim to establish technologies for sustainable citrus production in areas where citrus greening disease is endemic. With this aim, four sub-themes (I to IV) are being undertaken. Sub-theme I is 'The establishment of risk assessment methods for decision-making in plantations under the IPM program.' In this sub-theme, the establishment of techniques for risk assessment of CG and the elucidation of dispersal characteristics of the vector are conducted. Sub-theme II is 'The establishment of a simple monitoring method for the vector.' A monitoring method for the vector that is cheap and easy for farmers to use will be developed based on the physiological and ecological aspects of the vector. Sub-theme III is 'The development of techniques to attenuate damage caused by CG.' Under this sub-theme, the use of disease-free seedlings in combination with application of insecticides is being investigated for efficacy on the attenuation of yield loss by CG. Several cultural practices (Photo) and resistant rootstocks are also being tested for their efficacy against CG as components of IPM. Sub-theme IV, 'Estimation of the economic impact of citrus greening in farm management,' is the most unique part of this project. Under this sub-theme, countermeasures to CG that are developed under sub-themes I to III are measured for their economic efficacy in on-farm investigations to promote integrated management of the disease. This social scientific study will help the extension of new techniques by providing evidence on the economic efficacy of these techniques.

We are certain that our collaborative work will—literally—be fruitful, leading citrus producers in Mekong Delta towards practical and successful control of Citrus Greening disease.

A field experiment on the effect of guava interplanting as a cultural practice for controlling citrus greening disease is ongoing as a collaboration between SOFRI and JIRCAS.

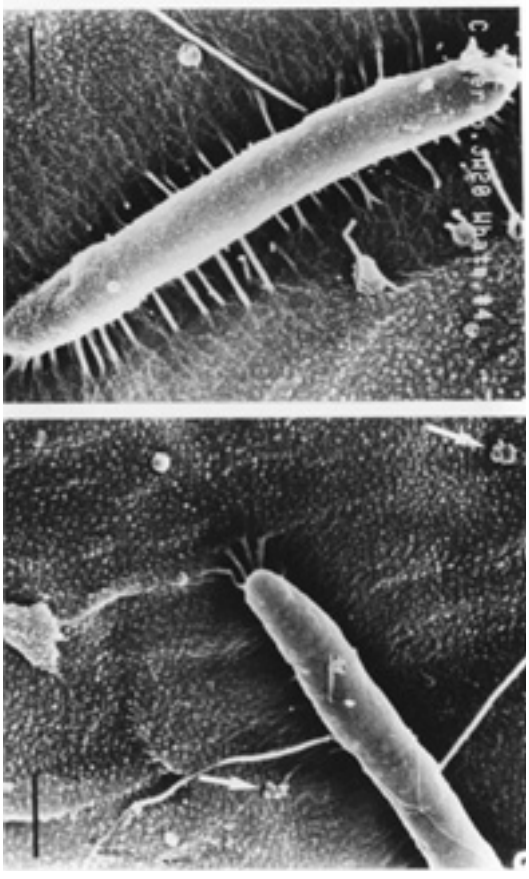
SOUTH ASIA: Development of biomass utilization technology suited to Southeast Asia

Southeast Asian countries are expected to make rapid economic progress, which due to their large population will have a major impact on the world's energy situation and the environment. Most are located in tropical areas and likewise possess abundant biomass resources. To contribute to attaining sustainable development in Southeast Asia with minimum pressure on the environment, JIRCAS has launched a six-year (2005–2010) project entitled "Development of biomass utilization technology suited to in Southeast Asia." This project deals with the following two primary themes: 1) Developing an ethanol production system using agricultural residues in tropical areas; and 2) Environmentally compatible material production from woody biomass.

Effective utilization of biomass resources for creating alternative fuels and materials is regarded as a key to solving the energy, environment and agricultural challenges facing Southeast Asian countries. The outcomes of the project will also provide the basic means by which Japan can achieve the

carbon dioxide emission reduction target imposed by the Kyoto Protocol, either through direct use of ethanol fuel and usable materials, or by utilizing the Clean Development Mechanism (CDM).

In 2005, Theme 1, "Development of an ethanol production system using agricultural residues in tropical areas," commenced in Thailand in collaboration with the School of Bioresources and Technology, King Mongkut's University of Technology Thonburi (KMUTT-SBT) and Kasetsart Agricultural and Agro-Industrial Product Improvement Institute, Kasetsart University (KAPI). The aim of this undertaking is the production of an alternative fuel to petroleum using agricultural residues, such as cassava stalk/peel and sugarcane bagasse/leaves. Through studies in FY2005, we characterized major biomass resources and concluded that cassava pulp is among the best resources for ethanol production. We also examined the conditions for degrading agricultural residues using various kinds of enzymes, including cellulase, hemi-cellulase and amylase. Subjects under Theme 2, "Environmentally compatible material production from woody biomass," are scheduled to start in 2006.



Active cellulase/hemi-cellulase complex (small particles) and the bacterium that produces it.

INTERNATIONAL COMPREHENSIVE PROJECTS

All projects are handled by JIRCAS Research Divisions.

Time Frame	Project Title	Research Site
1997–2006 2003–2006	Comprehensive studies on soybean improvement, production and utilization in South America Comprehensive studies on the development of sustainable soybean production technology in South America	• Ministry of Agriculture and Livestock (MAG), Paraguay • JICA-Agricultural Technology Center in Paraguay (CETAPAR), Paraguay • National Center for Soybean Research and National Center for Beef Cattle Research, Brazilian Agricultural Research Corporation (EMBRAPA), Brazil • Marcos Juarez Agricultural Experiment Station, the National Institute for Agricultural Technology (INTA), Argentina
2000–2006	Development of agroforestry technology for the rehabilitation of tropical forests	• Sabah Forest Research Centre, Malaysia
2001–2005	Studies on sustainable production systems of aquatic animals in brackish mangrove areas	• The Southeast Asian Fisheries Development Center (SEAFDEC), Philippines • Fisheries Research Institute (FRI) and the University of Malaya, Malaysia • Faculty of Fisheries, Kasetsart University, Thailand
2002–2008	Increasing economic options in rainfed agriculture in Indochina through efficient use of water resources	• Department of Agriculture (DOA), Thailand • Khon Kaen Animal Nutritional Research Center, Thailand • Department of Livestock Development (DLD), Thailand
2003–2007	Improvement of the fertility of sandy soils in the semi-arid zones of West Africa through organic matter management	• International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niger
2004–2008	Studies on stable food supply systems for mitigating the fluctuations of production and markets in China	• Research Department of Rural Economic Development, Research Center of the State Council, Peoples' Republic of China • Heilongjiang Academy of Agricultural Sciences, People's Republic of China • Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, Ministry of Agriculture, People's Republic of China • Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Ministry of Agriculture, People's Republic of China • Institute of Agricultural Economics, Chinese Academy of Agricultural Sciences, Ministry of Agriculture, People's Republic of China
2004–2008	Development of new technologies for the control of citrus huanglongbing (HLB) in Southeast Asia	• Southern Fruit Research Institute (SOFRI), Vietnam

Time Frame	Project Title	Research Site
2004-2006	Research on Physiological Functionalities of Indigenous Vegetables in Southeast Asia	• Asian Regional Center (ARC) of Asian Vegetable Research and Development Center (AVRDC)- The World Vegetable Center, Thailand • Kasetsart University Research and Development Institute (KURDI), Thailand
2005-2010	Development of biomass utilization technology suited to Southeast Asia	• The Institute for Research and Development of Agricultural Products and Industry, Kasetsart University, Thailand • King Mongkut's University of Technology Thonburi, Thailand • Universiti Sains Malaysia, Malaysia

JIRCAS RESEARCH DIVISIONS

The following pages offer an introduction to the wide range of activities pursued by the seven Research Divisions and the Okinawa Subtropical Station. Each Division summary features a brief overview describing current research priorities within the Division, followed by more detailed descriptions of selected topics pursued during Fiscal Year 2005.

DEVELOPMENT RESEARCH DIVISION

The Development Research Division consists of 13 senior researchers who specialize in a variety of academic disciplines and conduct distinctive interdisciplinary research on a range of issues centering on technology development, resource management, and socio-economic concerns in developing countries.

Overall, the Division aims to investigate and identify significant problems within these research themes by conducting surveys and analysis on both the micro (household and village) level and the macro (regional and national) level.

These activities also focus on the research and development process by improving rural survey methods, farming-system research, information networks, remote sensing and geographical information systems, and econometric/quantitative models.

To achieve the Division's goals, the following four research groups are formulated according to specific target areas: 1) the Research Strategy Group, 2) the Food Supply/Demand Analysis Group, 3) the Farm Management and Farming Systems Group, and 4) the GIS and Information Systems Group. Many researchers at the Division are also involved in various comprehensive research projects and play key roles, particularly in socio-economic and interdisciplinary studies. The following are the results of our program in FY2005.

Joint study on contract farming by JIRCAS, CAAS and IFPRI.

The Research Strategy Group contributed to formulating JIRCAS's new medium-term plan, which covers five years starting from FY2006. The Group raised issues to be studied for dry areas such as Mongolia, and they have been conducted under a project named "Development of a sustainable agro-pastoral system in dry areas of Northeast Asia" that aims to attain sustainable use of pastures and to increase the income of livestock farmers.

The Food Supply/Demand Analysis Group has developed a rice demand/supply model of the lower Mekong basin which has a stochastic structure, such as the influence of water cycle changes, and has linked it to a global model for estimating the impact of global warming on crop production and trade. The Group has also analyzed province-level rice demand/supply in China for simulating the regional impact of rice price changes.

The Farm Management and Farming Systems Group held a workshop to review farming systems research in Southeast Asia. The Group has also continued with participatory research on rational land and water use in Northeast Thailand, developed a management model by applying linear programming to reduce the risk of damage to rice crops from cold weather in China, and carried out surveys on vertical coordination between farmers and distributors/processors in several East Asian countries.

The Remote Sensing and GIS Group has implemented research on methodological development for monitoring land use and analysis of temporal vegetation changes in agriculturally marginal land. The project sites are located in China, Thailand, Laos and Burkina Faso.

Division members also played key roles in organizing seminars and workshops, including acting as Secretariat for the J-FARD & JIRCAS International Symposium named "Perspectives of R&D for improving agricultural productivity in Africa: What and how can Japan contribute to Africa?" in July.

The impacts of climate change on the world food market: Medium-term analysis using International Food and Agricultural Policy Simulation Model (IFPSIM)

Global warming caused by concentration of carbon dioxide in the atmosphere will be a major issue in world food markets over the next century. Agricultural production will be affected by climate change, such as rising temperatures or droughts, mainly through changes in crop yields. Environmental changes in a particular country or region will affect agricultural production in other countries or regions indirectly through the trade of food products. Thus, it is likely that climate changes, such as global warming, will cause drastic changes in agricultural markets. This research examines the possible impacts of global warming on world agricultural product markets using IFPSIM, the world food model of JIRCAS.

Rainfall and temperature affect crop production. It is assumed that only yield is affected by these climatic variables. The following double-log form yield function is estimated as $\ln YHt = a + b_1 T + b_2 \ln PRC_t + b_3 \ln TMP_t$, where YH is yield, T is the time trend, PRC is rainfall measured in millimeters, and TMP is temperature measured in degrees Celsius. The difference function is estimated if the probability that the yield data is non-stationary is higher than ten percent.

The rainfall and temperature data are the average values from the Global Historical Climatology Network (GHCN). The climate variables are based on monthly data on the flowering or silking season of each crop. The year term of the estimation period is from 1961 to 2000. Large countries are divided into regions based on the cropping map. The crops in the model are wheat, maize, other coarse grains, rice, and soybeans. The other coarse grains include barley, rye, oats, millet, and sorghum. The yield and production data for each crop is that of Food and Agriculture Organization of the United Nations (FAO)-STAT. The base year of the simulation is 1998 and the term of the projection is from the base year to 2025.

The assumptions of the simulation are as follows: (1) the cropping calendar is fixed, (2) the area available for cropping is fixed, (3) the climatic variables directly affect only yields, (4) the temperature measured in degrees Celsius of all countries and regions increases 0.05% per year, and (5) all other parameters are fixed.

Table 1 shows the results of the estimation. The parameters are the elasticities of yield for rainfall and temperature. The results show that rainfall has a significantly positive effect on the production of maize and other coarse grains. On the other hand, higher temperatures have a negative effect on the production of most crops except for rice. Figs. 1 and 2 show that the growth rates of production in different countries between 2005 and 2025. Wheat production in the USA will increase due to falling production in other countries. The production of rice in the USA will sharply decrease while that in Japan, South Korea, and many developing countries will increase.

Table 1. Elasticity of yields for climatic variables.

Wheat		
Country	Rainfall	Temp.
EU	-0.117	-1.076
Canada	0.344	-0.096
Australia	0.443	0.368
New Zealand	-0.214	-0.600
Eastern Europe	-0.062	-0.660
Egypt	-0.021	-0.348
Pakistan	-0.041	-0.482

Maize		
Country	Rainfall	Temp.
USA	0.186	-1.226
EU	0.138	-0.135
Eastern Europe	0.476	0.051
Ex-USSR	0.076	-0.764
Argentina	0.252	-1.191
Thailand	-0.038	-2.440
China	0.168	-0.913

Rice		
Country	Rainfall	Temp.
USA	-0.003	-1.123
EU	0.009	1.282
Japan	-0.230	1.043
Eastern Europe	-0.013	0.790
Brazil	0.135	-0.454
India	0.037	-1.994
S. Korea	-0.048	1.302

Other Coarse Grains		
Country	Rainfall	Temp.
USA	0.029	-1.525
EU	-0.017	-0.772
Japan	-0.095	-0.349
Canada	0.189	-0.489
Australia	0.423	-0.110

Other Coarse Grains (Cont.)		
Country	Rainfall	Temp.
Eastern Europe	-0.018	-0.492
Ex-USSR	0.506	-1.589
Argentina	0.144	-1.439
India	0.103	-3.395

Soybeans		
Country	Rainfall	Temp.
USA	0.220	-0.791
Japan	-0.335	-0.192
Eastern Europe	0.011	-0.850

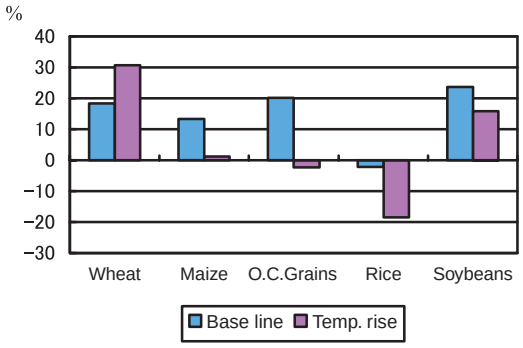


Fig. 1. Growth rate of production in the USA.

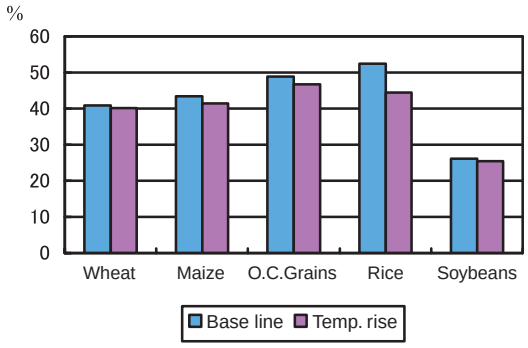


Fig. 2. World growth rate of production.

Fig. 2 shows that the world production of most farm commodities will not be severely affected by high temperatures, even though each country will be affected by climate change. This is because the sign of elasticity is different for each country, as seen in Table 1. Rice production, however, will be significantly affected by climate change, largely because of the sharp drop in rice yields and production in the USA and South Asian countries.

While the scenario is fairly simple (temperature increases 0.05% per year for all countries, or about 0.2 ˚C over the next twenty years), drastic changes in crop production are seen in some countries. Countries that suffer severe damage due to higher temperatures may need to consider changes in cropping patterns and practices.

(J. Furuya)

TOPIC 2

Spatial identification of the crop-fallow rotation cycle and potential capacity for regeneration of fallow in northern Laos by satellite imagery

In northern Laos, shifting cultivation, namely slash-and-burn agriculture, has been conventionally practiced for upland rice (Fig. 1). However, the crop-fallow rotation cycle is tending to shorten due to forest conservation policies and population pressure, causing deterioration of productivity and in turn affecting farmers' livelihoods in the region. To investigate the land condition in these areas, we developed a robust method of identifying the crop-fallow rotation cycle spatially using periodical observed satellite imagery, i.e., Landsat/Thematic Mapper (TM) and Enhanced Thematic Mapper + (ETM+). The study site was an area of 442,000 ha within N19˚30'; E101˚45'; – N20˚00'; E102˚30' in Luang Prabang Province.

Fig.1. View of hills in northern Laos where slash-and-burn agriculture is implemented.

According to the typical calendar for slash-and-burn agriculture in northern Laos, land is cleared from February to early April, and burned in March and April. Sowing is practiced from late April to June, and harvesting is from September to November. The most drastic change in the land surface is slashing to clear the fallow plants in the late dry season: the area used for cropping in the imminent rainy season changes to non-vegetation as a result of slashing for land preparation, but fallow areas show uninterrupted vegetative growth. The classification of vegetation/non-vegetation is one of the most reliable applications using remote sensing; therefore, land use in each year was identified by the presence of

vegetation in the late dry season. In this study, 8-scene imagery of TM and ETM+ acquired annually from 1995 to 2003 were applied.

The results of classification of 8 scenes were represented by an 8-digit code to track the land use change year by year. For 1995-2003, approximately 77,000 ha (17.3%) had never been cropped but 41,000 ha (9.2%) had been used for cropping every year. The former was regarded as forest and the later as sedentary farms growing rice. The rotated area between cropping and fallow was classified by crop intensity. The areas cropped 1-2 times, 3-4 times, and 5-6 times occupied 129,000 ha (29.1%), 83,000 ha (18.7%), and 54,000 ha (12.2%), respectively (Fig. 2).

Vegetation in fallow shows a succession from shrub to bush, and ultimately to forest. Normalized Difference Vegetation Index (NDVI), derived from TM and ETM+, is known to be related to biomass. Hence, NDVI was applied to assess the process of plant regeneration in fallow. Fallow was classified by fallow length (age) from the 1st to 7th years and the mean NDVI was calculated for each fallow age. The mean NDVI increased constantly with fallow age, and it was estimated that 11 years was needed to reach to the same NDVI as that of forest. However, the cropping intensity mentioned above showed that long-term fallow exceeding 7 years accounted for only 17.3% of the area, implying that a large area might be re-used before vegetation is sufficiently regenerated. In addition, the potentiality for vegetation regeneration in fallow was assessed by comparison to the mean NDVI corresponding to the same fallow age. The results indicated that low-potential areas showed a lower NDVI than the mean for 66,000 ha, confirming that low-potential area increased as cropping intensity increased.

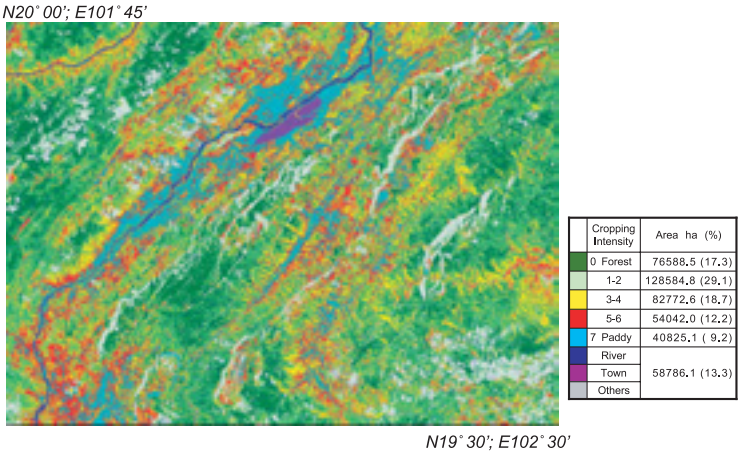


Fig. 2. Cropping intensity for 1995 – 2002.

Due to restrictions on slash-and-burn agriculture, farmers in northern Laos have been urged to switch to more productive and conservational farming systems. The method and spatial information provided in this study will be useful for regional scaled land resource management.

(Y. Yamamoto)

BIOLOGICAL RESOURCES DIVISION

The Biological Resources Division has made its target three areas on a trait basis. Abiotic stress tolerance, biological stress resistance, and quality are the major traits we work with, with the chief emphasis on abiotic stress tolerance. To tackle these traits, the division has been employing not only the conventional approach but also a molecular approach to its target crops, such as rice, wheat and soybeans. The conventional approach covers the evaluation of a wide range of germplasm under certain stressed conditions, identification of tolerant and susceptible germplasm, and acquisition of DNA markers tightly linked to the tolerance gene. The molecular approach focuses on the isolation of genes which confer tolerance on the plants through elucidation of the molecular mechanisms of stress tolerance, followed by development of stress-tolerant crops through transformation of tolerant genes coupled with a suitable promoter.

In collaboration with the International Rice Research Institute (IRRI) in the Philippines, we have identified the chromosomal regions responsible for heading date using SSR makers in the advanced generation of Near Isogenic Line (NIL) with an IR64 genetic background. Differential varieties for blast resistance targeting 14 different resistant genes have been completed against the genetic background of CO39 and LTH. Division scientists at the Nigeria Center of West Africa Rice Development Association (WARDA) have been re-evaluating root length of the top 100 lines selected at Bamako, Mali, in the previous year, and have developed a population that is categorized into long-root and short-root lines.

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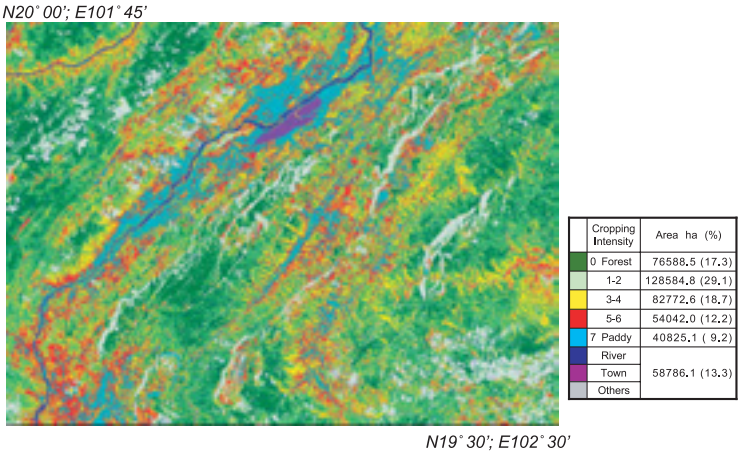

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In collaborative work with the International Maize and Wheat Improvement Center (CIMMYT), which is aiming at the development of a wheat variety resistant to *Fusarium* head blight (FHB), division scientists have identified candidate genes responsible for the reaction to the fungal toxin. Also, using a subtraction library between FHB resistant and susceptible wheat varieties, candidate genes such as the ribosomal protein Sm-D1 were detected. Meanwhile, a simple bio-assay system has been developed that can be used to analyze interactions between the fungus and the host. In collaborative work with International Center for Agricultural Research in Dry Areas (ICARDA), evaluation of 13 lines of synthetic wheat under different drought regimes has revealed that lines with drought tolerance appear to be derived from wild relatives, and that the relatively high grain yield observed in the drought-tolerant line could be explained by the rapid translocation rate of photosynthetic products into spikelets after the heading stage. Meanwhile, a system for monitoring the real-time moisture content of soil has been constructed, featuring the use of a small robot field server.

In the JIRCAS project entitled "Comprehensive studies on soybean improvement, production and utilization in South America," division scientists at the Brazilian Agriculture Research Corporation :Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), have succeeded in acquiring a DNA marker linked to 3 out of 4 major resistance genes of soybean to soybean rust disease, one of the major biotic threats to soybean production in South America. A trial to establish a reliable screening protocol for quantitative resistance genes to this disease, which are believed to be more durable than resistance controlled by a single major gene, has been initiated. As for abiotic stress tolerance, a division scientist and scientists of EMBRAPA have played an important role in introducing JIRCAS's dehydration responsive element binding protein (DREB) gene into Brazilian soybean varieties. After intensive transformation experiments using particle bombardment, they have successfully generated numerous independent soybean transformants, which now are under evaluation for various traits. In the JIRCAS internal project, "Selection of stress-tolerant soybean germplasm and identification of DNA markers associated with tolerant genes," a simple evaluation method for screening germplasm tolerant to salinity has been developed, enabling rapid screening in the greenhouse. In terms of evaluation for drought tolerance of soybeans, an agreement on collaborative work with Xinjiang Academy of Agricultural Sciences has been executed for collaboration starting from 2006.

Primary transformants of soybean generated by particle bombardment.

In collaboration with the Asian Vegetable Research and Development Center (AVRDC), two different projects have been conducted. One is breeding programs to improve the nutritional characteristics of soybeans and mung beans. Steady progress has been made toward each breeding goal: promising lines have been selected for immature soybeans adapted to tropical regions, mung beans with high methionine content, and soybeans with high nodulating ability. The other project, which aims at evaluation and selection for domestic vegetable species with high nutritional value, was completed this year. Based on 5 years of past research, a database describing the nutritional value and growth habitats of domestic vegetable species has been constructed at AVRDC.

For many years, the molecular biology group of the Division has been utilizing biotechnological approaches to reveal the mechanism of tolerance to abiotic stresses such as drought, salinity, and freezing in plants, with remarkable achievements, such as the discovery and isolation of DREB from *Arabidopsis*. This year, through further molecular characterization of downstream genes activated by transcriptional activating elements such as DREB and AREB (ABA-

responsive element binding protein), we have succeeded in constructing an active form of AREB and in isolating DREB2 derived from maize (ZmDREB2), both of which have been proven to confer tolerance to various abiotic stresses on introduction to the target plant species. Along with these new transcription factors, they have also identified a number of new sets of promoters with much higher responses to abiotic stress. Furthermore, novel classes of transcription factors, which may exhibit unique responses to various stresses, are close to final identification. With regard to soybeans, a new microarray carrying more than 40,000 soybean genes has been constructed, which it is believed will play an essential role in gene expression analyses, identification of novel genes, and the isolation of new classes of stress-inducible promoters of soybeans.

TOPIC 1

Improvement of drought stress tolerance by gene transfer of a transcription factor, AREB1, involved in ABA-responsive gene expression

Due to the food crisis and environmental pollution, it is becoming ever more important to breed environmental stress-tolerant crops. Plant productivity is greatly affected by environmental stresses, such as drought and high salinity. Genetic engineering has high potential to improve the stress tolerance of crops using gene transfer technology. Several different approaches to improving the stress tolerance of plants by gene transfer have been attempted. In our strategy, a gene encoding a transcription factor involved in abscisic acid (ABA)-responsible gene expression was used.

The plant hormone ABA is produced under drought and high-salinity stress conditions and plays a pivotal role in tolerance to these stresses. Numerous drought- and high-salinity-stress-inducible genes have been reported in plants, and many of them are also activated by ABA. In analyses of the promoters of such ABA-regulated genes, a conserved *cis*-element designated ABA-responsive element (ABRE; PyACGTGGC), which controls ABA-regulated gene expression, has been identified. The drought-responsive expression of an *Arabidopsis* gene, *rd29B*, is mainly mediated by ABA. Two ABREs play a crucial role in the expression of *rd29B* as *cis*-elements. Using yeast one-hybrid screening, we cloned three different cDNAs encoding ABRE-binding proteins (AREB1, AREB2, and AREB3) of *Arabidopsis*. Expression of *AREB1* and *AREB2* is upregulated by ABA and drought and high-salinity stresses. Both AREB1 and AREB2 function as *trans*-acting activators, as identified by transient expression analysis in protoplasts.

To determine the temporal and spatial expression patterns of AREB1, we analyzed transgenic *Arabidopsis* plants expressing an *AREB1* promoter-*GUS* reporter gene. In unstressed plants, weak *GUS* expression was observed in the roots, leaf vascular tissues and hydathodes. By contrast, drought or ABA treatment of plants enhanced the *AREB1* promoter activity in all tissues (Fig. 1). The subcellular localization of the AREB1 protein in plant cells was further analyzed using a Green Fluorescent Protein (GFP):AREB1 fusion protein. GFP fluorescence was detected in the nucleus, indicating that AREB1 is localized in the nucleus of the plant cells.

We generated transgenic plants overexpressing the *AREB1* cDNA under the control of the *CaMV 35S* promoter (*35S-AREB1*). However, constitutive overexpression of intact *AREB1* alone is not sufficient to activate its downstream genes such as *RD29B* under normal growth conditions. The ABA-induced modification of the AREB1 protein seems to be also required for the expression of its downstream genes. To overcome the masked transactivation activity of AREB1, we created an activated form of AREB1 (AREB1ΔQT) carrying the AREB1 internal deletion mutants containing the bZIP DNA binding domain and transcriptional active domain of AREB1. We generated transgenic plants overexpressing AREB1ΔQT and examined their stress tolerance. When plants grown in pots were not watered, almost all the wild-type plants died within 12 days. In contrast, nearly all the transgenic plants of two independent lines survived this level of drought stress and continued to grow when

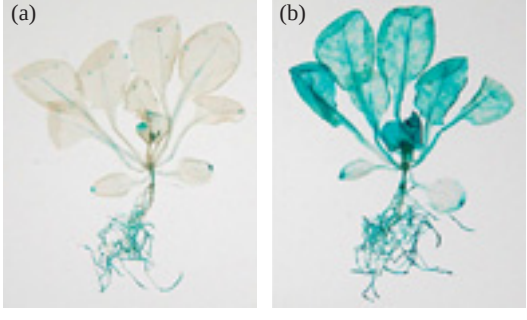

Fig. 1. Histochemical localization of *AREB1* promoter-driven *GUS* expression in *Arabidopsis*: (a) 2-week old plant, (b) 2-week-old plant treated with 50 μM ABA. Bars = 5.0 mm.

watering resumed, demonstrating their enhanced drought tolerance (Fig. 2). We analyzed upregulated genes in the transgenic plants using a microarray and found that eight genes in two groups were upregulated: LEA-class genes including *RD29B* and ABA- and drought-stress-inducible regulatory genes such as *HIS1-3* (encoding a linker histone H1), *GBF3* and *RD20*. All eight upregulated genes have at least two ABRE sequences in their promoter regions, and are known to be ABA- and stress-inducible. By contrast, an areb1 null mutant and a dominant loss-of-function mutant of AREB1 (AREB1:RD) with a repression domain exhibited ABA insensitivity. Further, AREB1:RD plants displayed reduced survival under dehydration. These data thus suggest that AREB1 regulates ABRE-dependent ABA-signaling that enhances drought tolerance in vegetative tissues. We believe that the activated form of AREB1 may be useful for improving the stress tolerance of agriculturally important crops by gene transfer.

(K. Yamaguchi-Shinozaki and Y. Fujita)

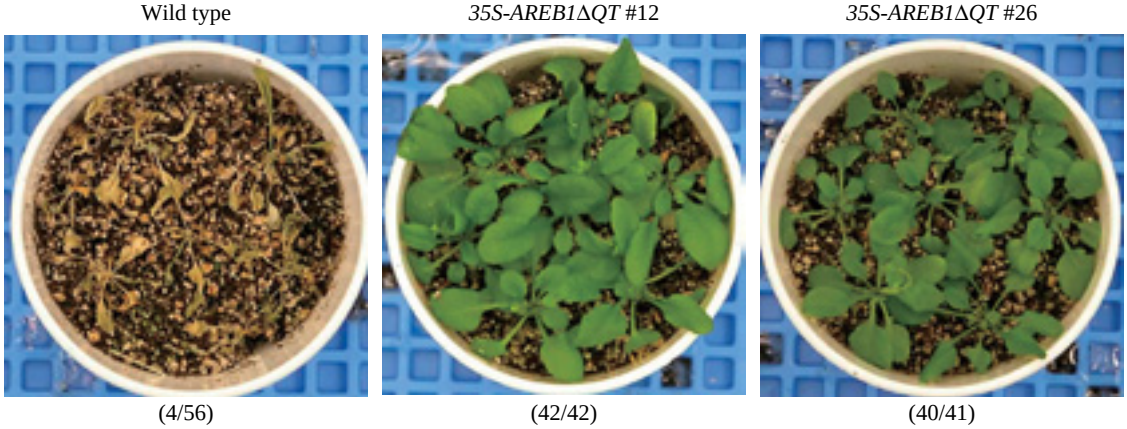

Fig. 2. Enhanced tolerance to drought in the *35S-AREB1ΔQT* plants (2 independent transgenic plant lines). Watering was withheld from 3-week-old plants for 12 days before the photograph was taken. Number codes = number of surviving plants out of the total.

TOPIC 2

Dehydration responsive element binding protein (DREB)1-type transcription factors in transgenic rice improve tolerance to drought, salt, and freezing

Drought, salt and freezing are environmental conditions that dramatically affect the growth of plants and crop yields. Genetic engineering has high potential for improving the stress tolerance of crops using gene transfer technology. A *cis*-acting promoter element, DRE/C-repeat (CRT), plays an important role in regulating gene expression in response to these environmental stresses. The *Arabidopsis* transcription factors DREB1s/C-repeat binding factor (CBF)s bind to DRE and control the expression of many stress-responsive genes. In rice, we have isolated cDNAs for DREB1 homologs and named them OsDREB1s. We have reported previously that overexpression of the *DREB1* or *OsDREB1* genes induces strong expression of the many stress-responsive genes in transgenic *Arabidopsis* plants, which in turn boost stress tolerance to high salt levels and freezing. In this study, we analyzed the function of the *OsDREB1A* and *OsDREB1B* genes in stress tolerance using transgenic rice and compared it with that of *DREB1A*. We observed improved tolerance to drought, high-salt and cold stresses in the transgenic rice plants.

To analyze the function of rice OsDREB1A and OsDREB1B proteins, we generated transgenic rice (*Oryza sativa* cv. Kita-ake) overexpressing *OsDREB1A* or *OsDREB1B* under the control of the constitutive maize promoter. To compare the function of the rice OsDREB1 family with that of *Arabidopsis* DREB1/CBF family in rice, we also generated transgenic rice overexpressing *Arabidopsis DREB1A*, *DREB1B* or *DREB1C*. These transgenic rice plants showed growth retardation under normal growth conditions in the same way as did the transgenic *Arabidopsis* plants overexpressing *OsDREB1* or *DREB1*. Both OsDREB1 and DREB1 showed a similar effect of growth retardation under normal growth conditions. The tolerance of the

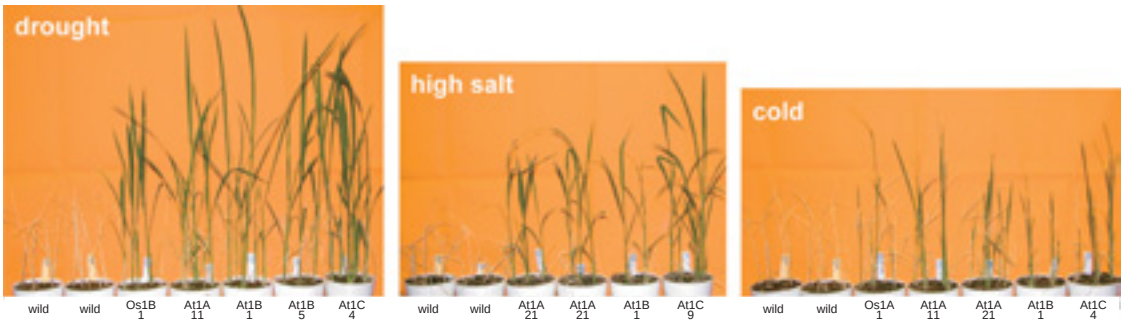

Fig. 1. Drought, high-salt and cold stress tolerance of the transgenic rice plants (cv. Kita-ake) overexpressing *OsDREB1* or *DREB1* genes, and wild-type plants. The stress treatments were conducted as described below. Drought = 17-day-old plants with water withheld for 9 days and then supplied with water again for 13 days. High-salt = 17-day-old plants soaked in 250 mM NaCl solution for 3 days and transferred to pots under normal growth conditions for 19 days. Cold = 17-day-old plants were exposed to a temperature of 2 ˚C for 93 h and then to 28 ˚C for 18 days. 'Wild', 'Os1A', 'Os1B', 'At1A', 'At1B' and 'At1C' mean wild-type plants and transgenic rice plants overexpressing OsDREB1A, OsDREB1B, DREB1A, DREB1B and DREB1C, respectively.

transgenic rice overexpressing *OsDREB1* or *DREB1* to drought, high-salt and cold stresses was compared with that of the control plants (Fig. 1). Although 0%, 5% and 5% of the wild-type plants survived under drought, high-salinity and cold conditions, respectively, 17 to 80%, 13 to 83% and 25 to 60% of the plants overexpressing *OsDREB1* or *DREB1* respectively survived under the same conditions.

Many plants accumulate a number of compatible osmolytes such as proline and various sugars under drought, high-salt and cold stress conditions, and these osmolytes function as osmoprotectants that contribute to tolerance to stress. Transgenic *Arabidopsis* plants overexpressing *DREB1A* have been reported to accumulate proline and various sugars even under unstressed control conditions. We examined whether transgenic rice overexpressing *OsDREB1A* or *DREB1A* also accumulated proline and various sugars under control conditions. The free proline levels in the wild-type rice under high-salt and cold stress conditions were approximately 5- and 7-fold higher than those under the control conditions, respectively. Even under control conditions, the transgenic plants overexpressing *OsDREB1A* and *DREB1A* accumulated 4- to 5-fold and 6- to 15-fold higher levels of proline, respectively, as compared with the wild-type rice. Similarly, wild-type rice plants accumulated high levels of sugars such as raffinose, sucrose, glucose and fructose in response to high salt or cold stress. Even under unstressed conditions, the transgenic rice plants overexpressing *DREB1A* accumulated high levels of these sugars.

The whole genome sequence of rice (cv. Nipponbare) has recently been determined. In addition, approximately 22,000 sequences of independent full-length cDNAs of rice (cv. Nipponbare) were registered in a public database, and an oligoarray containing approximately 21,500 rice probes was produced based on these sequences. To analyze the upregulated genes in the transgenic rice overexpressing *OsDREB1A* or *DREB1A*, we generated transgenic rice plants overexpressing *OsDREB1A* or *DREB1A* using cv. Nipponbare. We identified 12 target genes of OsDREB1A in the transgenic rice using microarray and RNA gel blot analyses (Fig. 2). These genes encode proteins that are thought to function in stress tolerance in plants and most of these genes were induced by at least one of drought, high-salt and cold stresses; many promoters of the upregulated genes contain DRE sequences. These results indicate that the DREB1/CBF cold-responsive pathway is conserved in rice and the DREB1-type genes are quite useful for improvement

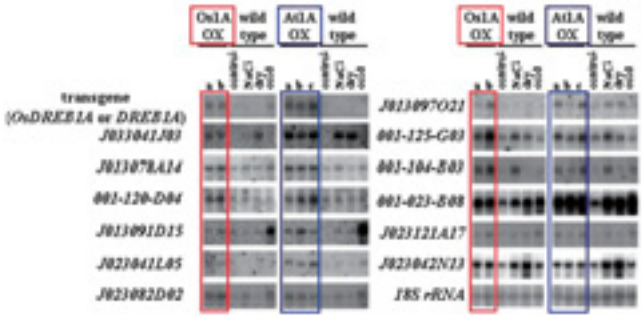

Fig. 2. Expression of the OsDREB1A upregulated genes in the transgenic rice plants (cv. Nipponbare) overexpressing the *OsDREB1A* or *DREB1A* genes and in the wild-type plants. Sixteen-day-old transgenic rice (cv. Nipponbare) seedlings grown hydroponically were sampled under unstressed conditions (control) to prepare total RNAs. The wild-type plants were kept in 250 mM NaCl for 5 h (NaCl), water withheld for 5 h (dry) or kept at 4 ˚C for 24 h (cold). Each lane was loaded with 10 mg of total RNA.

of tolerance to environmental stresses in various kinds of transgenic plants, including rice.

(Y. Ito, K. Maruyama and K. Yamaguchi-Shinozaki)

CROP PRODUCTION AND ENVIRONMENT DIVISION

Our goal is to develop sustainable agricultural production technologies through judicious utilization of the diverse functions of crops, microbes and natural resources. The division consists of five research groups: material cycling, crop management, plant physiology and nutrition, water resource management and plant protection. Nearly one third of our scientists in the division are seconded to several national and international organizations on long-term assignment and are involved in working on various comprehensive projects organized/managed by JIRCAS.

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A soybean field damaged by soybean cyst nematode in Paraguay.

Since 2005 was the last year of our first phase of MTP, major research highlights for the past five years from each research theme are briefly summarized as follows. In Theme (1), we developed a method for evaluating the recycling of organic resources in administrative territories or agricultural ecosystems and applied this method to estimating the sustainability of agricultural activity. It was shown that in north-eastern Thailand and in the Can Tho district of Vietnam, residues from crops and the feces and urine of domestic animals were not utilized efficiently, and the use of synthetic fertilizers was increasing. In Paraguay, South America, it was shown that the alternating use of land for agriculture and cattle raising was useful for replenishing and maintaining organic substances in the soil. We additionally advanced our study related to the technology for management of the ecological system of farmlands and soil management technology aimed at reducing environmental burdens. In the Mekong Delta of Vietnam, we conducted an experiment to evaluate the validity of a bio-digester designed to extract bio-gases from the feces and urine of pigs and demonstrated the usefulness of this device. At the same time, we demonstrated that the sludge from digested pig manure, which is rich in nitrogen and phosphorus, was useful as a fertilizer. Concerning the release of greenhouse gases (e.g., methane and nitrogen monooxide) and ammonia, our field work in China and indoor experiments demonstrated that the release of gases and ammonia can be reduced using controlled-release fertilizers and nitrification inhibitors and by adjusting the soil moisture level. In low fertility soil in north-eastern Thailand, the balance between nitrogen, phosphorus, and potassium was improved and crop yield was increased using cow feces, rice straw, and green manure made from leguminous plants. In the Sahel, West Africa, we showed that the use of cow feces on low fertility soil increased soil organic substances and agricultural productivity, and that the amount of carbon substrate contained in the soil was the limiting factor for microbial activity.

In relation to Theme 2, we identified major problems related to direct seeding, fertilizer application, and weed control in irrigated and

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rainfed rice fields in tropical regions. The techniques developed to resolve these problems were tested not only in experimental fields but also in farmers' fields alongside existing techniques, revealing that our new techniques were effective and capable of increasing yield. Among others, in the southern part of north-eastern Thailand, we proposed a technique of direct seeding of dry rice fields, combined with non-plow cultivation, for the production of Khao Dawk Mali (jasmine) rice, a high quality fragrant rice variety. Regarding upland farming in tropical regions, we showed the validity of our cultivation techniques (introduction of deep-rooted plants, water-saving cultivation, establishment of crop rotation, etc.) in resolving soil-related problems (hard pan, drought, clubroot, etc.). Concerning environmental stress on the soil, we elucidated a mechanism for soil adaptation to stress and devised a method for the simple evaluation of stress-resistant crop varieties. So far as water control technology is concerned, we developed a technique for evaluating the current status of water and land resource utilization in the rainfed farming areas of northeastern Thailand.

In Theme 3, we clarified the situation pertaining to the whitebacked planthopper (*Sogatella furcifera*), and, on the basis of an analysis of genes encoding resistance to this insect, we identified an excellent commercial variety of nonglutinous rice, "Kyoka No. 1," as being resistant to *S. furcifera*. We demonstrated the validity of cultivating this resistant rice variety with less application of agrochemicals in farmers' fields. We also clarified the situation related to *Helicoverpa armigera* and showed that two insects of the *Tachinidae* family, serving as natural enemies of *H. armigera*, are closely involved in regulating the population density of this pest. We additionally established a technique for raising these natural enemies for multiple generations, thus opening a path towards biological pest control. In South America, we investigated the distribution of soybean cyst nematode (*Heterodera glycynes*) and conducted race identification to speed progress toward the development of resistant soybean varieties. As illustrated above, we have obtained diverse findings, practical data, and information ranging from basic to applied fields, pertaining to comprehensive pest and disease control with the ultimate aim of achieving sustainable agricultural production.

TOPIC 1

First report on the growth reduction of soybean caused by *Heterodera glycines* and its distribution in Paraguay

The soybean cyst nematode, *Heterodera glycines*, one of the most widespread and destructive soybean pests, was identified in Paraguay in 2002. Since soybean is the most important crop in the country, the distribution of this nematode was surveyed. Soil samples were collected from 64 fields in the main soybean producing districts of Alto Parana, Itapua, Canindeyu and Caaguazu, from 2004 to 2006 in Paraguay. A soil sample of approximately 5 kg was collected from the top 0-15 cm soil from 10 points in each field. GPS coordinates of the sampling points were recorded. Nematode cysts were extracted using a flotation sieving technique. The nematode was identified on the basis of the shape and vulval cone structure of the cysts. *Heterodera glycines* was recovered from a total of 16 fields (Fig. 1), of which eight are new records of this nematode in Paraguay. In Canindeyu, *H. glycines* was detected for the first time in seven out of the 28 fields surveyed, i.e., a frequency of 25%. The nematode was also detected in two fields in which it had been previously reported. More than 10 cysts/50 g soil were extracted from some of these fields. The results suggest that

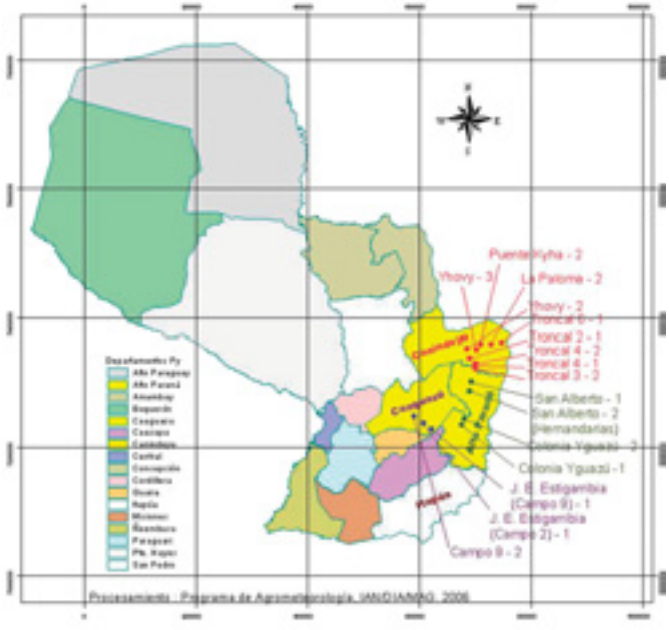


Fig. 1. Distribution of *Heterodera glycines* in Paraguay surveyed in 2004-2006. The key to each point indicates place and field code.

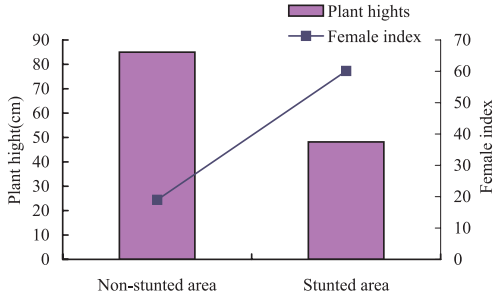


Fig. 2. Comparison of plant growth and degrees of infection of *Heterodera glycines* females between a stunted area and that of a non-stunted in a soybean field in San Alberto. Female infection index: none—0, light—25, moderate—50, considerable—75, and heavy—100.

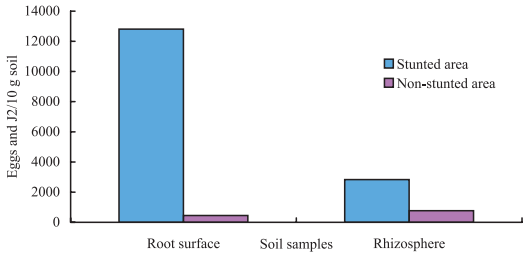


Fig. 3. Comparison of *Heterodera glycines* populations in stunted and non-stunted areaa in a soybean field in San Alberto, Alto Parana.

H. glycines may be distributed over large areas in this district. The nematode was also detected in four fields in Alto Parana and three fields in Caaguazu, respectively, but not in the Itapua district.

During the surveying process, an area of stunted plants was observed in late January 2005 in a soybean field at San Alberto, Alto Parana, that had been cropped with soybeans for many years. In this field, the soybean cv. Monsoy 7204 had been sown without tillage on October 22, 2004 and was at the seed-producing stage when sampled. To asses the effects of the nematode on the growth of the plants, a total of 32 and 36 soybean plants were randomly dug up from 10 points in the stunted area and in an area with no apparent stunting. The heights of the plants were measured and degrees of female infection were rated. Soil samples were collected at each of the 10 points where plants had been removed in the stunted and non-stunted areas. Soil attached to the root systems was also collected to examine the effect of the nematode on the growth of soybean. Nematode cysts were extracted using a sugar solution flotation technique. In the stunted area, the average height of soybean plants was 48 cm, less than 60% of that of plants (85 cm tall) from the non-stunted area. Chlorosis was not obvious at the time of survey, but browning of leaf margins was observed on the soybean plants in the stunted area. The female infection index was high (60.1) on the root-systems of stunted plants and fairly low (19) on the roots of the apparently non-stunted plants (Fig. 2). In the soil, the nematode population density was also extremely high in the stunted area (Fig. 3), where more than 12,800 eggs were extracted from 10 g of soil collected from the surface of roots, more than 20 times the density found in the non-stunted area. A similar trend was observed in the rhizosphere soil. Stunting of soybean plants caused by this nematode was detected in four other fields in surveys of 2005/2006 year soybeans.

These results indicate that *H. glycines* is potentially a serious threat to soybean production even in the "Terra rossa" soil type and subtropical climate conditions in Paraguay. More insights are necessary, therefore, on the ecology and pathogenicity of the nematode to allow the implementation of effective management measures.

(Z. Sano)

TOPIC 2

Effects of rice straw compost on rice cultivation on alluvial soil area in Mekong Delta, Vietnam

Few farmers in the Mekong Delta, Vietnam use organic matter for their rice cultivation. This is quite different from farmers in Vietnam's Red River Delta. Soil in the alluvial soil area in the Mekong Delta is fertile because nutrients have been supplied by floodwaters that arrive annually. However, it appears that exhaustion of soil fertility has been accelerated by intensive agriculture and the supply of nutrients by floodwaters has decreased due to dyke construction.

We conducted field experiments in an alluvial soil area in the Mekong Delta to elucidate the effects of rice straw compost. Rice was cultivated over 10 seasons with replicated management. Rice straw compost (6 Mg ha^{-1}) and different doses of chemical fertilizer were applied to compare with

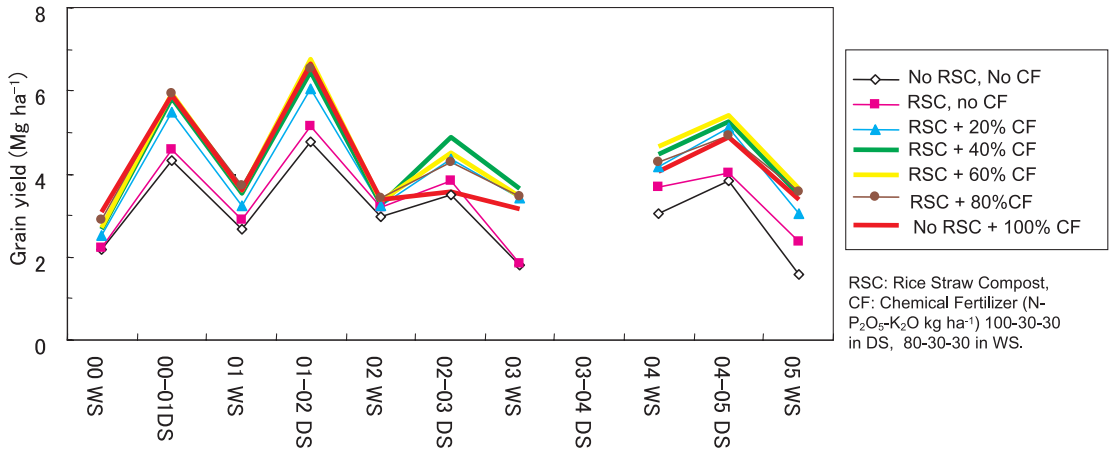


Fig. 1. Grain yield over 10 seasons.
WS: Wet Season, DS: Dry Season.

general fertilizer application without application of organic matter.

The results showed that it is possible to decrease chemical fertilizer (N, P and K) input by 60% without decreasing rice yield by applying rice straw compost (Fig. 1). Although the difference was not significantly different except for the 6th season, rice yields cultivated using chemical fertilizer alone were constantly lower than rice yields where rice straw compost and decreased amounts (up to 60%) of chemical fertilizer were applied.

Rice yields with general fertilizer application were significantly lower after outbreak of disease (in the 6th season). Rice cultivated using general fertilizer application was more severely damaged by rice blast than rice cultivated with rice straw compost and smaller amounts of chemical fertilizer (Fig. 2).

Soil organic matter, total-N and available-N did not show a clear difference among treatments after the 10th season. Originally, these concentrations were high in the field

Fig. 2. Rice heavily damaged by blast disease after general fertilizer application.
Right: General fertilizer application (100-30-30 N-P_2O_5-K_2O kg ha^{-1}).
Left: Rice straw compost (6 Mg ha-1) and (80-24-24 N-P_2O_5-K_2O kg ha^{-1}).

(Total-C: 31.7 gC kg^{-1}, Total-N 3.0 gN kg^{-1}, Available-N: 145 kgN ha^{-1} in the 0-10 cm soil layer). Ten seasons were not enough to cause significant differences in these parameters.

The results showed that general fertilizer application should be improved to increase fertilizer efficiency and mitigate pest damage.

(T. Watanabe)

TOPIC 3

Mitigation of nitrous oxide emissions from agricultural soil by 2-amino-4-chloro-6-methylpyrimidine

Agricultural soil is the largest anthropogenic source of nitrous oxide (N_2O), a greenhouse gas. Nitrification inhibitors have been used to increase fertilizer efficiency and to mitigate nitrogen leaching. They also decrease N_2O emissions from agricultural land. 2-chloro-6 (trichloromethyl) pyridine (nitrapyrin) is a strong nitrification inhibitor that has been used with liquid ammonia in the USA. However, it cannot be amended to solid fertilizer because of its low solubility and high volatility. To select an alternative nitrification inhibitor that is easy to handle and which will effectively mitigate N_2O emissions from the soil, 2-amino-4-chloro-6-methylpyrimidine (AM), sulfathiazole and 1-aryl-2-thiourea were compared. These chemicals can be amended into solid fertilizer.

The results of soil incubation experiments showed that AM mitigated N_2O emission from soil where nitrogen fertilizer had been applied. The effect of AM on reducing N_2O emissions was weaker than nitrapyrin but

stronger than sulfathiazole and 1-aryl-2-thiourea (Table 1). Application of AM did not inhibit soil respiration. The side effects of AM on 7 bacterial species that contribute to agricultural production in the field were tested. AM proved to inhibit the growth of these bacteria to the same degree as other inhibitors (Table 2). These results show that AM selectively inhibits nitrification bacteria and that the side effects on other bacteria are minor. It was concluded that AM can be used to mitigate N_2O emissions from agricultural soil as an alternative to nitrapyrin.

(T. Watanabe)

Table 1. Effect of nitrification inhibitors on mitigating N_2O emissions (Soil incubation experiment).

Experiment	Applied N	Soil moisture	Temperature	Duration	Nitrification inhibitors*	Applied inhibitor	N_2O-N emission	N_2O-N/applied N	Soil	Mitigation effect**
No.	mgN/kg dry soil	WFPS (%)	˚C	Days		mg/kg dry soil	ng/g dry soil	%		%
1	100	60	20	37	AM	2	13.4	0.012	Andosol	–74.3
1	100	60	20	37	ST	2	21.0	0.020	Andosol	–58.5
1	100	60	20	37	AT	20	36.0	0.035	Andosol	–27.3
1	100	60	20	37	None	–	49.2	0.048	Andosol	
1	0	60	20	37	None	–	0.9	–	Andosol	
2	100	60	20	37	AM	2	8.3	0.006	TYS***	–95.0
2	100	60	20	37	ST	2	21.8	0.020	TYS***	–83.5
2	100	60	20	37	AT	20	94.8	0.092	TYS***	–21.9
2	100	60	20	37	None	–	120.8	0.118	TYS***	
2	0	60	20	37	None	–	2.3	–	TYS***	
3	100	60	20	52	NP	1	8.3	0.007	Andosol	–83.8
3	100	60	20	52	AM	2	11.8	0.010	Andosol	–75.4
3	100	60	20	52	None	–	43.6	0.042	Andosol	
3	0	60	20	52	None	–	1.4	–	Andosol	
3	100	60	20	52	NP	1	2.8	0.002	TYS***	–96.6
3	100	60	20	52	AM	2	12.0	0.011	TYS***	–82.1
3	100	60	20	52	None	–	64.3	0.064	TYS***	
3	0	60	20	52	None	–	0.6	–	TYS***	

*: NP: Nitrapyrin, ST: Sulfathiazole, AT: 1-aryl-2-thiourea, None: no application

**: {(N_2O emission from +N without inhibitor)-(N_2O emission from +N with inhibitor)}/{(N_2O emission from +N without inhibitor)-(N_2O emission from -N)}

***: Terrace Yellow Soil

Table 2. Inhibitory effects of nitrification inhibitors on 7 bacteria useful in agriculture.

	NP (0.5)**	NP (1.0)**	AM (1.0)**	AM (2.0)**	ST (1.0)**	ST (2.0)**	AT (10)**	AT (20)**
B. megaterium	9.8	24.8	7.3	17.6	16.0	32.6	2.8	1.8
B. subtilis	9.1	31.7	9.5	20.9	19.8	28.0	0.5	2.6
A. faecalis	7.2	10.5	8.7	11.7	13.8	14.4	1.5	-2.4
P. fluorescens	14.7	22.2	10.5	19.9	16.0	33.7	1.1	18.0
Bradyrhizobium J.	2.4	12.4	2.2	6.7	8.5	26.4	0.6	4.4
Azospirills sp.	4.2	5.7	3.5	2.6	1.6	2.5	11.0	18.6
Herbaspirillum sp	1.3	15.3	2.1	16.7	3.5	21.0	2.0	19.3

*: The bacteria were cultured as pure strains and their growth was compared in media with and without inhibitor. The inhibitory effect is shown as a percentage.

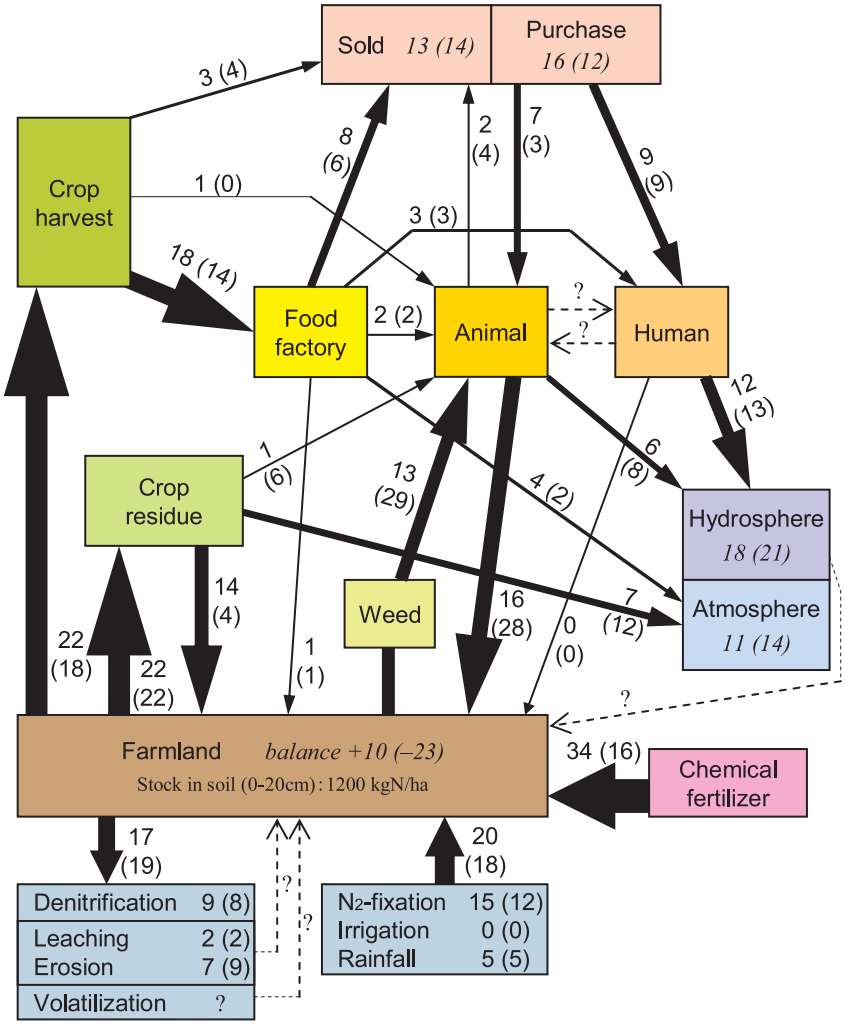
**: Concentrations in media (mg kg^{-1})

Change in nitrogen cycle related to agricultural activity from 1990 to 2000 in Khon Kaen Province, Thailand

With the development of the Thai economy from 1990 to 2000, the agricultural situation changed, showing increased chemical fertilizer application rates and lower numbers of buffalo being raised, resulting in a shortage of animal manure for farmers. To clarify the subsequent changes in the nitrogen cycle, we estimated the nitrogen cycle in Khon Kaen province in Northeast Thailand in 1990-92 and 2000-02.

The nitrogen cycle in Khon Kaen province was estimated using Thai agricultural statistics, study reports of food consumption and human excreta discharge, animal feed consumption and animal excrement production, survey data on the utilization of crop residues, human excreta, garbage, animal excrement and food factory (rice mill, sugar mill, cassava chips and starch) waste, measurement data of crop residue production and nitrogen content of crop residues, animal excrement and food factory waste, and journal articles on N_2 fixation and nitrogen losses from farmland.

Nitrogen cycle related to agriculture activity in 1990-92 and 2000-02 in Khon Kaen province is shown in Fig. 1. Chemical fertilizer application doubled from 16 kg N ha^{-1} year^{-1} in 1990-92 to 34 kg N ha^{-1} year^{-1} in 2000-02, caused by an increase in the chemical fertilizer application rate to rice and cassava cultivation by farmers to the recommended rate. Sugarcane was already having chemical fertilizer applied at the recommend rate in 1990. Animal manure input to farmland decreased 40%, from 28 kg N ha^{-1} year^{-1} in 1990-92 to 16 kg N ha^{-1} year^{-1} in 2000-02, because animal excrement production fell due to the sharp decrease in numbers of buffalo being raised, although the number of cattle, pigs and poultry increased. The amount of crop residues returned to farmland more than doubled, from 4 kg N ha^{-1} year^{-1} in 1990-92 to 14 kg N ha^{-1} year^{-1} in 2000-02, due to sugarcane residue (leaves and tops) production increasing as a result of a more than doubling of sugarcane area cultivated, and because the rate of return of sugarcane residue to farmland increased from 40% to 54%. The nitrogen balance in



Nitrogen cycle-related to agriculture activity in 1990-92 and 2000-02 in Khon Kaen Province, Thailand (kg N ha^{-1} year^{-1}). Values outside parentheses indicate nitrogen flow in 2000-02, and values inside parentheses indicate nitrogen flow in 1990-92. Values in italics are calculated by subtracting output from input.

farmland changed from a negative –23 kg N ha^{-1} year^{-1} in 1990-92 to a positive value of +10 kg N ha^{-1} year^{-1} in 2000-02, caused by an increase in the chemical fertilizer application rate to +18 kg N ha^{-1} year^{-1} and crop residue input of +10 kg N ha^{-1} year^{-1}in spite of a –12 kg N ha^{-1} year^{-1} decrease in animal manure input. Nitrogen supply to farmland thus changed mainly to chemical fertilizer, which threatens the sustainability of crop production due to degradation of soil organic matter. Nitrogen loaded from humans to the hydrosphere risks polluting underground water in populated areas. For sustaining crop production and environmental conservation in Khon Kaen province, effective utilization of crop residues is needed, such as the use of sugarcane residue as mulch and rice straw as compost, improvements in animal raising systems to increase manure production, and the development of treatment and effective use of human excreta.

(N. Matsumoto)

Actual situation of local soil fertility management on agricultural land in the Sahel, West Africa

The consistently low level of agricultural production in the Sahel zone of West Africa, especially in Niger, due to poor soil characteristics has hampered sustainable development in this region. It is important to make use of local farmers' knowledge through a better understanding of its context in order to mitigate existing problems that are impeding sustainable technology development. This is the basic and essential approach for a new technology to be more acceptable and sustainable at local farmers' level.

The agricultural lands in the study site are managed in two ways: intensively and extensively. Recycling (use of household waste and livestock excrement) and corralling (application of livestock excrement through the tethering of sheep, goats or cows in the fields in the evening) are systems categorized as intensive management, while fallow is a system practiced under extensive management. Based on a field survey of 2,430 ha, fallow is clearly the major system at the study site, since it accounted for 66% of surveyed fields. The corralling and recycling system account for the remaining 18% and 16%, respectively. Despite their large area, fields under the fallow system have the poorest soil fertility level of all due to the combination of longer cultivation periods (6 years on average) and shorter period of restoration (3 years). This impedes the production of millet, as shown in the results (Table 1). Local farmers adopt a recycling system (transporting household waste and/or animal dung) during the dry season, which lasts from late October to May. Since transport of waste using either animal carts or buckets carried on the head is time-consuming, this system is usually limited to fields adjacent to the village. On the other hand, corralling is done some distance from the village, since the pastoralists who use this system move to where they have better access to water for their livestock: areas which tend to be distant from the village. Consequently, fields located far from the village are managed using the fallow system. This

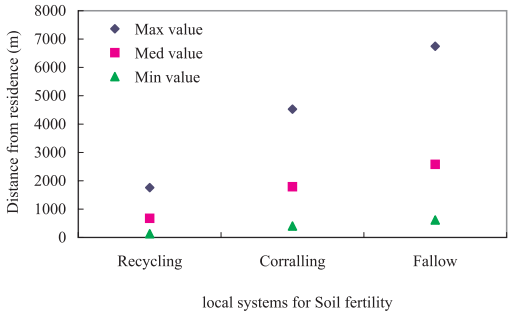


Fig. 1. Traits of local systems on soil fertility management with distance.

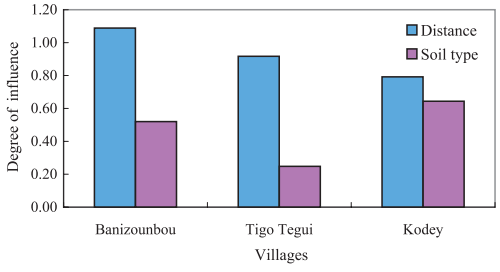


Fig. 2. Factors in the decision-making of local farmers on soil fertility management in the study area.

Photo 1. A compost heap in a compound of a village. This is the source for the recycling system and local farmers transport it once every few days.

Table 1. Productivity of millet and soil fertility characteristics of local fertility management systems.

	Productivity		Soil fertility characteristics (0-35cm)				
	Plant density	Yield	pH	Total acidity	ECEC	Bray1 P	T-N
	hills ha^{-1}	kg ha^{-1}	(H_2O)	cmol(+) kg^{-1}		kg ha^{-1}	
Fallow (6)	2800	242.4	5.0	0.29	1.06	21.91	700.43
Recycling (10)	3110	579.9	5.4	0.20	1.14	41.16	733.87
Corralling (4)	4438	750.2	5.4	0.17	1.25	27.97	957.09

phenomenon was confirmed quantitatively by a study of the distribution pattern of a field under different management systems (Fig. 1). Through factor analysis, the distance of a field from the village proved to be a more important factor than soil type for local farmers when managing soil fertility on their land (Fig. 2).

(K. Hayashi)

ANIMAL PRODUCTION AND GRASSLAND DIVISION

Domesticated animals provide human beings with essential commodities and services. Livestock can not only supply meat, milk, wool, and hides that are essential in daily life and serve as important source of income, but also contribute to efficient agricultural farming through nutrient recycling, in which less profitable biomass is converted into value-added products or processes and manure is used as a good organic fertilizer for infertile land. Thus, livestock form an essential part of the social fabric, especially in developing countries, where the demand for meat and milk is rapidly increasing. On the other hand, overgrazing or inappropriate management of livestock results in pollution, environmental degradation, and disease. To determine optimal methods of livestock management, the Animal Production and Grassland Division focused on research into enhancing the productive capacity of natural resources, managing grassland to secure feed resources, enhancing the utilization of agro-industrial by-products, controlling invasive animal diseases, and improving management practices in the world's developing regions.

During FY2005, the Division conducted 10 research subjects and has sent four long-term dispatch researchers and five short-term dispatch researchers overseas. Cooperative work with the National Center for Research on Beef Cattle (CNPGC-EMBRAPA) in Brazil was carried out to develop a sustainable management method of soybean production by means of an agro-pastoral system. Simultaneously, multiple strains of *Brachiaria humidicola*, a tropical grass, were selected for determination of an apomixes gene marker at the same National Center. A joint research project with the National Institute of Agronomic Technology (INTA) in Argentina was conducted to improve the use of agricultural byproducts by animals and the effect of supplementary feeds of these by-products on the performance of beef cattle in winter and on the milk yield of dairy cattle was investigated. In collaborative work with Kasetsart University in Thailand, lactic acid bacteria selected to make good quality grass silages in tropical areas were proven to be of practical use by employing an economical mass-culture method. Joint research with the Department of Livestock Development's (DLD) Khon Kaen Animal Research and Development Center in Thailand was carried out to evaluate nutritional values of drought-tolerant forage crops such as sugar cane and to improve animal performance by local feed resources and, moreover, to reduce the volume of methane emissions from ruminants by feeding high-energy by-products such as brewer's grain. The feeding systems of farm animals in the arid zones in inland China and Mongolia were surveyed to identify relevant research sites for the control of desertification of grassland. A collaborative study with the International Livestock Research Institute (ILRI) in Kenya was carried out to clarify the difference between macrophages separated from the cattle with different trypanosome sensitivity as measured by gene expression. Domestic research at Tsukuba was conducted to identify the flora of nitrogen-fixing endophytes in gramineous plants using culture-independent techniques, and some of the bacteria isolated were registered as stock cultures in the Gene Bank at the National Institute of Agro-biological Science.

Beef cattle grazing at Colonia Benitez Research Station, INTA, Chaco, Argentina.

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Attempt to practically use a lactic acid bacterial strain, SP 1-3, for making good quality silage in Thailand

Feeding of good quality silage (GQS) throughout the year is a suitable way to stably increase raw milk production in spite of its not being in wide use in Thailand. However, making GQS in Thailand is not always ensured if ensilage depends on natural fermentation. Therefore, lactic acid bacteria (LAB) strains to make GQS were screened, and strain SP 1-3 was selected.

For the practical use of this strain, a culture method for harvesting large numbers of LAB cells in a low-cost and convenient way was examined, and a culture medium composed of materials that are readily available in Thailand was designed. The medium designed here consisted of molasses 2.0%, rice bran 0.5%, yeast extract 0.2%, and mineral mixture (pH 6.5), and gave a cell mass of 10^9 cfu/ml after 24 h culture at 35˚C. The cost of this medium was calculated at about 23 yen/L, about 1/60 of that of MRS broth. A silage inoculant (spray-dried granule) from strain SP 1-3 cultured using this medium was prepared for trial. This granule was stable and kept a living cell count of $10^{8\sim9}$ cfu/g under storage at 4˚C for 28 days, as shown in Table 1, and reliably improved the fermentation quality of Napier grass silage prepared beforehand in the laboratory. To use these granules for the preparation of practical-scale silage, a low-cost and convenient method of increasing the cell mass of the LAB strain at farm level was developed using a 5-liter plastic drinking water bottle. LAB cell counts in the water (4.5 L), in which had been suspended 45 mg of granules together with the abovementioned medium, rose to 3.85×10^9 cfu/ml after culturing for 24 h. This LAB liquid (4.5 L) is ideal for preparing 4.5 ton of GQS. The additional cost using this

Table 1. Variation in the survival of the cells in granules prepared from strain SP 1-3.

Stored time (day)	Cell counts in storing at 4˚C		Cell counts in storing at 30˚C	
	DSC[1]	SFP[2]	DSC[1]	SFP[2]
1	–	–	6.08×10^8	1.87×10^9
7	7.03×10^8	1.68×10^9	7.22×10^8	1.62×10^9
14	6.77×10^8	1.52×10^9	5.72×10^8	7.10×10^7
21	6.25×10^8	1.28×10^9	3.15×10^8	4.84×10^5
28	5.83×10^8	1.12×10^9	1.68×10^8	5.01×10^4

[1]DSC: direct sampling from chamber, [2]SFP: sampling from product nozzle.
Sample powder was packed in a plastic pouch, sealed by a vacuum sealer and kept at 4˚C or 28~30˚C.

Table 2. Fermentation quality of practical-use silage inoculated with LAB strain SP 1-3.

Material	LAB	Silage pH[1]		Organic acid contents[2]			VBN[3]	Colony counts[4]	
		0 h	48 h	L	A	B		LAB	Yeast
Pangola grass	-	3.49	6.78	9.7±0.4	0	1.8±0.5	0.031	6.2±0.2	8.6±0.1
	+	3.51	6.38	10.7±1.1	0	3.3±0.8	0.020	6.3±0.2	8.6±0.1
Erianthus	-	4.40	5.21	1.8±0.7	0.7±0.8	0.2±0.2	0.021	6.8±0.2	5.8±0.2
	+	4.06	4.96	3.3±0.4	1.2±0.2	0.6±0.3	0.012	6.3±0.2	5.7±0.3

[1]pH value at silo opened and after 48 h; [2]Organic acid contents (DM %), L: lactic acid, A: acetic acid, B: n-butyric acid; [3]VBN: volatile basic nitrogen (DM %); [4]Colony counts (log cfu/g), LAB: lactic acid bacteria.
Silage was prepared in a plastic bag and kept at room temperature (30-35˚C) for 90 days (all experiments were triplicate). Inoculum size of strain SP 1-3 was 10^5 cfu/g.

system was calculated to be about 50 yen/ton.

Based on these results, Pangola grass and Erianthus silages inoculated with the LAB liquid were prepared on a practical scale. After being kept at 30~35˚C for 90 days, the silage pH, the organic acids and volatile basic nitrogen (VBN) content and microbial cell counts were examined. The results are shown in Table 2. Compared with silage without inoculation of LAB, the fermentation quality of silage inoculated with LAB liquid was improved as shown as pH reduced to below 4, increased lactic acid content, and reduced VBN content. These improvements were particularly notable in Erianthus silage. However, the yeast cell count was not reduced by inoculation with LAB. Abundant yeast cells in silage prepared in Thailand were hitherto known, and this trend was marked in the case of Pangola grass silage in this experiment. Abundant yeast cells in silage leads to the outbreak of aerobic deterioration after opening the silo. However, silage pH 48 h after opening the silo rose to almost neutral while the pH was about 3.5 on initial opening.

In addition, the palatability of silage inoculated with LAB was compared with non-inoculated silage by the cafeteria method using Brahman steers and native Thai steers. However, no significant difference in intake amount was seen between both types of silage (data not shown).

(S. Ohmomo)

TOPIC 2

Use of agricultural by-products for cattle feed in South America-Case Argentina

The northeastern area of Argentina has a humid subtropical climate with severe conditions of -7˚C in winter and over 40˚C in summer, where beef cattle production is one of the major industries. However, due to the low quality of rangeland, which is the main feed resource, there are many problems, especially in winter: high mortality, longer time to mature low quality of meat, low breeding rate, etc. To solve these problems, use of locally available agriculture by-products for feed for beef cattle was studied in collaboration with INTA Colonia Benitez.

Table 1. Summary of performance of growing heifers during the first winter after calving (data includes three trials carried by EEA-Colonia Benitez before the joint project).

Suppl. type	Suppl. level, in % of initial LW	Suppl., kg/day	Suppl.price, $/kg as fed	Daily gain, kg/day	Conversion,kg suppl./kg of added gain	Added gain, kg/day	Cost of extra gain, $/kg
Cotton seed	0.70	1.22	0.05	0.42	5.08	0.22	0.26
Control	0	0	-	0.20	-	-	-
Wheat bran	0.37	0.56	0.07	0.30	5.47	0.10	0.36
Wheat bran	0.76	1.12	0.07	0.37	6.68	0.17	0.44
Wheat bran	1.12	1.68	0.07	0.42	7.53	0.22	0.50
Control	0	0	-	0.20	-	-	-
Rice bran	0.43	0.69	0.08	0.27	6.27	0.12	0.52
Rice bran	0.84	1.37	0.08	0.32	7.82	0.17	0.65
Rice bran	1.27	2.06	0.08	0.42	7.43	0.27	0.62
Control	0	0	-	0.15	-	-	-
CSM	0.39	0.66	0.09	0.38	4.18	0.16	0.39
CSM	0.79	1.31	0.09	0.46	5.85	0.24	0.54
CSM	1.14	1.93	0.09	0.46	8.79	0.24	0.82
Control	0	0	-	0.22	-	-	-
RWSB	0.24	0.39	0.12	0.31	4.54	0.08	0.56
RWSB	0.47	0.77	0.12	0.40	4.39	0.18	0.54
RWSB	0.69	1.16	0.12	0.39	6.92	0.17	0.85
Control	0	0	-	0.22	-	-	-

RWSB = Raw whole soybean; CSM = Cottonseed meal; LW=Live weight Prices in US$.

From our three years' joint study and a previous INTA study, the results can be summarized as follows as a preliminary recommendation.

(1) Cotton seed: Economical feeding amount is up to 1 kg/head/day, which will result 200–400 g of daily gain. The cost for 1 kg of body weight gain is US$0.26~0.33. Cottonseed should not be used at more than 1 kg/animal in the finishing phase, since it may cause consumer acceptability problems with the beef.

(2) Wheat bran: Wheat bran is usually sold in pellet form. 100 g of daily gain is expected when given at 0.4% of body weight. The cost for 1 kg of body weight gain is US$0.36. Make sure to have enough feeder space to avoid overeating by dominant animals due to high palatability, which results in different body weight gains.

(3) Rice bran: Economical feeding amount is 0.4% of body weight. The cost for 1 kg of body weight gain is US$0.52. Rice bran is also available in the Region (Corrientes, Formosa). Rice bran is usually more expensive than wheat bran. It gives the same type of biological response but is more expensive. Rice bran is palatable but because it is a fine powder, it may cause refusals at high supplementation levels (at more than 1% of body weight). The choice will be dictated by price. Sometimes there is over-supply and can be a good option.

(4) Cotton seed meal: 0.4% of body weight of cotton seed meal can be fed as a protein supplement. The cost for 1 kg of body weight gain is US$0.39. Cottonseed meal should not be used at more than 0.8% of body weight because of very inefficient use of the supplement.

(5) Whole raw soybeans: When fed at 0.5% of body weight, the cost for 1 kg of body weight gain is US$0.54. This cost may decrease by up to 50% if soybeans unsuitable for the oil industry are used. It should not be used at more than 0.5% of body weight. Higher levels will cause a substitution effect with lower feed efficiency and lower pasture intake. Whole soybeans are now available at several locations in Chaco.

If the previous feeding method for beef cattle without supplemental feed is used, many problems, such as high mortality in winter, low meat quality and slow breeding were observed. However, these problems were greatly improved by feeding locally available and economical agriculture by-products.

(H. Kudo)

TOPIC 3

Utilization of sugarcane silage as feed for beef cattle in Northeast Thailand

Northeastern Thailand is the biggest region of beef cattle production in Thailand. Most beef cattle are raised on small mixed farms. It is generally recognized that the shortage of forage in the dry season is the chief factor limiting beef cattle production in the region. Additionally, hay and silage preservation is not easy, because of frequently unsuitable weather for forage drying during the rainy season and low fermentable substrate content in tropical grasses for silage fermentation. Sugarcane, which is planted widely in this region, has high amounts of fermentable substrates, i.e., sugars, and gives high yields. Therefore, there is the potential for preparing reliable and high-quality silage that will provide a steady supply of food throughout the year. This study aimed to make and evaluate sugarcane silage, and to investigate the effect of sugarcane feeding on growth performance in beef cattle.

Pangola grass (*Digitaria eriantha*), which was cut at early bloom, and sugarcane, which was harvested at around six months after regrowth, were chopped and ensiled in plastic bags, then evaluated for their chemical components and quality six months later. Crude protein content in sugarcane silage was lower than that in pangola grass silage (Table 1). On the other hand, the lactic acid content was higher for sugarcane silage than pangola grass silage, and pH and spoilage ratios due to molds were lower for sugarcane silage than pangola grass silage. These results show that the fermentation quality of sugarcane silage was higher than that of pangola grass. Total digestible nutrient content, digestible energy content and metabolizable energy content of the sugarcane silage were respectively 49.6% DM, 9.7 MJ/kgDM and 7.8 MJ/kgDM. A feeding experiment with the beef cattle diet was conducted at a beef cattle raising farm in Khonkaen District. Six American Brahman crossbred bulls (around 18 months old) were

separated into two groups, one of which was fed Ruzi grass (*Brachiaria ruziziensis*) hay with concentrate and the other sugarcane silage with concentrate. Both groups were fed the same roughage-to-concentrate ratio (38:62) for three months. The results showed that an average daily gain of 0.9 kg/day could be achieved with sugarcane silage during the feeding period (Table 2).

It is possible to supply silage which of good and reliable quality using sugarcane, and to raise beef cattle using sugarcane silage as the basic diet. However, sugarcane silage needs to be consumed as soon as possible after opening due to its low aerobic stability.

(T. Suzuki)

Table 1. Chemical components and fermentation quality of pangola grass silage and sugarcane silage.

		Pangola	Sugarcane
Chemical components			
Dry matter	%FM†	23.2	23.9
Crude protein	%DM	8.5	5.7
Neutral detergent fiber	%DM	65.1	72.8
Non fibrous carbohydrate	%DM	7.9	11.2
Organic acid produced			
Lactic acid	%FM	0.57	1.08
Acetic acid	%FM	0.25	0.36
Propionic acid	%FM	0.01	1.43
Butyric acid	%FM	0.03	0.04
pH		5.1	4.1
VBN/Total-N	%	15.6	12.5
Spoilage ratio	%	18.7	3.0

†FM: fresh matter, DM: dry matter, VBN: volatile basic nitrogen.

Table 2. Feed chemical components and performance of beef cattle fed Ruzi grass hay or sugarcane silage with concentrate†.

		Ruzi	Sugarcane
Chemical components			
Crude protein	%DM‡	12.0	11.6
Crude fat	%DM	1.4	1.7
Neutral detergent fiber	%DM	38.2	39.6
Dry matter intake	%BW/day	1.9	1.7
Initial body weight	kg	285	348
Final body weight	kg	366	418
Average daily gain	kg/day	1.0	0.9
Cost of purchased feed	Baht	1,789	1,893
Sale price	Baht	16,800	19,000

†Concentrate consisted of cassava, rice bran, soybean meal, molasses, $CaHPO_4$, urea, sulfur and mineral premix.
‡DM: dry matter, BW: body weight.

FOOD SCIENCE AND TECHNOLOGY DIVISION

There is increasing emphasis on the agri-food sector, which focuses on improving food quality and safety, storage, beneficial processing, product differentiation and distribution, due to a number of emerging global trends that include urbanization, globalization, and rising consumer concerns about food quality and safety. The operation and processes conducted in the agri-food sector are now considered to be critical for the achievement of developmental goals for food security, poverty alleviation, and sustainable growth. The role of the Division is to contribute to the technological advancement of this sector in developing countries.

The Division is currently conducting research on the physiological functionalities of tropical indigenous vegetables and traditional Chinese fermented foods as well as the flavors of aromatic rice for the purpose of value addition to these agricultural products. In 2005, we tested 237 tropical edible plants samples and detected very strong anti-oxidative activity in 5 samples and high anti-mutagenic activity in 26 samples. Peptides with inhibitory activity against angiotensin I-converting enzyme, which indicates blood pressure-preventive activity, were identified in Chinese *douchi* (fermented soy nuggets). We isolated lactic acid bacteria from a traditional fermented rice noodle factory in China and showed that these bacteria could be used as starters to produce good-quality noodles. As for quality improvement studies of aromatic

Chinese *douchi* (fermented soy nuggets).

separated into two groups, one of which was fed Ruzi grass (*Brachiaria ruziziensis*) hay with concentrate and the other sugarcane silage with concentrate. Both groups were fed the same roughage-to-concentrate ratio (38:62) for three months. The results showed that an average daily gain of 0.9 kg/day could be achieved with sugarcane silage during the feeding period (Table 2).

It is possible to supply silage which of good and reliable quality using sugarcane, and to raise beef cattle using sugarcane silage as the basic diet. However, sugarcane silage needs to be consumed as soon as possible after opening due to its low aerobic stability.

(T. Suzuki)

Table 1. Chemical components and fermentation quality of pangola grass silage and sugarcane silage.

		Pangola	Sugarcane
Chemical components			
Dry matter	%FM†	23.2	23.9
Crude protein	%DM	8.5	5.7
Neutral detergent fiber	%DM	65.1	72.8
Non fibrous carbohydrate	%DM	7.9	11.2
Organic acid produced			
Lactic acid	%FM	0.57	1.08
Acetic acid	%FM	0.25	0.36
Propionic acid	%FM	0.01	1.43
Butyric acid	%FM	0.03	0.04
pH		5.1	4.1
VBN/Total-N	%	15.6	12.5
Spoilage ratio	%	18.7	3.0

†FM: fresh matter, DM: dry matter, VBN: volatile basic nitrogen.

Table 2. Feed chemical components and performance of beef cattle fed Ruzi grass hay or sugarcane silage with concentrate†.

		Ruzi	Sugarcane
Chemical components			
Crude protein	%DM‡	12.0	11.6
Crude fat	%DM	1.4	1.7
Neutral detergent fiber	%DM	38.2	39.6
Dry matter intake	%BW/day	1.9	1.7
Initial body weight	kg	285	348
Final body weight	kg	366	418
Average daily gain	kg/day	1.0	0.9
Cost of purchased feed	Baht	1,789	1,893
Sale price	Baht	16,800	19,000

†Concentrate consisted of cassava, rice bran, soybean meal, molasses, $CaHPO_4$, urea, sulfur and mineral premix.
‡DM: dry matter, BW: body weight.

FOOD SCIENCE AND TECHNOLOGY DIVISION

There is increasing emphasis on the agri-food sector, which focuses on improving food quality and safety, storage, beneficial processing, product differentiation and distribution, due to a number of emerging global trends that include urbanization, globalization, and rising consumer concerns about food quality and safety. The operation and processes conducted in the agri-food sector are now considered to be critical for the achievement of developmental goals for food security, poverty alleviation, and sustainable growth. The role of the Division is to contribute to the technological advancement of this sector in developing countries.

The Division is currently conducting research on the physiological functionalities of tropical indigenous vegetables and traditional Chinese fermented foods as well as the flavors of aromatic rice for the purpose of value addition to these agricultural products. In 2005, we tested 237 tropical edible plants samples and detected very strong anti-oxidative activity in 5 samples and high anti-mutagenic activity in 26 samples. Peptides with inhibitory activity against angiotensin I-converting enzyme, which indicates blood pressure-preventive activity, were identified in Chinese *douchi* (fermented soy nuggets). We isolated lactic acid bacteria from a traditional fermented rice noodle factory in China and showed that these bacteria could be used as starters to produce good-quality noodles. As for quality improvement studies of aromatic

Chinese *douchi* (fermented soy nuggets).

rice, the biosynthesis pathway of a flavor component, 2-acetyl pyrroline, was determined by tracer experiments and gene expression experiments.

In addition to the food quality and functionality research, the Division covers non-food use of agricultural products, that is, biomass research. Biomass research is considered to be a key to solving energy, environmental and agricultural problems. Thus, we have launched a six year project entitled "Development of biomass utilization technology suited to Southeast Asia" aiming at developing a practical system to produce an ethanol fuel from tropical crop residues and environmentally compatible materials using woody biomass. The biomass project is described in Research at JIRCAS section of this report.

TOPIC 1

Piperine, a component of long pepper, suppresses insect pests of rice storage

Under the JIRCAS international research project entitled "Development of low-input technology for reducing postharvest losses of staples in Southeast Asia," the research team studied the growth-inhibitory effect against stored-product insect pests of various botanicals. The target insect pests were the rice weevil (*Sitophilus oryzae*), maize weevil (*S. zeamais*), red flour beetles (*Tribolium castameum*) and rice moth (*Corcyra cephalonica*), which are commonly found in stored rice worldwide. The project team found a strong growth-inhibitory effect of a spice plant, long pepper (Fig. 1, *Piper retrofractum*) against weevils and the beetle. Long pepper is a vine in the family *Piperaceae*; the fruit has a hot taste similar to black pepper. It is widely used in many types of food and medicines in tropical and subtropical regions. In the experiment, dried and powdered long pepper fruits were mixed into feed and its effect against insect pests was examined. Long pepper completely suppressed adult emergence from eggs of weevils at a dose of 0.5% (w/w), and the growth of 1–7-day-old red flour beetle larvae by approximately 90% at a dose of 5% (w/w). In addition, long pepper showed a definite suppressive effect against red flour beetles in the model experiment using imitation warehouse-like boxes in which brown rice and starch powder mixed with long pepper powder were separately placed. Long pepper also inhibited the development of another important insect pest, the rice moth (*Corcyra cephalonica*), but the effect was not as strong as against *Coleoptera*. The growth-inhibitory component of long pepper was then isolated by activity-guided fractionation using weevils. The obtained pale yellow crystals of the active principle were identified as piperine by mass and nuclear magnetic resonance (NMR) spectrometry. Piperine is an alkaloid found in the black pepper seed that has a hot flavor. Purified piperine substantially suppressed the adult emergence of weevils by 50% (ED_{50}) at a dose of approximately 50 ppm (Fig. 2). The risk of long pepper extract or piperine to human health is likely to be much lower than most other synthetic insecticides, since it has a long history of use as a spice. We therefore believe that long pepper has the potential to

Fig. 1. Long pepper (*Piper retrofractum*), fresh fruit and leaves (left bottom); dried fruits (top right).

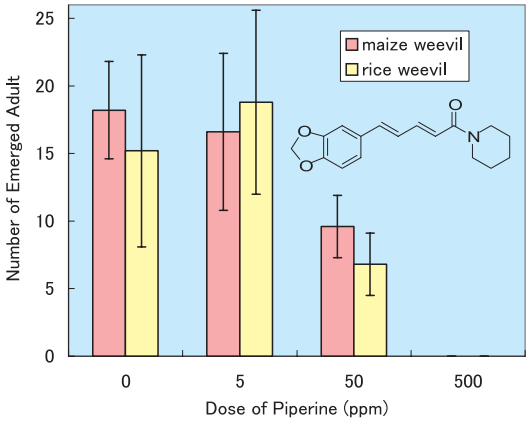

Fig. 2. Growth- inhibitory effect of piperine against weevils.
Eggs of weevils were reared in the feed pellet containing purified piperine at the indicated doses. Emerged adult weevils during 8 weeks were counted. The chemical structure of piperine is shown in the panel.

provide a safe alternative to synthetic insecticides. The project team is currently studying how to apply long pepper or piperine extracts on an individual scale in rice storage.

(G. Trakoontivakorn, R. Juntarawimoon, Y. Hanboonsong and K. Nakahara)

FORESTRY DIVISION

The increasing demand for food is compelling farmers to exploit larger areas of arable land, leading to the massive decline of natural forests, particularly in the developing regions of the world. Forest degradation has generated serious economic and environmental problems, not only at the local level but also on a global scale. The development of technology based on scientific data aiming at achieving the rehabilitation and sustainable management of forest areas therefore remains an urgent necessity. To arrest forest decline, forest production systems and postharvest technologies need to be improved and refined.

The Forestry Division has focused on developing technologies for the rehabilitation of degraded forests and grasslands and the sustainable use of forest products in Southeast Asia. Our activities and research goals for achieving the sustainable use of forest resources in the tropics have been put forth in JIRCAS's five-year Medium-Term Plan that commenced in 2001. Along these lines, we have established the following three themes through which we will attain such goals: 1) the development of regeneration technology for forest environment conservation; 2) the development of technologies for the improvement of forest quality; and 3) the development of processing technologies for the efficient use of unexploited forest resources.

In Fiscal Year 2005, the Division conducted five overseas projects, dispatching a total of three researchers, of whom two were dispatched to the Forest Research Center (FRC) in Sabah State, Malaysia and the third to the Forest Research Institute Malaysia (FRIM), on long-term assignments. Eleven researchers were also dispatched to the project as short-term visiting scientists. Under the administrative Invitation Program, the Division invited Mr. Thanee Viriyarattanaporn, the Director of the Forest Management and Forest Product Research Office, the Royal Forest Department (RFD) of Thailand, and Dr. Cecilia N. Gascon, the Acting President of the Southern Luzon Polytechnic College, Philippines, and Dr. Wan Rosli Wan Daud, the Dean of the School of Industrial Technology, the University Science Malaysia, to discuss various aspects relating to the ongoing projects.

With the collaboration of the RFD of Thailand, the Division has carried out a study to determine the chemical structure of the sex pheromones of the mahogany shoot borer, *Hypsipyla robusta*, and the teak beehole borer, *Xyleutes ceramica*, to utilize their sex pheromones for the monitoring and control of both species.

In collaboration with the FRIM, a study on the regeneration processes following selective logging in hill dipterocarp forests is being carried out in Semangkok Forest Reserve, Selangor State, to evaluate several methods for accelerating seedling regeneration.

The Forestry Division initiated a comprehensive research project, entitled "Development of agroforestry technology for the rehabilitation of tropical forests," in the year 2000. The project is being implemented mainly in collaboration with the FRC of the Forestry Department of the State Government of Sabah, Malaysia. From the growth survey of various species planted under canopies of *Acacia mangium*, the project found a medicinal plant, Noni (*Morinda citrifolia*) to be a useful cash crop for agroforestry in Sabah.

With the collaboration of the same FRC, the Division has conducted a study concerning basic wood properties of *Acacia mangium* in Sabah, Malaysia. To develop a technology to utilize the Acacia's timber more effectively, the radial variations of wood density and length of wood fiber at different height of trees were examined.

An *Acacia mangium* tree was felled to collect wood samples for examination of the wood's basic properties.

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An *Acacia mangium* tree was felled to collect wood samples for examination of the wood's basic properties.

Basic wood properties of *Acacia mangium* in Sabah, Malaysia

The forestry industry is still one of the most important industries in Sabah, despite the rapid shrinkage of forested areas. Logs for timber are produced mainly from natural forests and partly from plantation forests in Southeast Asia. In the case of Sabah, for example, logs produced from natural forests and plantation forests totaled 2,588,417 m^3 and 250,018 m^3, respectively, in 2001. Of logs from natural forests, species of Dipterocarpaceae are the most important element, making up 65.8% of the total volume. However, these valuable resources are now precipitously declining as a result of overexploitation of the natural forests, and there is an urgent need to consider the sustainable supply and effective utilization of timber. It is thus very important to increase the share of timber from plantation forests to prevent the degradation of natural forests. *Acacia mangium* is the commonest plantation tree species in Southeast Asia. In Sabah, out of a total 130,655 ha of forest plantation, 106,581 ha are planted with fast-growing species, of which *A. mangium* account for about 72%. However, 94.6% of logs of *A. mangium* produced in 2002 were exported to other countries without any processing in Sabah. The purpose of this study was to investigate the basic wood properties of *A. mangium* to enable more effective use of its timber.

For the investigation of basic wood properties such as wood density and length of wood fiber, 13 year old *Acacia mangium* Willd. trees in the plantation of Segaliud Lokan of the Forest Research Centre of Sabah (FRC) were investigated. In 2003, eleven trees of several sizes (height: 21.8 –33.7 m, DBH: 14.3 – 42.8 cm) were cut, and sample disks were collected every 2 m, starting at breast height. After drying in an air-conditioned room, a disk at each position was cut into strips 3 cm wide, containing pith, using a bandsaw. The strips were divided into small blocks every 3 cm (1 cm at the strip taken at DBH) from the pith using a hatchet. The air-dried densities of each block were measured using a floating method. Small pieces of wood were taken from the blocks every 3 cm (1 cm at the strip taken at DBH) from the pith, and macerated using Franklin's method (6% acetic acid, 6% hydrogen peroxide, 60˚C x 48 hrs). The length of the wood fibers was measured under a light microscope equipped with a measurement system (VM-60N Video Micrometer, Olympus)

Fig. 1 shows the radial variation in wood

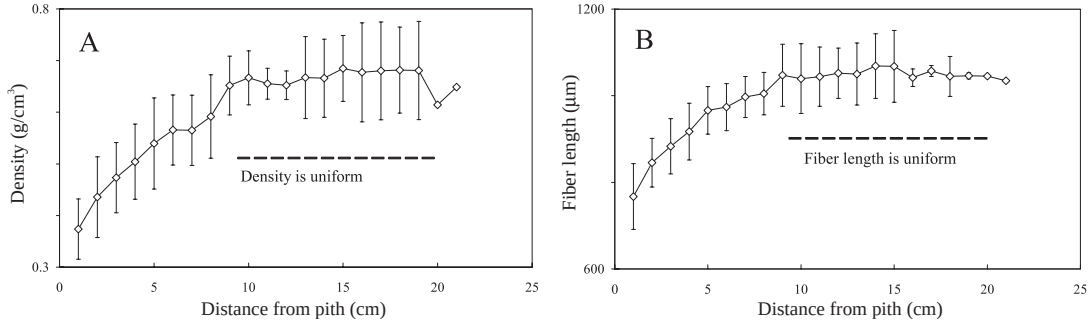

Fig. 1. Radial variation of (A) wood density and (B) length of wood fiber at breast height of trunks of *A. mangium*.

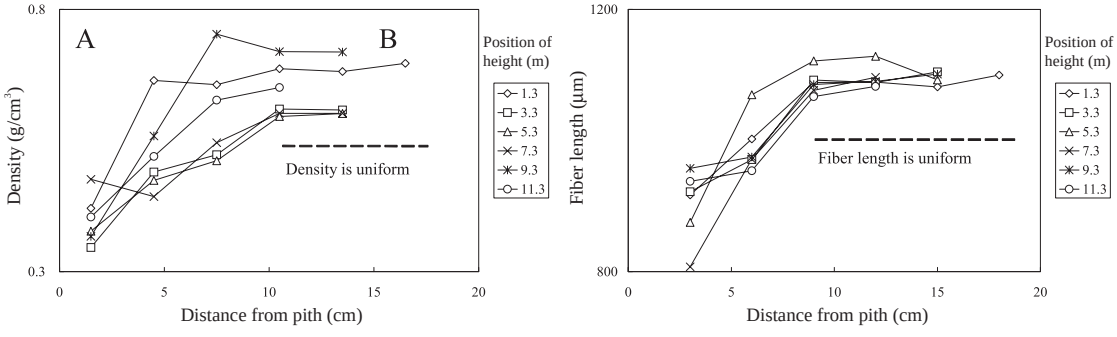

Fig. 2. Positional change in the radial variations of (A) wood density, and of (B) length of wood fiber with height of trunk of *A. mangium*.

density and the length of wood fibers at breast height in the trunks. The wood density and the length of wood fibers increased from the pith to the bark, and showed almost constant values in the outer part from 9 cm distance from the pith. Fig. 2 shows longitudinal variation in the wood density and length of wood fiber. There was no significant difference in the pattern of radial variation of the wood density and the fiber length among the disks taken from different height positions on the trunk.

These results indicate that the wood outer part from 9 cm from the pith has uniform properties in *A. mangium* planted in Sabah. This means that trees with a higher growth rate produce more wood with uniform properties than trees with a lower growth rate. Our results are of potential use as fundamental data for the industry to utilize *A. mangium* timber more effectively, and for policymakers to select sites for plantations of *A. mangium*.

(H. Abe)

FISHERIES DIVISION

Excessive acts by the fisheries industry, such as overfishing and highly intensive aquaculture, often destroy the environment from which people receive major benefits and, as a consequence, erode profits and even threaten the fisheries themselves. In the light of these facts, the Fisheries Division aims to develop sustainable fisheries techniques that cause minimal destruction of the environment in developing countries thorough collaborative research with foreign and domestic institutions.

A major project of the fisheries division, entitled "Studies on sustainable production systems of aquatic animals in brackish mangrove areas (2002-2005)" has successfully come to a fruitful conclusion. This project was mounted to address the serious problems of environmental destruction of brackish mangrove areas caused by intensive aquaculture in Southeast Asia. The Fisheries Division of JIRCAS implemented the project in collaboration with the Fisheries Research Institute (FRI), Malaysia, Kasetsart University (KU), Thailand, the Southeast Asian Fisheries Development Center (SEAFDEC) and domestic institutions such as the Fisheries Research Agency (FRA) and Forestry and the Forest Products Research Institute (FFPRI). To discuss the results of the project and to spotlight the remaining problems, an international workshop was held at JIRCAS on December 7-8, 2005.

The major outcomes achieved in the project were as follows. 1) Snappers (*Lutjanus* spp.) and groupers (*Epinephelus* spp.) are commercially important species of fish in mangrove estuaries. Field studies in collaboration with FRI suggested that John's snapper (*L. johnii*), the predominant *Lutjanus* species in the Matang and Merbok mangrove estuaries, enters there at a size of around 50 mm or less in total length, and their recruitment is regarded as a year-round phenomenon. Juvenile snappers are assumed to spend about 6 months to 1 year there before migrating back to the open sea on reaching about 200 mm in total length. A preliminary stock assessment revealed that the John's snapper population of northwestern Peninsular Malaysia might have been overexploited. 2) In collaboration with KU, mangrove and seaweed were revealed to have the function of water purification. A prototype model utilizing the water purification function of mangrove and seaweed was proposed for a sustainable shrimp culture system (Topic 2, 3). 3) In marine tropical fish species, arachidonic acid was found, in a collaborative study with SEAFDEC, to be a major fatty acid and important in reproduction and larval/fry performance. Adding an optimum amount of arachidonic acid to broodstock diets or larval feeds of marine tropical fish proved to markedly improve seed production (Topic 1). The fisheries Division was presented a Plaque of Recognition from the Aquaculture Department (AQD) of SEAFDEC in appreciative recognition of our valuable contribution to the advancement of aquaculture technology development in the Southeast Asian region through the

Malaysian fishermen carrying the uploaded indian mackerel.

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SEAFDEC/AQD-JIRCAS five-year collaborative program.

With funding from the Bio-oriented Technology Research Advancement Institution (BRAIN) of Japan, the Fisheries Division has been carrying out a project entitled "Development of land-based recirculating aquaculture systems for domestic production of the whiteleg shrimp, *Litopenaeus vannamei*" since August 2004. For this 5-year project, JIRCAS has formed a research consortium with International Mariculture Technology (IMT) Co., an aquacultural engineering firm; Higashimaru K.K., an aquaculture feed company; and the National Research Institute of Aquaculture. The research consortium has already raised *L. vannamei* successfully to market size several times using IMT's unique low-salinity recirculating production system, and is now focusing on the development of domestic-based methods of seed production for the species. Under this project, JIRCAS is also conducting basic research on the elucidation of osmoregulatory and reproductive mechanisms in *L. vannamei*. In particular, Division researchers are focusing on the biochemical isolation and identification of eyestalk hormones that are involved in regulating reproductive processes, and are now elucidating their physiological functioning.

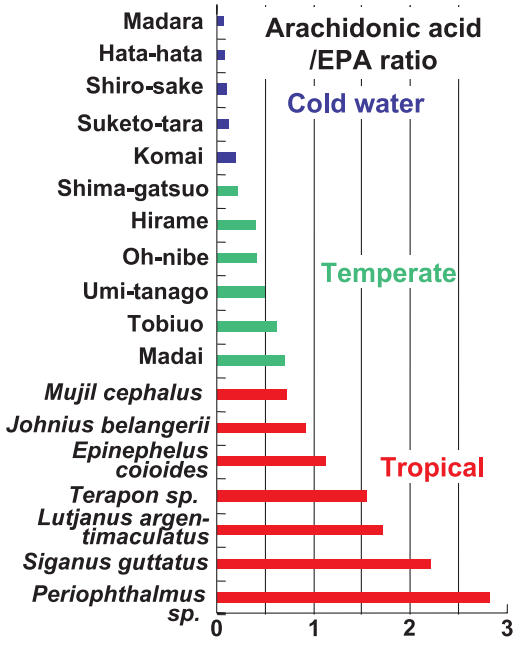


Fig. 1. Arachidonic acid level is hither in tropical fishes than in cold water fishes.

TOPIC 1

Arachidonic Acid can Help the Aquaculture Industry to Take off in Developing Countries
"Hatcheries in the Tropics require arachidonic acid for stable fry production"

Aquaculture contributes significantly to food production, incomes and jobs in developing regions. However, the persistent constraint in aquaculture development is presently the supply of good quality seeds (fry) in quantity. Hatcheries are expected to provide stable fry supply for farmers, but fry production is often highly variable due to low survival rates. During the period 2002–2005, the Southeast Asian Fisheries Development Center - Aquaculture Department (SEAFDEC/AQD, Iloilo, Philippines) and JIRCAS have collaborated on studies aimed at developing advanced diets to improve the quality and production of eggs, larvae and seedstock for tropical marine fish species.

The most striking difference between cold water fish species and tropical fish species is that arachidonic acid, which is found in only minor quantities in cold water fish species with their high EPA levels, is one of the major essential fatty acids in the ovaries, testes, eggs and muscles of tropical fish species from mangrove areas or coral reefs in the Philippines, Malaysia and Ishigaki, Japan. It is notable that the major essential fatty acids in tropical fish species are DHA and arachidonic acid (not EPA) at a ratio of about 2:1. This result suggests that a dietary ratio of DHA/arachidonic acid (not EPA) of about 2 or greater can be recommended as an ideal regimen for broodstock of tropical fish species.

Thus, arachidonic acid is a major fatty acid widely distributed in tropical marine fish species and is likely to be important to reproduction and larval/fry performance. However, most studies on essential fatty acids in relation to fry production have been focused on EPA and DHA, and the potential value of arachidonic acid has not been applied to fry production technologies for tropical and subtropical fish species.

In the mangrove red snapper, total egg production and total number of spawn can be clearly improved providing a formulated diet containing arachidonic acid at 5 g/kg. Moreover, this diet can increase the

percentage of normal larvae and boosts the cumulative survival rate to more than twice the level of those on diets without arachidonic acid. Rabbitfish fry, when fed rotifers or brine shrimps enriched with a combination of DHA and arachidonic acid, always showed the best survival rate. We conclude that adding arachidonic acid to broodstock diets or larval feeds dramatically improves seed production. Improved hatchery production of seedstocks can thereby help aquaculture take off in the developing tropical countries.

(H. Ogata)

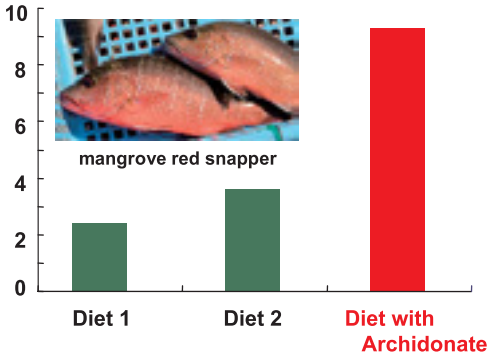


Fig. 2. Dietary arachidonic acid improves egg production. Total egg production ($\times 10^6$)

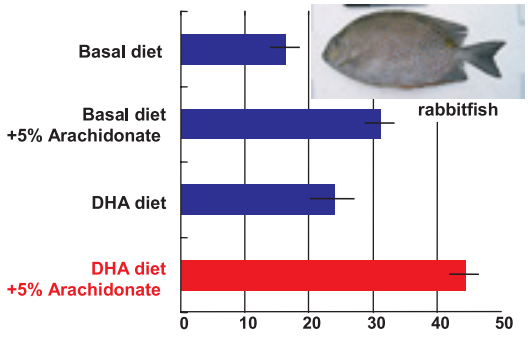


Fig. 3. Arachidonic acid improves survival of rabbitfish fry. Survival (%)

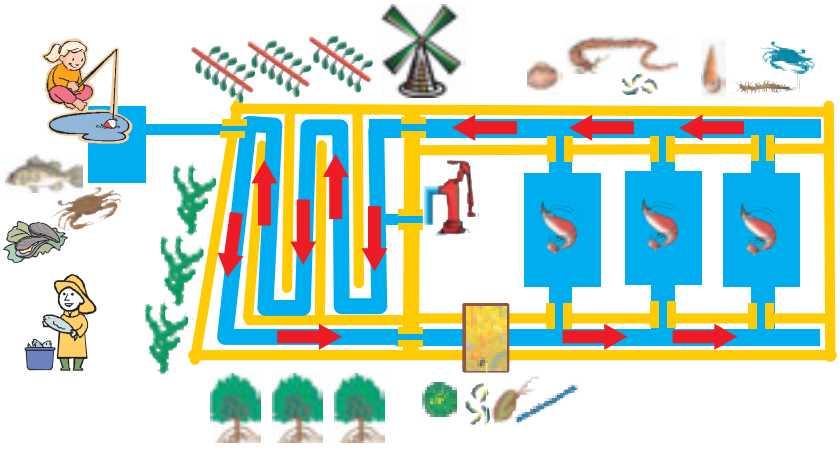
TOPIC 2

Recycling-oriented aquaculture system utilizing natural ecological functions

Coastal aquaculture in mangrove swamp areas has rapidly developed and expanded since the middle of the 1980s, and the production of cultured prawns has greatly increased. During the 25 years from 1975 to 2000, shrimp farming areas increased more than sixfold, from 129 km^2 to 811 km^2. However, excessively intensive utilization of brackish water areas has resulted in the destruction of many mangrove ecosystems and water pollution affecting the culture ponds and adjacent coastal areas. Recovery of mangrove ecosystems is of utmost importance for restoring the productivity of coastal aquaculture and fisheries. To develop a rational and sustainable utilization strategy for mangrove ecosystems, it is necessary to carry out studies relating to the practical use of coastal aquaculture systems that are compatible with the preservation of the environment.

To investigate rational and sustainable utilization of benthic organisms for prawn aquaculture, the community structure of macrobenthic organisms was examined in Samut Songkhram aquaculture ponds in the innermost part of the Gulf of Thailand. A total of 84 species/taxa of macrobenthos were identified, in which 42 species/taxa were found in the six experimental ponds: four ponds used for prawn culture and two ponds planted with mangrove stands. The dominant species belong to three taxonomic categories; that is, (1) sedentary, tube-dwelling spionids, *Polydora* sp., free-living nereids, *Perinereis* sp. and some other polychaetes (Annelida); (2) gastropods such as *Cerithidea cingulata*, *Cerithium coralium*, *Thiara riqueti*, and *Stenothyra ovalis*, which live on the surface or in the shallow layers of the substratum (Mollusca); and (3) barnacles, *Balanus* sp., and some small crustaceans such as ostracods, copepods, harpacticoids, amphipods and dipterans (Arthropoda). Population density, biomass and species diversity in the mangrove planted ponds were higher than those in the prawn culture ponds, and depending on their behavioral traits, the depth of sediment utilized.

Model experiments of a recycling-oriented prawn aquaculture that exploited the natural purification capacity of the mangrove ecosystem and the productivity of the macrobenthic community were carried out in the experimental ponds in Samut Songkhram. The survival rate and average weight of prawns in the water-circulated culture systems



A model of recycling-oriented aquaculture system utilizing natural ecological functions of benthic and planktonic organisms, mangrove stands and seaweeds.

were higher than those in the closed culture system. When prawns were cultured under semi-intensive conditions in mangrove planted ponds, their average size increased about by 25%, and artificial feed could be reduced about by 19% compared to the intensive culture system. Diversity and biomass of the macrobenthos decreased during the culture experiments in the prawn culture ponds, while they increased in the mangrove ponds, indicating the possibility that the prawns fed on the small macrobenthos such as polychaetes and juvenile gastropods as a natural food source under aquaculture conditions. The results of feed preference experiments in the laboratory demonstrated that prawns significantly selected polychaetes and crustaceans over commercially sold pellet feed. It was concluded that macrobenthic invertebrates are an important natural feed for prawn aquaculture and may participate closely in the transfer of energy from the producer organisms to the cultured prawns.

On the basis of the results of the present study, we constructed a model of a recycling-oriented aquaculture system by utilizing the natural ecological functions of benthic and planktonic organisms, mangrove stands and seaweeds.

(Y. Fujioka)

Overview of recycling-oriented aquaculture system of Samut Songkhram.

Co-culture of Black tiger shrimp (*Penaeus monodon*) and Sea grapes (*Caulerpa lentillifera*)

We are attempting to develop co-culture in shrimp farming intended to improve the environment within shrimp ponds by using biofilters. *Caulerpa lentillifera*, a species of edible seaweed, was chosen for co-culture with *Penaeus monodon*.

It became obvious that *C. lentillifera* has high water purification abilities (dissolved nutrient uptake and physical filtration) and it also offers a hiding place for the shrimp.

On the other hand, *C. lentillifera* is expected to guarantee an alternative income in the event that the *P. monodon* perish in large numbers, making it possible to prevent the abandonment or neglect of shrimp culture ponds.

The co-culture of *P. monodon* and *C. lentillifera* markedly decreased the ammonia nitrogen (by up to approximately 50%), which exerts the most adverse effect on the cultivation of underwater shrimp. We discovered that favorable water quality could be easily maintained over the long term by co-culture with seaweed, since seaweed grows more steadily than phytoplankton. As a result of *C. lentillifera* utilizing the nutrients dissolving from leftover shrimp feed, chemical fertilizers are not needed for growth of *C. lentillifera*. The growth of seaweed by this system showed an almost identical value to that grown independently using chemical fertilizers.

Caulerpa lentillifera has the ability to adapt to environments with a salinity of approximately 25~35% and water temperatures between approximately 23~33 ˚C. It was thus thought that *C. lentillifera* would be a suitable species for shrimp culture ponds where temperature and salinity can readily change. The growth of shrimp is not obstructed by co-cultivation with the *C. lentillifera.*

Using this co-culture system, the number of bacteria adhering to the gills of the shrimp decreased, and the biomass of bacteria in the water stabilized. It is possible to prevent total annihilation of the shrimp from the normally inescapable yellow head virus (YHV), since 1% of shrimps infected with YHV in several earthen shrimp ponds were observed to survive due to co-culture with *C. lentillifera.*

When a taste test targeting Thai people

was conducted, the unexpected flavor and fragrance of this species of *C. lentillifera* presented no problems, and the texture was particularly popular. It has the potential to become a popular food throughout Bangkok and subsequently Thailand, and may have a bright future as a secondary means generating income for small-scale shrimp culture farmers.

We believe that seaweed has a potentially large market in Thailand, since it can be utilized as human food, in cosmetic and pharmaceutical products, and for animal feed. Our experiments indicate that some seaweeds are effective in improving the aquatic environment. A further series of experiments will be necessary to choose other organisms, like shellfish, to act as effective biofilters in an integrated system.

(K. Hamano)

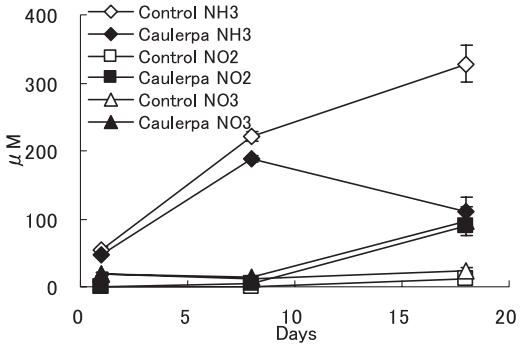


Fig. 1. Changes in ammonia (NH_3), nitrite (NO_2) and nitrate (NO_3) concentration in the water of monoculture and co-culture tanks. Error bars indicate standard deviation with n = 4.

Fig. 2. A Black Tiger Shrimp that survived mass death by YHV disease in a culture pond where *Caulerpa lentillifera* grows abundantly.

OKINAWA SUBTROPICAL STATION

The Okinawa Subtropical Station is tackling technological developments for sustainable agricultural production in tropical and subtropical underdeveloped regions, especially on tropical small islands.

The Station was established in 1970 in Ishigaki City, Okinawa Prefecture, as a branch office of the Tropical Agriculture Research Center, the predecessor of the present JIRCAS.

Ishigaki Island, one of the chief southernmost islands of the Ryukyu Islands, is located at 24˚N, 129˚E, and is surrounded by a variety of subtropical environments.

The Okinawa Subtropical Station takes full advantage of its natural conditions on an island of the subtropics.

The Station comprises the International Collaborative Research Section plus five Laboratories: the Islands Environment Management Lab., the Environmental Stress Lab., the Crop Breeding Lab., the Tropical Fruits Crop Lab., the Plant Protection Lab., in addition to the Administration Office and Field Management Section.

The total area of the station is about 30 ha: 8 ha for buildings, facilities and the windbreak forest surrounding the station, and 22 ha for experimental fields.

Established in 2001, the station has carried out research under 6 themes. 1) Elucidation of factors responsible for unstable crop production on islands and development of technologies for reducing soil runoff and for efficient use of water and fertilizers, 2) Evaluation and utilization of heat and salinity traits for snap beans, paddy rice and other crops, 3) Evaluation and utilization of useful genetic resources of sugarcane and tuber crops, 4) Development of basic technology for the evaluation of characteristics such as regulation of tree shape and the taste of fruits as well as for mass production of tropical fruit trees, 5) Analysis of ecological characteristics and occurrence of Citrus Greening Disease in tropical and subtropical areas, and 6) Development of techniques for fixing variations in characters like heading traits in rapid generation advancement of paddy rice and other crops.

These research subjects were carried out, in just the last year of the Five year medium-term research plan of the station, based on the

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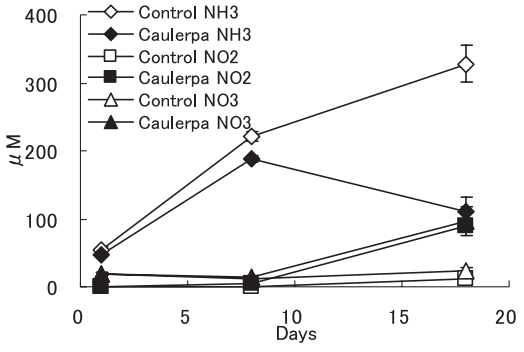

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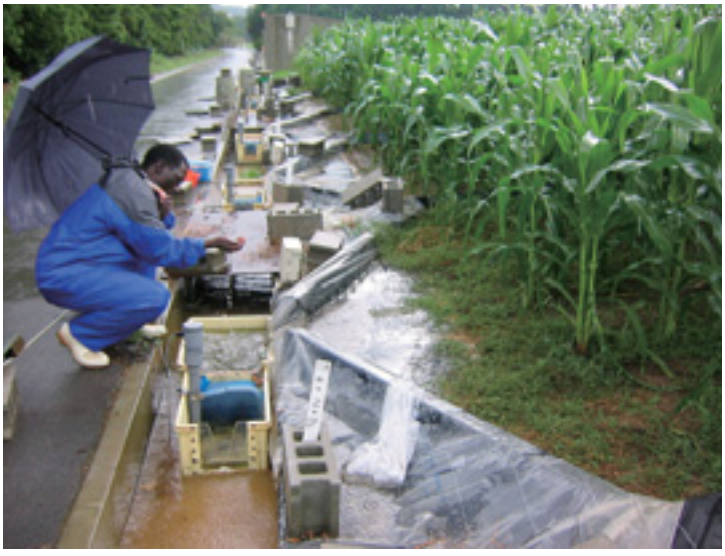

Monitoring of soil erosion and water runoff from a sloping field.

combined efforts of all the station staff, comprising Japanese researchers and invited research fellows from overseas (total 38 persons), administrative officers (4 persons), field management staff (9 persons), and part-time assistants (34 persons), as a close-knit team.

TOPIC 1

Effect of shuttle breeding by taking advantage of the wide latitude in Japan for heading traits of wheat

Usually it takes many years to breed wheat cultivars. Rapid generation advancement is, therefore, one of the more important techniques for shortening the process. On the other hand, photoperiod response (photoperiod-sensitive or insensitive) and vernalization response (winter or spring growth habit), which are controlled by *Ppd* and *Vrn* genes, respectively, are particularly important physiological characters, since they are responsible for earliness of heading and are thus closely related to regional adaptability. If the desirable *Ppd* and *Vrn* genotypes can be selected by natural and artificial selection during rapid generation advancement, its system should be very efficient. In this study, to establish an efficient method of rapid generation advancement applicable to spring wheat breeding programmes, the impact of shuttle breeding through fall-sown cultivation on Ishigaki (24˚N), Okinawa, in the southernmost part of Japan, followed by the spring-sown cultivation at Memuro (42˚N), Hokkaido in the northernmost part of Japan on the fluctuation in the frequency of the *Ppd* and *Vrn* genotypes was investigated.

Analysis of heading date in characteristic wheat cultivars and the F_2 populations indicated that the earliness of heading in Okinawa and Hokkaido was closely related to both *Ppd* and *Vrn* genotypes and the *Vrn* genotype, respectively. The two hybrid populations segregating for *Ppd* or *Vrn* genes, 'Saitama 27' (*Ppd-S*, *Vrn-A1*) × 'Haruhikari' (no *Ppd* genes, *Vrn-A1 Vrn-B1*) and 'Saitama 27' × 'Norin 59' (*Ppd-S*, no *Vrn* genes), were treated using rapid generation advancement (F_2: Okinawa, F_3: Hokkaido). As a control, the same cross combinations were also treated using the single seed descent method in F_2 - F_3 generations. The analysis of their photoperiod and vernalization responses showed that plants with photoperiod-sensitivity and winter growth habit were eliminated in Okinawa and those with winter growth habit were eliminated in Hokkaido (Table).

The present study proved this system of rapid generation advancement to be effective in eliminating the photoperiod-sensitive and winter types, therefore making it useful for photoperiod-insensitive spring wheat breeding. In addition, it was considered that, in a cross combination between distantly related parents, the following shuttle breeding system scheme would be appropriate, taking the degree of fixation into account: 1st year (F_2: Okinawa, F_3: Hokkaido) and 2nd year (F_4: Okinawa, F_5: Hokkaido). On the other hand, for photoperiod-sensitive spring wheat breeding, a long-day treatment is necessary to avoid eliminating photoperiod-sensitive types in fall-sown cultivation in Okinawa.

(M. Tanio, K. Kato, N. Ishikawa, T. Tabiki, Z. Nishio, K. Nakamichi, Y. Tamura, M. Sato, H. Takagi and M. Matsuoka)

Table. Fluctuation in photoperiod response (A) and vernalization response (B) with rapid generation advancement (RGA) or single seed descent (SSD) in two wheat hybrid populations.

(A) Photoperiod response in 'Saitama 27' (*Ppd-S Ppd-S*) × 'Haruhikari' (*ppd-S ppd-S*).

Population	No. of plants			χ^2 (expected segregation ratio)		
	Insensitive[1)]	Sensitive[1)]	Total			
F_2	95	35	130	0.26 (3:1) ^{ns}	94.82 (15:1) **	543.60 (63:1) **
RGA F_3	105	25	130	18.51 (5:3) **	0.62 (5:1) ^{ns}	
RGA F_4	102	28	130	26.06 (9:7) **	0.83 (3:1) ^{ns}	19.23 (9:1) **
SSD F_2	72	58	130	2.81 (5:3) ^{ns}	73.11 (5:1) **	
SSD F_4	69	61	130	0.53 (9:7) ^{ns}	33.32 (3:1) **	196.92 (9:1) **

(B) Vernalization response in 'Saitama 27' (*Vrn-A1 Vrn-A1*) × 'Norin 59' (*vrn-A1 vrn-A1*)

Population	No. of plants			χ^2 (expected segregation ratio)		
	Spring[2)]	Winter[2)]	Total			
F_2	92	38	130	1.24 (3:1) ^{ns}	117.17 (15:1) **	647.03 (63:1) **
RGA F_3	109	21	130	25.27 (5:3) **	0.02 (5:1) ^{ns}	
RGA F_4	123	7	130	77.75 (9:7) **	26.68 (3:1) **	3.08 (9:1) ^{ns}
SSD F_3	83	47	130	0.10 (5:3) ^{ns}	35.54 (5:1) **	
SSD F_4	63	67	130	3.20 (9:7) ^{ns}	48.83 (3:1) **	249.23 (9:1) **

RGA: In Okinawa, F_2 populations were sown on November and the ripened F_3 seeds were harvested in March. Afterwards, in Hokkaido, the F_3 populations were sown in April and the ripened F_4 seeds were harvested in July.
ns: not significant, **: significant at the 1% level.
[1)] The genotype of insensitive plants is *Ppd-S Ppd-S* or *Ppd-S ppd-S*, and the genotype of sensitive plants is *ppd-S ppd-S*.
[2)] The genotype of spring plants is *Vrn-A1 Vrn-A1* or *Vrn-A1 vrn-A1*, and the genotype of winter plants is *vrn-A1 vrn-A1*.

TOPIC 2

Evaluation of functional components in passionfruit cultivated under drip-fertigation and light culture

Passionfruit is produced from South Kyushu to Okinawa in Japan and is consumed as a table fruit or as juice. The flavor is appealing and the taste is subacid to acid. Passionfruit contains many functional components such as carotenoids and ascorbic acid. In open field culture, passionfruit is harvested only in summer and winter. However, it is possible to harvest it in autumn as well by using drip-fertigation and light culture, which comprises drip-fertigation culture that allows optimum control of fertilizer application and ground temperature, and light culture using energy-efficient red LEDs that induce flower bud formation (Fig. 1). We attempt to identify functional components contained in passionfruit and examine the influence of harvesting season on the quantity of the functional components under drip-fertigation and light culture.

'Summer Queen' passionfruit used in this study was collected from the Kagoshima Fruit Tree Experimental Station. As a result of analyzing the juice of the passionfruit using HPLC, it was found from the absorption spectrum that the main carotenoid in the passionfruit was ζ- carotene (Fig. 2). The UV-visible spectrum of ζ-carotene showed λ_{max} at 379, 400 and 425, with high spectral fine structure (%III/II 93). After filtering the passionfruit juice on a Sep-Pak C18 cartridge, the concentration of ascorbic acid was rapidly and simply determined using the Reflectoquant Ascorbic Acid Test (Merck Ltd., Japan) without the need to use HPLC. The quantities of ζ-carotene and ascorbic acid in the passionfruit juice varied significantly according to harvesting season (Fig. 3). The concentrations of ζ-carotene and ascorbic acid were significantly higher in fruits harvested in autumn than in summer and winter. There was a direct correlation between ζ-carotene and ascorbic acid content (Fig. 4) that was not

Fig. 1. Light culture by red LEDs (A) and drip-fertigation (B) of passionfruit.

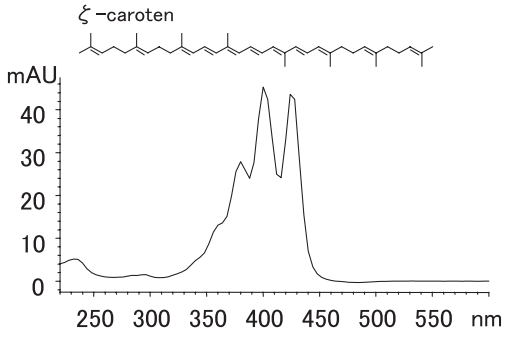

Fig. 2. UV-visible spectrum of major carotenoid fraction (retention time = 59.29 min).
The conditions were as follows: column, YMC carotenoid S5 µm (4.6 x 250 mm); temperature, 40°C; flow rate, 1.0 mL/min; mobile phase, A: 20% (v/v) MeOH in H_2O, B: MTBE: MeOH (9:1); gradient, 26% B hold for 15 min, to 34% B in 25 min, to 44% B in 10 min, to 56% B in 15 min, hold for 10 min, then back to 26% in 5 min.
The structural formula of ζ-carotene is illustrated.

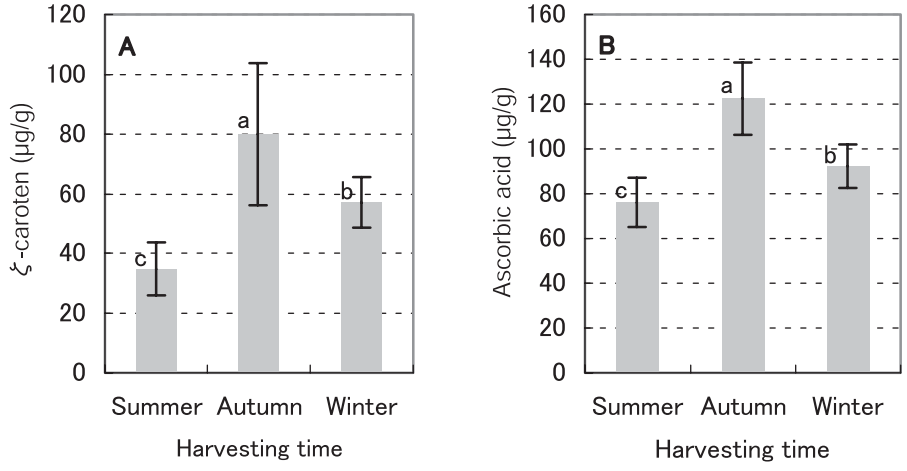

Fig. 3. Concentration of ζ-carotene (A) and ascorbic acid (B) in the juice of 'Summer Queen' passionfruit.
The concentration of ζ-carotene is measured as β-carotene corresponding.
Vertical bars indicate SE (n = 4-15). Different letters are significant at $P < 0.05$ according to the Tukey-Kramer HSD test.

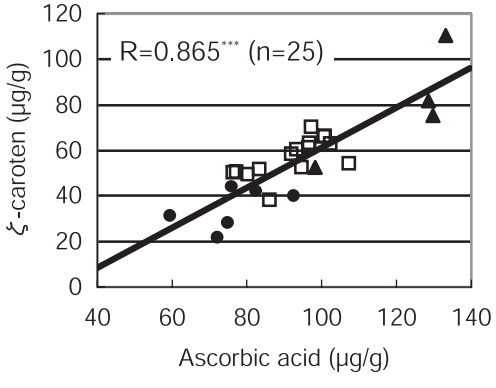

Fig. 4. Relationship between contents of ζ-carotene and ascorbic acid in juice of 'Summer Queen' harvested in summer (●), autumn (▲) and winter (□).
*** Significant at the 0.1% level.

influenced by harvesting season, making it possible to estimate the concentration of ζ-carotene by measuring the concentration of ascorbic acid using the Reflectoquant Ascorbic Acid Test.

These results indicate that drip-fertigation and light culture is useful for harvesting autumn fruit that contains numerous functional contents.

(H. Kato)

Moving distance a day of the released citrus psyllid, *Diaphorina citri* using a newly developed marking method

The Asian citrus psyllid, *Diaphorina citri* Kuwayama, is a vector of Asian Citrus Greening Disease which is spreading in Asia, including Japan, North and South America. Citrus greening disease or Huanglongbing (HLB) is the most destructive disease affecting citrus production. However, although knowledge of its vector ecology, especially dispersal studies, is needed for its control, data regarding the movement of this psyllid is minimal or entirely lacking. We have recently developed an effective marking method for this psyllid using fluorescent powder. We investigated the moving ability of the psyllids using this newly developed marking method and took into account moving characteristics as related to weather factors in the field.

First, we prepared 20,000 marked psyllids (Fig. 1) in a release experiment, reared for mass propagation in a glasshouse on orange jasmine. The reared psyllids used in this experiment were CG-free, since the CG bacterium does not propagate in orange jasmine. These marked psyllids were monitored at 65 points which comprised four orange jasmine trees per point, located concentrically at 50-m intervals up to 350 m from the release point (the center of our station) after one day (Fig. 2). Release experiments were conducted twice, in March and October 2005, at our station on Ishigaki Island, southwest of Japan.

The first experiment was conducted on March 21, 2005. The daily mean wind speed and daily mean wind direction at our station were 2.2 m/s and SSW, respectively, on the day of release. One day later, 516 psyllids had taken up residence on the orange jasmine plants at the monitoring points. Of those, 79.5% were observed on the north side and on the leeward of the release point. The maximal distance traveled after a day of these marked psyllids was measured as 350 m and the mean distance traveled was estimated at 79.8 m (Fig. 2).

The second experiment was conducted on October 15, 2005. The daily mean wind speed and daily mean wind direction at our station were 5.8 m/s and NNE, respectively, on the day of release. One day later, 118 psyllids were observed on the orange jasmine plants at the monitoring points. Of these, 96.6% were observed on the north side, on the leeward of the release point. The maximal distance traveled after a day of these marked psyllids was measured as 200 m and the mean moving distance was estimated at 66.9 m.

These results indicate that the marked vector psyllids moved to the leeward of the release point, and the maximal distance traveled after a day of these marked psyllids was measured as 350 m. The mean distance traveled in the two field experiments was estimated at 73.4 m. Since the psyllids moved 350 m in the first release experiment, some may have father migrated to the leeward side, exceeding the monitoring limit. These results will contribute to basic knowledge of the control strategy of this insect.

(T. Nakata)

Fig. 1. Large amount of marked psyllids on orange jasmine for release experiments.

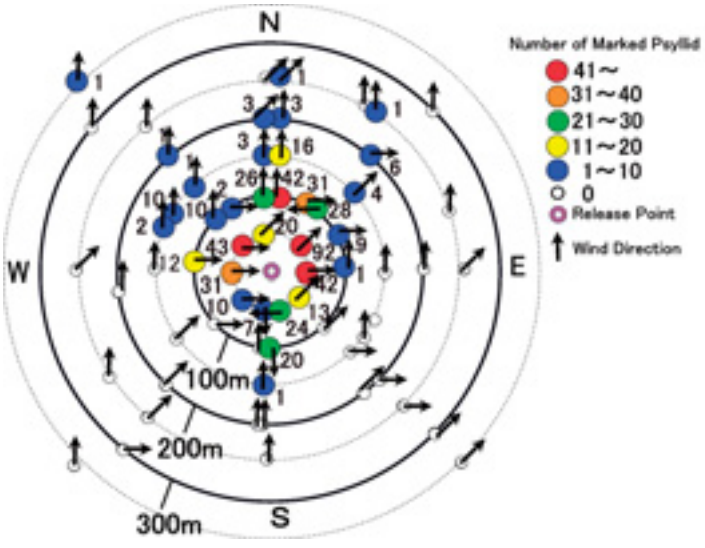

Fig. 2. The movement of marked psyllids in a day from a release point.
20,000 marked psyllids were released in the field on March 21, 2005, and a day later the number of psyllids was monitored visually on the orange jasmines. The intervals of the concentric circle were 50 m and the maximum range was up to 350 m.

Invasion of citrus psyllids in rehabilitated orchards and its probability decreased with distance of the new orchard from adjacent long-established ones

Citrus greening disease (referred to as CG hereinafter), or Huanglongbing, is currently one of the most serious problems facing citrus farmers worldwide, since it results in destructive damage to citrus production only a few years after its invasion. There is no decisive control method for this disease. The most practical management considered at this moment is the combination of removal of all rutaceous trees in and around orchards, planting new disease-free seedlings, and application of systemic insecticides thereafter. The success of this method appears to be primarily and strongly dependent on the re-invasion of viruliferous psyllids of the orchard after its sanitation. We can expect a negative correlation between the probability of re-invasion and the distance of the new orchard from the nearest old orchard. Knowing this correlation *a priori*, we can predict the risk of disease occurrence through the invasion of vectors in new orchards. If we use insecticides only when or where the risk is predicted to be high, it will help to reduce the use of pesticides or enable their more effective and rational use.

We examined the above hypothesis using four orchards in the Mekong Delta Region of southern Vietnam, varying their distances from the nearest old orchard from 0 to 50 m. We planted disease-free seedlings of king mandarin in May to June 2005. We will propose more efficient and economic control of psyllids for new orchards based on our results.

The probability of invasion of new orchards by psyllids was dependent on the distance of the new orchard from the nearest old one. Orchards which were at a distance of 20 m were heavily invaded by psyllids two weeks after planting, with mean densities (adults/tree) generally from 0.1 to 0.9 (Fig. 1).

Many first-generation nymphs appeared within one month of planting these orchards. The maximum density of nymphs reached 0.4 colony/tree in one orchard (Fig. 2).

On the other hand, an orchard 50 m distant from the nearest old orchard was rarely invaded by psyllids, and the time of the first invasion was delayed for one and half months (Figs. 1, 2). No nymphs were found throughout the study period (6 months).

Psyllids use new shoots as feeding and egg-laying sites. However, the numbers of new shoots were not apparently different between the studied orchards (Fig. 3), indicating that the re-invasion of psyllids depended on the distance of the new orchard from the nearest orchard.

In orchards within 20 m of the nearest old orchards, the population density of psyllids reached more than 0.2 adult/tree in one month and maintained this high density for three to four months. Accordingly, the densities of nymph colonies were likely to be high during these months. Thus, if some trees are infected with the CG pathogen vectored by invading adult psyllids, the pathogen will be rapidly transmitted by adults that had developed from nymphs on the CG-infected trees at high frequency, with the result that CG will be quickly spread throughout the orchard. Hence, to prevent a second dissemination of the pathogen, control of psyllids in these orchards should be undertaken immediately after they

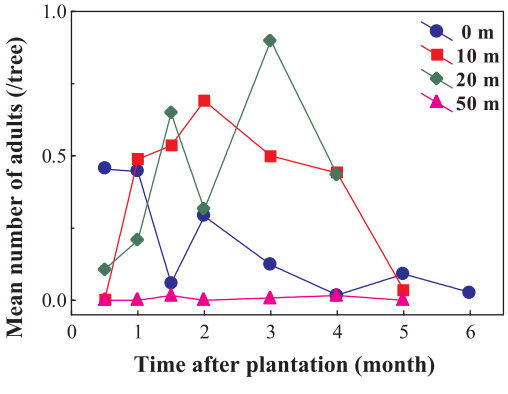

Fig. 1. Change in the number of psyllid adults in citrus orchards at different distances from the nearest old orchard after planting seedlings.

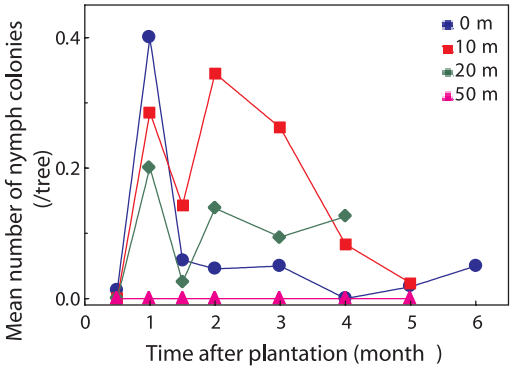

Fig. 2. Change in number of psyllid nymph colonies in citrus orchards at different distances from the nearest old orchard after planting seedlings.

are planted.

Both the latency to the occurrence of the first invasion and the frequency of psyllid invasion may be determined not only by the distance but also the season of planting, cultivation system, geographical situation of the orchard, vegetation in or around the orchard, and so on. These factors remain to be examined.

(K. Ichinose, D. H. Tuan, N. M. Chau, L. Q. Dien, and D. V. Bang)

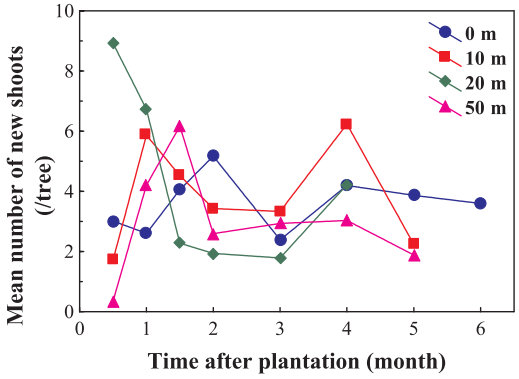

Fig. 3. Change in number of new shoots in citrus orchards at different distances from the nearest old orchard after planting of seedlings.

TOPIC 5

Economic efficiency of the combination of planting disease-free seedlings with application of systemic insecticides for the Citrus Greening problem in the Mekong Delta Region

Citrus Greening disease (referred to as CG hereinafter), or Huanglongbing, is currently one of the most serious problems facing citrus farmers worldwide, since it results in destructive damage to citrus production only a few years after its invasion. There is no decisive control method for this disease. The most practical management considered at this moment is the combination of removal of all rutaceous trees in and around orchards, planting of new disease-free seedlings, and application of systemic insecticides thereafter. The effectiveness of this management has not been proved, and it will take a long time to study its management in the field. However, circumstantial evidence of its effectiveness has been obtained by a questionnaire on the relationship between farmers' management of citrus orchards and crop yields in each orchard. Our hypothesis was that crop yields in orchards where disease-free seedlings have been planted and systemic insecticides applied are higher than in other orchards where neither of these managements was undertaken.

We randomly selected 116 farmers in the Mekong Delta Region of Vietnam and asked them if they used disease-free seedlings with or without systemic insecticide. We also asked them how much they invested financially in their orchards and the income from the crop yield. To examine the above hypothesis, we compared the results between management with disease-free seedlings and systemic insecticide with other types of management and evaluated the effectiveness of our combination against the citrus greening problem.

We identified four management patterns of citrus cultivation according to combination of seedlings and systemic insecticides: the use of both disease-free seedlings certified by a public organization and systemic insecticide (Free/Chem), disease-free and no systemic insecticides (Free/No), seedlings without any certification (uncertified seedlings) but the use of systemic insecticides (Uncert/Chem), and uncertified and no systemic (Uncert/No chem). In the studied area, our estimates suggest that CG reduced crop yield by 10.3% in the Free/Chem orchards, 16.1% in the Free/No chem orchards, 14.5% in the Uncert/Chem orchards, and 28.5% in the Uncert/No chem orchards, compared to the crop yield in the absence of CG.

We define the economic durability of an orchard as the period in which farmers can expect an income of more than 300,000 dong/1000 m^2 from the orchard after planting seedlings. The economic durability of orchards was five to six years without the use of systemic insecticide and seven to eight years with it, while fruit production started the third year after planting in both cases (Fig. 1). Mean annual yield during the economic durability period was 1.758 ± 0.342 (ton/1000 m^2) in the Free/Chem orchards, 0.730 ± 0.142 in the Free/No chem orchard, 1.150 ± 0.255 in the Uncert/Chem orchard, 0.588 ± 0.128 in the Uncert/No chem orchard.

Mean annual investment (million dong/1000 m^2) by each management type is shown in the Table 1. Naturally, investments in the purchase of seedlings and pesticides were the highest in the Free/Chem orchard. Investment in fertilizer was also fairly high in the management of systemic insecticide,

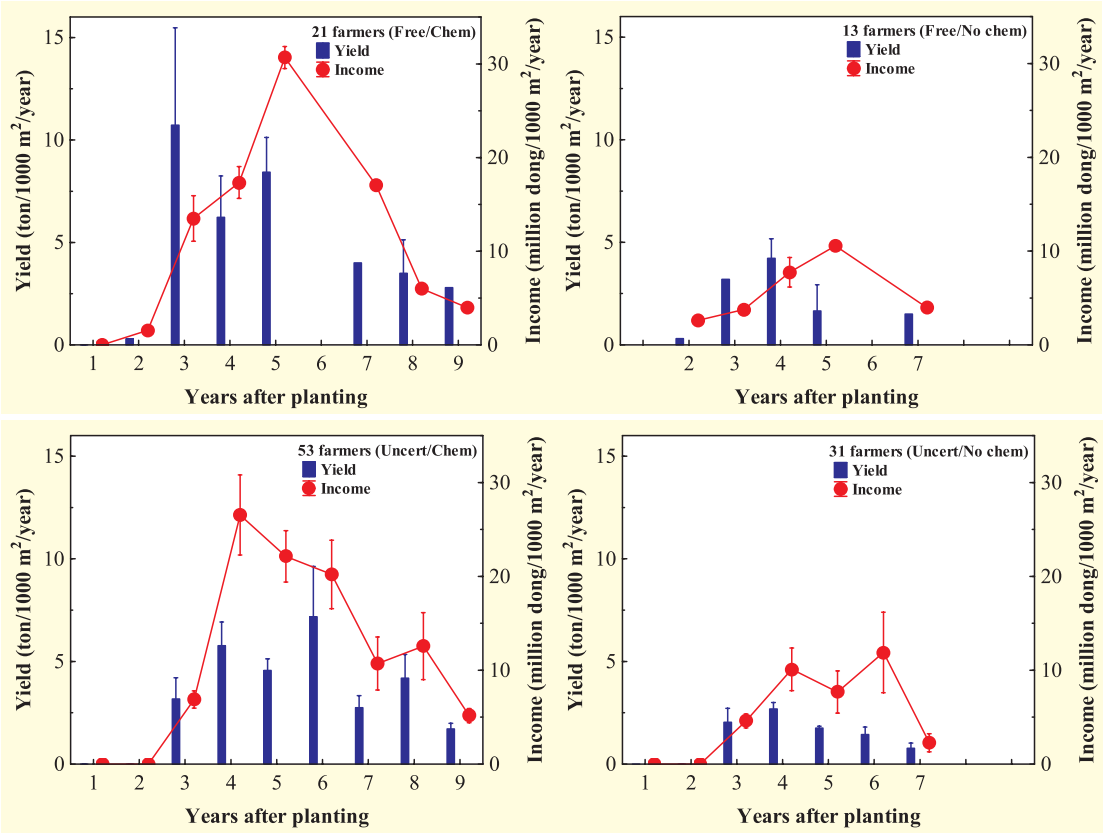

Fig. 1. Mean annual yield of crop and income by the four separate types of citrus management, categorized according to combination of disease-free seedling and systemic insecticide (cf. text for the definition of the managements).

Table 1. Mean annual investment (± SD) by the four separate management types of citrus, according to combination of disease-free seedling and systemic insecticide.

Management		Individual investment (million dong[1)]/yr/1000 m^2)				Total investment (dong/yr/1000 m^2)
Seedling	Insecticide	Seedlings	Fertiliser	Chemicals	Labour	
Disease-free	Systemic	1.36 ± 0.41	1.32 ± 0.78	0.35 ± 0.26	1.71 ± 0.67	4.74 ± 1.15
	No systemic	1.20 ± 0.28	0.82 ± 0.36	0.16 ± 0.24	1.18 ± 0.33	3.36 ± 1.54
Uncertified	Systemic	0.72 ± 0.10	1.52 ± 1.00	0.28 ± 0.31	1.56 ± 0.57	4.09 ± 0.43
	No systemic	0.71 ± 0.12	0.66 ± 0.36	0.11 ± 0.77	1.28 ± 0.38	2.76 ± 0.33

Note: 1) Exchange rate is 15,850 dong/US dollar.

while that in labor was similar among the four managements.

Our study revealed that although management that combines the planting of disease-free seedlings with use of systemic insecticides required the highest monetary investment, it promises both the highest yield and income. However, our study is inevitably impeded by statistical problems. In this present study, we were not able to analyze either the effects of differences in geographic/weather conditions between fields/years or those due to variation in management styles undertaken by farmers. We need to perform field experiments in which these conditions are included. This is a future issue.

(D. H. Tien, T. Kano, K. Ichinose, and R. Yamada)

TOPIC 6

The advantages and disadvantages of subsurface drip irrigation

Drip irrigation has been increasingly used since the 1960s, due to its advantages such as increased productivity and greater water saving. One advantage of subsurface (SDI) and surface drip irrigation (DI) is that it also is a cost-effective method for application of nutrients, pesticides, etc., at frequent intervals throughout the crop-growing season. Although the yield response for many crops indicated that the crop yield under SDI was greater than or equal to that under other irrigation methods, including DI, and required less water in many cases, no clear differences were observed between SDI and DI, since differences in the number of experimental years and sites often yielded differing results. Further, plants under SDI need to distribute their roots into a deep water-supplied area during the early stages of growth, and there are few reports evaluating the effects of this stage. In this study, we measured the evapotranspiration rates, LAI, root activities and shoot dry weights of cabbage grown under DI and SDI (15 cm depth) to clarify the reason for uncertainness in the difference between SDI and DI in each growing stage.

Cabbage evapotranspiration rates were greater under DI and SDI in the early and later stages of growth, respectively (Fig. 1). LAI of cabbage was also greater under DI and SDI in the early and later stages of growth, respectively.

The roots penetrated to slightly below 15 cm depth in the early stage of growth 17 days after transplanting (DAT). This means that under SDI, only parts of the roots are likely to reach the water-supplied area. This was one reason why the evapotranspiration rate of cabbage under SDI was lower than that under DI in the early stages of growth before 20 DAT. The root TTC reduction capacity (root activity) of cabbage under SDI increased when its evapotranspiration rate increased in the later stage of growth (Figs. 1 and 2). These results demonstrate that the root activity and evapotranspiration rate of the plant under SDI increased in the later stages of growth, although the evapotranspiration rate was lower and the growth was slower in the early stages of growth than for plants under DI. A nutrient-rich and water-rich environment would be preferable for plants

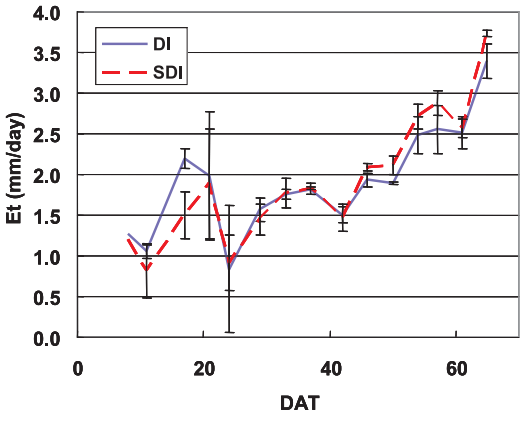

Fig. 1. Evapotranspiration rate of cabbage grown under DI and SDI at each stage of growth.
DAT: days after transplanting.

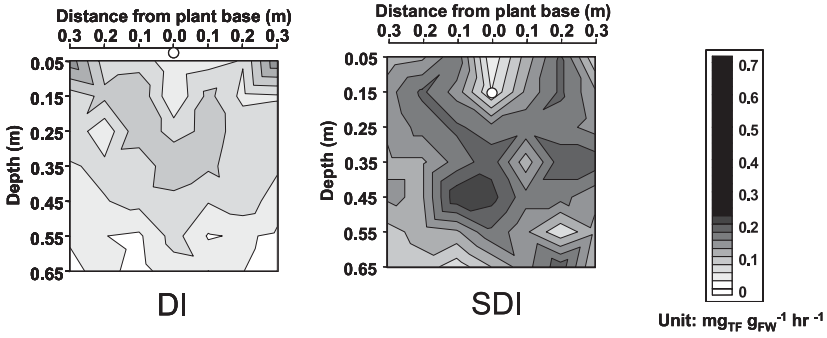

Fig. 2. TTC reduction capacity (root activity) of cabbage grown under DI and SDI at 56 DAT (day after transplanting).

under DI and SDI in the early and later stages of growth, respectively. Thus, plant growth under DI and SDI appears to change according to whether other environmental factors such as temperature and solar radiation are advantageous in the early or later stages of growth. These factors are what created the uncertainness in the difference in shoot dry weight and yield between DI and SDI.

(K. Nakamura and K. Ozawa)

TOPIC 7

Runoff of nutrients cause decreasing crop yield in fields with lower infiltration rates in Southern Mali

In Southern Mali, over a distance of approximately 300 km, or for every 2˚ difference in latitude, annual precipitation has decreased within the recent few decades by 600 mm, from 1,400 mm to 800 mm. Local farmers tend to believe that the reduction in precipitation is the only cause of recently decreasing and unstable crop production. However, we were able to demonstrate that runoff of fertilizer elements due to precipitation decreased crop yield in fields with low infiltration rates in the region. The

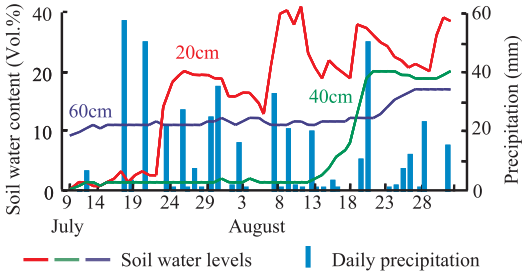

Fig. 1. Changes in soil water content at different depths and in relation to daily precipitation in Niessemana, Mali.

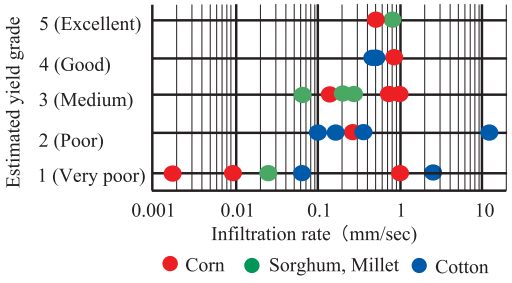

Fig. 2. Relation between infiltration rate in soil surface and estimated yield grade.

research was conducted with budgetary support from the Japanese Ministry of Education over a period of three years from 2000.

The region is located on one of the old geological plates, where soils have become divided into two distinct types during its long history. The first type is gravelly soil, with a high infiltration rate, located mainly in highland areas where erosion occurs. The other type is clayey soil, with a low infiltration rate, located mainly in lowland areas, where deposition occurs. In the first type of soil, rainwater infiltrates rapidly into the subsoil, while in the second type, there is considerable rainwater runoff from the soil surface.

We hypothesized that either type of water movement could cause loss of nutritive elements and thereby result in reduced yield. We tested this hypothesis first by examining the infiltration rate. Analysis showed that, from the beginning of the rainy season, at least 614 mm of precipitation and 90 days were needed before the water capacity of the soil at a depth of 60 cm was completely filled (Fig. 1).

According to our results, over 90% of the water from precipitation was calculated to be lost due to soil surface runoff and evaporation. Growth of maize, millet, sorghum and cotton was visually estimated from standing plants, and was analyzed in terms of its relationship with the infiltration rates in twenty-one fields in Diou. For measurement of the infiltration rate, a cylinder 20 cm^2 in cross section and 10 cm in height was inserted into the soil to a depth of 2.5 cm, after which water was poured into the cylinder to a height of 5 cm. Crop growth was poor in fields where infiltration rates were either much lower than the average range, at under 0.04 mm/sec or much higher at over 1.00 mm/sec (Fig. 2).

Root distribution maps of maize were drawn from three fields with low, medium, and high infiltration rates, respectively. Crops in fields with soils with low infiltration rates showed signs of mild water stress early in the cropping period. Crops in fields with soils showing high infiltration rates gave signs of restricted root development later in the cropping period. These results show that runoff of water and nutritive elements from the soil surface, as well as leaching into the subsoil, collectively result in poor growth.

Table 1. Effects of additional application of urea and coated urea on cotton ball yield in fields with different infiltration rates.

Infiltration rate in fields	Conventional application	Urea additional application	Coated urea additional application
(mm/sec)	(t/ha)	(t/ha)	(t/ha)
0.56	1.30±0.17	1.43±0.11	1.35±0.14
	a	N.S.	N.S.
0.04	0.58 ±0.07	0.53 ±0.06	0.98 ±0.05
	b	N.S.	***

Different alphabetic letters show significant differences.
N.S.: No significant difference from conventional application.
***: Significant difference between conventional and coated urea application, P > 0.1%.

To verify the above hypothesis experimentally, effects on cotton yield of quick-acting and slow-acting fertilizers were compared. Cotton yield in plots receiving slow-acting fertilizer were higher in fields with soils showing lower infiltration rates (Table 1). This shows that the lack of nutritive elements due to rainwater runoff on the soil surface decreased water use efficiency in fields with lower infiltration rates, even in this region where a general water shortage already limits crop production.

Practices to decrease nutritive element runoff on soil surfaces, including split application of fertilizer, construction of levees surrounding fields, and drainage canals could

be useful in fields with lower infiltration rates. The infiltration rates of 12% of fields in the region were under 0.04 mm/sec.

(K. Ozawa, M. Doumbia, A. Yorote and J. S. Caldwell)

TOPIC 8

Midday drop in leaf water content is an effective trait for evaluating germplasm for heat and drought tolerance in snap bean (*Phaseolus vulgaris*).

In the subtropical islands of Okinawa, snap bean production in summer is very difficult due to high temperatures, strong solar radiation, and drought, etc. The crop faces a water deficit due to excessive transpiration caused by high temperatures. However, the influences of high temperature and drought on pod/seed production, shoot extension, water status and photosynthesis as related to cultivar variations have hitherto been unclear. To develop simple physiological traits for heat and drought tolerance is also desired for breeders to accelerate the screening of stress-tolerant germplasm. This study was, therefore, conducted to identify the plant traits/processes related to heat and/or drought stresses and to elucidate the mechanisms of stress tolerance in snap bean.

A discriminant analysis revealed that the five cultivars (Haibushi, Ishigaki-2 Kurodane-Kinugasa, Kentucky Wonder and 92783) displayed two distinct types of response (Fig. 1). One group included cultivars Haibushi, Ishigaki-2 and Kurodane-Kinugasa, which showed a large reduction of about 16-20% in both shoot extension and water potential under unirrigated dry conditions; these produced a higher number of pods per plant and seed yield than cultivars Kentucky Wonder and 92783. Cultivars Kentucky Wonder and 92783, which formed a separate group, displayed a comparatively smaller reduction (4-8%) in both water potential and shoot growth under unirrigated dry conditions. On the other hand, the former group displayed a smaller reduction in leaf water content while the latter group displayed a larger reduction in leaf water content. These results indicate that the maintenance ability of relatively higher leaf water content with increasing water deficit plays an important role in terms of higher pod setting, pod retention and seed yield in snap bean under stressed conditions.

The leaf water content was positively correlated to photosynthetic parameters such as stomata conductance and intercellular CO_2. The cultivars with a smaller midday drop in leaf water content showed a higher pod setting ratio and produced a larger number of pods per plant and consequently gave higher yields than plants with a larger midday drop in leaf water content (Fig. 2).

From these results, it can be concluded that leaf water content plays an important role in maintaining better photosynthetic conditions and, thus, higher pod/seed production under heat and drought conditions, and is maintained by reduction in leaf water potential and shoot extension in response to heat and drought stresses. These traits can thus be used as a marker to screen germplasm for heat and drought tolerance.

(H. Omae, A. Kumar, K. Kahiwaba, and M. Shono)

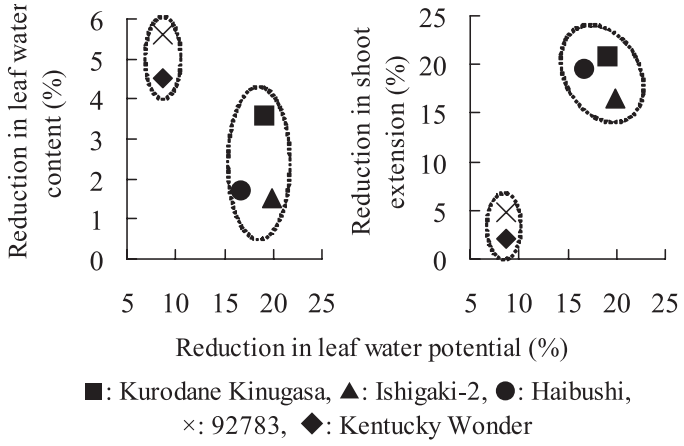

Fig. 1. Relationship of reduction (ratio of unirrigated to irrigated control in percentage) in leaf water potential with leaf water content and shoot extension in 5 cultivars of snap bean. Each dotted circle encloses a group of cultivars/strains identified by discriminant analysis. *: $P < 0.05$.

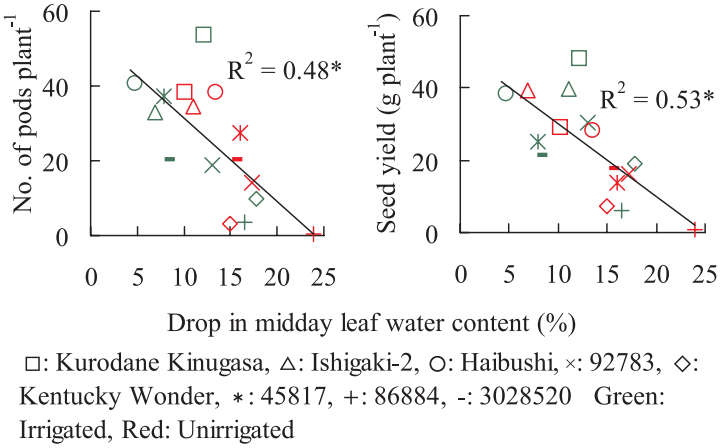

Fig. 2. Association of midday drop in leaf water content (ratio of leaf water content at midday to morning) with the number of pods per plant and seed yield. The measurements were taken in 8 cultivars under irrigated and unirrigated hot conditions during the reproductive stage. *: $P < 0.05$, ** $P < 0.01$.

MISCELLANEOUS PROJECTS OUTLINE

In addition to comprehensive international projects, JIRCAS conducts a variety of miscellaneous projects, including projects conducted abroad; domestic projects in cooperation with other MAFF-affiliated incorporated administrative agencies; commissioned research primarily in cooperation with universities; cross-ministry projects currently involving the Ministry of Education, Culture, Sports, Science, and Technology and the Ministry of the Environment, as well as other organizations; and special allotment projects.

OVERSEAS PROJECTS

Evaluation of environmental impact associated with the construction of logging roads
(At the Forest Research Institute of Malaysia, 2001–2005)

Innovation of cultivation technologies and agricultural systems to control clubroot disease in the West Java highlands
(At the Central Research Institute for Horticulture, Indonesia 2003–2005)

Socio-economic research for the technological advancement of various agricultural systems
(At the Center for Coarse Grains, Pulses, Roots, and Tuber Crops in the Humid Tropics of Asia and the Pacific [CGPRT Center] and the Center for Agro-Socioeconomic Research and Development [CASERD], 2003–2005)

Evaluation of rice gene resource properties and development of new varieties in West Africa
(At the West Africa Rice Development Association [WARDA], 2003–2005)

Elucidation of production environment characteristics and foodstuff functionality of South and Southeast Asian vegetables
(At the Asian Vegetables Research and Development Center, 2003–2005)

Investigation of the roles of the TNF-α gene in trypanosomosis and elucidation of the mechanisms of infection and development of trypanosomosis
(At the International Livestock Research Institute [ILRI], 2003–2005)

Studies on molecular breeding of whitebacked planthopper-resistant *japonica* rice varieties suitable for the Changjiang River valley
(At the China National Rice Research Institute, 2004–2006)

Development of technologies related to high-level environmental stresses placed on wheat in arid areas
(At the International Center for Agricultural Research in Dry Areas [ICARDA], 2004–2006)

Elucidation of characteristics of, genetic improvement, and development of sustainable cultivation techniques for beans in tropical and subtropical areas
(At the Asian Vegetable Research and Development Center [AVRDC], 2004–2006)

Development of technology for a sustainable rice production system in the rainfed lowland of West Africa
(At the Institute of Agronomic Research of Guinea, Guinea [IRAG], 2004–2008)

Development of a technology assessment method for determining the factors influencing diffusion of technology in Southeast Asia
(At the International Rice Research Institute [IRRI], 2004–2008)

DOMESTIC PROJECTS

In close cooperation with related research organizations, JIRCAS conducts domestic research at its main premises in Tsukuba and at its Okinawa Subtropical Station to support its international collaborative projects.

JIRCAS is further enhancing its comprehensive projects through its Tsukuba and Okinawa research fellowship programs, in which foreign researchers from JIRCAS counterpart organizations are invited to carry out studies that support ongoing collaborative projects abroad. These programs also promote positive relationships between JIRCAS and foreign institutions and facilitate future exchange of individual research staff. JIRCAS domestic research has produced a variety of significant results, especially in the areas of

drought-resistant crop development and world food supply-and-demand analysis. By focusing on fields in which it can apply its strengths in research management and coordination, JIRCAS is able to effectively utilize its limited budget and personnel in resolving critical agricultural and food supply problems in developing countries. Current domestic research is focused on the following themes: 1) world food supply analysis; 2) development of sustainable agriculture; 3) development of technologies for utilizing animal resources; 4) evaluation of crop tolerance to low temperatures, drought, and blight; 5) analysis of circulation of nitrogen in the soil; 6) utilization of remote-sensing technology for evaluating environmental resources; 7) development of technologies for the preservation and utilization of environmental resources; 8) evaluation of foodstuff quality in developing countries; and 9) cultivation and practical application of fisheries resources.

Research and development of highly functional food products using computer technology
(Food Science and Technology Division, 1997–2005)

Development of resistance to high-level environmental stresses to add practical value to farm products
(Biological Resources Division, 1999–2005)

Developing an improved model for forecasting future supply and demand statistics
(Development Research Division, 2001–2005)

Development of widely usable, reliable technologies for the production of high-biomass sugarcane
(Crop Production and Environment Division, 2002–2006)

Economic evaluation of the impact of global warming on world agricultural, forestry, and fisheries production
(Development Research Division, 2002–2006)

COMMISSIONED RESEARCH

RESEARCH PROJECTS WITH OTHER GOVERNMENT MINISTRIES AND ORGANIZATIONS

In cooperation with the Ministry of Education, Culture, Sports, Science, and Technology

Development of a model to estimate the potential water supply derived from river basins in the Asian Monsoon Region
(Crop Production and Environment Division, 2002–2006)

Evaluation of tropical forest ecology and wood quality
(Forestry Division, 2003–2006)

In cooperation with the Ministry of the Environment

Fragility of Sahelian farming and soil degradation: a consideration of policy intervention
(Development Research Division, 2003–2005)

Development of greenhouse-gas sink/source control technologies through the conservation and efficient management of terrestrial ecosystems
(Animal Production and Grassland Division, 2003–2007)

In cooperation with the Japan Science and Technology Corporation

Functional analysis of rice genes encoding transcription factors
(Biological Resources Division, 2002–2007)

Research on changing water use in the Mekong Delta and its influence on economic growth in Delta countries, and development of a model for water usage and management
(Developmental Research Division and Crop Production and Environment Division, 2002–2007)

Use of biotechnology in developing regions in order to stabilize agricultural production and fisheries resources
(Biological Resources Division and Fisheries Division, 2001–2005)

Research and development of comprehensive technologies used to preserve soil and water quality in tropical and subtropical island areas

(Okinawa Subtropical Station, 2002–2007)

Comprehensive strategy for ASEAN biomass research and development
(Food Science and Technology Division, 2004–2006)

In cooperation with the Bio-oriented Technology Research Advancement Institution (BRAIN)

Study on regulation of gene expression and signal transduction pathways regulated by the plant hormone ABA (abscisic acid) and its application to biotechnology
(Biological Resources Division, 2001–2005)

Systematization of safe production techniques for shrimp (*Penaeus vannamei*) in Japan
(Fisheries Division, 2004–2008)

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 concerning agriculture, forestry, and fisheries administration, while at the same time strengthening international research ties among scientists and administrators in other countries. Current programs are described in greater detail below.

1) Administrative Invitation Program

Under the Administrative Invitation Program, JIRCAS invites administrators from counterpart organizations to its Tsukuba premises to engage in discussions and review ongoing research in order 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). Finally, 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 cooperation. Forty-five individual visits to JIRCAS were made during FY 2005 under the Administrative Invitation Program, including three invitations to the International Symposium on "Perspectives of R&D for Improving Agricultural Productivity in Africa." Invited administrators and their home institutions are listed below.

Administrative Invitations, FY 2005

Li Shuyun	Chief Division of Bilateral Cooperation Department of International Cooperation Chinese Academy of Agricultural Sciences (CAAS) P.R. China	April 4-16, 2005
Vania Beatriz Rodrigues Castiglioni	Chefe-Geral Centro Nacional de Pesquisa de Soja (CNPSo) EMBRAPA Brazil	July 19-29, 2005
Kriengsak Surisuk	Director Groundwater Research Center Khon Kaen University Thailand	Oct.16-23, 2005
Lamourdia Thiombiano	Senior Soil Resources Officer FAO, Regional Office for Africa Burkina Faso	Sept. 10-13, 2005
Nteranya Sanginga	Director Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT) Ghana	Sept. 10-13, 2005
Thanee Viriyarattanaporn	Director Forest Management and Forest Product Research Office Royal Forest Department (RFD) Thailand	Aug. 21-28, 2005

Chen Youqi	Professor Institute of Agricultural Resources and Regional Planning Chinese Academy of Agricultural Sciences (CAAS) P.R. China	Nov. 21-25, 2005
Xu Xianbin	Researcher Institute of Cultivation Heilongjiang Academy of Agricultural Sciences P.R. China	Nov. 21-25, 2005
Yang Xiu	Associate Professor Institute of Agro-Environment and Sustainable Development Chinese Academy of Agricultural Sciences (CAAS) P.R. China	Nov. 21-25, 2005
Jiao Jiang	Director Institute of Cultivation Heilongjiang Academy of Agricultural Sciences (CAAS) P.R. China	Nov. 21-25, 2005
Xu Yinlong	Associate Professor Institute of Agro-Environment and Sustainable Development Chinese Academy of Agricultural Sciences (CAAS) P.R. China	Nov. 21-25, 2005
Jong Foh Shoon	Director P. T. National Timber and Forest Products Indonesia	Oct. 12-20, 2005
Hossain Mohabubu	Head Social Sciences Division (SSD) International Rice Research Institute (IRRI) Philippines	Oct. 3-6, 2005
Giro Orita	Honorary Senior Consultant International Center for Agricultural Research in the Dry Areas (ICARDA) Syrian Arab Republic	Nov. 13-Dec. 1, 2005
Suppachai Summawuthi	Manager Samutsongkhram Fisheries Research Station Kasetsart University Thailand	Dec. 5-11, 2005
Cecilia N. Gascon	Acting President Southern Luzon Polytechnic College Philippines	Oct. 13-26, 2005
Supranee Impithuksa	Deputy Director General Department of Agriculture, Ministry of Agriculture and Cooperatives Thailand	Oct. 23-29, 2005

Manuel Celiz Palada	Head Crop and Ecosystem Management Unit Asian Vegetable Research and Development Center (AVRDC) Republic of China	Oct. 24-28, 2005
Sayad Nooruddin Hariq	Deputy Director General Research Department Ministry of Agriculture, Animal Husbandry and Food Afghanistan	Dec. 10-17, 2005
Theib Y. Oweis	Director Management of Scarce Water Resources and Mitigation of Drought International Center for Agricultural Research in the Dry Areas (ICARDA) Syrian Arab Republic	Dec. 11-17, 2005
Miloudi M. Nachit	Senior Staff International Center for Agricultural Research in the Dry Areas (ICARDA) Syrian Arab Republic	Dec. 11-17, 2005
Saidou Koala	Director for West and Central Africa International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)-Niamey Niger	Nov. 5-13, 2005
Junaidi Bin Ayub	Director General Department of Fisheries Malaysia (DOF) Malaysia	Dec. 5-11, 2005
Chee Fhaik Ean	Section Head Fisheries Research Institute (FRI) Malaysia	Dec. 5-11, 2005
Prathak Tabthipwon	Vice Dean Faculty of Fisheries Kasetsart University Thailand	Dec. 5-11, 2005
Chong Ving Ching	Professor Institute of Biological Sciences University of Malaya Malaysia	Dec. 5-11, 2005
Wang Zhiben	Senior Researcher Institute of Agricultural Economics Chinese Academy of Agricultural Sciences (CAAS) P.R. China	Dec. 14-27, 2005
Bruno Gerard	Senior Scientist International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)-Niamey Niger	Dec. 10-18, 2005

Wan Rosli Wan Daud	Dean School of Industrial Technology Universiti Sains Malaysia Malaysia	Nov. 29-Dec. 6, 2005
Md. Majibur Rahman	Professor Department of Microbiology University of Dhaka Bangladesh	March 3-9, 2006
Haseena Khan	Professor Department of Biochemistry and Molecular Biology University of Dhaka Bangladesh	March 6-9, 2006
Chen Shisong	Director Animal Inspection and Quarantine Division Beijing Entry-Exit Inspection and Quarantine Bureau P.R. China	March 6-9, 2006
Xu Yan	Dean School of Biotechnology Southern Yangtze University (SYTU) P.R. China	March 6-9, 2006
Maria Nunik Sumartini	Head Subdivision of Reporting and Auditing Program Evaluation Directorate General of Processing and Marketing of Agricultural Products Ministry of Agriculture Indonesia	March 6-9, 2006
Jae-Ho Ha	Director Food Safety Research Korea Food Research Institute Korea	March 6-9, 2006
Yun-Ji Kim	Senior Researcher Hazard Control Research Team Korea Food Research Institute Korea	March 6-9, 2006
Gulam Rusul Rahmat Ali	Professor School of Graduate Studies Universiti Putra Malaysia Malaysia	March 6-9, 2006
Maria Antonia Tuazon	Regional Training Program on Food and Nutrition Planning Institute of Human Nutrition and Food College of Human Ecology University of the Philippines Philippines	March 6-9, 2006

Gilberto F. Layese	Director Bureau of Agriculture and Fisheries Product Standards Department of Agriculture Philippines	March 6-9, 2006
Warapo Mahakarchanakul	Lecturer Department of Food Science and Technology Faculty of Agro-Industry Kasetsart University Thailand	March 6-9, 2006
Siriporn Stonsaovapak	Head Applied Microbiology Department Institute of Food Research and Product Development (IFRPD) Thailand	March 6-9, 2006
Nam-Hyouk Lee	Senior Researcher Division of Food Material Processing Technology Korea Food Research Institute Korea	March 6-9, 2006

International Symposium Invitees, FY 2005		
Monty Patrick Jones	Forum for Agricultural Research in Africa (FARA) Sierra Leone	July 13-16, 2006
Abu-Michael Foster	Sasakawa Africa Association Uganda Office Ghana and UK	July 12-16, 2006
Mafa Evaristus Chipeta	Policy Assistance Division Technical Cooperation Department Food and Agriculture Organization of the United Nations Malawi	July 12-16, 2006

2) 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 both to enhance the quality of research conducted in foreign countries and to facilitate exchanges between individual research staff. Twenty researchers were invited under the Counterpart Researcher Invitation Program during FY 2005. Invited researchers, their affiliated research organizations, and their research activities are summarized below.

Gilberto F. Layese	Director Bureau of Agriculture and Fisheries Product Standards Department of Agriculture Philippines	March 6-9, 2006
Warapo Mahakarchanakul	Lecturer Department of Food Science and Technology Faculty of Agro-Industry Kasetsart University Thailand	March 6-9, 2006
Siriporn Stonsaovapak	Head Applied Microbiology Department Institute of Food Research and Product Development (IFRPD) Thailand	March 6-9, 2006
Nam-Hyouk Lee	Senior Researcher Division of Food Material Processing Technology Korea Food Research Institute Korea	March 6-9, 2006

International Symposium Invitees, FY 2005		
Monty Patrick Jones	Forum for Agricultural Research in Africa (FARA) Sierra Leone	July 13-16, 2006
Abu-Michael Foster	Sasakawa Africa Association Uganda Office Ghana and UK	July 12-16, 2006
Mafa Evaristus Chipeta	Policy Assistance Division Technical Cooperation Department Food and Agriculture Organization of the United Nations Malawi	July 12-16, 2006

2) 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 both to enhance the quality of research conducted in foreign countries and to facilitate exchanges between individual research staff. Twenty researchers were invited under the Counterpart Researcher Invitation Program during FY 2005. Invited researchers, their affiliated research organizations, and their research activities are summarized below.

Counterpart Researcher Invitations, FY 2005

At JIRCAS, National Agricultural Research Center for Kyushu Okinawa Region (Kumamoto and Tanegashima), National Institute of Livestock and Grassland Sciences (Tsukuba and Nishinasuno), June 13-July 12, 2005		
Kritapon Sommart	Associate Professor Faculty of Agriculture Khon Kaen University Thailand	Development of a method of feeding lactating cows using food by-products
At JIRCAS, National Institute of Livestock and Grassland Science, Kyoto Prefectural University, June 21-July 22, 2005		
Osvaldo Balbuena	Team Leader INTA-Colonia Benitez Argentina	Study on PCR techniques for methanogen identification and measurement of methane production
At JIRCAS, July 20-September 2, 2005		
Zhang Guomin	Chief Department of Rice Breeding and Cultivation Institute of Cultivation Heilongjiang Academy of Agricultural Sciences P. R. China	Development of a farm-planning model for reducing the risk of production fluctuations
At JIRCAS, July 20-September 2, 2005		
Luo Liangguo	Deputy Researcher Institute of Agricultural Economics Chinese Academy of Agricultural Sciences Agricultural Policy Division P. R. China	Development of a farm-planning model for reducing the risk of production fluctuations
At JIRCAS, August 8-October 28, 2005		
Wu Wenbin	Research Assistant Institute of Natural Resources and Regional Planning Chinese Academy of Agricultural Sciences P. R. China	Development of a method for monitoring areas sown with major crops using satellite data
At JIRCAS, July 24-August 20, 2005		
Seth Dominic Meyer	Assistant Research Professor Food and Agricultural Policy Research Institute University of Missouri-Columbia USA	Development of a model for the supply and demand of rice in Vietnam
At JIRCAS, August 22-October 1, 2005		
Esteban Suarez Garibay	Research Assistant Research Division Aquaculture Department Southeast Asian Fisheries Development Center (SEAFDEC) Philippines	1. Fatty acid composition of tropical fish fed with essential fatty acid-enriched rotifers 2. Amino acid composition of local squid meal in the Philippines

At JIRCAS, National Research Institute for Rural Engineering, Hokkaido University, October 10-November 5, 2005		
Thawing Norkham	Soil Surveyor Soil Survey and Land Use Planning Land Development Department (LDD) Ministry of Agriculture and Cooperatives (MOAC) Thailand	Measurement of physical properties of soil in Northeast Thailand for efficient use of water
At JIRCAS, National Research Institute for Rural Engineering, Okayama University, October 10-November 5, 2005		
Kunnika Homyamyen	Soil Surveyor Soil Survey and Land Use Planning Land Development Department (LDD) Ministry of Agriculture and Cooperatives (MOAC) Thailand	Analytical simulation for irrigation planning according to soil water movement
At JIRCAS, Maihama Research Center, Ogawa Flavor & Fragrances Co., Ltd., September 1-30, 2005		
Sumitra Boonbumrung	Researcher Institute of Food Research and Product Development (IFRPD) Kasetsart University Thailand	Stabilization of unstable flavor substances by using rice powder or starch, and their release characteristics
At JIRCAS, Hokkaido University, October 4-8, 2005		
Ngo Ngoc Hung	Associate Professor Department of Soil Science and Land Management Faculty of Agriculture Can Tho University Vietnam	Nitrogen cycling in East and Southeast Asia
At JIRCAS, October 24-December 22, 2005		
Zou Jinqiu	Research Assistant Institute of Agricultural Resources and Regional Planning Chinese Academy of Agricultural Sciences P. R. China	Use of satellite data for analysis of changes in areas sown with major crops
At JIRCAS, Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF), Tokyo University, October 11-November 10, 2005		
Guo Jianjun	Chief Department for Rural Economic Development Research Center of The State Council P. R. China	Elucidation of trends in the supply and demand of rice in the northern region of China
At JIRCAS, Seikai National Fisheries Research Institute, Ishigaki Branch, November 14-December 11, 2005		
Chumpol Srithong	Lecturer Faculty of Fisheries Kasetsart University Thailand	Studies on the role of benthic organisms as food for marine resources

At JIRCAS, Utsunomiya University, Kagoshima Agricultural Experiment Station, Kyushu University, JIRCAS Okinawa Subtropical Station, Okinawa Agricultural Experiment Station, November 28-December 28, 2005		
Do Hong Tuan	Researcher Southern Fruit Research Institute (SOFRI) Vietnam	Management of the citrus greening disease vector, psyllid, in disease-free seedling orchards
At JIRCAS, National Agricultural Research Center for Kyushu Okinawa Region (KONARC), National Institute of Livestock and Grassland Sciences (NILGS), February 12-March 14, 2006		
Nuttanart Khotprom	Scientist Animal Nutrition Division Department of Livestock Development (DLD) Thailand	Establishment of a rapid method for estimating the nutritive value of feeds by an *in vitro* gas technique
At JIRCAS, Forestry and Forest Products Research Institute (FFRI), The University of Tokyo, JIRCAS Okinawa Subtropical Station, Organic Noni Farm, Kansai Research Center FFRI, Japan International Forestry Promotion and Cooperation Center (JIFPRO), February 26-March 19, 2006		
Ricky Alisky Martin	Head Social Agroforestry Section Forest Management Plan Division Sabah Forestry Department Malaysia	Discussion and consultation on ongoing project
At JIRCAS, National Research Institute of Fisheries Science (Nikko), December 5-11, 2005		
Denny Ramos Chavez	Aquaculture Expert Research Division Aquaculture Department Southeast Asian Fisheries Development Center (SEAFDEC) Philippines	Improved broodstock and larval diets for tropical fish
At JIRCAS, National Research Institute of Fisheries Science (Nikko), December 5-11, 2005		
Leobert D. de la Pena	Scientist Fish Health Section Aquaculture Department Southeast Asian Fisheries Development Center (SEAFDEC) Philippines	Development of methods to control factors suppressing sustainable production of aquaculture species
At JIRCAS, Policy Research Institute, MAFF, FAO Liaison Office, Japan, February 17-24, 2006		
Josef Schmidhuber	Senior Economist Global Perspective Studies Unit Economic and Social Department Food and Agriculture Organization of the United Nations (FAO) Germany	Impacts of global warming on world food market and evaluation of price fluctuation risk
JIRCAS Asia Biotechnology Study Program (October 2005 to February 2006)		
Jonathan Manito Niones	Project Leader Plant Breeding Unit Philippine Rice Research Institute (PhilRice) Philippines	Construction of a linkage map and QTL analysis for agricultural traits using DNA markers

Nguyen Van Dong	Researcher Molecular Biology Laboratory Agricultural Genetics Institute (AGI) Vietnam	Molecular analysis of abiotic stress-inducible promoters in rice

JSPS Postdoctoral Fellowships for Foreign Researchers (April 2003 to November 2007)

At JIRCAS, April 4, 2003-April 3, 2005

Nguyen Van Dong	Researcher Molecular Biology Laboratory Agricultural Genetics Institute (AGI) Vietnam	Molecular analysis of abiotic stress-inducible promoters in rice

At JIRCAS, November 10, 2003-November 9, 2005

Selina Ahmed	Division of Agronomy Bangladesh Jute Research Institute Bangladesh	Improvement of rice drought-stress tolerance by gene transfer of transcription factors

At JIRCAS, November 29, 2003-November 28, 2005

Nur Ahamed Khondaker	Visiting Research Fellow Okinawa Subtropical Station JIRCAS Bangladesh	Improvement of water-use efficiency, with particular attention to soil-air-oxygen dynamics

At JIRCAS, November 30, 2004-November 29, 2006

Hoi Xuan Pham	Researcher National Key Laboratory for Plant Cell Technology National Institute of Agricultural Genetics Vietnam	Functional analysis of genes that encode transcription factors involved in abiotic stress tolerance

At JIRCAS, November 30, 2005-November 29, 2007

Subramaniam Gopalakrishnan	India	Physiological, biochemical, and genetic analysis of nitrification inhibition in *Brachiaria humidicola*

At JIRCAS, October 3, 2005-October 2, 2007

Humnath Bhandari	Visiting Research Fellow Social Sciences Division International Rice Research Institute (IRRI) Nepal	Impact of social capital on water management in different rice ecosystems in Southeast Asia

3) JIRCAS Visiting Research Fellowship Program at Okinawa

The Okinawa Visiting Research Fellowship Program was initiated in FY 1992. The program invites post-doctoral scientists to conduct research for a period of one year at the Okinawa Subtropical Station. In FY 2005, researchers focused on important topics relating to tropical agriculture in developing countries, within one of five research themes: 1) efficient use of water and fertilizers; 2) evaluation and utilization of heat- and salt-tolerant crops; 3) evaluation and utilization of useful traits in sugarcane and sweet potato; 4) evaluation and characterization of tropical and subtropical fruit trees; and 5) development of new technologies for the integrated management of citrus huanglongbing (greening disease).

Nguyen Van Dong	Researcher Molecular Biology Laboratory Agricultural Genetics Institute (AGI) Vietnam	Molecular analysis of abiotic stress-inducible promoters in rice

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JIRCAS Visiting Research Fellowships at Okinawa (December 2004 to November 2005)		
Robert Bellarmin Zougmore	Institut de l'Environnement et de Recherches Agricoles (INERA) Burkina Faso	Soil erosion and maize productivity as affected by tillage system and cover crops under the subtropical climate at Ishigaki, Okinawa, Japan
Saleh Mahmoud Ismail Ibrahim	Assiut University Egypt	Effect of irrigation frequency and timing on root development, crop yield, and water-use efficiency
Peruma Vidhana Arachchige Lal	University of the Ryukyus Bangladesh	Study on the effectiveness of fertigation at different frequencies through an underground drip irrigation system in sugarcane cultivation
Jilin Tian	Environmental Sciences Research Institute Shanghai Academy of Agricultural Sciences P.R. China	Molecular analysis and salt tolerance evaluation of HANA transgenic rice
Ashok Kumar	CCS Haryana Agricultural University India	Elucidation of heat tolerance mechanism in snap bean (*Phaseolus vulgaris* L.)
Xueqin He	Inner Mongolia Agricultural University P.R. China	Cloning of anthocyanin transcriptional activator gene of sweet potato
Bambang Sugiharto	University of Jember Indonesia	Development of an efficient *Agrobacterium*-mediated transformation method for sugarcane
Mustad Maulid Macha	Sokoine University of Agriculture Tanzania	Effect of temperature and soil moisture on fruit qualities of passionfruit 'Summer Queen' (*Passiflora edulis* × *P. edulis* f. *flavicarpa*)
Mohammad Abul Kashem Chowdhury	Patuakhali Science and Technology University Bangladesh	Cultivar discrimination and genetic diversity assessment in tropical fruits

4) JIRCAS Visiting Research Fellowship Program at Tsukuba

A program similar to the Okinawa Visiting Research Fellowship Program has been implemented on JIRCAS's Tsukuba premises since October 1995. The Tsukuba Visiting Research Fellowship Program aims to promote collaborative research to address various problems confronting countries in developing regions. There are two types of Fellowship Program: JIRCAS type (long-term) and NIAS type (short-term). Under the JIRCAS-type program, 10 researchers are invited to conduct research at JIRCAS HQ in Tsukuba for a period of one year. Four researchers are similarly invited under the NIAS-type program to carry out five-month projects at the National Institute of Agrobiological Sciences (NIAS), which is one of JIRCAS's competent and reputable collaborators in agricultural research, located in Tsukuba. Ten researchers have been invited under the JIRCAS-type program from December 2004 to November 2005, and four researchers under the NIAS-type program from November 2005 to March 2006. The invitees and their research activities in FY 2005 are listed below.

More information on the JIRCAS Visiting Research Fellowship Program can be obtained by contacting the International Relations Section, JIRCAS, 1-1 Ohwashi, Tsukuba, Ibaraki 305-8686, Japan. (Tel.: +81-29-838-6335; Fax: +81-29-838-6337; e-mail: irs@ml.affrc.go.jp)

JIRCAS Visiting Research Fellowships at Tsukuba (JIRCAS Type: December 2004 to November 2005)		
Cemal Atici	Adnan Menderes University Turkey	Quantitative analysis of long-term food and agricultural resource situation
Zhijie Wang	China National Engineering Research Center for Information Technology in Agriculture P.R. China	Crop monitoring methods using remote sensing and GIS
Feng Qin	Tsinghua University P.R. China	Cloning and functional analysis of DREB proteins in response to cold and drought stresses from *Zea mays* L.
Sobrizal	National Nuclear Energy Agency Indonesia	Construction of a DNA marker's linkage map and its application on QTL analysis in rice (*Oryza sativa* L.)
Trimurtulu Nunna	Acharya NG Ranga Agricultural University India	Mitigation of nitrous oxide emission from cultivated soil
Andrew Kalyebi	Namulonge Agricultural and Animal Production Research Institute Uganda	Parasitoid flies for biological control of insect pests
Subramaniam Gopalakrishnan	India	Biological phenomenon of nitrification inhibition in tropical pastures
Mohamed Faize	Morocco	Studies on the physiology and ecology of endophytic nitrogen-fixing bacteria in gramineous plants: effect of plant genotype on the diversity of the nifH gene of nitrogen-fixing communities associated with rice
Syeda Shahnaz Parvez	Food Science and Technology Division JIRCAS Bangladesh	Determination and analysis of natural antioxidants from indigenous vegetables in Asian countries
Ashraf Suloma Mahmoud	Cairo University Egypt	Physiological and nutritional studies on important fish and crustacean aquaculture species. Distribution of arachidonic acid, EPA, and DHA in coral reef communities: a guideline for developing broodstock diets for tropical coral reef fish

JIRCAS Visiting Research Fellowships at Tsukuba (NIAS type: November 2005 to March 2006)		
Talaat Abdel-Fattah Ahmed	Assiut University Egypt	Comparative genomics approach to QTLs for *Fusarium* head blight (FHB) resistance in wheat
Haifei Zhou	Institute of Botany Chinese Academy of Sciences P.R. China	Diversity of AA-genome *Oryza* species in Asia and New Guinea
Suphawat Sinsuwongwat	Chiangmai University Thailand	Cloning of cleistogamy genes in barley
Momtaz Mohamed Yehya Hegab	Cairo University Egypt	Identification of key chemical compounds associated with allelopathic activity of rice

5) JIRCAS Asia Biotechnology Study Program

Starting in 2001, JIRCAS initiated the "Asia Biotechnology Study Program" under a contract research arrangement with the Ministry of Agriculture, Forestry and Fisheries (MAFF) to address the food production and utilization concerns in developing countries through human resources development and capacity-building. The program invites researchers from target countries for periods of up to six months to undergo training in the field of biotechnology. Fifteen fellows have participated in the program since its inception.

6) Other fellowships for visiting scientists

The Government of Japan sponsors a postdoctoral fellowship program for both Japanese and foreign scientists through the Japan Society for the Promotion of Science (JSPS). The program places postdoctoral and sabbatical fellows in national research institutes throughout Japan according to research theme and prior arrangement with host scientists, for terms of generally one month to three years. Fellowships can be undertaken in any of the ministries, and many fellows are currently working at various IAAs affiliated with MAFF. In 2005, the following visiting scientists resided at JIRCAS: Dr. Nguyen Van Dong (Vietnam) and Dr. Selina Ahmed (Bangladesh), Biological Resources Division; Dr. Nur Ahamed Khondaker (Bangladesh), Okinawa Subtropical Station; Hoi Xuam Pham (Vietnam), Biological Resources Division; Subramaniam Gopalakrishnan (India), Crop Production and Environment Division; and Humnath Bhandari (Nepal), Development Research Division.

Three Japanese fellows, Dr. S. Watanabe, Biological Resources Division; Dr. R. Ichiki, Crop Production and Environment Division; and Dr. M. Hayano, Okinawa Subtropical Station, have also conducted research at JIRCAS.

SYMPOSIA AND WORKSHOPS

1) INTERNATIONAL SYMPOSIA

Between 1979 and 1993, the Tropical Agriculture Research Center (TARC), the predecessor of JIRCAS, sponsored annual international symposia in order to promote scientific exchanges while accurately gauging and responding to the agricultural, forestry and fishery needs of the world's developing regions. Since its transition from TARC in 1993, JIRCAS has continued this practice. At present, each year's JIRCAS International Symposium is organized around themes of central importance to international agricultural research. Appropriately, the 12th JIRCAS International Symposium was held in July 2005, following the Japanese Government's commitment in supporting African agricultural development, which is in pursuance of the policy set forth in the G8 Summit in Gleneagles, Scotland. The program appears below:

12th JIRCAS International Symposium
"PERSPECTIVES OF R&D FOR IMPROVING AGRICULTURAL PRODUCTIVITY IN AFRICA: WHAT AND HOW CAN JAPAN CONTRIBUTE TO AFRICA?"

In FY 2005, JIRCAS and the Japan Forum on International Agricultural Research for Sustainable Development (J-FARD) served as the main organizers of the 2005 African Agriculture Symposium on "**Perspectives of R&D for Improving Agricultural Productivity in Africa**: *What and how can Japan contribute to Africa?"*. The co-sponsors were the Japan International Cooperation Agency (JICA), United Nations University (UNU), Food and Agriculture Organization of the United Nations Liaison Office in Japan (FAOLOJA), the Consultative Group on International Agricultural Research (CGIAR), the Ministry of Foreign Affairs (MOFA), and the Ministry of Agriculture, Forestry and Fisheries (MAFF). As many as 320 participants from foreign countries attended and participated in discussions on the outputs, strategies, and potential contributions of agricultural research towards development in Africa.

Program:

Opening Address

- Shinobu Inanaga (Chairman, Steering Committee for the Symposium)
- Hans J.A van Ginkel (UN Undersecretary-General; Rector , UNU)

Welcome Remarks

- Ken Okaniwa (Director, Aid Planning Division, MOFA)
- Kiyoaki Maruyama (Research Councilor, AFFRC / MAFF)

Keynote Speeches:

- Kimio Fujita (Former President,JICA;Advisor,JAICAF)
- Ian Johnson (World Bank Vice-President ; Chairman,CGIAR)

Main Themes

Session 1: Current and Historical Perspectives
Session 2: Case Study: Research
Session 3: Case Study: Development
Panel Discussion A: (Viewpoints of Research Cooperation)
Panel Discussion B: (Viewpoints of Development Cooperation)

2) SPECIAL PROGRAMS

INTERNATIONAL WORKSHOP: "STUDIES ON SUSTAINABLE PRODUCTION SYSTEMS OF AQUATIC ANIMALS IN BRACKISH MANGROVE AREAS"

Mangroves play various important roles in tropical and subtropical coastal ecosystems. Humans have obtained many benefits, such as the supply of fisheries and forestry products, from these highly productive brackish mangrove areas. In spite of the importance of the world's mangrove areas to humans, however, more than 50% were lost last century as a result of various types of development, including aquaculture. In particular, intensive prawn aquaculture in mangrove areas has increased rapidly in Southeast Asia since the 1980s. It has not only deprived coastal ecosystems of the functions provided by mangroves but has also caused water pollution in these areas.

To deal with this problem, an international project entitled "Studies on Sustainable Production Systems of Aquatic Animals in Brackish Mangrove Areas" (2001–2005) was conducted in collaboration with the Fisheries Research Institute (FRI) of Malaysia, the University of Malaya, Kasetsart University in Thailand, the Southeast Asian Fisheries Development Center (SEAFDEC), and Japanese domestic institutions such as the Fisheries Research Agency (FRA), Forestry and Forest Products Research Institute (FFPRI), and Ehime University, with a focus on the sustainable use of brackish mangrove areas for fisheries. The project finished this fiscal year, having achieved great success and bumper harvests. On December 7 and 8, 2005, an international workshop was held at JIRCAS to discuss the major outcomes achieved during the course of the project and to clarify the remaining problems. The proceedings of the workshop will be published in 2006 as a JIRCAS working report.

Participants in the workshop.

Program:

Opening addresses

- Dr. Akinori Noguchi, Vice-President, JIRCAS
- Dr. Junaidi Bin Che Ayub, Director General, Department of Fisheries (DOF) Malaysia

Session 1:

- How Important Are Zooplankton to Juvenile Fish Nutrition in Mangrove Ecosystems?
- Occurrence and Seasonal Recruitment of Fish Larvae in Matang Mangrove Estuary, Malaysia.
- Mangrove Related Coastal Fisheries of Northwest Peninsular Malaysia
- Preliminary Stock assessment of John's snapper resources in mangrove estuaries and related coastal areas on the northwest coast of Peninsular Malaysia
- Studies on coupling habitat, biology and management of commercially important fish species in mangrove estuaries: findings and achievements of five-year study 2001-2005

Session 2:

- Nutrients budget in shrimp aquaculture pond with mangrove enclosure and aquaculture performance
- Studies on role of benthic organisms as food of marine resources
- Effect of sediment management systems using sediment suspension and periodically removal of sediment on water quality and the amount of phytoplankton in a closed culture system for black tiger prawns (*Penaeus monodon*, Fabricius)
- Comparison of Microbial Abundances and Community Structures between Shrimp Culture Ponds and Mangrove Areas in Thailand.
- A quantitative evaluation of forest stand's contribution to the sustainable production of aquatic animals in brackish mangrove area.
- Passive immunization of anti-*Vibrio harveyi* egg yolk immunoglobulin against luminous disease in black tiger shrimp (*Penaeus monodon*)
- Genetic management of tiger shrimp culture in Thailand
- Co-culture of shrimp and algae: enhancement of water quality
- Evaluation of the health of black tiger shrimp in some culture systems
- Preventive measures in hatchery stage against major viral diseases of black tiger prawn and orange-spotted grouper with emphasis on White spot syndrome virus (WSSV) and Viral nervous necrosis (VNN)
- Viral nervous necrosis (VNN) as a critical infectious disease of grouper in the Philippines
- Improved Diets by Arachidonic Acid Supplementation and Squid Meal in Fry Production of Tropical Fish
- Distribution and Importance of Arachidonic Acid in Tropical Fish

Session 3:

- Analysis of farm management and economic benefits of new sustainable fish production systems in brackish mangrove areas

General Discussion

Closing Address

WORKSHOP AND MEDIUM-TERM EVALUATION MEETING FOR PROJECT ON "INCREASING ECONOMIC OPTIONS IN RAINFED AGRICULTURE IN INDOCHINA THORUGH EFFICIENT USE OF WATER RESOURCES"

In FY 2005, JIRCAS organized a workshop and medium-term evaluation meeting under a collaborative research project entitled "Increasing Economic Options in Rainfed Agriculture in Indochina through Efficient Use of Water Resources", which formally commenced in April 2002 in collaboration with several research and development organizations in Thailand and the Lao PDR. The project comprises the following three themes: 1) assessment of regional water availability and identification of factors limiting more efficient use of water in existing farming systems; 2) development of crop production technologies for more effective water use; and 3) adaptation and integration of new technologies into farming systems through participatory methods. These themes are closely linked to each other with the aim of increasing the economic options available to farmers practicing rainfed agriculture in the region.

After three years of project implementation, a mid-project workshop was held on July 4, 2005 in Khon Kaen, Thailand, to review the results of the research activities carried out thus far. The program of the one-day workshop is described briefly below. For the medium-term evaluation meeting held the next day, Dr. Takeshi Horie, Professor, Kyoto University; Dr. Hideo Yano, Professor, Kyoto University; Dr. Akira Gotoh, Professor, Utsunomiya University; and Mr. Sakol Oorakul, former Specialist in the Department of Agricultural Economics, were invited as external reviewers. Two divisional directors from JIRCAS who are responsible for the project's implementation presented outlines of the research outcomes from the eight sub-themes, and the reviewers provided critical comments and valuable suggestions for further improvement of the project's performance.

Program:

Opening address

- Dr. Osamu Ito, Director of Crop Production and Environment Division, JIRCAS

Welcoming address

- Mr. Preecha Cheuyehom (Director of Region 3 Office, Department of Agriculture)
- Mr. Chumpol Lilittham (Director of Office of Soil Survey and Land Use Planning, Land Development Department)

Session 1: Water resources (6 presentations)
Session 2: Farmer participatory research in Nong Saeng village (3 presentations)
Session 3: Poster presentation (20 posters)
Session 4: General discussion

Workshop participants pose for a group photo during the medium-term evaluation meeting for the "Rainfed Agriculture" Rpoject.

Development of Early-Warning Systems for Mitigating the Risk Caused by Climate Disasters through Technological Enhancement of Resource Monitoring and Crop-Model Simulation

A workshop entitled "Development of early-warning systems for mitigating the risk caused by climate disasters through technological enhancement of resource monitoring and crop-model simulation" was held at Tsukuba on November 22, 2005 to review the results obtained during the implementation of Subject I of the Project over the previous 2 years. The workshop consisted of four parts: "Monitoring methods using remote sensing and GIS," "Meteorological data collection through networks and field servers," "Assessment of agricultural disasters using mesh climate data" and "Crop models and early-warning systems." There were seven speakers from Chinese institutions, including the Institute of Agricultural Resources and Regional Planning, Institute of Environment and Sustainable Development in Agriculture, and the Institute of Cultivation in Heilongjiang Academy of Agricultural Sciences, and there were seven speakers from Japan. This workshop was fruitful in that it helped us to understand the attainments of each research group and the need for further collaboration among groups, not only for participating researchers but also for the advisory members of the Project.

Program:

Part.1: Monitoring method by using remote sensing and GIS
Part.2: Meteorological data collection through networks and field servers
Part.3: Assessment of agricultural disasters using mesh climate data
Part.4: Crop models and early-warning systems

JIRCAS–SORFI WORKSHOP: "INVASION HISTORY AND CURRENT SITUATION OF CITRUS GREENING (HUANGLONGBING-HLB) DISEASE IN SOUTHERN VIETNAM"

The workshop was held in the city of My Tho in Vietnam from September 14 to 16, 2005. It was organized as an internal meeting of the current project ("Development of new technologies for control of citrus HLB in Southeast Asia") aimed at collecting data under the project's specific sub-theme 401, Survey of HLB Prevalence in the Mekong Delta Region. For this purpose, delegates from each provincial agricultural extension center reported the current situation of HLB and the measures currently being taken to counter the disease in each province of southern Vietnam. Educational lectures for participants were incorporated into the program to raise the quality of data collected under this sub-theme and promote extension of the technologies developed in this project. We are certain that these actions will increase the interest of provincial governments in citrus greening disease and will contribute to the achievement of the overall goals of the project.

Program:

Opening address

- Dr. Nguyen Minh Chau (Director of Southern Fruit Research Institute (SOFRI))

Session topics

- Plant protection policy and its role in southern Vietnam (Ministry of Agriculture and Rural Development, Southern Plant Protection Center)
- The role of JIRCAS and its research program on HLB (Japan International Research Center for Agricultural Sciences (JIRCAS))
- Educational programs on HLB (SOFRI, National Institue of Plant Protection (NIPP), VACVINA, Cantho University, Kyushu-Okinawa National Agricultural Research Center, Okinawa Prefecture Agricultural Experiment Station)

- HLB disease in the southern provinces of Vietnam (provincial agricultural extension centers of Vietnam)
- Annual survey of HLB disease (SOFRI)

WORKSHOP AND PRELIMINARY EVALUATION MEETING FOR PROJECT ON "DEVELOPMENT OF AN INTEGRATED RICE CULTIVATION SYSTEM UNDER WATER-SAVING CONDITIONS"

JIRCAS organized a workshop and preliminary evaluation meeting on April 11 and 12, 2005 for a research project entitled "Development of an Integrated Rice Cultivation System Under Water-saving Conditions", which formally commenced in August 2005 in collaboration with International Rice Research Institute (IRRI). The project comprises the following two themes: 1) development of breeding materials for a water-saving system; and 2) development of soil and crop management techniques for water-saving. Through integration of those two themes the project aims to develop a rice cultivation system that can be operated with significantly less water than conventional systems and attains the same levels of yield.

At the workshop there were 14 presentations, not only by scientists from IRRI and JIRCAS, but also by those from Centro Internacional de Agricultura Tropical (CIAT) and Philippine Rice Research Institute (PhiRice). For the preliminary evaluation, Dr. Shu Fukai, Professor at The University of Queensland, Australia, Dr. Atsushi Yoshimura, Professor, Kyusyu University, and Dr. Akira Yamauchi, Professor, Nagoya University were invited as external reviewers. The reviewers acknowledged that the issue taken by the project is adequate and that the initiation of the project is timely from the viewpoints of food security, the diminishing availability of water resources for agriculture, and the emerging problem of the environmental impact of agriculture.

Program:
- Welcome address from IRRI
- Welcome address from JIRCAS
- Overview of the IRRI–Japan Project and the role of the Crop Production and Environment Division of JIRCAS in the Project
- Role of the Biological Resources Division of JIRCAS in IRRI–Japan Project V

- Positioning of IRRI–Japan Project V at Plant Breeding, Genetics and Biochemistry (PBGB), IRRI
- Positioning of IRRI–Japan Project V at Crop, Soil and Water Sciences (CSWS), IRRI
- Development of suitable rice breeding materials for water-saving cultivation
- Development of soil and crop management techniques for water-saving systems
- Related activities at IRRI and collaboration in the IRRI–Japan Project
  Approach to genetic improvement using biotechnology
  Study of breeding for tolerance to abiotic stresses
  Pathological and genetic studies on disease resistance in rice breeding
  Water management
  Soil and fertilizer management
  Modeling
- Related activities at other institutes and possible collaborations with the IRRI-Japan Project
  Introduction of research on transgenic rice at CIAT
  Microbiological and environmental research activities at PhilRice
  Nutrient and water management technologies at PhilRice

Workshop & Project Meeting on "Development of integrated Rice Cultivation System under Water-Saving Conditions"
International Rice Research Institute (IRRI)-Japan International Research Center for Agricultural Sciences (JIRCAS)
April 11 & 12, 2005

3) INTERNATIONAL RESEARCH WORKSHOPS

Attended jointly by JIRCAS researchers and foreign invitees, these workshops aim to facilitate discussion on the numerous collaborative research projects that JIRCAS is currently undertaking with counterpart institutions throughout the world.

July 6, 2005

Annual Workplan Meeting
Collaborative research project on "Increasing economic options in rainfed agriculture in Indochina through efficient use of water resources"
Held in Khon Kaen, Thailand, and attended by representatives of JIRCAS; the Land Development Department (LDD), Thailand; Department of Agriculture (DOA), Thailand; Khon Kaen Animal Nutrition Research and Development Center (KKANRC), Thailand; and Khon Kaen University, Thailand

September 10, 2005

JIRCAS and ICRISAT Symposium on "Improvement of the fertility of sandy soils in the semi-arid zones of West Africa through organic matter management."
Attended by representatives of JIRCAS; Kyoto University, Japan; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niger; Institut National de la Recherche Agronomique du Niger (INRAN), Niger; Tropical Soil Biology and Fertility Institute of Centro Internacional de Agricultura Tropical (TSBF-CIAT), Kenya; Japan International Cooperation Agency, Niger; Institut d'Environnement et de Recherches Agricoles (INERA), Burkina Faso; Deutscher Entwicklungsdienst (DED), Niger; Food and Agriculture Organization of the United Nations (FAO), Niger; Centre Réional de Formation et d'Application en Agrométérologie et Hydrologie Operationelle (AGRHYMET), Niger; Centre Réional d'Enseignement Spéialisé en Agriculture (CRESA), Niger; Centre de Recherche Médicale et Sanitaire (CERMES – Réseau International des Instituts Pasteur), Niger; Réseau de l'Environnement pour un Développement Durable (REDD), Niger; and United Nations Development Program (UNDP), Niger

September 14-16, 2005

JIRCAS–Southern Fruit Research Institute (SORFI) Workshop: "Invasion history and current situation of Citrus Greening (Huanglongbing-HLB) disease in Southern Vietnam"
Attended by representatives of JIRCAS, Japan; SORFI, Vietnam; Ministry of Agriculture and Rural Development, Vietnam; Southern Plant Protection Center, Vietnam; National Institute of Plant Protection, Vietnam; VACVINA, Vietnam; Provincial Agricultural Extension Centers of Thua Thien-Hue, Dong Thap, Ben Tre, Tra Vinh, Soc Trang, Can Tho, Hau Giang and Kien Giang provinces, Vietnam; Plant Protection Bureaus of Binh Phuoc, Dong Nai, Lam Dong, and Tien Giang provinces and Ho Chi Minh City; Agricultural Bureau of Vinh Long and Dong Nai; Kyushu-Okinawa Agricultural Research Center, Japan; Okinawa Prefecture Agricultural Experiment Station, Japan.

November 22, 2005

Workshop on "Development of early-warning systems for mitigating the risks caused by climate disasters through technological enhancement of resource monitoring and crop-model simulation"
Attended by representatives of JIRCAS; external reviewer (Tokyo University, Japan); National Agriculture and Bio-oriented Research Organization; National Institute of Agro-Environmental Sciences, Japan; Institute of National Resource and Regional Planning, CAAS, China; Institute of Agro-environment and Sustainable Development, CAAS, China; and Institute of Cultivation, HAAS, China

December 7-8, 2005 — Workshop on "Studies on sustainable production systems of aquatic animals in brackish mangrove areas"
Attended by representatives of JIRCAS; Evaluation Committee (The University of Tokyo, Japan, University of Tsukuba, Japan, Port of Nagoya Public Aquarium, Japan, and Kasetsart University, Thailand); Agriculture Forestry and Fisheries Research Council of MAFF, Japan; Fisheries Research Agency, Japan; Forestry and Forest Products Research Institute, Japan; Ehime University, Japan; Fisheries Research Institute (FRI), Malaysia; University of Malaya, Malaysia; Kasetsart University, Thailand; and Southeast Asian Fisheries Development Center (SEAFDEC)

March 14, 2006 — Workshop on "Problem of food and the organization of farmers in China"
Attended by representatives of JIRCAS; Embassy of Japan, Beijing; Policy Research Institute of MAFF; Meiji University, Japan; and Institute of Agricultural Economics and Development, CAAS, China

4) JIRCAS RETURN SEMINARS

At JIRCS, each researcher returning from an overseas dispatch or research project gives an oral presentation, accompanied by a written summary of his or her activities that is distributed to JIRCAS staff. These sessions are termed "JIRCAS Return Seminars" and are held during, or upon the completion of, research projects and overseas dispatch assignments. These seminars are ordinarily held twice a month, and each year approximately 30 scientists give presentations.

APPENDIX

PUBLISHING AT JIRCAS

OFFICIAL JIRCAS PUBLICATIONS

In English	
1) JARQ (Japan Agricultural Research Quarterly)	Vol. 39-No. 2, No. 3, No. 4 Vol. 40-No. 1
2) Annual Report	No. 11 (2004)
3) JIRCAS Newsletter	No. 43, No. 44-45
4) JIRCAS Working Report Series	No. 44 Studies on Sustainable Production Systems of Aquatic Animals in Brackish Mangrove Areas
	No. 45 Development of low-input technology for reducing postharvest losses of staples in Southeast Asia
	No. 46 Physio-genetic Study on Yield Determination and Ecological Adaptability for Sustainable Rice Culture
	No. 47 Increasing Economic Options in Rainfed Agriculture in Indochina through Efficient Use of Water resources
	No. 49 Supporting Farmer Decisions in Response to Climatic Risk
5) JIRCAS International Symposium Series	No. 13 Problems and Research Perspectives of Agricultural Environment in the Tropical and Subtropical Islands

In Japanese	
1) JIRCAS News	No. 43, No. 44-45
2) JIRCAS Working Report Series	No. 48 Development of rice farming in the Northeast of China and trends of farmers organizations
3) JIRCAS Research Highlights	No. 12

LIBRARY ACQUISITIONS

April 1, 2005 - March 31, 2006

	Books			**Periodicals (titles)**			**Materials (proceedings, maps and other)**		
Language	Purchased	Gifts	Total	Purchased	Gifts	Total	Purchased	Gifts	Total
Japanese	101 (1)	48 (0)	149 (1)	50 (28)	488 (115)	538 (143)	0 (0)	109 (22)	109 (22)
Foreign	48 (0)	39 (0)	87 (0)	108 (7)	316 (15)	424 (22)	0 (0)	51 (0)	51 (0)
Total	149 (1)	87 (0)	236 (1)	158 (35)	804 (130)	962 (165)	0 (0)	160 (0)	160 (22)

( ) Indicates separate acquisitions by the Okinawa Subtropical Station

RESEARCH STAFF ACTIVITY 2005-2006

Journal articles, book chapters, and monographs

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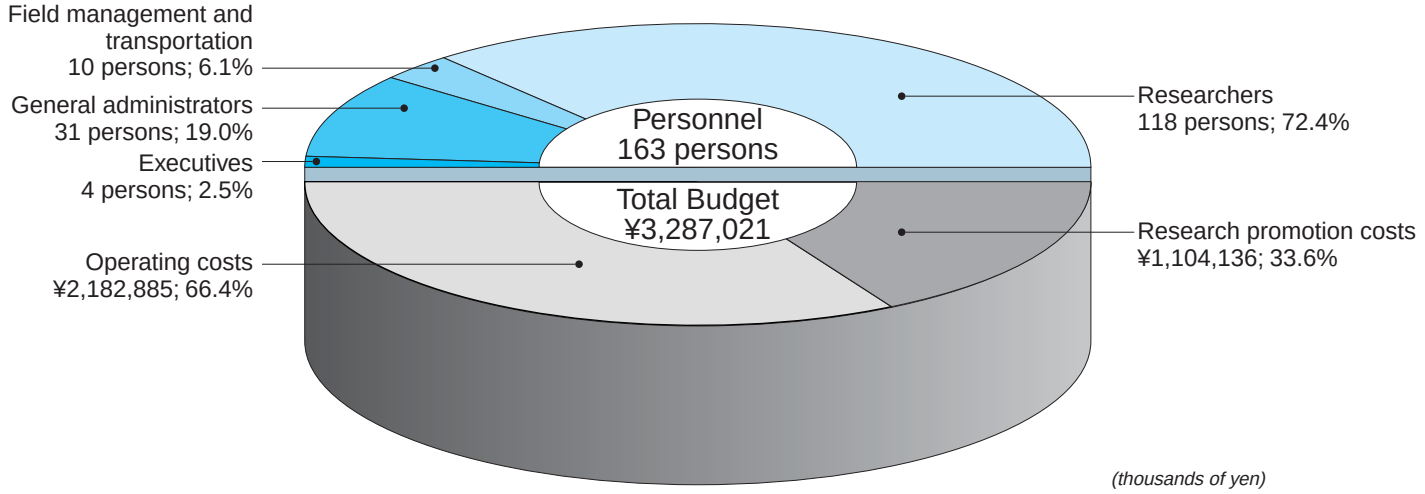
FINANCIAL OVERVIEW

Fiscal Year 2005

	thousands of yen
TOTAL BUDGET	**3,287,021**
OPERATING COSTS	**2,182,885**
Personnel (163)	1,679,163
President (1), Vice President (1), Executive Advisor & Auditor (2)	
General administrators (31)	
Field management and transportation (10)	
Researchers (118)	
*Number of persons shown in ( )	
Administrative Costs	503,722
RESEARCH PROMOTION COSTS	**1,104,136**
Research Development	332,100
Overseas Dispatches	281,709
Research Exchange/Invitation	7,955
Research Information Collection	104,492
International Collaborative Projects	285,076
Fellowship Programs	92,804

Budget FY2005 (Graph)



(thousands of yen)

TENETS OF THE JIRCAS MEDIUM-TERM PLAN (April 2001–March 2006)

On April 1, 2001, the Japan International Research Center for Agricultural Sciences (JIRCAS) was inaugurated as an Incorporated Administrative Agency (IAA) and commenced implementation of research programs and administrative operations according to a 5-year Medium-Term Plan approved by the Ministry of Agriculture, Forestry, and Fisheries (MAFF). The tenets of this Medium-Term Plan, divided into research and administrative operations, are detailed below.

RESEARCH

I. Enhancement of the quality of experiments, research, and investigations

A. Analysis of the orientation of agriculture, forestry, and fisheries activities in developing regions, examination of their research status in Japan and overseas, and elucidation of trends in technological development

1) Analysis of trends in world food supply and demand, and development of medium-term strategies to promote international collaborative research

1. Analysis of research orientation in major developing countries
   An information network necessary for the accumulation of research information will be developed; the background, future objectives, and orientation of research themes pursued by developing countries and relevant international research organizations will be examined and medium-term research strategies will be proposed.
2. Improvement of models for world food supply and demand through analysis of trends, particularly in China
   In order to define medium- and long-term trends in world food supply and demand, JIRCAS's world food supply model will be modified on the basis of analyses of relevant policies and economic conditions, particularly in China.

2) Analysis of regional characteristics and orientation of development relating to food production and environmental conditions in developing regions

1. Analysis of major constraints on agriculture, forestry, and fisheries development as well as trends in technological and economic development in Indonesia, Vietnam, West Africa, and other regions. The characteristics of each region will be analyzed in terms of background, social customs, and differences in technological levels in order to implement research collaboration in an effective manner.
2. Analysis of trends in the development of sustainable farming systems in Indonesia, Vietnam, Thailand, South America, and other regions. Examination of the status of farming systems in these developing regions and analysis of constraints on their effective adoption will be conducted.

B. Research and development for sustainable agriculture, forestry, and fisheries in developing regions

1) Improvement and development of sustainable and environment-friendly production technology

1. Improvement of technology for soil amelioration and nutrient cycling evaluation in diversified ecosystems
   Nutrient cycling will be studied in target areas and techniques will be developed for the management of cultivated ecosystems and soil.
2. Development of low-input technologies for production of rice and upland crops in Thailand, Vietnam, and other countries
   More efficient methods of soil management and cultivation, as well as technology to improve water management and achieve higher yields and quality, will be developed.
3. Analysis of the prevalence of major diseases and insect pests in rice and soybean in Southeast Asia, South America, and other developing regions
   The incidence of major disease pathogens and insect pests will be determined in order to develop suitable countermeasures.
4. Analysis of characteristics of under-utilized local forage resources, such as gramineous pasture grasses and maize stems and leaves, under agro-pastoral systems
   The physiological and ecological characteristics and nutritive value of forage resources will be determined and potential utilization methods will be examined.
5. Analysis of physiological characteristics of cattle, pigs, and other livestock, as well as the prevalence of major livestock diseases in Thailand, Vietnam, and other countries

Physiological characteristics such as nutrient metabolism will be analyzed and the prevalence of diseases such as trypanosomosis will be evaluated.

6. Development of technology for supplementary natural regeneration of valuable tree species in tropical forests with tree species of low quality
   Silvicultural and logging technology for the sustainable management of forests in Southeast Asia will be developed, and the restoration of forests in degraded grassland areas through the utilization of useful low-quality trees will be promoted.
7. Development of environmentally friendly aquaculture technology
   Analyses of maturation and spawning stages, feeding behavior, selection and culture of biological feeds, and identification and utilization of various artificial feeds for major aquaculture species will be conducted. Aquaculture technology characterized by low feed and drug inputs will be developed.

2) Improvement and development of technology for quality evaluation, distribution, and processing of agriculture, forestry, and fisheries commodities in developing regions
   1. Analysis of quality parameters for food resources in Southeast Asia
      Methods of evaluation utilizing low-cost instrumentation and materials will be developed to determine the basic characteristics of food resources before harvest and during postharvest processing and distribution. Factors affecting quality changes will be identified.
   2. Development of methods for preventing deterioration in quality and methods for improving processing technologies
      Technology for low-input drying and storage of food commodities will be developed in order to reduce postharvest losses. Local processing technologies will be improved to develop more value-added products.
   3. Development of technology for the use of under-utilized wood resources
      Technology for the processing of wood materials into wood products will be developed through analyses of the characteristics of materials such as oil palm residue.
   4. Development of technology for the use of under-utilized aquatic resources and the production of "surimi" (fish paste) in China
      Technology for environmentally friendly utilization of aquatic products will be developed in consideration of the status of food production, distribution, and consumption in China.
3) Development of technology for the analysis and utilization of genetic resources and biological functions in developing regions
   1. Development of technology for the analysis and transformation of mechanisms of resistance to environmental stresses
      Resistance mechanisms in model plant species will be analyzed at the molecular level in order to develop genetically modified crops with resistance to drought, salinity, and other stresses.
   2. Development of breeding materials and technology to evaluate the resistance of rice and wheat to disease pathogens and insect pests
      The characteristics related to disease and insect pest resistance in crops such as rice, wheat, and soybean will be elucidated for the purposes of developing useful breeding materials.
   3. Collection, evaluation, and preservation of genetic resources of vegetables and fruit trees in tropical and subtropical regions
      JIRCAS will serve as a sub-bank to the central gene bank of the National Institute of Agrobiological Sciences (NIAS), a fellow MAFF-affiliated IAA.
4) Evaluation of environmental resources and bio-diversity
   1. Evaluation of characteristics of environmental resources related to agricultural production and analysis of the mechanisms of changes in land use
      Technology for the analysis and effective utilization of environmental resources will be developed, and the relationship between changes in land use and these resources will be elucidated.
   2. Analysis of necessary conditions for introducing agroforestry technology in Malaysia and other developing countries
      The establishment of productive and environmentally friendly agroforestry systems will be promoted, with emphasis on bio-diversity and sustainability of tropical forest regeneration.
   3. Analysis of changes in major aquatic resources in coastal and brackish water mangrove ecosystems in Southeast Asia
      The changes in major fish and aquatic resources associated with the development of coastal areas, including the changes in environmentally valuable brackish water mangrove areas, will be

analyzed.

5) Research activities in Okinawa

1. Evaluation and utilization of heat and salinity resistance in snap bean and rice
   Through the evaluation of characteristics related to high-temperature stress tolerance in vegetable species such as snap bean, useful breeding materials will be collected and studied.
2. Development of technology for the evaluation and utilization of useful traits in sugarcane and root crops
   Characteristics related to useful traits of vegetatively propagated crops from tropical and subtropical regions will be evaluated, and breeding materials with outstanding characteristics will be developed through genetic engineering.
3. Development of basic technology for the evaluation and mass propagation of tropical fruit trees
   The production of substances required for regulation of tree form, fruit set, and flowering will be studied. Basic technologies will be developed for quality evaluation and mass propagation.
4. Analysis of ecological characteristics and the incidence of major insect pests and diseases in tropical and subtropical areas
   The eco-physiological characteristics of major diseases, insect pests, and natural enemies occurring in tropical and subtropical crops will be elucidated.
5. Analysis of factors leading to the instability of crop production on tropical and subtropical islands, and development of technology for crop cultivation using low water and fertilizer inputs
   The effect of environmental factors such as weather and soils on crops and their subsequent responses will be elucidated.
6. Development of methods for controlling variations in heading traits of rice and other crops through generation advancement
   Technology will be developed for effectively fixing variations in heading traits through generation advancement.

II. Contribution to society through research activities

A. Analyses and consultation
   Upon the requests of administrative authorities, corporations, and universities, JIRCAS will conduct various analyses and experiments, extending its expertise to other organizations.

B. Training courses and programs

1) JIRCAS will organize training courses and lectures for administrative authorities and various research organizations and offer its collaboration in programs sponsored by the government or the private sector.
2) JIRCAS will make significant efforts to receive trainees from other IAAs, universities, national public organizations, and the private sector in order to further develop human resources, upgrade existing technology, and promote information and technology transfer. JIRCAS will also conduct invitation programs for overseas counterpart scientists.
3) JIRCAS will be entrusted by the Japanese government to develop and provide human resources for activities related to research in the fields of international agriculture, forestry, and fisheries.
4) JIRCAS will establish consultations with various organizations in order to conduct information exchange on technical problems.

C. Collaboration with administrative authorities, international organizations, academic societies, and other organizations
   JIRCAS will dispatch delegates to participate in committee meetings and conferences sponsored by administrative authorities, international organizations, and academic societies. Upon request from administrative authorities, JIRCAS will also supply relevant technological information, both in Japan and overseas.

III. Publication and dissemination of research results

A. Promotion and utilization of research results
   Manuals and databases will be prepared for use by administrative authorities, research organizations, and primary producers in developing regions. Efforts will also be made to promote the dissemination and application of research results through the MAFF research network and through international collaborative efforts.

B. Publication and dissemination of research results

1) JIRCAS researchers will be encouraged to present research results at meetings organized by academic societies and at symposia held in Japan and overseas. During the period covered in the medium-term Plan, a goal has been established to publish over 540 reports in scientific journals and organizational bulletins.
2) Research results will be made available on the Internet and published at expositions and other appropriate venues. Important achievements will also be reported through suitable mass media.

C. Acquisition and utilization of intellectual property rights

1) Active acquisition of intellectual property rights will be encouraged; a goal has been established to submit over 20 patent applications to the Japan Patent Office during the period covered in the medium-term Plan. JIRCAS will also encourage the submission of patent applications in countries other than Japan.
2) Plant varieties developed through breeding research will be registered on the basis of the Seed and Stock Law. JIRCAS will also encourage applications by foreign organizations to utilize registered varieties overseas.
3) Information concerning intellectual property rights will be disseminated through the Internet, and requests for the utilization of these rights will be actively considered.

ADMINISTRATION

I. Evaluation and review of research activities

A. Internal review will be conducted under the guidance of experts from outside organizations, as well as JIRCAS directors and administrators.

B. Review of research themes will be conducted in order to evaluate research strategies, planning, and progress. These results will be evaluated under the guidance of outside experts and JIRCAS directors and administrators, and will be made public.

II. Efficient utilization of resources allocated for research activities

A. Resources for research activities will be allocated in the context of the objectives of the medium-term Plan.

III. Promotion of liaison and collaboration

A. Liaison and collaboration with other IAAs

Liaison and collaboration with other MAFF-affiliated IAAs will be actively pursued and will include common research objectives, joint research, and personnel exchange.

B. Liaison and collaboration with research organizations in developing regions

1. Research administrators from counterpart organizations will be invited to Japan through the Administrative Invitation Program in order to exchange information and opinions on policy-making and project design.
2. Researchers from counterpart organizations in developing regions will be invited to Japan to conduct collaborative research.

C. Liaison and collaboration with organizations from the private sector, universities, and the government

1. Collaborative research or researcher exchange with national public organizations, universities, the private sector, overseas organizations, international organizations, and the Japan International Cooperation Agency (JICA) will be actively promoted.
2. Research collaboration conducted with public organizations utilizing governmental support will be promoted.

The status of mutual relations and collaboration will be evaluated annually. The promotion of research activities at JIRCAS will be examined with the participation of representatives from related IAAs and administrative authorities and from municipal, district, and prefectural organizations.

ADVISORS AND PRINCIPAL STAFF

Advisors

Hisao Azuma	President, Agricultural and Fishery Co-operative Savings Insurance Corporation
Takeshi Hara	Senior Counselor, Japan Fisheries Resources Conservation Association
Kenji Iiyama	Professor, Tokyo University of Agriculture
Hiroshi Kakurai	Economic Analyst (formerly Commentator), Nippon Hoso Kyokai (NHK)
Sakue Matsumoto	Advisor, Japan Food and Agriculture Organization (FAO) Association
Eiichi Tsutaya	Managing Director, Norin-Chukin Research Institute Co., Ltd.

JIRCAS External Evaluation Committee

Haruo Inagaki	Head of Committee Counselor, Japan Food and Agriculture Organization (FAO) Association
Hiroko Morishima	Professor, Department of Agriculture, Faculty of Agriculture, Tokyo University of Agriculture
Seiichi Murayama	Professor and Vice-President, Faculty of Agriculture, University of the Ryukyus
Katsumi Mushiake	Professor, Faculty of Symbiotic Systems Science, Fukushima University
Keiji Ohga	Professor, Department of Food Economics, College of Bioresource Sciences, Nihon University
Naoto Owa	Professor, Department of Applied Biological Chemistry, Faculty of Agriculture, Niigata University
Yoshinobu Yasunaga	Technical Advisor, Overseas Fisheries Cooperation Foundation
Hitoshi Yonekura	Professor, Graduate School of Agricultural Science, Tohoku University
Hiroyuki Watanabe	Professor Emeritus, Kyoto University

External Reviewers for International Collaborative Projects

Studies on stable food supply systems for mitigating the fluctuations of production and markets in China

Koji Kameoka	Vice-President, Mie University
Kazuhiko Kobayashi	Professor, Graduate School of Agriculture and Life Sciences, the University of Tokyo
Keisuke Sugenuma	Associate Professor, Faculty of Economics and Business Administration, Fukushima University

Comprehensive studies on soybean improvement, production, and utilization in South America (multi-national)

Peter Kerridge	Former Project Leader, CIAT Asia Program, Lao PDR Office, Centro Internacional de Agricultura Tropica (CIAT)
Kazuo Kawano	Former Professor, Food Resources Education and Research Center, Faculty of Agriculture, Kobe University
Makie Kokubun	Professor, Graduate School of Agricultural Science, Tohoku University
Muneo Oikawa	Formerly Chief Editor, Japan Grassland Agriculture and Forage Seed Association
Shinji Sakai	Formerly Director, Department of Integrated Research for Agriculture for the Kanto and Tokai Region, National Agricultural Research Center,

Development of agroforestry technology for the rehabilitation of tropical forests

Fujio Kobayashi	Vice-Chairman, Japan Forestry Association
Minoru Kumazaki	President, Gifu Academy of Forest Science and Culture
Yoshiya Tadaki	Director, Ecological Research Center, PREC Institute Inc.
Mitsuyoshi Yatagai	Professor, Graduate School of Agricultural and Life Sciences, the University of Tokyo

Studies on sustainable production systems of aquatic animals in brackish mangrove areas

Kunihiko Fukusho	Director, Breeding and Exhibit Department, Port of Nagoya Public Aquarium
Fumitake Seki	Professor Emeritus, the University of Tsukuba
Prathak Tabthipwon	Vice Dean, Faculty of Fisheries, Kasetsart University
Makoto Terazaki	Professor, Ocean Research Institute, the University of Tokyo

Increasing economic options in rainfed agriculture in Indochina through efficient use of water resources

Tawachai Na Nagara	Advisor and Former Director, Soil Science Division, Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand
Sakol Ooraikul	Agricultural Economics Specialist, Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand
Paiboon Pramopjanee	Associate Professor, Faculty of Agriculture, Walailak University; Visiting Professor, Ritsumeikan Asia Pacific University
Akira Goto	Professor, Environmental Engineering, Faculty of Agriculture, Utsunomiya University
Takeshi Horie	Professor, Laboratory of Crop Science, Faculty/Graduate School of Agriculture, Kyoto University
Hideo Yano	Professor, Division of Applied Sciences, Faculty/Graduate School of Agriculture, Kyoto University

Improvement of the fertility of sandy soils in the semi-arid zones of West Africa through organic matter management

Nteranya Sanginga	Director, Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT)
Lamourdia Thiombiano	Senior Soil Resources Officer, FAO Regional Office for Africa
Tomoki Takamura	Professor Emeritus, Kyoto University
Shuhei Shimada	Professor, Graduate School of Asian and African Area Studies, Kyoto University
Jun-ichi Yamaguchi	Formerly Professor, Graduate School of Agriculture, Hokkaido University

Development of new technologies for the control of citrus huanglongbing (HLB) in Southeast Asia

Nguyen Huu Huan	Deputy Director General, Department of Plant Protection, Ministry of Agriculture and Rural Development, Vietnam
Meisaku Koizumi	Former Deputy Director, AVRDC–The World Vegetable Center
Tamotsu Murai	Professor, Department of Bioproductive Science, Faculty of Agriculture, Utsunomiya University

JIRCAS STAFF in FY 2005

( ) Indicates previous position holder.

President

Shinobu Inanaga

Vice-President

Akinori Noguchi

Executive Advisor & Auditor

Kazuyuki Ito
(Shigeo Matsui from April 1, 2006)
Akimi Fujimoto

Research Planning and Coordination Division

Masami Yasunaka, Director

Research Planning Section
Yoshinobu Egawa, Section Head
Takeshi Urao, Senior Researcher
Ryuichi Yamada, Senior Researcher

Research Coordination Section
Takahito Noda, Section Head

International Relations Section
Hideto Fujii, Section Head
Akihiko Yokota, Senior Researcher

International Research Coordinators
Satoru Miyata, Representative of SE-Asia Office
Kazuhiro Suenaga, Wheat Breeding
Takeshi Kano, Plant Pathology

CGIAR Liaisons Coordinator
Masayoshi Saito, Senior Researcher

Public Information Officer
Kunimasa Matsumoto, Head
Mie Kasuga, Researcher

Publication and Documentation Section
Fumio Yoshida, Section Head
Hiromi Miura, Librarian

Field Management Section
Haruo Tamura, Chief
Takashi Komatsu, Field Operator

Administration Division

Tokuzo Ono, Director

General Affairs Section
Keizo Kôyama, Section Chief
Ryoichi Saito, Assistant Section Chief
Kaoru Watanabe, Personnel Overseer
Yasuhiro Onozaki, Section Manager
Yoshinori Kawasaki, Personnel Manager
Ryo Okamoto, Personnel Officer
Koichi Fuse, Welfare Manager
Yukio Konuma, Social Affairs Head

Accounting Section
Moriji Uchino, Section Chief
Nobuhiko Nakamura, Assistant Section Chief
Tetumi Takegahara, Auditing Chief
Katsunori Kanno, Financial Manager
Takashi Kitami, Financial Officer
Yoshihiko Sumomozawa, Accounting Manager
Kazuo Miyajima, Auditing Manager
Takafumi Dôgami, Supplies/Equipment Manager
Naomi Yamamoto, Supplies/Equipment Officer
Kuniaki Katsuyama, Facilities Manager

Overseas Staff Support Section
Kazutoshi Tateyama, Section Chief
Hatsui Yashiro, Overseas Affairs Overseer
Gaku Takeda, Overseas Operations Manager
Toshiki Kikuchi, Overseas Expenditures Manager
Tsuneyoshi Sasaki, Overseas Travel Manager
Junichi Irino, Overseas Shipments Manager

Development Research Division

Osamu Koyama, Director
[Minoru Tada from April 1, 2006]

Development Research Coordinators
Kazunobu Toriyama, Soil Science
Satoshi Uchida, Geographic Information Systems

Research Staff
John S. Caldwell, Horticulture and Farming Systems
Hsiaoping Chien, Agricultural Economics
Jun Furuya, Agricultural Economics
Akira Hirano, Geographic Information Systems
Hiroshi Komiyama, Development Economics
Kazuo Nakamoto, Agricultural Economics

Shunji Oniki, Agricultural Economics
Tomohide Sugino, Development Economics
Minoru Tada, Agricultural Economics
Toshihiro Uetani, Agricultural Economics
Yukiyo Yamamoto, Geographic Information Systems
Norihiro Yamashita, Agricultural Economics
Kumi Yasunobu, Agricultural Economics

Biological Resources Division

Takashi Kumashiro, Director

Research Staff
Tomohiro Ban, Wheat Breeding
Yoshimichi Fukuta, Rice Breeding
Masanori Inagaki, Wheat Breeding
Kazuo Ise, Rice Breeding
Yusuke Ito, Plant Molecular Biology
Masayasu Kato, Plant Pathology
Mie Kasuga, Plant Molecular Biology
Nobuya Kobayashi, Physiology and Breeding
Kyonoshin Maruyama, Plant Molecular Biology
Ryoichi Matsunaga, Legume Breeding
Kazuo Nakashima, Plant Molecular Biology
Hidekazu Sasaki, Vegetable Physiology
Motoki Takahashi, Legume Physiology
Xu Tonghe, Plant Molecular Genetics
Hiroshi Tsunematsu, Rice Breeding
Naoki Yamanaka, Plant Molecular Genetics
(Kazuko Yamaguchi-Shinozaki, Plant Molecular Biology)

Crop Production and Environment Division

Osamu Ito, Director

Research Staff
Hiromasa Hamada, Groundwater Hydrology
Tamao Hatta, Mineralogy and Geology
Keiichi Hayashi, Soil Management
Yasukazu Hosen, Soil Chemistry
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Naruo Matsumoto, Environmental Conservation
Satoshi Nakamura, Insect Ecology
Masato Oda, Crop Management
Junichi Sakagami, Crop Improvement
Zen-ichi Sano, Nematology
Sachiko Senô, Crop Science
Kenji Suzuki, Environmental Hydrology
Guntur V. Subbarao, Crop Physiology and Nutrition
Satoshi Tobita, Plant Physiology and Nutrition
Takeshi Watanabe, Soil Chemistry
Matthias Wissuwa, Plant Physiology and Genetics
Mitate Yamada, Agronomy

Animal Production and Grassland Division

Shuichi Oshio, Director

Research Staff
Yasuo Ando, Plant Microbiology
Hiroshi Kudo, Rumen Microbiology
Takehiro Nishida, Animal Nutrition
Sadahiro Ohmomo, Applied Microbiology
Katsuhisa Shimoda, Pasture Management
Seishi Yamasaki, Animal Nutrition
Kazuhiro Yoshihara, Immunology

Food Science and Technology Division

Yutaka Mori, Director

Research Staff
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Akihiko Kosugi, Molecular Microbiology
Kazuhiko Nakahara, Food Chemistry
Hiro Nakamura, Cereal Chemistry and Plant Breeding
Eizo Tatsumi, Food Science
Koji Yamaki, Food Functionality
Tadashi Yoshihashi, Food Evaluation

Forestry Division

Shozo Nakamura, Director

Research Staff
Hisashi Abe, Wood Science
Fumio Kawamura, Forest Chemistry
Kazuki Miyamoto, Silviculture
Masahiko Tokoro, Entomology
Tsutomu Yagihashi, Silviculture
Tsuyoshi Yamada, Forest Soil Science
Yasuhiro Yokota, Social Forestry

Fisheries Division

Koji Nakamura, Director
[Shoji Kitamura from April 1, 2006]

Research Staff
Yoshimi Fujioka, Coastal Ecology
Kaoru Hamano, Physiology

Yukio Hanamura, Ecology
Masaki Kaneniwa, Food Chemistry
Ikunari Kiryu, Fish Pathology
Hiroshi Ogata, Fish Nutrition
Marcy N. Wilder, Crustacean Biochemistry

Okinawa Subtropical Station

Toshihiro Senboku, Director
Kazuo Shibano, Associate Director for Research

General Affairs Section
Hideki Ebata, Section Chief
Hisato Ohshima, Section Manager
Takao Ohga, Accounting Manager
Osamu Oikawa, Accounting Officer

International Collaborative Research Section
Yoshimitsu Katsuda, Section Head

Islands Environment Management Laboratory
Kiyoshi Ozawa, Agrometeorology, Head
Fujio Nagumo, Soil Science
Ken Nakamura, Soil Science

Environmental Stress Laboratory
Mariko Shono, Plant Physiology, Head
Kouichi Kashiwaba, Plant Breeding
Hide Ohmae, Plant Physiology

Tropical Crop Breeding Laboratory
Hiroko Takagi-Watanabe, Plant Breeding, Head
Koshun Ishiki, Plant Breeding and Genetic Resources
Mitsunori Sato, Sugarcane Breeding
Yasuaki Tamura, Rice Breeding
Masahiko Tanio, Wheat Breeding

Tropical Fruit Crops Laboratory
Yoshimi Yonemoto, Pomology, Head
Tatsushi Ogata, Pomology
(Hiroshi Fukamachi, Pomology)
Hidenori Kato, Plant Physiology

Plant Protection Laboratory
Masatoshi Ohnuki, Plant Virology, Head
Katsuya Ichinose, Entomology
Kunimasa Kawabe, Plant Virology
Tadafumi Nakata, Entomology

Field Management Section
Tadahiro Hayashi, Section Head
Masakazu Hirata, Machine Operator
Hirokazu Ikema, Machine Operator
Masahide Maetsu, Machine Operator
Yuho Maetsu, Machine Operator
Yasuteru Shikina, Machine Operator
Masato Shimajiri, Machine Operator
Masashi Takahashi, Machine Operator
Koji Yamato, Machine Operator

Researchers on Loan to Other Organization

Africa Rice Center (WARDA)
Ryoichi Ikeda, Rice Breeding

THE JAPANESE FISCAL YEAR AND MISCELLANEOUS DATA

The Japanese Fiscal Year and the Annual Report 2005

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) 2005 covers the period from April 1, 2005 through March 31, 2006. The Annual Report 2005 summarizes the full extent of JIRCAS activities that occurred during this period. The subsequent Annual Report will detail events and programs from April 1, 2006, through March 31, 2007 (FY 2006).

Buildings and campus data

Land	(units: m^2)
Tsukuba premises	109,538
Okinawa Subtropical Station	294,912
Total	404,450

Buildings	(units: m^2)
Tsukuba premises	10,749
Okinawa Subtropical Station	9,523
Total	20,272

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