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Annual Report 2003 (Apr. 2003–Mar. 2004)

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

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

Japan International Research Center for Agricultural Sciences

Annual Report 2003

(April 2003-March 2004)

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Message from the President

President
Dr. Mutsuo Iwamoto

JIRCAS in the next ten years: issues and challenges

The year 2003 marked a major turning point for Japan with the revision of the Official Development Assistance (ODA) framework and JICA's restructuring as an Independent Administrative Agency (IAA) in September 2003, as well as the undertaking of the Third Tokyo International Conference on African Development (TICAD III) held in November. This year, 2004, is in addition highly memorable as we celebrate the 50th anniversary of our country's participation in the Colombo Plan in 1954 and the implementation of the ODA framework.

The year 2003 was also an important year for JIRCAS in which we observed the institute's 10th anniversary since its re-organization from JIRCAS's predecessor, the Tropical Agriculture Research Center (TARC). A commemorative symposium which focused on the effects of globalization and changes in natural resources and environment on food security and agricultural sustainability in developing regions, and methods of addressing such issues was held to mark this occasion. Additionally, a follow-up workshop was held in order to allow symposium participants to discuss possible ways of strengthening partnerships among Japanese and foreign institutions. In accordance with discussions conducted in these meetings, we have determined to pursue the following four objectives over the next ten years as detailed below.

One of our most important objectives is to strengthen joint research programs with research centers affiliated to the Consultative Group on International Agricultural Research (CGIAR) aiming at the development of public goods. For instance, JIRCAS has achieved major breakthroughs in the field of biotechnology such as the isolation of useful genes; when developing new varieties of plants through the introduction of such genes, we believe that it is essential to draw upon the expertise of the CGIAR centers in order to achieve results that can be utilized and disseminated worldwide. In the field of breeding, we intend to strengthen joint research with the West Africa Rice Development Association (WARDA) in order to further studies on "New Rice for Africa" (NERICA), with the International Maize and Wheat Improvement Center (CIMMYT) to pursue advanced studies on wheat, and with the International Rice Research Institute (IRRI) on rice.

A second objective is to create new frameworks in which collaborative research may be conducted with developing countries. Up until the present, joint research between JIRCAS and institutes in developing countries had been carried out principally on a bilateral basis. However, a number of these countries have developed sufficient capacity such that they are in turn able to support the research activities of other developing countries. In this way, it has become increasingly important that JIRCAS conduct multi-partite, regional joint research projects with the CGIAR centers and a range of other research organizations in both developing and developed countries. For instance, a new project will commence in Vietnam between JIRCAS and France's Centre de Coopération Internationale en Recherché Agronomique pour le Développement (CIRAD), in order to develop technology for controlling outbreaks of citrus greening disease.

Yet a third objective is to increase the availability of human resources. In order to address the pressing problems that confront developing countries, cooperation among individuals having diverse professional knowledge and experience is required. Keeping in mind that joint research with the

CGIAR centers and other research organizations will further aid this objective, we will initiate joint studies with such institutions within the course of the coming year, including the exchange of researchers and personnel. In addition, as mandated by our Ministry's Agriculture, Forestry and Fisheries Research Council Secretariat, we will implement a new human resources development program aiming to train graduate students and young scientists affiliated to Japan's public research institutes and universities in order to awaken interest in and deepen understanding of international development research.

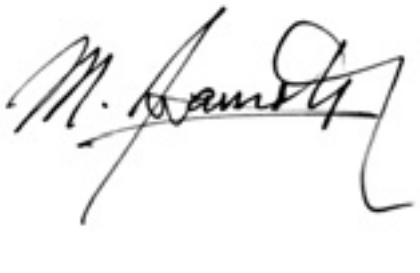
Finally, as a fourth objective, JIRCAS will assume the role of a national center directed towards international development in agriculture, forestry and fisheries-related research. To this end, JIRCAS is serving as the secretariat for the newly-established Japan Forum on International Agricultural Research for Sustainable Development (J-FARD), for which preparations have been undertaken with the cooperation of the relevant government ministries, such as the Japan International Cooperation Agency (JICA), universities, and other institutions.

As of last year, the Agriculture, Forestry and Fisheries Research Council formulated the new "Guidelines for the promotion of international agriculture research". As apparent from the Guidelines' sub-heading, "Japan's challenge aiming at the solution of food and environmental issues," these Guidelines were laid down in order to allow our nation to tackle international development research issues effectively and efficiently and to develop a research infrastructure capable of dealing with fluctuations in conditions associated with international development. An outline of these Guidelines was disseminated worldwide at the CGIAR Annual Meeting held in Nairobi, Kenya in October 2003, and was met with a positive response.

JIRCAS Main Building.

Also of much significance, the year 2004 was designated as the "International Year of Rice" by the United Nations. In recognition of this notable occasion, a symposium sponsored by Japan's Ministry of Agriculture, Forestry and Fisheries, will be held in November 2004, in cooperation with IRRI and other relevant organizations. As the secretariat of this "World Rice Research Conference," JIRCAS is at the forefront of making preparations to ensure the successful execution of this symposium.

In conclusion, having passed the midpoint of its Mid-Term Plan and having entered its fourth year since becoming an IAA, JIRCAS is determined to continue fulfilling its task as a national center through the promotion of diversified programs on international development as well as research and technological development. We hope for the cooperation of all concerned in this regard.



HIGHLIGHTS FROM 2003

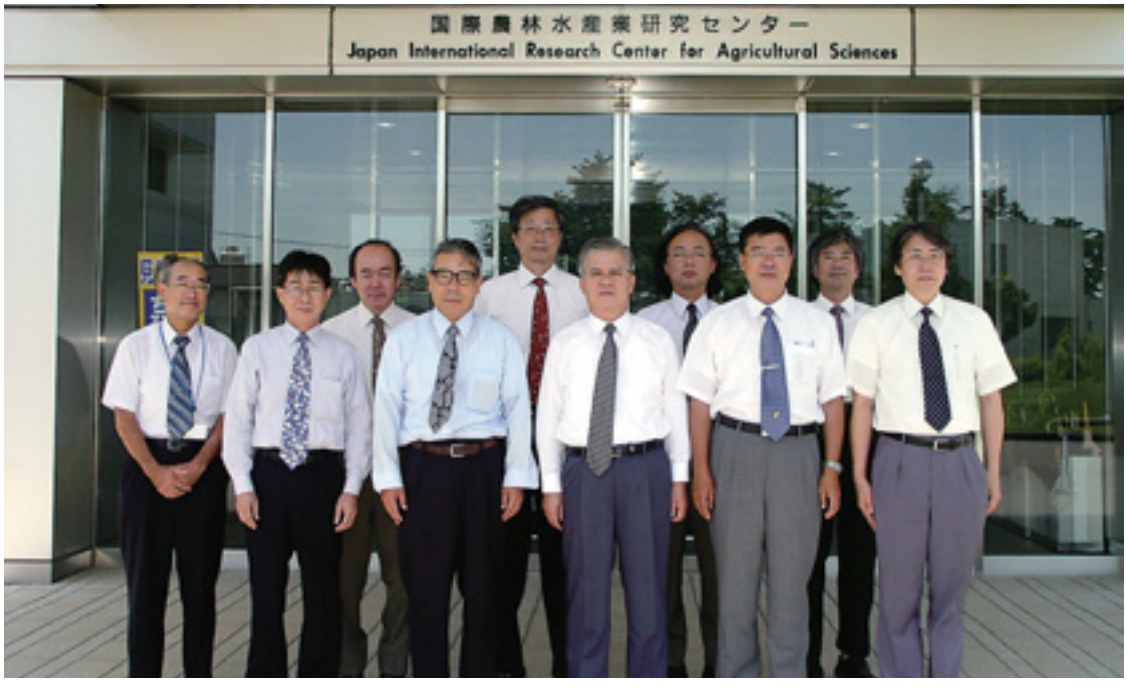
During Fiscal Year 2003, the Japan International Research Center for Agricultural Sciences (JIRCAS) made a number of strides in its overall efforts to improve world food security. As an Incorporated Administrative Agency (IAA), JIRCAS held several evaluation meetings to share and discuss the progress being made in various projects. We are pleased to highlight these activities and achievements in greater detail.

IMPORTANT NEW DEVELOPMENTS

JIRCAS's new policy promoting international research

Through collaborative studies with developing countries and related organizations, JIRCAS is mandated to carry out research on the development of world-wide sustainable agriculture, forestry and fisheries production that will promote stabilization of worldwide food supplies and at the same time, not adversely affect the environment. In the past several years, the importance of this mandate has become evermore apparent, as it has become clear that the foreign community expects Japan to play an increasingly important role in international developmental assistance. With the observance of JIRCAS's tenth anniversary during this past year, JIRCAS has strengthened its current objectives and has formulated a new in-house policy that will allow our institution to meet the expectations of the international community as well as the Japanese public. To this end, we will continue to investigate and identify developing regions with the most serious concerns; strengthen ties with international agricultural research institutions as well as with domestic organizations including universities and other related Incorporated Administrative Agencies (IAAs); and develop human resources relevant to international agricultural research.

Under the new policy, the project-planning roles of the Development Research Coordinators and International Research Coordinators respectively affiliated to the Development Research Division and the Research Planning and Coordination Division continue, and issues raised at international workshops, and suggestions and comments proposed by outside professionals and critics are taken into consideration in formulating research themes which address the needs of developing countries. As a result, in Fiscal Year 2003, joint research was initiated with France's Centre de Coopération Internationale en Recherché Agronomique pour le Développement (CIRAD), and Vietnam's Southern Fruit Research Institute (SOFRI) in order to control citrus greening disease which is seriously affecting citrus production not only in Southeast Asia, but also in our own country. Research has also been initiated with



JIRCAS senior administrators pose for a group photograph at the JIRCAS front entrance. Front row: K. Nakamura, T. Kumashiro, K. Kato, M. Iwamoto, A. Noguchi, O. Koyama. Back row: O. Ito, M. Yasunaka, Y. Mori, S. Nakamura.


A. Fujimoto


N. Kikuchi


S. Oshio


S. Asanuma

the People's Republic of China aiming to stabilize food resources in East Asia. In addition, plans to implement a project to develop methodology for the effective usage of under-utilized biomass resources such as cassava starch and oil-palm empty fruit bunches in Southeast Asia, are underway for Fiscal Year 2004. Our new policy in addition stipulates that we conduct domestically-based "seeds research," or fundamental research covering a wide range of topics, that serve to support and give further impetus to our larger, internationally-based research projects.

JIRCAS will continue to target all of the world's developing regions, but in the past several years, the Japanese government has made a series of new policy decisions to strengthen support for research and development activities in Africa. Commensurate with this new policy, in Fiscal Year 2002, cooperative research aiming to improve soil-production technology in the semi-arid zones of Africa, was initiated with the Sahel Center of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) located in Niger; in addition, in order to promote the further development of rice cultivation industries in West Africa, collaborative studies were initiated in FY 2003 with the West Africa Rice Development Association (WARDA), International Center for Tropical Agriculture (CIAT), CIRAD, Institut de Recherché Agronomique de Guinée (IRAG) and other related organizations. Having been developed in Africa, "New Rice for Africa" (NERICA) is considered to have great potential; JIRCAS has therefore already commenced research on evaluation of its nutritional value and physiological characteristics. With enhanced cooperation based on the above multilateral ties, we sincerely hope that NERICA may be made widely available for cultivation in Africa.

With our goal to produce research results that will lead to worldwide benefits, JIRCAS will continue to promote collaborative research not only on a bilateral basis, but also on a multilateral basis, in particular, with the Consultative Group on International Agricultural Research (CGIAR) and other international agricultural research centers. Under this policy, JIRCAS has tied MOUs with ICRISAT, the International Livestock Research Institute (ILRI), CIAT, and with the Asian Center of the International Center for Agricultural Research in the Dry Areas (ICARDA). In the future, JIRCAS plans to develop new, or strengthen existing partnerships with the International Food Policy Research Institute (IFPRI), the International Maize and Wheat Improvement Center (CIMMYT), the International Rice Research Institute (IRRI), and other CGIAR Centers. In support of these objectives, we will be initiating a new program for the dispatch of young scientists and graduate students under JIRCAS auspices to the CGIAR centers in order to cultivate a new awareness of international developmental research.

Finally under the new policy, with the awareness of the necessity to create grounds for encouraging partnerships and promoting the exchange of information with multiple institutions, JIRCAS has initiated the Japan Forum on International Agricultural Research for Development with participants representing government institutes, JICA, universities, NGOs and other related organizations. Through this new forum, JIRCAS hopes to achieve the understanding and trust of the international and domestic communities in the most efficient and effective manner possible.

The 10th JIRCAS Symposium on Prospects for Food Security and Agricultural Sustainability: New roles of International Collaborative Research

Every year, JIRCAS hosts international symposia on common issues related to agricultural development in developing regions. This year's Symposium was held at the U Thant Conference Hall located in the United Nations University in Tokyo on November 18-19, 2003 to commemorate JIRCAS's 10th anniversary since its transition from its predecessor, the Tropical Agricultural Research Center (TARC). Approximately 240 participants from more than 30 developing and developed countries as well as international organizations attended the Symposium, which covered various disciplines ranging from international cooperation, collaborative research policy-making, strategy development, and fieldwork. The Symposium focused on the impacts of factors such as globalization and changes in natural resources and environment on food security and agricultural sustainability in developing regions, their prospects and possible directions of international

cooperation, and collaborative research to cope with such factors. Consisting entirely of inter- and multidisciplinary presentations and discussions, the 2003 Symposium opened with two keynote speeches. Dr. Yonosuke Hara, Professor of Interfaculty Initiative in Information Studies and Director of the Institute of Oriental Culture, the University of Tokyo, gave an influential address entitled 'The 21st century: Reconsidering the roles of agriculture in the century of substantial development.' The second address, given by Dr. Francisco Reifschneider, Director of the Consultative Group for International Agricultural Research (CGIAR), introduced the new roles that the CGIAR will play in present and possible future Japan-CGIAR partnerships.

The Symposium consisted of the following four sessions: 'Perspectives for achieving international development goals'; 'Perspectives and issues for sustainable development of agriculture, forestry and fisheries in developing regions'; 'Strategies for international collaborative research activities'; and 'Strategic themes for international collaborative research activities.' At the end of each session, guest commentators provided additional comments and suggestions, which were then followed by a short discussion held among speakers and general participants.

In the last session, newly-appointed CGIAR Science Council member Dr. Keiji Kainuma chaired a 2-hour discussion on integration and synthesis of the overall Symposium. The majority of the participants reached a consensus that future international collaborative research targeting development would need to shift from a bilateral to a more multilateral network between developed countries and developing regions in order to improve its efficiency and effectiveness. As a result, many participants expressed strong expectations towards Japan's future initiatives.

In addition, a follow-up workshop was held in the International Conference Room at JIRCAS's Tsukuba premises on the next day, and the Symposium speakers and major Japanese participants were invited to attend. Consisting of three presentations concerning new Japanese policies on international cooperation and collaborative research and two reports on university activities in international collaboration, the workshop allowed participants to exchange opinions on possible ways to strengthen partnerships among Japanese institutions and foreign and international institutions. Next, JIRCAS president Dr. Mutsuo Iwamoto gave an overview of various new activities designed to strengthen domestic partnerships, including the establishment of a Japanese agricultural research forum. Every participant expressed strong support of such activities and agreed to pursue further communications for the purpose of creating more sustainable partnerships.

At the culmination of this three-day Symposium, it became apparent that the international society increasingly looks towards Japan's further intellectual input and leadership to successfully achieve its development goals despite budgetary constraints on Japan's contributions to international development assistance.

Symposium speakers, major Japanese participants, and JIRCAS administrators pose for a group photograph.

NEW RESEARCH COLLABORATION

New MOUs initiated in Fiscal Year 2003

South America:
Sustainable soybean production

JIRCAS has been conducting two comprehensive projects related to soybean production and agro-pastoral systems in South America, entitled "Comprehensive studies on soybean improvement, production and utilization in South America," and "Comprehensive studies on the development of sustainable agro-pastoral systems in the subtropical zone of Brazil." These projects were implemented under a Memorandum of Understanding (MOU) with the Brazilian Agricultural Research Corporation (EMBRAPA) of Brazil, and a Record of Discussion (R/D) with the Ministry of Agriculture and Livestock (MAG) of Paraguay, and another with the National Institute for Agricultural Technology (INTA) of Argentina. Following the initiation of a new project "Comprehensive studies on development of sustainable soybean production technology using agro-pastoral systems in South America," encompassing the previous two projects, the present MOU and the two R/Ds were renewed with the relevant organizations.

A new RD with INTA was signed by Dr. Carlos Vuegen, President of INTA and JIRCAS President Dr. Mutsuo Iwamoto in April, 2003. Under this R/D, JIRCAS and INTA commenced new activities concerning the application of agricultural by-products used in feeds. The MOU with EMBRAPA was renewed by Dr. Clayton Campanhola, Director-President of EMBRAPA, and former JIRCAS Vice-President Dr.Yoshinori Morooka, on October 24, 2003. Activities relating to the applications of DREB technology and investigation of soybean rust are now being conducted at EMBRAPA/Centro Nacional de Pesquisa de Soja (CNPSo). The renewed RD between MAG and JIRCAS was signed by Dr. Antonio Ibaños, Minister of MAG and Dr. Morooka on October 29, 2003. The soybean cyst problem is a serious issue in Paraguay, and it will be addressed through collaborative research between JIRCAS and MAG.

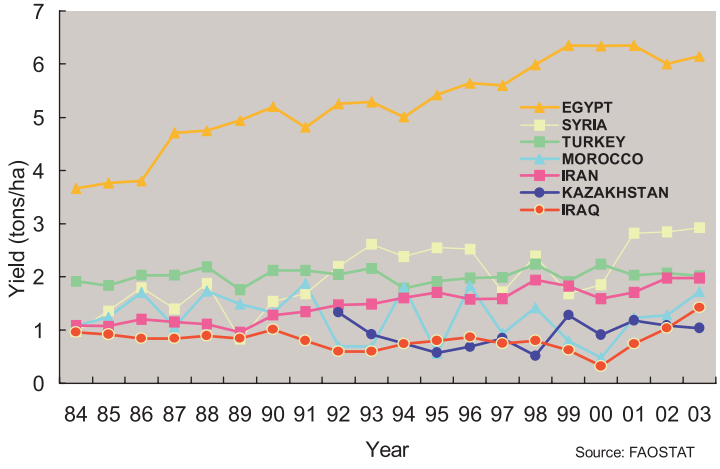
In addition to the above-mentioned activities, the project includes other themes as well, such as activities related to the development of agro-pastoral systems. The project has now entered the last four years of its 10-year duration, and is being aimed toward sustainable soybean production as the final goal.

Former JIRCAS Vice-President Dr. Yoshinori Morooka and Dr. Antonio Ibaños, Minister of Paraguay's Ministry of Agriculture and Livestock (MAG), sign a new Record of Discussion (R/D) at MAG headquarters in Asuncion, Paraguay.

Syria:
Evaluation of genetic resources and biotechnological approaches for the improvement of wheat germplasm tolerant to environmental stresses

Agricultural production in the dry regions of Central and West Asia and North Africa (CWANA) mainly under rainfed conditions is far from sufficient in meeting the demands of the rapidly growing population. Productivity remains low due to unfavorable environmental conditions; Main constraints include the lack of water resources and soil infertility, as well as biotic and abiotic stresses such as diseases and pests. In particular, rapid rehabilitation of sustainable agriculture is urgently demanded in regions where agricultural systems have been destroyed by recent conflicts.

Wheat is considered to be one of the major cereal crops in addition to rice, maize, and barley. Such crops are produced and consumed not only in developed regions but also in developing regions. Developing regions, which are subjected to unfavorable environmental conditions, produce less than half of the world wheat supply, while utilizing more than half. The International Maize and Wheat Improvement Center (CIMMYT), founded in 1966, has thus been implementing research and training programs in order to increase and improve wheat production in these areas. Wheat varieties developed under



Wheat yield of several countries in CWANA regions.

CIMMYT breeding programs have so far contributed significantly toward increasing wheat production under irrigated conditions at low latitudes in countries such as Mexico, India and Egypt among others, resulting in the Green Evolution of the 1970's. However, there is a greater demand for stable and sustainable wheat production in order to meet the needs of the rapidly increasing population, especially in CWANA regions that are under rainfed conditions.

The wheat yield of CWANA regions mostly remains as low as 1-3 ton/ha, with the exception of that of Egypt under irrigated conditions. Yet, these regions harbor an extremely rich genetic diversity of wheat and barley relatives. To meet high demands for increased and stabilized wheat production in these regions, it is necessary to focus research efforts on the extensive utilization of genetic resources indigenous to these regions, and the development of crop management practices under conditions of limited water usage and soil infertility.

The International Research Center for Agricultural Research in the Dry Areas (ICARDA) established at Aleppo, Syria in 1977 provides the benefits of poverty alleviation in CWANA regions through integrated productivity using sustainable natural-resource management practices. Technical advances for overcoming the constraints of sustainable agriculture have been achieved with the improvement of water-use efficiency and germplasm in several regions. In order to effectively transfer such technologies and information to farmers in these regions, ICARDA is focusing its efforts on the extensive and integrated agricultural research by increasing the availability of human resources.

ICARDA Headquarters surrounded by wheat fields in Aleppo, Syria

Taking these perspectives into consideration, a Memorandum of Understanding (MOU) initiating research collaboration between ICARDA and JIRCAS was signed in July 2003 with the aim of improving wheat germplasm tolerant to environmental stresses. Within the framework of the collaborative project, a study on wheat entitled "Evaluation of genetic resources and biotechnological approaches for the improvement of wheat germplasm tolerant to environmental stresses" is planned to be implemented for a three-year period from 2004 to 2006.

New projects

Development of new technologies for the control of Citrus Huanglongbing (HLB) in Southeast Asia

Citrus HLB, or greening, is a serious disease affecting the productivity of citrus trees in tropical and subtropical regions in East and Southeast Asia. "Huanglongbing" is the Chinese name for the disease, meaning "yellow dragon disease." The yellowed leaves of severely affected trees have provided the namesake for this particular indication. The term "greening," on the other hand, originates from the color of the diseased fruits. Instead of becoming orange when ripe, fruits of affected trees remain green. Recently, the disease has been spreading in temperate regions presumably under the influence of global warming. In 2003, the disease was also detected in the Ryukyu Islands belonging to Okinawa and Kagoshima Prefectures, areas which are located very close to the main citrus production regions of Japan.

Citrus HLB is transmitted by an insect vector, the Asian citrus psyllid, *Diaphorina citri*. HLB-free trees are easily infected

through contact with viruliferous vectors. It is therefore essential that we develop technologies in order to control vectors through investigation of psyllid ecology. In order to implement research aimed at the development of disease-prevention technology, JIRCAS has initiated a five-year project starting from April, 2004 in collaboration with Vietnam's Southern Fruit Research Institute (SOFRI) and France's Centre de Coopération Internationale en Récherche Agronomique pour le Développement (CIRAD), as well as with Japanese national and prefectural agricultural research institutes that are currently investigating the domestic problems of the disease.

The main purpose of the project is to develop individual physical, chemical and biological control methods for reducing the likelihood of infection of HLB disease in disease-free trees in newly-planted citrus orchards. Development of monitoring techniques for citrus psyllids, analysis of dispersal modes of citrus psyllids in the field, evaluation of the disease-transmitting ability of viruliferous psyllids, utilization of natural enemies, analysis of pathogenic bacteria relating to symptom development, development of increasingly efficient diagnostic methods of pathogenic bacteria, analysis of disease reaction of citrus germplasm and rootstocks to HLB, and evaluation of economic damage due to HLB disease are some of the topics that will be covered through research in Vietnam.

After development of individual control methods, those methods can then be utilized in a follow-up project to establish prevention technology applicable for use in citrus orchards. Along these lines, JIRCAS will strive to achieve the overall goals of the current project, which are to extend practical disease-control methods to Southeast Asian citrus orchards where HLB is endemic, and to disseminate useful scientific information to the relevant research scientists and administrators, enabling them to provide agriculturists with appropriate guidance on disease control.

Diaphorina citri, the insect vector of Citrus HLB (body length: 3 mm)

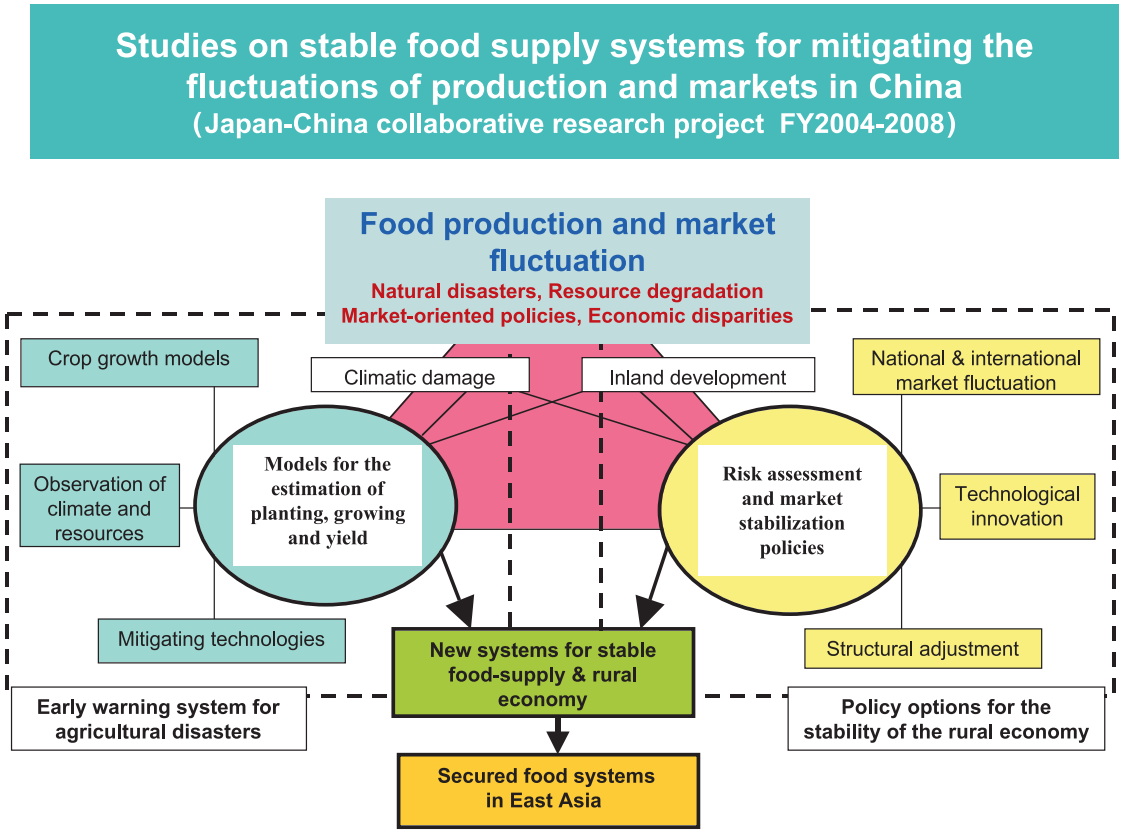
Citrus plants showing symptoms of HLB.

Studies on stable food supply systems for mediating fluctuations in food production and markets in China

China has extended international trade relationships to many countries including Japan through the application of open-market policies. In contrast to the rapid economic growth in the eastern coastal areas, the inland and Northeastern areas of China exhibit very gradual growth, and the issue of regional differences between urban and rural areas is becoming a serious concern. Underdeveloped areas are generally influenced by natural conditions, and frequent occurrences of natural disasters such as cool summers and droughts are obstacles for their integration into developed regions. In addition, rapid shifts in agricultural policies towards market-oriented policies exacerbate these instabilities. The main goal of this project is to integrate and stabilize farm and rural economy in China by developing several stable food supply systems to mitigate fluctuations in food

production and markets caused by both natural and economic phenomena. This project also aims to disseminate basic scientific knowledge that can be applied towards practical usage in order to attain a balanced co-existence of East Asian agriculture and economic development. More specific objectives of this project are, 1) to develop early warning systems for mitigating risks caused by climatic disasters such as cool summers and droughts through technological enhancement of resource monitoring and crop-model simulation, and 2) to propose alternative farm management and institutional measures by conducting various socio-economic analysis of farm management risks, farmer-market integration, as well as domestic and international market fluctuations.

This project will be implemented under a governmental agreement, which will be finalized at the 23rd meeting of the Japan-China Agricultural Science and Technology Exchange Group to be held in July 2004. The project will be conducted over a period of about five years starting in Fiscal Year 2004 and reaching completion at the end of FY 2008. Main participating research organizations in China include several research institutes belonging to the Chinese Academy of Agricultural Sciences, a research institute of the Heilongjiang Academy of Agricultural Sciences and the Development Research Center of the State Council. The pre-evaluation meeting for this project is scheduled to be held in June 2004.



Conceptual scheme of the new Japan-China project.

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 2003.

Dr. Kumi Yasunobu, Senior Researcher in the Development Research Division, received the **Academic Award of the Farm Management Society of Japan** on October 4th, 2003 for her book entitled "Emergence of New Types of Rice Farmers in Malaysia". This award is given to societal members whose publications are recognized as significant academic contributions to future progress in the field of Farm Management. Dr. Yasunobu was the sole author of the book, which was published in July 2002 and consisted of 8 chapters spanning 266 pages. In her work, Dr. Yasunobu presents the existing developmental constraints of farm management on Malaysian rice farms through detailed analysis of farm household monitoring data. In addition, she discovered that group activities among small-scale farm owners correlated highly with improvements in household economy. Though a great deal of farm management research has been conducted in Japan, there exists a lack of information on how differing socio-cultural circumstances affect farm management practices in developing countries. Dr. Yasunobu's work has thus contributed to the development of new perspectives and dimensions relating to farm management studies in Southeast Asia.

Dr. Marcy N. Wilder, Senior Researcher in the Fisheries Division, received a **Letter of Commendation** from the Rector of Cantho University, Prof. Dr. Le Quang Minh, recognizing JIRCAS's support and collaboration under the international project "Development of new technologies and their practice for sustainable farming systems in the Mekong Delta" which enabled **Cantho University** to receive the "**Golden Rice Award**" on December 4, 2003. The award was given by Vietnam's Ministry of Agriculture and Rural Development in recognition of Cantho University and JIRCAS's work on "Research and its applications in the development of freshwater prawn (*Macrobrachium rosenbergii*) seed production technology utilizing the modified static green water system." The national-level award recognizes achievements made in the establishment of new and useful technology furthering the development of agriculture and fisheries-related industries in Vietnam.

Dr. Kiyoshi Ozawa, Head of the Islands Environment Management Laboratory of the Okinawa Subtropical Station received the **Award for Achievement on Technology Dissemination of the Society of Agricultural Meteorology of Japan** for his work on "Development and extension of a new furrow bottom seeding technique for the improvement of micro-environments under vegetable production in cold weather districts". Dr. Ozawa found that leafy vegetable growths were accelerated in footprint dimples under row coverings during winter. By modifying the dimples, he developed a new furrow bottom seeding (FBS) technique to be used under row coverings. Seeds are sown on the bottoms of continuous V-shape furrows, which are 10 cm in width and 5 cm in depth. The increase in minimum soil and leaf temperatures under row coverings with FBS accelerates plant growth. In addition, this technique is effective under hot and dry conditions without row coverings because it decreases maximum soil and leaf temperatures, curbs evaporation, and reduces salt accumulation. FBS was thus widely introduced to vegetable growers in northern Japan, and has improved the effectiveness of vegetable production in these areas.

Koji Yamato, Hirokazu Ikema and Masato Shimajiri, staff members of the Field Management Section, Okinawa Subtropical Station received the **2004 Ingenuity Award of the Ministry of Education, Culture, Sports, Science and Technology of Japan.** This award is given to individuals who have made significant contributions toward the development of innovative technologies in their respective disciplines. The above staff members innovated a novel nutrient culture bed model for plants, consisting of double-story culture beds, a portable nutrient tank at one corner of each culture bed, and casters on the entire structure, which provides efficient, labor-saving and economical means of producing sugarcane seedlings and various leaf vegetables. The functionality of the model was well recognized at the 2001 APEC Science and Technology Week held in Brunei, and it is expected to be utilized not only in research stations, but also in kitchen gardens for the cultivation of leafy vegetables.

RESEARCH STRUCTURE AND EVALU

Research Structure at JIRCAS

JIRCAS is located in the 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 national, private and independent research institutions and experimental facilities.

JIRCAS currently has 164 staff members, including research scientists and administrators. Thirty-six 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 of 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.

In order 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 JIRCAS's comprehensive projects, such as those relating to China, South America, and Africa. 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

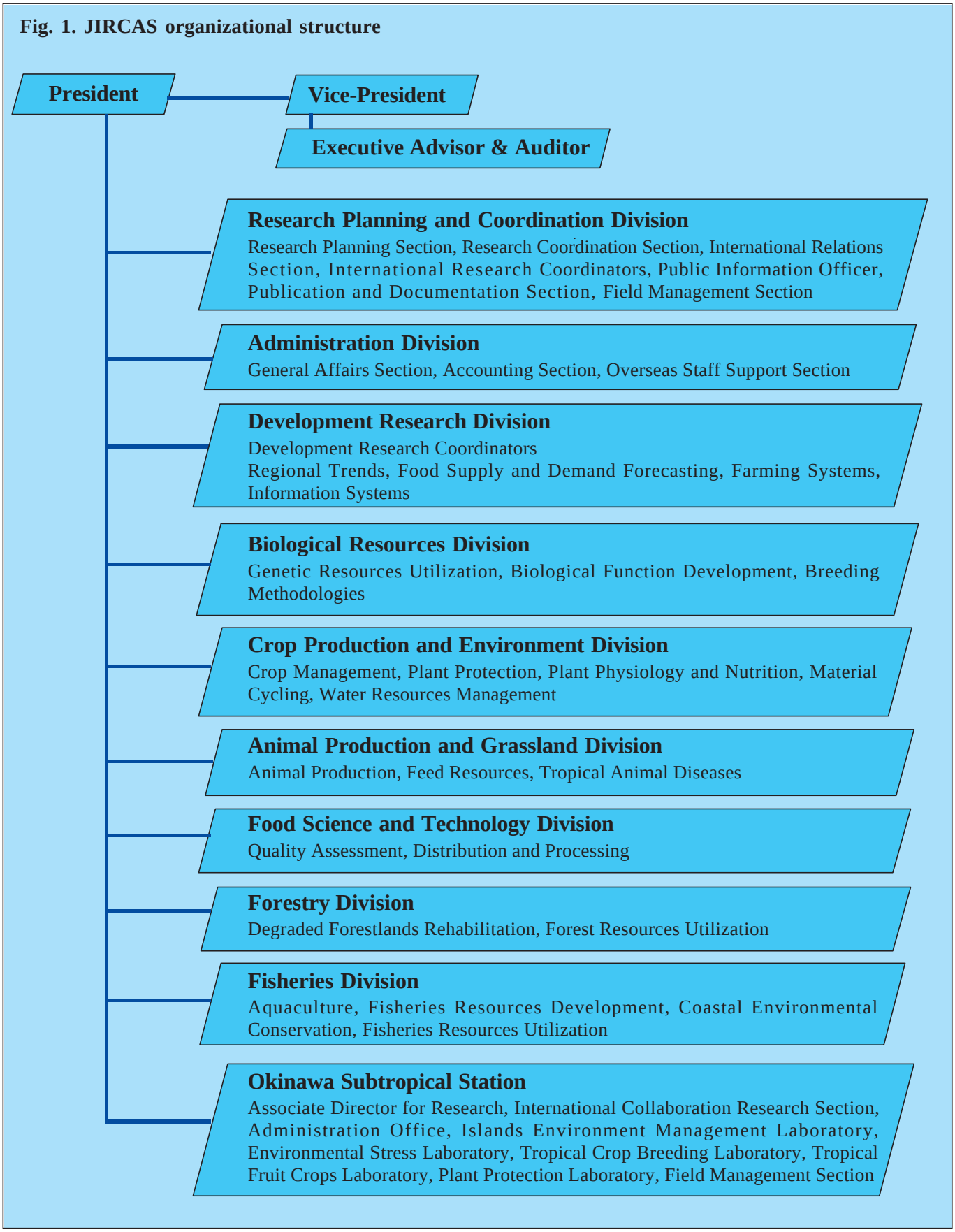
The Administration Division consists of three sections: the General Affairs Section, Accounting Section, and Overseas Staff Support Section. The General Affairs Section is responsible for the management of official documents, personnel-related matters and social affairs pertaining to JIRCAS staff. The 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 the 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 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 multi-disciplinary approach including the evaluation of 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 into the initiation of research programs to 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 1-2 months. JIRCAS researchers who are not on long-term assignments abroad are located in Tsukuba and 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.

Finally, JIRCAS conducts an "Annual Meeting for the Review and Promotion of Research for International Collaboration" with the participation of representatives from MAFF, other MAFF-affiliated IAAs, universities, non-governmental organizations (NGOs), and the private sector, in order to ensure the efficient implementation of each project. At this meeting, the previous year's activities are evaluated and new strategies and goals are established for the coming year.

JIRCAS as an Incorporated Administrative Agency

On April 1, 2001, under the Government of Japan's administrative reform facilitating the reorganization of government-affiliated research organizations, the Japan International Research Center for Agricultural Sciences (JIRCAS) became an Incorporated Administrative Agency (IAA) under the supervision of the Ministry of Agriculture, Forestry and Fisheries (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 mid-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 Mid-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 mid-term objectives, and the results of this evaluation will be applied, as necessary, to structural modifications of operational and financing systems for subsequent fiscal years. The comprehensive assessment of JIRCAS's performance will contribute towards the enhancement of 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 both in 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 Mid-Term Plan and in-house evaluation system

JIRCAS conducts its research activities based on mid-term and annual plans (Table 1), with the results and efficiency of outcome 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 Mid-Term Plan and

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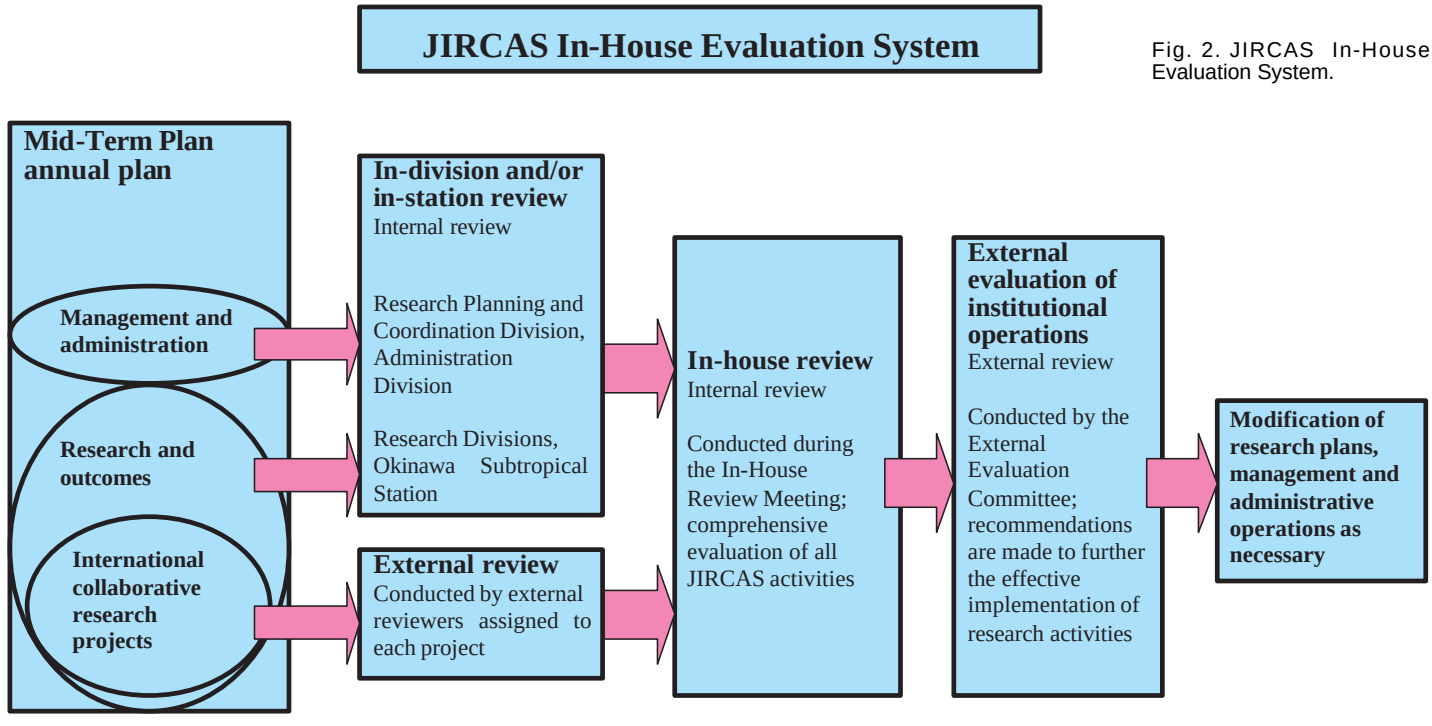


Fig. 2. JIRCAS In-House Evaluation System.

Table 1.

JIRCAS Mid-Term Plan (April 2001-March 2006) Experiments, research and investigations	INTERNATIONAL	
	Production and utilization of major food resources 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 in 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 of development of sustainable farming systems in Indonesia, Vietnam, Thailand, South America, and other regions		
B. Research for 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	●	

●							●	●	●						●				Soybean production and utilization in South America
●			●		●			●	●			●	●						Farming systems in the Mekong Delta
●	●												●						Reducing postharvest losses of staples in Southeast Asia
				●								●							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
				●									●		●				**PROJECTS WITH OTHER GOVERMENT AGENCIES**
							●	●							●				**COMMISSIONED RESEARCH AND MAFF SPECIAL RESEARCH ALLOTMENTS**

COLLABORATIVE RESEARCH PROJECTS

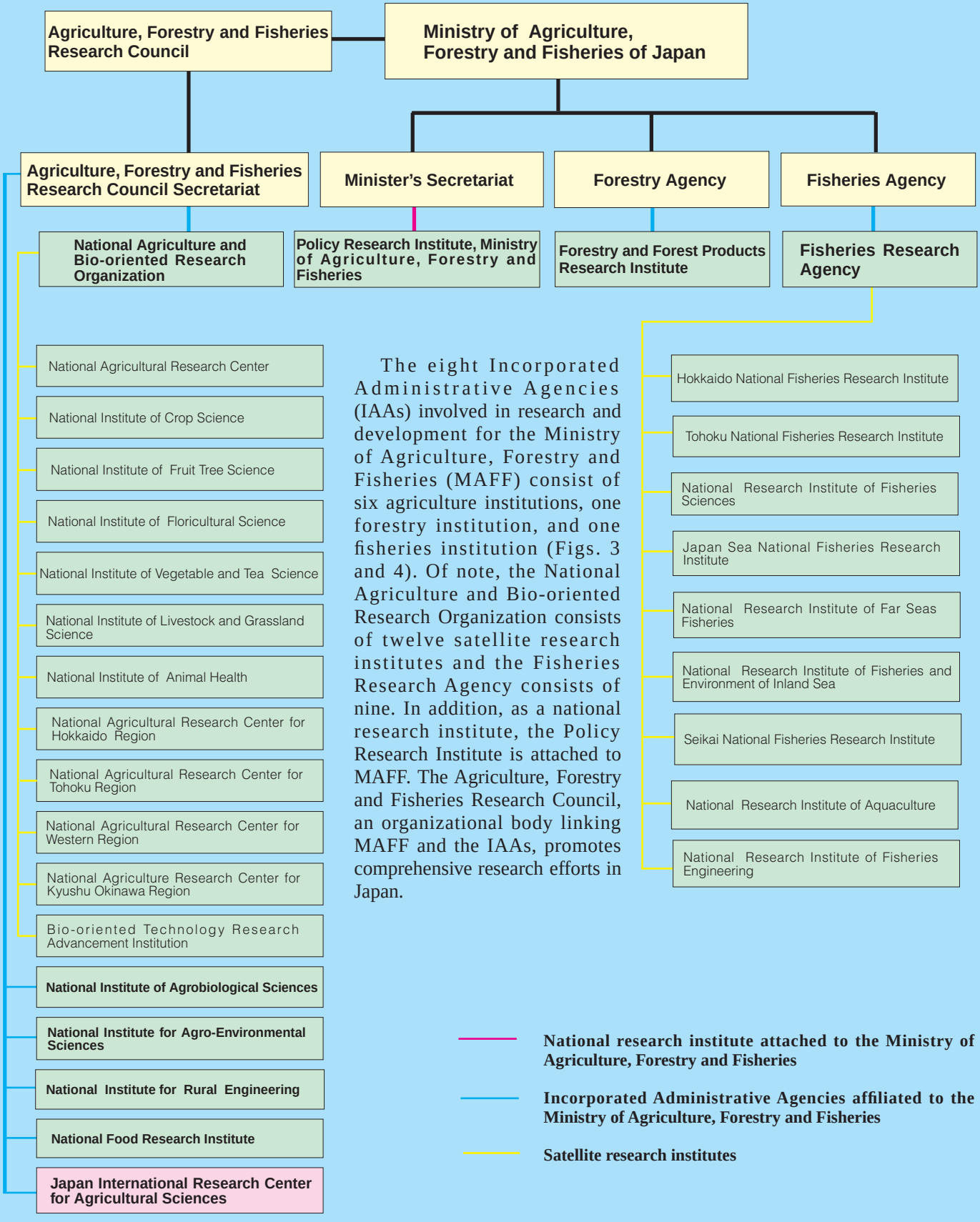
MISCELLANEOUS PROJECTS

Table 1.

JIRCAS Mid-Term Plan (April 2001-March 2006) Experiments, research and investigations	INTERNATIONAL	
	Production and utilization of major food resources in China	
(3) Uses for under-utilized wood resources such as oil palm residue		
(4) Uses for under-utilized 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 bio-diversity 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 activities 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 generation advancement of rice, wheat, and other crops		

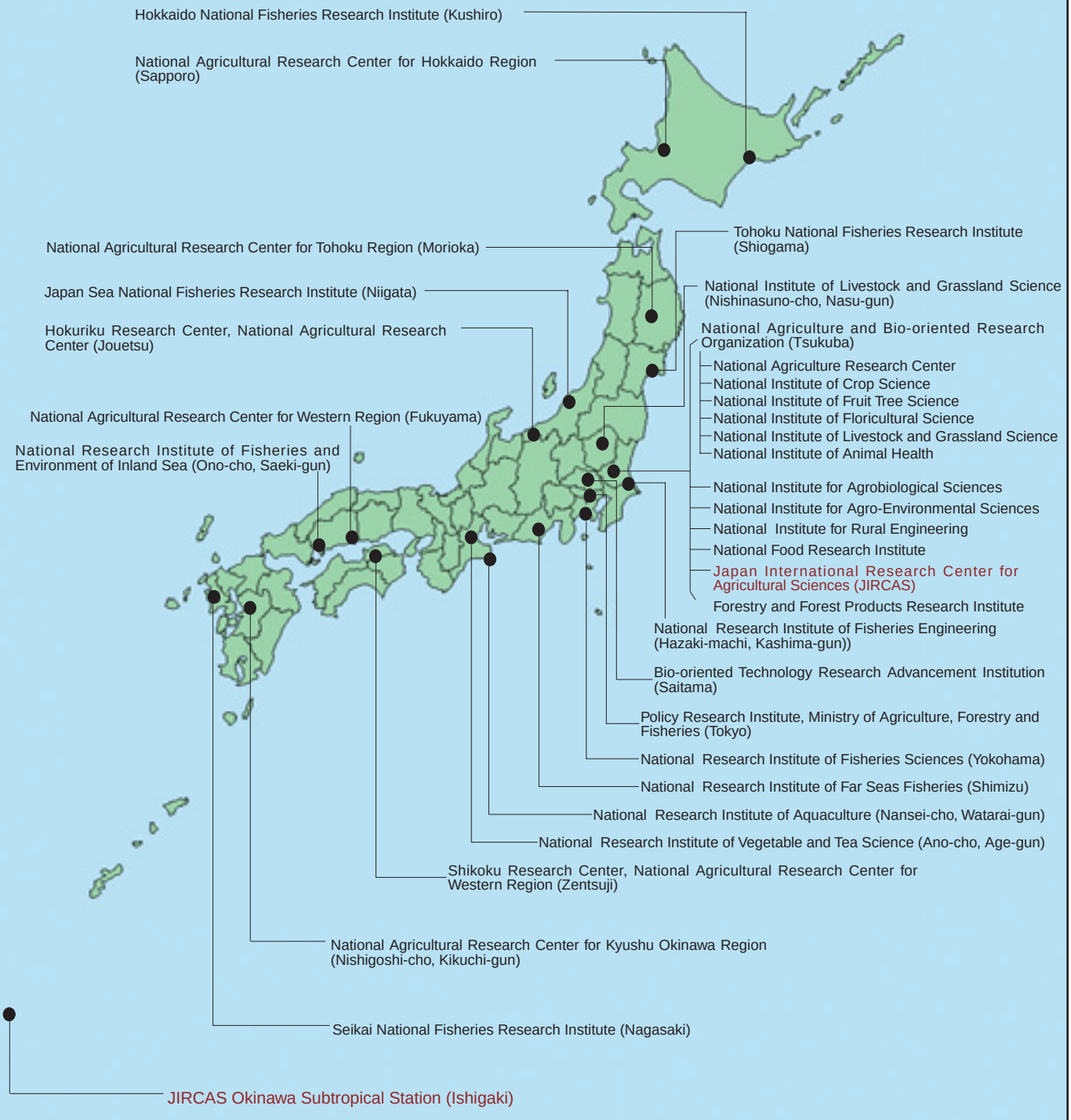
											●		●			Soybean production and utilization in South America	COLLABORATIVE RESEARCH PROJECTS
																Farming systems in the Mekong Delta	
																Reducing postharvest losses of staples in Southeast Asia	
								●								Agroforestry technology for tropical forests	
							●									Production 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	
					●								●			**PROJECTS WITH OTHER GOVERMENT AGENCIES**	
												●				**COMMISSIONED RESEARCH AND MAFF SPECIAL RESEARCH ALLOTMENTS**	

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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annual plan are firstly 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 results.

For efficient implementation of the individual research components of the Mid-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 Mid-Term Plan and annual plans and make recommendations for the further effective implementation of JIRCAS's research activities as necessary.

Experiments, research and investigations conducted according to the JIRCAS Mid-Term Plan are shown in Table 1. The tenets of the Mid-Term Plan are detailed in the Appendix.

JIRCAS ANNUAL REPORT EDITORIAL BOARD

JIRCAS's Annual Report is managed by the Research Planning and Coordination Division and an editorial board formed by staff administrators and researchers. In addition to a Chairman, Vice-Chairman, Editors-in-Chief, Editorial Committee, and Advisory Panel, the Board receives the participation of a student intern from Harvard University who serves as a Special assistant to the Editors-in-Chief. (front row: Toshihiro Uetani, Masami Yasunaka, Marcy N. Wilder, Yoko Wakabayashi; back row: Takaharu Hayashi, Ryuichi Yamada, Yoshinobu Egawa, Zenko Hamada, Junji Hashimoto, Vidya Jayasankar, Kyoko Nakamura)

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 were 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. 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 that were originally carried out under TARC and a variety of other miscellaneous projects.

The following section presents recent developments in JIRCAS's ongoing comprehensive projects. In 2003, JIRCAS was involved in eight comprehensive projects in the People's Republic of China; South America including Brazil, Argentina, and Paraguay; Vietnam; Southeast Asia including Malaysia, Thailand, 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 of a specific region through focused research on the relationships between various factors such as natural resources, 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 Phillippines 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, these projects promote comprehensive joint research through collaboration with the government of the partner country. This year, the China project falls under this classification. Multinational comprehensive projects incorporate researchers in many fields from 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.

CHINA: Development of sustainable production and utilization of major food resources in China

Since 1997, JIRCAS has been implementing its first comprehensive research project with the national government of the People's Republic of China. The project aims to develop an effective production and distribution system for food resources in order to accommodate fluctuations in supply and demand of agricultural products due to economic development in China, which has increased the purchasing power of middle-class citizens as well as their concerns for dietary nutrition.

Fiscal Year 2003 was the final year of the seven-year project period. Appropriately, conclusive research activities were carried out throughout the year. Four workshops assessing the final project outcome were held in China. During this fiscal year, JIRCAS had dispatched four researchers on long-term assignments, 20 researchers on short-term assignments, and several administrators in order to ensure smooth implementation of the project plans. Eight Chinese administrators and counterpart researchers took part in invitation programs, despite the difficulties in

travel due to the SARS epidemic in the first few months of this fiscal year.

Significant progress was made in many subjects during FY 2003, such as the comparative provincial analysis of off-farm incomes, monitoring of winter-wheat growth using satellite data, analysis of current policies on agricultural industrialization, development of new rice breeding materials for more stable and higher rice yields, field trials of the environment-friendly cultivation of an anti-insect rice variety, development of databases categorizing the genetic resources of east Asian soybeans, quantification of nitrogen flows on the prefectural scale, effects of electrolyzed water on sterilization of soybean products, evaluation of fat composition in fish powder, and trials on the digestion of silage made from corn leaves and canes. Some of these subjects are covered in further detail in the Research Divisions section of this Annual Report.

Although the project made considerable progress in achieving the original research goals, agricultural development in China has dramatically changed due to its accession to the WTO framework in 2001. The gap in economic development between the coastal and the inland regions has widened, and in addition, rural areas are suffering from unstable conditions brought about by natural disasters, environmental degradation and rapid policy reforms. In order to address these problems, a new research project is being planned by both Japanese and Chinese researchers during this fiscal year. Some of the subjects covered in the initial project will be pursued further and brought to conclusion in the follow-up project.

Research assistants measuring resistance to downward pressure.

VIETNAM:
Development of new technologies and their practice for sustainable farming systems in the Mekong Delta

The Mekong Delta Project (Mekong II) has been conducted since 1999, aiming to establish technologies which allow the reuse and recycling of by-products and wastes generated by VACR systems. VACR is a Vietnamese acronym, which stands for fruits and vegetables, aquaculture, livestock, and rice-farming systems.

Research topics under this project include the development of component technologies to be used in farming systems for rice, livestock, fruit, and aquaculture production. In recent progress, techniques were developed for breeding salt-tolerant varieties of rice and implementing an integrated pest management system for rice cultivation. Regarding livestock, improvements were made in feeding management practices for swine, and a method for the pathological diagnosis of porcine diseases was innovated. In fruit production, a model orchard was created at JIRCAS's on-farm trial site in Tan Phu Thanh Village, Cantho Province. In the case of aquaculture, basic technology for freshwater prawn seed production was developed and several rice-prawn farming trials were conducted around Cantho and Vinh Long Provinces. In addition, methods for assessing nitrogen cycling were set up at various trial sites and are currently being evaluated, adjusted, and improved. Under socio-economic studies, farming systems in the Mekong Delta area were classified and analyzed from the perspective of cause-and-effect relationships and technical and economical problems. The project also aimed to evaluate the current VACR systems, develop technologies in order to enhance their environmental sustainability, put these technologies into practice, and establish model VACR farming and extension systems at JIRCAS's on-farm trial site.

The project has been conducted in cooperation with Cantho University, the Cuu Long Delta Rice Research Institute (CLRRI), and the Southern Fruit Research Institute (SOFRI) and concluded in March, 2004. In Fiscal Year 2003, two researchers were dispatched to Vietnam on a long-term basis. A workshop was held at Cantho University on November 25-26, 2003, in order to review the

Prawn-rice farming site in the Mekong Delta. Inset: the target species, the giant freshwater prawn, *Macrobrachium rosenbergii*.
(photo: M.N.Wilder)

research activities carried out during Fiscal Year 2002. Participants agreed that several promising technologies were developed under the project auspices and that those technologies should be integrated into a model farming system. There was also a consensus that the economic validity of the new technologies should be closely evaluated. A final evaluation meeting and workshop was held at JIRCAS's Tsukuba premises on March 16-17, 2004 in which it was concluded that the current project achieved the majority of its research goals and that some of the research data should be supplemented by additional efforts in the future. Additionally, it was recommended that some issues such as citrus greening disease, freshwater prawn seed production, and community-based natural resource management be further considered for future follow-up activities.

THAILAND: Development of low-input technology for reducing post-harvest losses of staples in Southeast Asia

In Southeast Asia, the post-harvest loss of staples, which has been estimated at approximately 30%, is one of the most serious problems in the agricultural food sector. In order to address this problem, a five-year (2000-2004) project entitled "Development of low-input technology to reduce post-harvest losses of staples in Southeast Asia" has been in operation, with emphasis on the following four primary themes: surveyance of post-harvest losses of rice and identification of factors effecting quality change; analysis of the annual incidence of major insect pests found in stored products, sources of damage and possible prevention; development of low-input drying technology and biological control of insect pests using natural enemies and bioactive botanical substances; and development of environment-friendly technologies for the purpose of reducing post-harvest losses of staples. The project has been conducted in collaboration with the Thai Department of Agriculture, Kasetsart University, King Mongkut's University of Technology, and Japanese institutions such as the National Food Research Institute and the National Agricultural Research Organization.

Piper retrofractum (Piperaceae), an indigenous plant that has strong inhibitory effects on the growth of the red flour beetle and weevils. (Photo: K. Nakahara)

The major outcomes of the project in Fiscal Year 2003 were as follows: indigenous plants including long pepper (Piperaceae), celery, pomelo and turmeric were revealed to exhibit potent toxicity against major insect pests found in stored products, such as the red flour beetle (*Tribolium castaneum*) and weevils (*Sitophilus zeamais*). As for natural enemies, a predacious bug, *Joppeicus paradoxus*, was found to be a very active predator towards various kinds of insect pests. Adult *Joppeicus paradoxus* were left unfed for three days, and then placed into containers containing different prey densities. Based on the results of this experiment, the mean predation activity index of *Joppeicus paradoxus* was two-fold higher than that of the commercial bug, *Xylocoris flavipes*, which is already on the US market. Patent applications were thus filed in both Japan and Thailand for technology using *Joppeicus paradoxus* as a new natural enemy of stored-product insect pests. In addition, a guidebook categorizing the natural enemies of insect pests in Thailand was compiled for the first

time by project members and published in the English and Thai languages, and a low-cost paddy-drying method was developed using rice husks and tapioca pearls.

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

In Fiscal Year 2000, 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 Forestry Department of the State Government of Sabah, Malaysia.

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

Currently under these subjects, three JIRCAS researchers specializing in silviculture, soil science, and mycology have been dispatched on long-term assignments since December 2001. The silviculture and mycology researchers have already fulfilled their research assignments and have returned to JIRCAS; a second researcher specializing in silviculture has been on assignment since December 2003. In order to further studies on fruit tree cultivation, crop cultivation and socio-economic aspects of agroforestry, three experts in these fields were dispatched to FRC on a short-term basis in June, October and March 2004, respectively. Moreover, a FRC researcher overseeing research on the growing of non-arboreal crops under forest canopies was invited to JIRCAS in October 2003 in order to exchange opinions and review progress made under the project.

During Fiscal Year 2003, the growth and survival of various plant species were monitored and the amount of weeding for growing plants have been studied at the experimental sites of the FRC research stations. The results suggest that moderate shade cast by canopies facilitate the growth of seedlings, thus reducing the amount of necessary weeding and saving weeding costs by a significant amount compared to conventional planting in cleared sites.

An experiment in which various plant species were grown in thinning *Acacia mangium* plots in Sandakan, east Malaysia. (Photo: K. Kamo)

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

The ocean occupies 70% of the earth's surface area and supports diverse ecosystems. However, these ecosystems are not distributed uniformly throughout, but are mainly concentrated in coastal areas. This phenomenon is based on the rich supply of nutritive salts such as phosphorus and nitrogen compounds found in coastal areas, which are essential for plankton sustainability. Such areas are crucial to the surrounding ecosystems because of their large biomass productivity. In addition to coastal habitats, mangrove areas in tropical/subtropical climate zones serve as safe havens for young marine life to thrive by supplying protection and shelter from predators, as well as conserving the environment through water purification and carbon dioxide absorption. Recently, however, mangrove trees have been cut down in large quantities for economic and industrial purposes, such as to obtain material for the manufacture of charcoal and construction of aquaculture ponds used in shrimp and fish culture. Because of rapid industrial growth and a significant decline of mangrove forests in many tropical/subtropical countries, there is a great deal of concern regarding the further deterioration of marine environments.

To effectively utilize mangrove areas while simultaneously sustaining them, we have

promoted a joint research project pursuing the following three topics: investigation and analysis of ecosystems found in mangrove areas, development of aquacultural conditions friendly to the natural environment, and development of aquacultural technology for fish species of economic value originating in mangrove areas. Research on the first topic was conducted at Malaysia's Merbok and Matang mangroves, placing emphasis on food chains, correlation among ecosystems, identification of microorganisms and plankton, and stomach contents of snappers and groupers, which are of economic importance. The results reflect that mangrove areas play a significant role in the development and protection of ecosystems, especially for fish such as John's snapper and the Duskytail grouper, which inhabit those areas in the early stages of their lives.

Under the second topic, research was conducted at Thailand's Samut Songkhram Coastal Aquatic Research Station belonging to the Faculty of Fisheries of Kasetsart University. In order to elucidate natural purification means of aquaculture ecosystems, an experiment in which water was circulated between shrimp aquaculture ponds and mangrove aquaculture ponds was carried out. Water exchange between shrimp ponds and mangrove ponds proved to facilitate the purification of pond water, maintain mud quality and provide a natural source of feed, thus improving the efficiency of shrimp production while positively affecting surrounding ecosystems. As for the third topic, cooperative research on fish nutrition and disease is being implemented in Iloilo, the Philippines. Further detail concerning the above-mentioned topics can be found in the Fisheries Division section of this Annual Report.

A purification pond in Thailand run by a windmill (scheduled to be re-planted with mangrove trees prior to completion).

INDOCHINA:
Rainfed agriculture in Indochina: Increasing economic options through efficient use of water resources

Rainfed regions where agricultural production is largely if not entirely dependent on rainfall are widely distributed in the central part of the Indochina Peninsula. In order to achieve stable agricultural production in these regions, it is essential to develop technologies that will allow efficient use of water resources. Technological advancement is necessary in order to achieve better utilization not simply of rainfall, but also of water collected in catchment-basins, taking into account factors such as micro-topography of undulating areas and shallow-layer ground water. In addition, in order for farmers to adopt new technologies, they must be actively involved in the development of such advancements by participating in hands-on research conducted at actual farms. This project aims to develop specific technologies for increasingly efficient collection, storage, and distribution of water, as well as crop production technologies with high efficiency water-usage. The target areas of this project are the sloped regions ranging between lowland and highland areas spanning Northeast Thailand and Laos, where mixed small-scale farming is predominant. Assessment of regional water availability and identification of factors limiting the efficiency of water use in existing farming systems, development of crop production technologies for more effective water use, and the adaptation and integration of new technologies into current farming systems through active participation are the three main themes of this project.

As in the previous year, the project was conducted from the time of the pre-evaluation meeting at the start of the project year until the final evaluation meeting at the end of the project year. A planning meeting for Fiscal Year 2003 was held on July 4, 2003 and a subsequent meeting reporting the results was held on February 11, 2004, with scientists from JIRCAS and counterpart organizations presenting and actively participating in both meetings. Through these two meetings, participating scientists have been able to place direct input into both planning and reviewing, which are the two most important components of project management. Such collaborative planning and review assures both straightforwardness and systematic

monitoring. Farmers also provided input for the research agenda, through two farmers' meetings and on-farm assessments held during September 2003 in Nong Saeng Village, at which the project was conducted. The objective of these meetings was to develop a consensus among farmers and researchers on the prospect of on-farm research. At the conclusion of this process, farmers separated into three experimental groups consisting of farmers who volunteered to carry out on-farm trials on livestock, vegetables, and integrated farming. The vegetable group began an on-farm trial in November using the mother-child method in which each central village location is paired with a subplot on individual farmers' fields. After this trial, farmers themselves proposed and organized a second trial with the researchers' support in February 2004.

JIRCAS has extended research activities to Laos by assigning a scientist on a long-term basis to conduct research at the CIAT Asian Center from May 2003, on GIS/remote sensing in collaboration with CIAT and Laotian collaborators. Likewis, Dr. Rod Lefroy, research manager for the CIAT Asian Center, was invited to participate in the JIRCAS International Symposium on November 2003. During his stay, a meeting was held with project team members in order to share research output and exchange ideas on future research collaboration with JIRCAS scientists. In Fiscal Year 2003, two more scientists with experience in crop management and animal nutrition joined the long-term project team located in Khon Kaen. Dr. Christophe Le Page, a specialist from the multi-agent system (MAS) of the Centre de Coopération Internationale en Recherché Agronomique pour le Développement (CIRAD), was invited in November-December 2003 to collaborate with JIRCAS scientists in modifying the MAS source code to make it more compatible with the objectives and data of our project. By providing model decision-making processes, information exchange, and negotiation through MAS, it may become possible for individual farmers to make informed decisions on crop selection and land use within their own villages and simulate aggregate effects on overall water status and economic benefit. This may be based on the use of different scenarios of diversification, introduction of new technologies developed in the project, and gradual alterations of biophysical and socio-economic environments. In addition, MAS is expected to be a powerful tool for the dissemination of information obtained from small regions into much larger regions.

A focus group exercise at a local farmers' meeting. Farmers are discussing the various constraints and successes in achieving their goals of integrated farming.

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

The semi-arid zone of West Africa is a region in which food security is severely threatened. To battle with these harsh climatic conditions, a close cooperation among millet/sorghum-based farmers and cattle herders has developed. This agro-pastoral system forms the basis of the agricultural system in this region. However, recent population growth and inadequate management of soils associated with climate change have affected the agro-environmental resources of the region, and are now endangering the sustainability of agriculture and the livelihood of the people.

The soil in semi-arid tropical Africa is mostly sandy, and contains a minimal amount of clay, which acts as a nutrient-retaining medium. This low nutrient retention capacity is an intrinsic limiting factor for agricultural production in the region. In such soils, organic matter (OM) plays an important role in soil fertility as the source and retention medium of nutrients. Even with sufficient use of chemical fertilizers, the maintenance of soil organic matter is important for the preservation of soil fertility. However, the mechanisms and effectiveness of OM in sandy soils of semi-arid zones have not been sufficiently elucidated. In addition, sources of OM such as crop residues and manure is very limited, thus constraining the improvement of soil fertility

through organic matter management. To address this soil problem, JIRCAS has initiated a five-year project from April 2003 at Niamey, Niger with the additional collaboration of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Kyoto University.

The main goal of the project is to study the role of OM in soil fertility through the examination of the structures and functions of organic-inorganic complexes in sandy soils under semi-arid conditions. Since pressing problems, especially agriculture-related problems in Africa, have been forcing scientists to develop solutions within short periods of time, fundamental research issues such as the dynamics and retention of organic nitrogen in soils, and the interaction between organic and inorganic fertilizers have not been thoroughly addressed. Recently, it has been demonstrated that there is a wide range among crop species in their ability to utilize different fractions of organic nitrogen in soils. Accumulating such fundamental information and knowledge could be useful in developing rational fertility management systems for the region.

The project also implements systematic evaluation of plant genetic resources (PGR), with emphasis placed on the use of legume crops for efficient utilization in the agricultural systems. Indigenous and exotic PGR will be evaluated from the viewpoint of soil fertility preservation such as production of biomass as a source of OM, solubilization of immobile nutrients, prevention of soil erosion and nitrogen-fixing ability.

Based on the results of those research activities, improved systems and techniques for sustainable management of natural resources to preserve soil fertility will be proposed and tested through on-farm trials under the close collaboration of ICRISAT, Kyoto University and other research institutes in the region, such as the International Institute of Tropical Agriculture (IITA), the International Livestock Research Institute (ILRI), the Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), and the Institut National de Récherche Agronomique du Niger (INRAN).

This project started in April 2003 and a planning meeting was held on May 28 at JIRCAS's Tsukuba premises. In order for project members to develop a consensus regarding the direction and final aim of the project, a workshop was held at ICRISAT, Niamey on October 30, 2003. The logical frame of the project and the detailed research plan of each sub-specific theme was analyzed in order to clarify how the various research activities would be conducted. In addition, discussions with the National Agricultural Research System (Niger, Mali, Burkina Faso) and the International Agricultural Research Centers (IITA, ILRI, TSBF-CIAT and ICRAF) were held to examine how partnerships with those institutions could be developed in context of each research theme.

Preliminary investigation was carried out in the Fakara region (annual rainfall : 400 mm, a marginal area in the country), and three villages were selected as the main study sites of the project. In addition, Gaya (located in the southern part of Niger, annual rainfall : 800 mm, an area with relatively higher potential for food production) was selected as a comparative study site. Part of the field experiments for sub-themes 2 and 3 have been initiated from the rainy season of 2003. For the purpose of carrying out analysis of soil and plant samples under favorable conditions, additional laboratories were set up and new analytical equipment was purchased.

A cowpea field, photographed before the harvesting season. Cowpea is commonly used as livestock fodder.

SOUTH AMERICA:
Comprehensive studies on the development of sustainable soybean production technology using agro-pastoral systems in South America

Soybean is considered to be one of the principal crops that are crucial to human sustenance; they are also a major source of food, oil, and protein-rich livestock feed. Consequently, production of this valuable crop has increased substantially in the past three decades in comparison to other major grains. At present, Brazil, Argentina, and

Paraguay (MERCOSUR countries) account for half of the global soybean production, thereby constituting the world's leading soybean export countries. Recent high market prices of soybean have impelled farmers to engage in continuous soybean cropping, and soybean cultivation has rapidly expanded to areas characterized by environmentally unfavorable conditions, such as arid and acid soils characterized by low fertility. Such continuous cropping may result in serious outbreaks of pests and diseases, and soil erosion may adversely affect future soybean production. In order to address such concerns, comprehensive, multinational research efforts have been initiated in order to develop sustainable and increasingly efficient soybean production methods in South America.

The JIRCAS research project entitled "Comprehensive studies on soybean improvement, production and utilization in South America" commenced in 1997, marking a new initiative to promote multidisciplinary studies on soybean production and utilization in MERCOSUR countries through collaborative research among Japanese and South American specialists. The so-called "Soybean Project," was since re-organized in 2003 under a new title, "Comprehensive studies on the development of sustainable soybean production technology using agro-pastoral systems in South America."

The new project consists of the following three primary themes: development of breeding technologies for soybean and grasses; agro-ecological and physiological characterization in agro-pastoral systems; and improvement of agro-pastoral systems. These research activities have been implemented under the collaboration of several South American and Japanese research organizations, including the Brazilian Agricultural Research Corporation (EMBRAPA), Brazil; the Ministry of Agriculture and Livestock (MAG), Paraguay; the National Institute of Agricultural Technology (INTA), Argentina; the Japan International Cooperation Agency (JICA); National Federation of Agricultural Cooperative Associations for Colonization (JATAK); International Center for Tropical Agriculture (CIAT); and other Japanese research institutes and universities. With the re-initiation of the "Soybean Project", JIRCAS concluded a new MOU as well as a Material Transfer Agreement for the use of DREB genes with EMBRAPA, and a Record of Discussion (R/D) with MAG and INTA.

Soybean seeding during October 2004 in Yguazu, Paraguay.

One of the major targets of this project is to investigate the drought tolerance of soybeans. Molecular biological and physiological modifications of soybeans are being carried out in order to improve drought tolerance. EMBRAPA is conducting soybean transformation using DREB genes developed by JIRCAS, while sequencing of soybean full-length DREB cDNA clones is being performed at JIRCAS in order to develop DREB genes more suitable for soybean application.

Another major topic of investigation is the problem of soybean rust. The first outbreak of soybean rust in Paraguay and Brazil was reported in 2001, and the disease has been spreading rapidly ever since. Because it is urgent to develop efficient control systems for this highly destructive disease, JIRCAS initated collaboration with the Centro Nacional de Pesquisa de Soja (CNPSo) of EMBRAPA, by dispatching a pathologist to Brazil on a long-term basis. The proliferation of regions affected by cyst nematodes is another serious problem threatening the sustainability of soybean production in South America. JIRCAS also dispatched a nematologist on a short-term basis to Instituto Agronomico Nacional (IAN) of MAG, in order to investigate the current status of cyst nematodes and develop future research plans for dealing with problems brought about by this pest. In addition, a large-scale field experiment was initiated at the Centro Tecnológico Agropecuario en Paraguay (CETAPAR) belonging to JICA for the purpose of verifying the effects of agro-pastoral systems on sustainable soybean production. In Fiscal Year 2003, JIRCAS dispatched a total of 5 long-term and 8 short-term scientists to EMBRAPA, MAG and

INTA . Two scientists from INTA and one from CIAT were invited to JIRCAS for a period of 1.5 to 3 months to engage in collaborative studies.

INTERNATIONAL COMPREHENSIVE PROJECTS

All projects are handled by JIRCAS Research Divisions.

Time Frame	Project Title	Research Site
1997-2003	Development of sustainable production and utilization of major food resources in China	Institute of Agricultural Economics, Institute of Natural Resources and Regional Planning, Research Center for Rural Economy, China Agricultural University, Institute of Soil Science (ISS), China National Rice Research Institute, Shanghai Fisheries University, the Soil and Fertilizer Institute (SFI) and the Soybean Institute and Animal Science Branch of the Jilin Academy of Agricultural Sciences (SIJAAS), People's Republic of China
1997-2006	Comprehensives studies on soybean improvement, production and utilization in South America	Ministry of Agriculture and Livestock (MAG) and 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; and Marcos Juarez Agricultural Experiment Station, the National Institute for Agricultural Technology (INTA), Argentina
1999-2003	Development of new technologies and their practice for sustainable farming systems in the Mekong Delta (Phase II)	Cuu Long Delta Rice Research Institute (CLRRI), Cantho University, and the Southern Fruit Research Institute, (SOFRI), Vietnam
2000-2006	Development of low-input technology for reducing postharvest losses of staples in Southeast Asia	Kasetsart University, King Mongkut's University of Technology, and the Department of Agriculture (DOA), Thailand
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), the 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), Khon Kaen Animal Nutritional Research Center, Department of Livestock Development (DLD), Thailand
2003-2008	Improvement of fertility of sandy soils in the semi-arid zone of West Africa through organic matter management	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niger

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 2003.

DEVELOPMENT RESEARCH DIVISION

The Development Research Division is staffed by 18 senior researchers who specialize in a variety of academic disciplines and conduct distinctive interdisciplinary research on a wide range of issues including technology development, natural resource management and socio-economic institutions and conditions in developing countries. As a whole, the Division aims to investigate and identify significant problems within these research themes by conducting surveys and analyses on both local (households, villages) and global (regions, countries) scales. These activities also focus on the research and development process by improving rural survey methods, farming system studies, information networks, remote-sensing and geographical information systems and econometric/quantitative models.

In order to achieve the Division's goals, the following four research groups were formed and assigned to specific themes: the Research Strategy Group; the Food Supply/Demand Analysis Group; the Farm Management and Farming Systems Group; and the GIS and Information System Group. Many of the Division researchers also participate in various comprehensive research projects and play key roles, particularly in socio-economic and interdisciplinary studies. Below are the results of the activities conducted in Fiscal Year 2003.

The Research Strategy Group, which was officially initiated last year, continues to pursue research subjects from the previous fiscal year. The group conducted studies on research priorities of various research fields of different developing regions. This year, studies were focused on technologies related to water logging in dry areas, biomass utilization and citrus diseases, as well as on the regional research priorities of China, India and West Africa. In November 2003, a JIRCAS international symposium was organized mainly by this group in order to discuss roles of international collaborative research, inviting prominent speakers from related institutes worldwide.

The Food Supply/demand Analysis Group carried out econometric analyses on issues concerning resources and environmental constraints of food supply in Asia, as well as investigations of alterations in agricultural structures and producer organizations in China. The Farm Management and Farming Systems Group conducted economic evaluation of various farming systems such as the VACR (fruit-fish-livestock-rice) system in the Mekong Delta region of Vietnam and the pond-irrigation system in northeast Thailand. The group continues to improve participatory research methods by conducting on-site trials and farmers meetings at several research sites. The GIS and Information System Group developed novel methodologies for monitoring large-scale winter wheat growth using remote sensing data in northern China. The group also pursued the development of subject maps displaying water resources (precipitation and evapo-transpiration) in Laos and use in seasonal flooding areas of Mali.

In addition, the Division organized several research seminars and workshops, including a joint co-sponsored seminar with the Asia Pacific Advanced Network (APAN) on multilingual services for agricultural information exchange held in Busan, Korea.

Interviewing local agriculturists in Guizhou Province, the People's Republic of China.

Transition in cropping systems from lowland rice-based to temperate vegetable-based systems between 800 and 1800 m elevation in West Java, Indonesia

Agriculture in West Java, Indonesia, is characterized by rice paddies in the lowlands and temperate vegetables in the highlands. Intercropping is widely practiced for vegetables (Fig. 1). We developed the "focused transect survey" method and applied it in two production areas to understand the diversity of cropping systems depending on elevation. This method adapts agro-ecosystems analysis for more quantitative assessment, by combining GPS measurement, field transects, farmer participatory methods, and household surveys in a comprehensive rapid survey method.

Transect and household surveys were conducted in two temperate vegetable-producing regions in West Java from 2001 to 2002. Horizontal transects of 120 m were placed perpendicular to a vertical transect at intervals of 200 m (Garut) or 100 m (Bandung) elevation from 800 m to 1800 m and cropping patterns recorded. Cropping patterns over 1999-2001 and reasons for each pattern were obtained by respondent surveys of three farmers for each elevation level. In Garut, over three years, cole crops, white potato, and tomato predominated, with a range of other types of vegetables taken together also forming an important percentage of plantings. On transects in 2001, the most important vegetables were cabbage, carrot, onion, white potato, and other types of vegetables taken together. In Bandung, both over three years and on transects in 2002, celery was more important, followed by onion, cole crops, white potato, and other types of vegetables taken together (Fig. 2). During the three-year period from 1999 until 2001, the transition from rice to vegetables occurred between 1100 m and 1200 m in both sites.

Paddy was selected primarily due to experience and economics, especially lack of capital. Experience, rotation, and

Fig. 1. An example of intercropping.

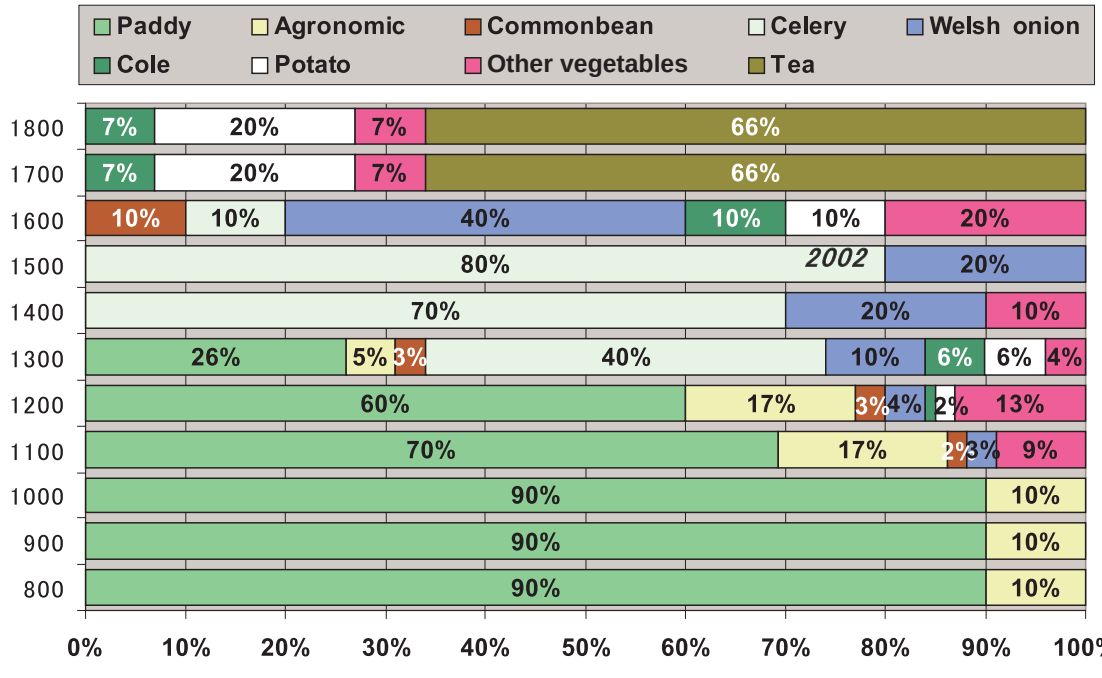


Fig. 2. Types of crops at different elevations.

environmental factors were predominant reasons for selection of cole crops and white potato in both sites. Environment and rotation were more important selection factors at the highest altitudes (≥1400 m in Garut, ≥1300 in Bandung). Costs and capital were more important at lower levels (800 m in Garut, 800-1000 m in Bandung). The proportion of transect length in sole cropping was 3-4 times the proportion in intercropping and trellis culture. In both sites, intercropping was concentrated in the 1100-1600 m zone. Border intercropping and in-row intercropping comprised over half of the intercropped plantings in Garut, while trellis culture was the most important type of intercropping in Bandung. Reasons for intercropping were based on horticultural considerations and economic motivations rather than tradition. Plant protection comprised 60-83% of farmer production constraint responses, with insects and diseases equally important.

(J. Caldwell)

TOPIC 2

Interlinkage in the rice market of Ghana: Money-lending millers enhance efficiency

The development of local agricultural markets plays a crucial role in the agricultural development of developing countries. Due to recent trade liberalization, the importance of local agricultural markets has further increased. One of the significant aspects of rural economies is interlinked transaction. By studying the nature of interlinkages in a particular region, we will be able to identify the constraints of market development and implement new policies to facilitate further development. Following along these lines, this study has analyzed rice markets in Ghana, particularly focusing on rice millers.

Millers are key players in Ghana's rice market. The millers mill the paddy and charge producers for milling fees. After milling, the producers sell milled rice to traders through those millers. Not only do they serve as middlemen, but some also provide rice producers with funds on a loan basis under the agreement that they will bring paddy only to that miller; surprisingly, the millers do not charge interest in most cases. In order to investigate whether this interlinkage between producers and millers, known as "Pareto," is improving and evolving, a study was conducted to examine the effects of the millers' no-interest loans on the efficiency of their milling operations.

To this end, we estimated a short-run quadratic cost function for the millers and evaluated the impact of money-lending on the operating rate. As experimental subjects, 61 millers were randomly selected from the Kumasi area in Ghana. We interviewed miller owners and their operators to obtain information on each mill and their milling activities in 2001. For this study, we used "capacity utilization" as the operating rate index and a two-stage regression method to control "self-selection bias."

Table 1 shows the estimated costs and capacity utilization of money-lending and non-lending cases, and Fig. 1 indicates the relationship between capital input and average variable cost for each case. The results suggest that the operation rate of the mills increases by 24% if farmers are provided with loans. In addition, the total cost should decrease by 17.1% when compared to situations in which farmers are not provided with loans, and thus increase efficiency. Based on this interlinkage transaction, we can conclude as the following: (1) the amount of paddy collection increases by providing farmers with loans; (2) the operation rate and efficiency of millers increase; and (3) the

Fig. 1. Simulation results of capital input and average variable costs. (8600 cedi = 1 US$).

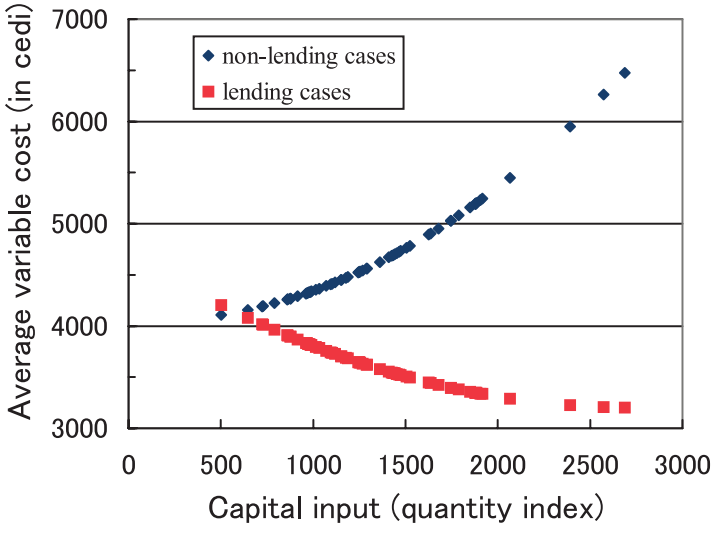


Table 1. Costs and capacity utilization.

	Estimates and averages	
	Non-lending	Lending
Unit variable cost (cedi/kg)	66.811	51.971
Unit total cost (cedi/kg)	86.600	71.760
Capacity utilization	0.683	0.925

farmers are able to obtain credit with little or no interest.

Nevertheless, the emergence of this interlinkage underlines the inefficiency of the Ghanaian rice market. Although our data suggests that relatively larger mills are more technically efficient, the millers cannot fully optimize their utilization capacity due to the underdevelopment of transportation and paddy storage, as well as the difficulty of obtaining market information. Large-scale mills should be promoted in Ghana, not only because of their superior efficiency, but also because of their better milling potential, both of which will enhance the competitiveness of local rice production. Efficiency of the rice markets may not improve as expected without complementary policies to develop efficient transportation, storage facilities to alleviate seasonal fluctuations of operation efficiency rates, and information systems to relay current demands for paddy milling.

(J. Furuya and T. Sakurai)

BIOLOGICAL RESOURCES DIVISION

Biological resources play a key role in meeting global challenges in the fields of food security and environmental preservation in developing countries. The international community is committed to the goals of safe conservation, sustainable use and equitable sharing of the benefits of biodiversity. The active use of genetic diversity towards sustainable socio-economic development presents a tremendous challenge for scientists and policymakers.

Over the last decade, there has been remarkable progress in science and the development of technological tools for the improved utilization and understanding of genetic diversity. For example, nearly all economically useful plants are now amenable for transformation, and the molecular bases of biological functions such as stress tolerance are now much more clearly understood. Genomic science is providing sound tools and techniques for the manipulation of genes and their functioning to achieve plant improvement. The Division takes full advantage of such progress to engage the challenges facing developing countries, promoting the active use of genetic diversity for sustainable socio-economic development.

In collaboration with the International Rice Research Institute (IRRI) in the Philippines, we have been developing isogenic lines each with different resistance genes to blast. Using DNA markers, we have also identified both loci of the blast resistance gene, *Pish* and the low-tillering gene, *Ltn* (t) on chromosomes 1 and 8, respectively. Working with the West Africa Rice Development Association (WARDA), we have conducted analysis to detect genes having water-stress tolerance and applied research to utilize those qualities in rice production in Africa. This year, QTL analysis for high tillering ability at the seedling stage of African rice was carried out using backcrossed recombinant inbred lines. To determine the numbers of sample units used in rice breeding, an optimum sample size for estimating the coefficient of variation was established.

In order to develop wheat resistance to *Fusarium* head blight (FHB), intensive work is being conducted in collaboration with the International Maize and Wheat Improvement Center (CIMMYT). The intra-varietal variation in both well-known FHB resistant varieties, Sumai 3 and Frontana, were analyzed using DNA markers. The susceptible factor suppressing the effects of FHB QTL on Sumai 3 was identified on the 2D chromosome short-arm. The pathway of FHB resistance genes found in spring wheat in the western areas of Japan was analyzed using haplotype DNA markers. By utilizing the extension-AFLP method, we successfully converted two AFLP markers which are located on chromosome 3BS and are associated with FHB resistance into STS markers. Our results indicated that the extension-AFLP method is an efficient approach for converting AFLP markers into STS markers in wheat. The developed STS markers may be used for marker-assistant selection (MAS) for FHB resistance in wheat breeding programs.

As part of JIRCAS's comprehensive project entitled "Comprehensive studies on soybean improvement, production and utilization in South America," Division scientists, in collaboration with INTA-Marcos Fuarez (Argentina), are working on the delineation of sudden death syndrome (SDS), which is becoming a major threat to sustainable soybean production in MERCOSUR countries. In Fiscal Year 2003, we evaluated the resistance of cultivars and lines in greenhouses and in fields. A certain

strain of saprophytic *Fusarium* reduced the severity of SDS in pot tests in greenhouses; however, a field test is further required in order to confirm such results. We examined the performance of the flowering-time gene, *FT2*, against SDS in terms of their survival rates under inoculation, and found a remarkable correlation between growth rate and SDS resistance. It was concluded that the *FT2* gene has secondary effects on SDS resistance. Another serious threat to soybean production is soybean rust, caused by *Phakopsora pachyrhizi*. In this joint project, we surveyed the prevalence of rust infection in kudzu (*Pueraria lobata*) and soybean in western Parana in southern Brazil and in Alto Parana and Itapua in southeastern Paraguay. In southeastern Paraguay, kudzu rust infection most likely affects the occurrence of rust in soybeans.

At present, JIRCAS is supporting China's efforts to boost soybean productivity in order to reduce reliance on foreign imports. More than 500 accessions of native soybean germplasm have been evaluated in terms of primary characteristics, such as protein and lipid contents. We have developed a germplasm database containing more than 3,000 accessions of soybeans. Germplasm resistant to cyst nematode disease was re-evaluated to test heat resistance in hot spots in fields in Jilin Province. Based on SSR marker analysis, it was revealed that the genetic variation of soybean germplasm in China was of a much greater range than that of Japan.

Currently, a Division staff member is working with the Asian Vegetable Research and Development Center (AVRDC) on the evaluation and use of traditional vegetable germplasm in South and Southeast Asia. Traditional vegetables are expected to contribute to improvement of the nutritional status of low-income populations in these regions, and offer new income-generating opportunities. Up to date, we have selected 19 promising *Amarantus* spp. accessions, as well as 19 *Basella alba*, and 16 *Corchorum* ssp. and *Ipomea aquatica* accessions. These selections were based on morphological traits, yielding anti-oxidant ability and activity of the various accessions. In addition, genetic variability in *Amarantus* spp. and *Cajanus cajan* was analyzed using RAPD-PCR methods, and agro-physiological traits in these species, especially tolerance to environmental stresses, were evaluated.

Under the project entitled "Improvement of fertility of sandy soils in the semi-arid zone of West Africa through organic management," we have just started the systematic evaluation of plant genetic resources (PGR), with emphasis placed on legume crops for efficient utilization in agricultural systems. Indigenous and exotic PGR are being evaluated from the viewpoint of soil fertility preservation such as biomass production as a source of organic matter, prevention of soil erosion, and nitrogen-fixing ability.

The molecular biology group of the Division has utilized biotechnological methods to study tolerance to environmental stresses such as drought, salinity, and freezing in higher plants. In particular, the group made important advances toward understanding the molecular mechanisms of plants' defenses against environmental stresses, such as the dehydration responsive element binding protein (DREB) of *Arabidopsis*, as well as toward developing techniques for their genetic manipulation. This year, the group clarified that the *DREB1E* gene is induced by abscisic acid (ABA) which functions under stressful conditions of drought or salinity, and confers tolerance against drought or low temperature through a mechanism based on over-expression of the gene. The group also found that the zinc finger-typed STZ transcription factor gene is induced through stress factors such as drought, salinity or low temperature and also confers drought tolerance through gene over-expression. Using microarray analysis, the transcription factor genes in *Arabidopsis* have been thoroughly investigated.

Both transgenic rice plants harboring *DREB1A* derived from *Arabidopsis* or *OsDREB1A* from *Oryza sativa* have been examined in terms of drought tolerance and were revealed to show differing degrees of tolerance against stress factors such as drought, salinity and low temperature

Wheat, lentil, and barley fields spreading out before an olive orchard in a dry region of Northern Syria.

depending on the level of gene expression. Plants also showed that the over-expressed enzymatic genes synthesizing ABA increases the quantity of ABA produced and strengthens tolerance to drought. The transcription factor genes for stress tolerance in rice have also been extensively examined through rice oligo-microarray analysis.

TOPIC 1

Monitoring expression profiles of rice genes under cold, drought and high-salinity stresses, and ABA application using both cDNA microarray and RNA gel blot analyses

Drought, high salinity, and low temperature are the most common environmental stress factors that influence plant growth and development, and place major constraints on plant productivity in cultivated areas worldwide. To overcome these limitations and improve crop yield under conditions of stress, it is important to increase stress tolerance in crops. Genetic engineering can be used as a fast and precise means of achieving enhanced stress tolerance. The identification of novel genes, determination of their expression patterns in response to the stresses, and an improved understanding of their functions in stress adaptation will provide us with the basis for effective engineering strategies to increase stress tolerance.

Rice (*Oryza sativa* L.), one of the world's most important staples, has now emerged as an ideal model species for the study of crop genomics due to its commercial value, relatively small genome size (~430 Mb), diploid origin (2x=24), and close taxonomic relationship to other important cereal crops. Determination of the biological functions of rice genes is one of the greatest challenges of post-genomic research. A multidisciplinary approach using studies on structural similarities, expression profiles and mutant phenotypes is required for assignment of gene function. We have initiated transcriptional monitoring of stress-inducible rice genes in response to dehydration, high salinity, low temperature and abscisic acid (ABA) application.

First, we prepared a rice cDNA microarray including about 1700 independent cDNAs derived from cDNA libraries obtained from drought-, cold- and high-salinity-treated rice plants. We confirmed stress-inducible expression of the candidate genes selected by microarray analysis using RNA gel blot analysis, and finally identified a total of 73 genes as stress-inducible including 57 novel unreported genes in rice. Among them, 36, 62, and 57 genes were induced by conditions of cold, drought, and high salinity, and 43 genes were induced by ABA application (Fig. 1). We observed a strong association among the expression levels of the stress-responsive genes with increased stress tolerance, and found 15 genes that responded to all four

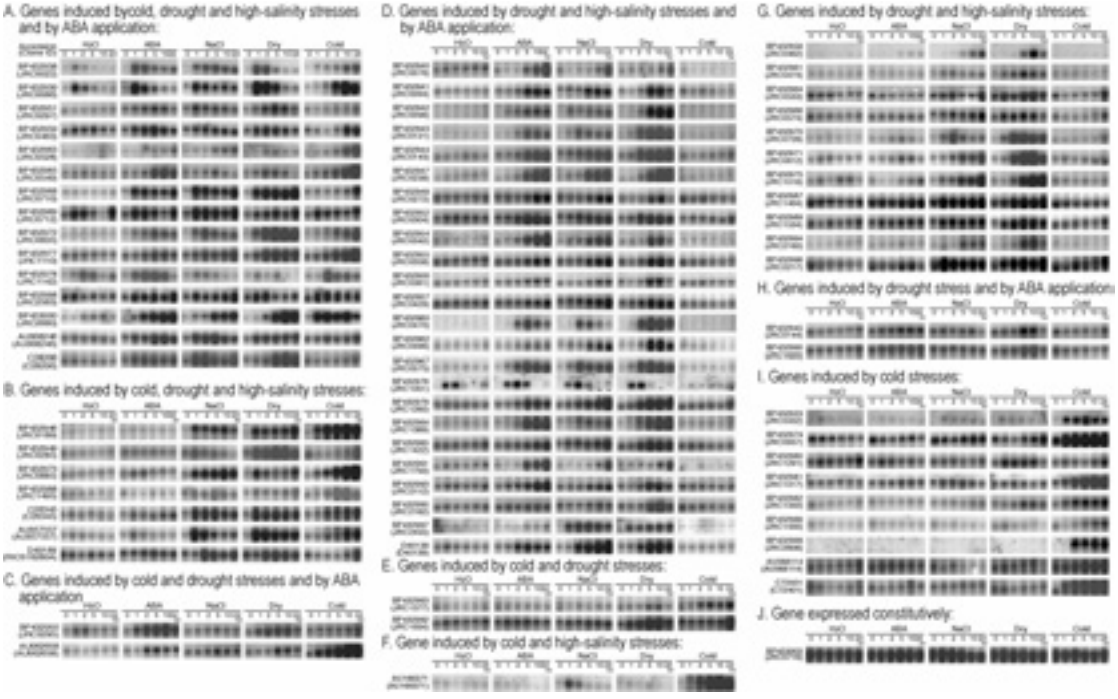


Fig. 1. RNA gel blot analysis of stress-inducible genes. Each lane was loaded with 10 µg of total RNA isolated from two-week-old rice seedlings that were each exposed to H_2O, dehydration, 250 mM NaCl, 100 µM ABA and 4°C cold treatment for 1, 2, 5, 10 and 24 hours. RNA was analyzed by gel-blot hybridization using gene-specific probes based on selected stress-inducible clones obtained via rice cDNA microarray analysis. Stress-inducible clones were classified into various groups on the basis of their expression patterns in RNA gel blot analysis under each stress treatment. Some of the inducible genes were induced by all four stress-treatments while some were upregulated by cold, drought and high salinity, and others were induced by drought and high salinity. Some genes were induced by singular conditions such as cold only.

treatments. Venn diagram analysis revealed greater cross-communicaton between signaling pathways for drought, ABA application and high-salinity stresses than between signaling pathways for cold and ABA stresses, or cold and high-salinity stresses in rice.

By conducting a rice genome database search for the identified genes, we were able to not only identify possible known cis-acting elements in the promoter regions of several stress-inducible genes, but to also predict the existence of novel cis-acting elements involved in stress-responsive gene expression in rice stress-inducible promoters. Comparative analysis of *Arabidopsis* and rice showed that among the 73 stress-inducible rice genes, 62 have already been reported in *Arabidopsis* with similar functions or gene names, 38 of which have been documented as stress-inducible in *Arabidopsis*. These results indicate that there exist similar molecular mechanisms of stress tolerance and response between dicots and monocots. Transcriptome analysis also revealed novel stress-inducible genes suggesting some differences between *Arabidopsis* and rice in their response to stress.

Analysis of our data also enabled us to identify a number of promoters and possible cis-acting elements of several stress-inducible genes responsive to a variety of environmental stresses. Further analysis of these stress-inducible genes using transgenic plants will provide more information concerning the functioning of the stress-inducible genes involved in stress tolerance, as well as novel cis-acting promoter elements involved in cold-, drought-, high-salinity- or ABA-responsive gene expression in the promoter regions of these stress-inducible rice genes. The studies are underway not only to analyze the cis-acting elements involved in drought-, cold-, high-salinity- or ABA-responsive expression in the promoter regions of these selected genes, but also to identify early responsive and strong stress-inducible promoters in rice crops as well.

(K. Yamaguchi-Shinozaki)

TOPIC 2

Genetic variation of accessions within Fusarium head blight resistant wheat cultivars revealed by SSR markers

Fusarium head blight (FHB) is one of the most destructive diseases that afflicts wheat. Repeated screening of genetic resources has led to the identification of several resistant cultivars of spring wheat, such as Frontana from Brazil, Sumai 3 from China and Nobeokabouzu-komugi from Japan. It is known, however, that several morphological and ecological variations with different responses to FHB exist within global

Table 1. Number of SSR markers showing polymorphism within Frontana and Sumai 3 accessions compared to the Brazilian cv. Frontana-BRZ and the Chinese cv. Sumai 3-CHN

Chromosome	No. of markers	Frontana accessions compared with Frontana-BRZ					Sumai 3 accessions compared with Sumai 3-CHN							
		USA	CAN	JPN	Nobeoka	Gamenya	USA	CAN	IRN	AUT	JIR	JPN	Nobeoka	Gamenya
1A	8	-	-	2	4	3	-	-	-	2	-	1	2	4
1B	13	-	-	4	4	7	-	-	-	1	-	-	2	9
1D	9	-	-	1	4	4	-	-	-	-	-	1	3	4
2A	18	-	-	4	5	11	-	-	-	6	-	6	3	12
2B	18	-	-	3	8	11	-	-	-	1	-	3	5	11
2D	18	-	-	4	4	7	-	-	-	6	-	7	6	7
3A	10	-	-	2	6	5	-	-	-	2	-	3	5	6
3B	19	-	2	1	10	9	-	-	-	1	-	2	2	12
3D	9	-	-	1	3	3	-	-	-	-	-	-	3	4
4A	10	-	-	3	5	4	-	-	-	1	-	-	4	5
4B	4	-	-	-	1	-	-	-	-	-	-	-	1	-
4D	2	-	-	-	-	-	-	-	-	-	-	-	-	-
5A	21	-	-	3	8	11	-	-	-	2	1	11	8	13
5B	22	-	2	3	15	13	-	-	-	6	-	-	11	13
5D	7	-	-	3	4	4	-	-	-	2	-	1	-	4
6A	8	-	-	-	2	5	-	-	-	1	-	2	2	5
6B	8	-	-	1	2	1	-	-	-	-	-	4	-	3
6D	14	-	-	1	1	4	-	-	-	1	-	4	3	5
7A	12	-	-	-	5	5	-	-	-	-	-	1	4	7
7B	7	-	-	1	1	2	-	-	-	-	-	1	2	3
7D	5	-	-	-	-	2	-	-	-	-	-	-	1	3
Total	242	0	4	37	92	111	0	0	0	32	1	47	67	130
Polymorph (%)		0.0	1.7	15.3	38.0	45.9	0.0	0.0	0.0	13.2	0.4	19.4	27.7	53.7

- : no polymorphism; polymorph (%) = (no. of polymorphic markers/ Total no. of markers) x 100

accessions of Frontana and Sumai 3, and differing sources of Sumai 3 have been identified by DNA markers. In this study, we revealed genetic variation within accessions of Frontana (Brazil, the United States, Canada and Japan) and Sumai 3 (China, the United States, Canada, Iran, Austria and Japan) that had been sent to the International Maize and Wheat Improvement Center (CIMMYT) by using 242 SSR markers (Fig. 1) which encompass the entire wheat genome. Frontana-USA and -CAN were found to be identical with, or to be variants of, the original Brazilian accession. In the case of Sumai 3, the American, Canadian and Iranian accessions were of the same genotype as the Chinese accession. Sumai 3-JIR may possibly be a derivative of these accessions. The Austrian accession was determined to be a derivative of an original Chinese accession following out-crossing and selection with additional resistance genes to FHB (Table 1). The results of genetic variation analysis within accessions of Frontana and Sumai 3 reveal that we must always consider the source and genotype of such accessions when evaluating the results of QTL analysis and utilizing them in breeding programs with marker-assisted selection.

(T. Ban)

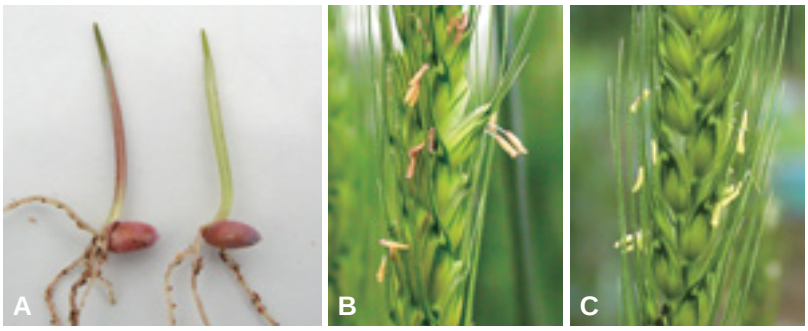


Fig. 1. Morphological variations within Sumai 3 accessions. Anthocyanin pigmentation of coleoptiles (A-left) and anthers (B) vs. yellow ones (A-right and C)

TOPIC 3

Development of extension-AFLP method for conversion of AFLP markers into STS markers in wheat

Amplified fragment length polymorphism (AFLP) analysis has proven to be a powerful tool for tagging genes or QTLs of interest in plants. However, conversion of AFLP markers into sequence-tagged site (STS) markers is technically challenging in the case of wheat due to the complicated nature of its genome. In this study, we developed an 'extension-AFLP' method to convert AFLP markers into STS markers. When an AFLP marker of interest was detected with an *Eco*RI+3/*Mse*I+4-selective primer combination, the PCR product was used as a template for an additional selective amplification with four primer pairs in which one base (either A, C, G, or T) was added to the 3´-end of one of the two primers. The extended primer-pair that produced the targeted band was further extended by adding each of the four selective bases for the next round of selective amplification (Fig. 1). By using the extension-AFLP method, we successfully converted two AFLP markers which are located on chromosome 3BS and are associated with FHB resistance into STS markers (Fig. 2). Our results indicated that the extension-AFLP method is an efficient technique for converting AFLP markers into STS markers in wheat. The developed STS markers may be used for marker-assistant selection (MAS) for FHB resistance in wheat breeding programs.

(T. Ban)

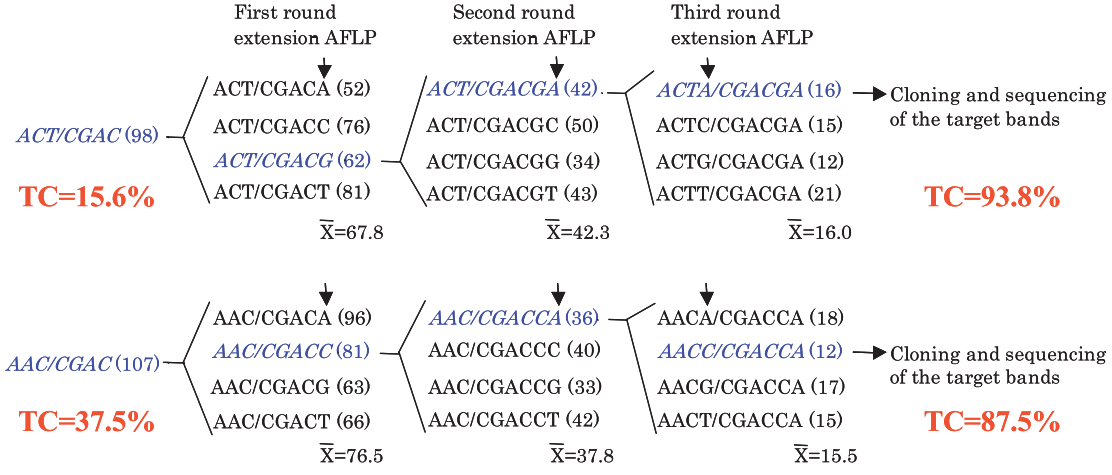


Fig. 1. Flow chart of extension-AFLP for the two AFLP markers, E-ACT/M-CGAC118-120 (upper), and E-AAC/M-CGAC285 (lower). Primer pairs that amplified the target bands are indicated in italics. Numbers in parentheses indicate the total number of AFLP bands produced by each primer combination.

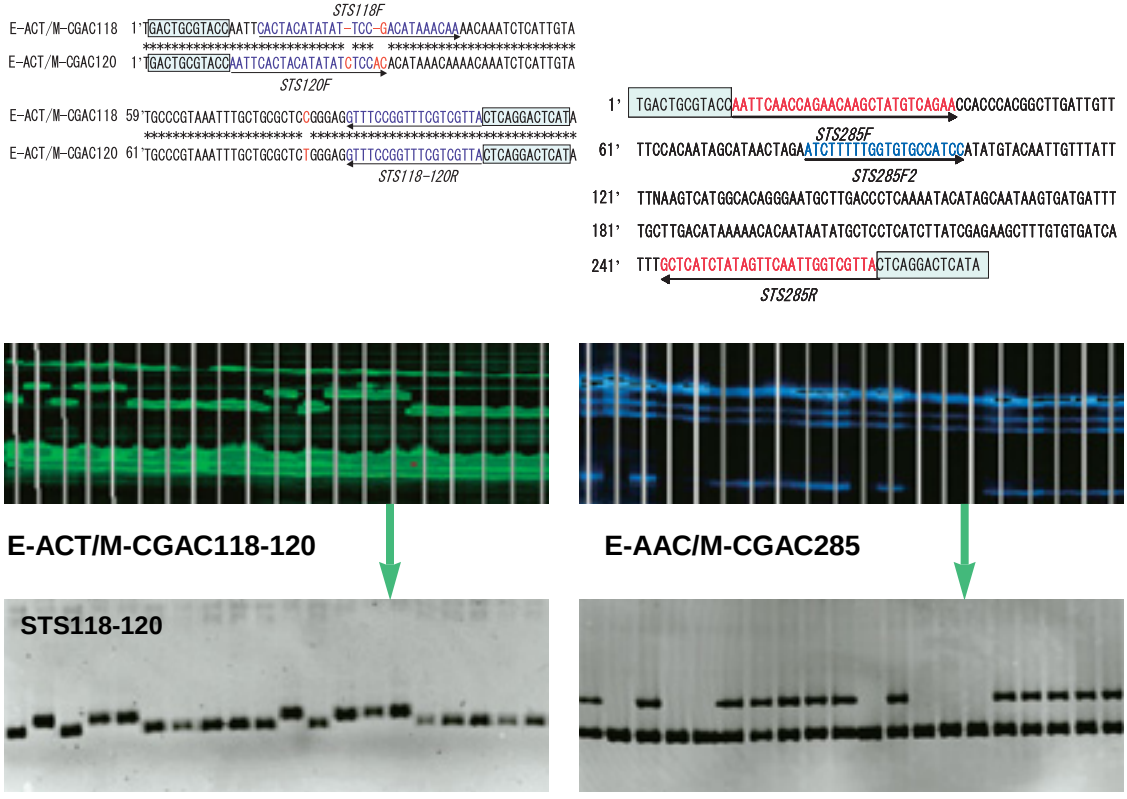


Fig. 2. Sequence alignment between two allelic fragments of AFLP marker E-ACT/M-CGAC118-120. STS primers are indicated with arrows (upper). Adaptor sequences of the two sides are shown in boxes. Band patterns of the two AFLP markers, E-ACT/M-CGAC118-120 and E-AAC/M-CGAC285, and their corresponding STS markers in a deoxycholate hydrogen sulfide lactose (DHL) population derived from 'Sumai 3' and 'Gamenya.' Lane 1 shows 'Sumai 3'; Lane 2, 'Gamenya'; and Lanes 3-20, DHLs.

TOPIC 4

Characteristics and genetic diversity of soybean genetic resources in Northeast China

Northeast China is thought to be one of the regions from which soybean originated, due to the existence of a number of valuable soybean varieties in this region. Although these soybean varieties are important as genetic resources for breeding purposes, their primary characteristics and genetic diversity have not yet been clarified. Therefore, we studied the main characteristics of some 3,000 soybean genetic resources and constructed a database, aiming to improve the efficiency of their utilization as breeding stock. In addition, we evaluated their diversity to clarify the usefulness of northeast Chinese soybean genetic resources.

In evaluation of primary characteristics, considerable variation was found in the quantitative and qualitative characteristics of soybean genetic resources. For example, a large variation was found in main stem length, ranging from 7 to 277 cm, with a mean value of 86 cm. This measurement was somewhat longer than that of Japanese varieties, but the incidence of lodging tends to be small, except for climbing varieties. The results for seed composition analysis revealed, on average, 42.6% protein and 18.8% oil content. There were some varieties that were rich in protein content and low in oil content, while others had high oil content and low protein content. Highest and lowest protein contents were 59.4% and 11.5%, and highest and lowest oil contents were 23.6% and 10.3%, respectively. Chinese soybean genetic resources clearly showed a wide range of variation in protein and fat content. It is considered that many varieties would be useful as materials for various types of industrial processing. As these results show, soybean genetic resources in Northeast China harbor great diversity and differ in some traits from Japanese varieties. They may thus hold great potential as breeding materials.

In order to evaluate soybean genetic resources using the techniques of molecular genetics, evaluation at the DNA level, utilization of soybean SSR markers to classify varieties and investigation of genetic diversity is necessitated. The plant materials that were used as subject matter for this research totaled 253 types: 194 varieties of Northeast Chinese soybean genetic resources and, for comparison, 59 Japanese soybean varieties. The evaluation of genetic diversity and

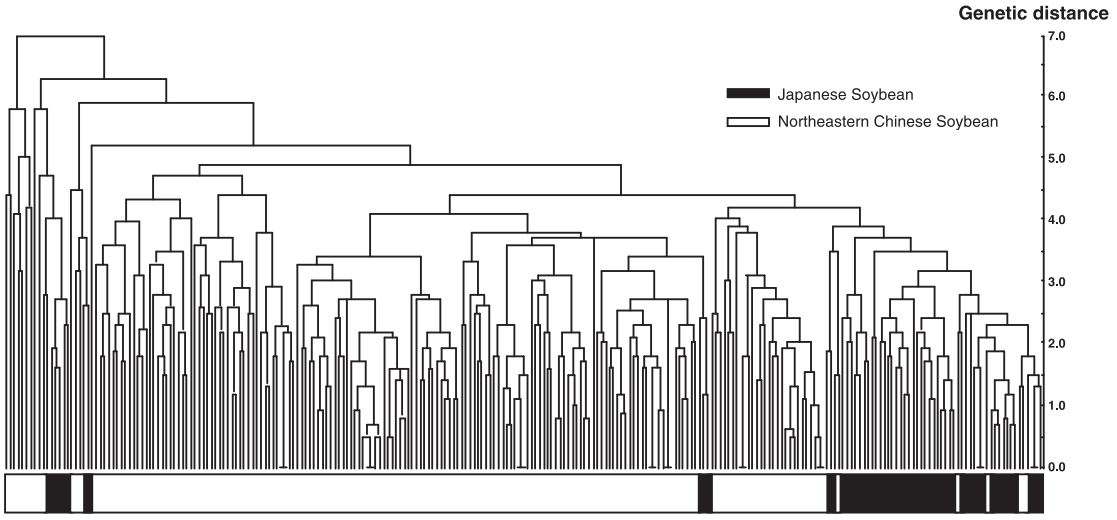


Fig. 1. A dendrogram (UPGMA) of Japanese and northeastern Chinese soybean varieties based on SSR markers. Black and white boxes denote Japanese and northeastern Chinese soybean groups, respectively.

classification of varieties were conducted through cluster analysis. Almost all varieties and most Japanese varieties can be classified into one cluster, as a subgroup of Chinese varieties (Fig. 1). These results indicate that the Northeast Chinese and Japanese soybean genetic resources are distantly related genetically and that Chinese genetic resources are clearly rich in diversity at the DNA level; thus, the incorporation of both Japanese and Chinese genetic resources into new soybean varieties will be effective for promoting enhanced breeding strategies.

(N. Yamanaka)

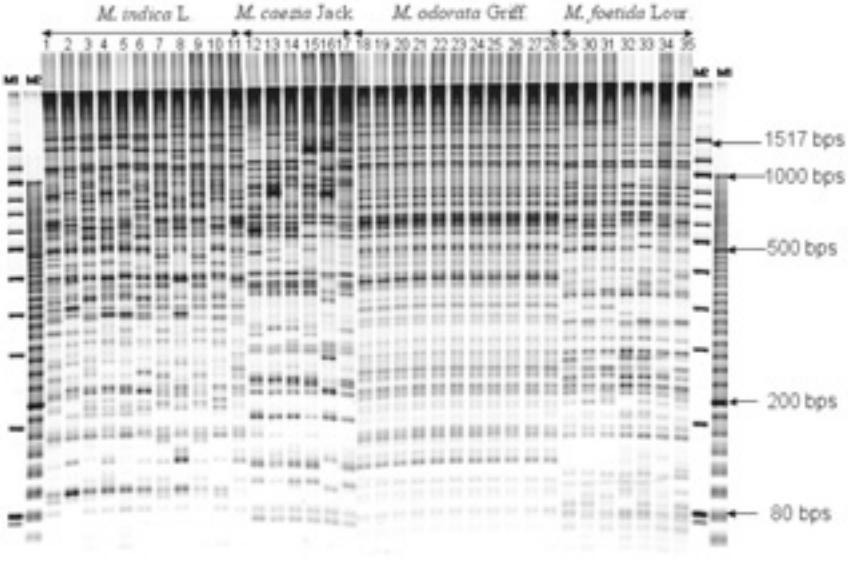
TOPIC 5

Genetic relationship and diversity between and within *Mangifera* species revealed by AFLP analysis

Mangifera indica L. (common mango) and its relatives of the genus *Mangifera* are important crops and can be found throughout tropical Asia. The origin and the center of diversity are thought to be located in South East Asia with the greatest diversity occurring in Peninsular Malaysia, Borneo and Sumatra. Currently, classical methods are applied to identify *Mangifera* species based on phenotypic characteristics such as leaves, fruits and seeds of the plant. However, this method is a slow process due to the long cultivation periods and the evaluation itself, which is easily affected by environmental factors. Nevertheless, with the incorporation of new methodologies such as molecular markers, this identification process will be accelerated and optimized.

Amplified fragment length polymorphism (AFLP) analysis was utilized to investigate the genetic relationship and diversity among and within 4 *Mangifera* species. As shown in Fig. 1, we analyzed 35 accessions consisting of 11 accessions (8 cultivars and 3 landraces) of *M. indica* L., 11 accessions (landraces) of *M. odorata* Griff., 7 accessions (landraces) of *M. foetida* Lour., and 6 accessions (landraces) of *M. caesia* Jack. We carried out AFLP analysis using 8 kinds of primer combinations and 16% polyacrylamide gel. Polymorphic bands among accessions were recorded to clarify diversity and genetic relationship. Eight combinations of primers produced a

Fig. 1. AFLP analysis banding patterns of 35 *Mangifera* accessions. DNA markers M1 and M2 as well as the E-ACC/M-CTA primer combination were used.



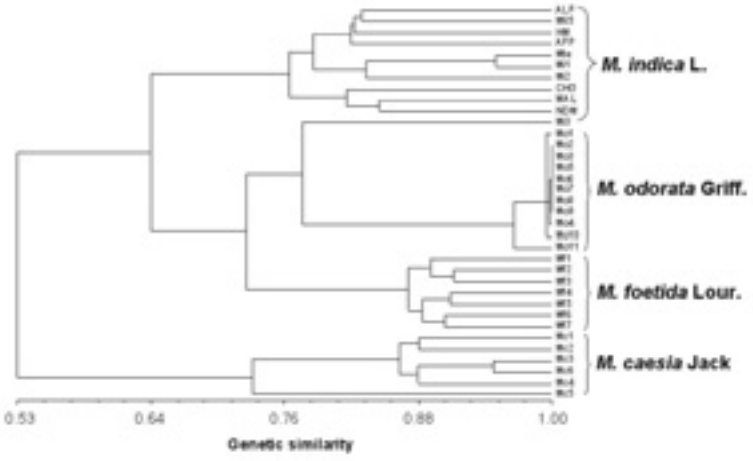


Fig. 2. A dendrogram of *Mangifera* accessions displaying the results of AFLP analysis.

total of 518 reliable bands in all 35 accessions and a pair of primer combinations yielded 64.8 bands on average. Four-hundred and ninety-nine bands were polymorphic and thus accounted for 96.3% of the total bands. Clustering analysis showed that all 35 accessions were basically classified into four groups corresponding to the four *Mangifera* species (Fig. 2). However, the accession in *M. indica* L., Mi 3, was distantly related to the other *M. indica* L. accessions and closely related to the *M. odorata* Griff. group. Although *M. odorata* Griff. accessions showed very little diversity compared to other *Mangifera* accessions, this was a suitable method for differentiating between other *Mangifera* accessions. In the *M. caesia* Jack accession, Mc 5 was clustered into a group of *M. caesia* Jack accessions, but this accession was distantly related to the other *M. caesia* Jack accessions. *M. caesia* Jack is grouped out from the other species, indicating that its genetic variation is different within the taxa. Our results indicate that the morphological differences and genetic relationship of *Mangifera* accessions revealed by AFLP analysis are in a good agreement thus AFLP analysis is an applicable and effective means of conducting taxonomic studies in *Mangifera* species.

(N. Yamanaka)

TOPIC 6

Development of a new international standard differential variety series to integrate blast resistance of rice (*Oryza sativa* L.)

The first international standard differential variety (ISDV) set composed of monogenic lines for targeting 24 blast (*Pyricularia grisea*) resistance genes, e.g., *Pia, Pib, Pii, Pik-s, Pik, Pik-h, Pik-m, Pik-p, Pish, Pit, Pita (Pi4), Pita-2, Piz, Piz-5 (Pi2), Piz-t, Pi1, Pi-3, Pi5, Pi7* (t), *Pi9, Pi11* (t), *Pi12* (t), *Pi19*, and *Pi20*, was recently developed in rice (*Oryza sativa* L.), and has already been disseminated to more than 15 countries through the IRRI-Japan collaborative research project entitled "Physio-genetic studies on yield determination and ecological adaptability for sustainable agriculture." Additionally, new ISDVs and near isogenic lines (NILs) for targeting 14 blast resistance genes -*Pib, Pik-s, Pik, Pik-h, Pik-m, Pik-p, Pish, Pita (Pi4), Pita-2, Piz-5 (Pi2), Piz-t, Pi1, Pi5, Pi7* (t) having an Indica-type rice CO 39 genetic background will be also distributed in 2004. CO 39 NILs are the first sets of ISDVs for Indica-type rice. Two other kinds of differential variety sets, NILs with Chinese Japonica type susceptible variety Lijiangxintuanheigu and US-2 genetic backgrounds are also being developed at IRRI. These ISDVs will be available worldwide, for use in pathological analysis of blast races and as the gene sources of resistance genes in breeding programs.

Monogenic lines were developed by several backcrosses between donor varieties of resistance gene and a Chinese Japonica-type variety Lijiangxintuanheigu (LTH) as a recurrent parent. Monogenic lines including only a single gene in each genetic background targeting for 24 kinds of genes were developed by the Division as the first international standard differential variety set. These lines have already been distributed to more than 15 countries and have been used in pathogenic analysis and rice breeding as sources of resistance genes.

The other three NILs were backcrossed at least six times with recurrent parents, LTH, CO 39, and a high- yield type rice US-2. In each backcrossed and selfed generation, the resistant plants with targeted genes were selected using avirulent isolates. Inoculation and selection of resistance genes were continued from BCnF4 to BCnF11 in order to purify the lines and fix their morphological traits.

A total of 31 NILs for targeting 14 kinds of resistance genes - *Pib, Pik-s, Pik, Pik-h, Pik-m, Pik-p, Pi1, Pi7* (t), *Pish, Pita, Pita-2, Piz-5, Piz-t and Pi5* (t) - were developed and characterized. Each NIL holds the major target gene for resistance with the exception

Table 1. New international standard differential variety series used to evaluate rice blast resistance under the IRRI-Japan collaborative research project.

Target gene	Designation	
	Monogenic lines	CO39 near isogenic lines(including *Pia*)
Pia	IRBLa-A, IRBLa-C	-
Pib	IRBLb-B	IRBLb-IT13/CO, IRBLb-W/CO
Pii	IRBLi-F5	-
Pik	IRBLk-Ka	IRBLk-Ka/CO, IRBLk-Ku/CO
Pik-h	IRBLkh-K3	IRBLkh-K3/CO
Pik-m	IRBLkm-Ts	IRBLkm-Ts/CO
Pik-p	IRBLkp-K60	IRBLkp-K60/CO
Pik-s	IRBLks-F5, IRBLks-S	IRBLks-CO/CO
Pish	IRBLsh-S, IRBLsh-B	IRBLsh-S/CO,IRBLsh-B/CO, IRBLsh-Ku/CO
Pit	IRBLt-K59	-
Pita (Pi4)	IRBLta-K, IRBLta-CT2, IRBLta-CP1	IRBLta-Ya/CO
Pita-2	IRBLta2-Pi, IRBLta2-Re	IRBLta2-Pi/CO,IRBLta2-Re/CO, IRBLta2-IR64/CO
Piz	IRBLz-Fu	-
Piz5 (Pi2)	IRBLz5-CA	IRBLz5-CA/CO
Piz-t	IRBLzt-T	IRBLzt-IR56/CO
Pi1	IRBL1-CL	IRBL1-CL/CO
Pi3	IRBL3-CP4	-
Pi5 (t)	IRBL5-M	IRBL5-M/CO
Pi7 (t)	IRBL7-M	IRBL7-M/CO
Pi9	IRBL9-W	-
Pi11 (t)	IRBL11-Zh	-
Pi12 (t)	IRBL12-M	-
Pi19	IRBL19-A	-
Pi20	IRBL20-IR24	-

of *Pia*, as confirmed by the stability of their reaction patterns of monogenic lines to standard isolates. In addition, each NIL was very similar to recurrent parent CO 39 in morphological terms. Among them, 21 NILs will be made available by the IRRI-Japan collaborative research project in 2004, as a new set of ISDV having Indica-type genetic background.

The other two kinds of NILs having differing genetic backgrounds, LTH and US-2, are being developed as the targets of 17 and 16 resistant genes, respectively. However, in order to complete LTH NILs backcrossing, it is necessary to generate and select fixed lines within each line, because isolation of some morphological traits are still observed. In US-2 NILs, several lines will be backcrossed one or two more times and the selection and fixation for resistance and morphological traits will be continued until at least the F9 generation.

The designation and target resistance genes of developed monogenic lines and CO 39 NILs are shown in Table 1. Monogenic lines and NILs are labeled as IRBL, which is followed by the type of resistance gene and an abbreviation of the donor variety having the initials of the recurrent parent.

(Y. Fukuta)

TOPIC 7

Identification of the low-tiller gene in rice (*Oryza sativa* L.)

The genetic mechanisms of low-tillering in two Japonica-type rices, Aikawa 1 and Shuho, were clarified and the controlling gene was

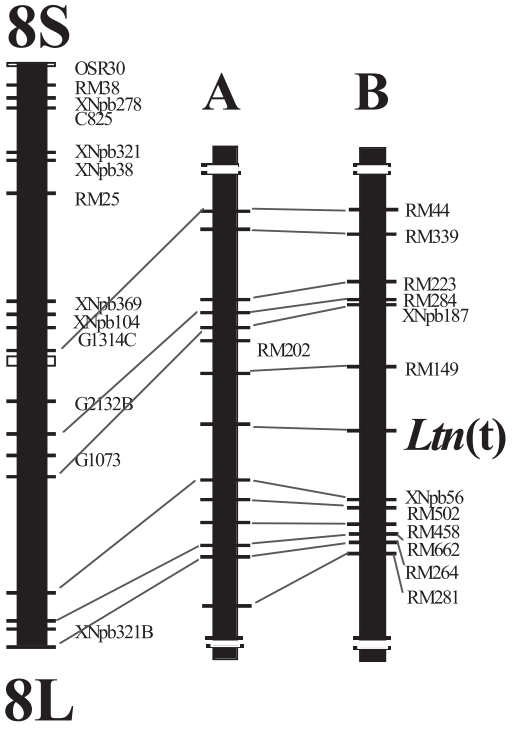


Fig. 1. Identification of *Ltn* (t) locus using DNA markers. A: BC_1F_2 (IR64/Aikawa1//IR64) family lines (n=33).
B: BC_1F_2 (IR72/Shuho//IR72) family lines (n=74).

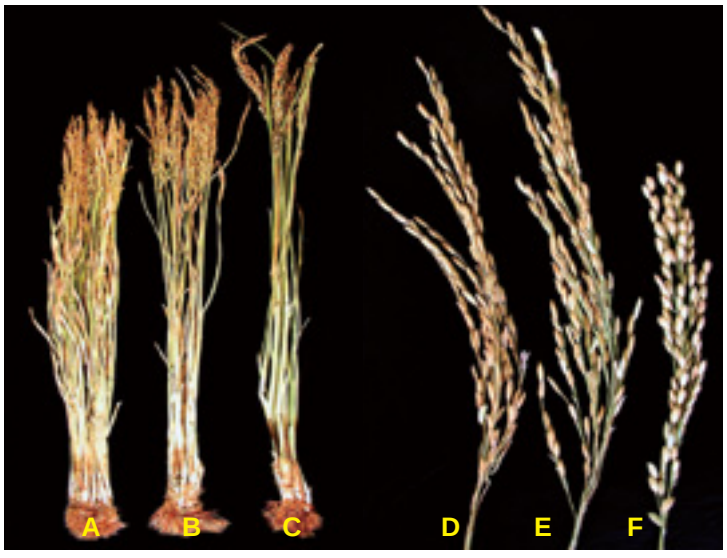


Fig. 2. Near isogenic lines introduced with the low-tiller gene, *Ltn* (t), into the IR64 and IR72 genetic backgrounds. A: IR64; B: IR64 NIL (IR64/Aikawa1/5/IR64, BC_6F_3); C: Aikawa 1; D: IR72; E: IR72 NIL (IR72/Shuho/5/IR72, BC_6F_3); F: Shuho.

identified on rice chromosomes using molecular markers. In these two Japonica varieties, the single dominant gene controlling low-tillering was confirmed on the basis of segregation analyses in each BC_1F_2 population derived from the crosses with Indica-type varieties IR64 and IR72 as recurrent parents, respectively.

Aikawa 1 and Shuho were found to have the same low-tiller gene based on results of allelism tests in F_2 populations derived from reciprocal crosses between Aikawa 1 and Shuho. Transgressive segregation was not observed in any of the distributions of 378 Aikawa 1/Shuho and 425 Shuho/Aikawa 1 F_2 plants. The low-tiller gene was mapped between the SSR marker, *RM149*, and the RFLP marker, *XNpb56*, on the long arm of chromosome 8 using DNA markers (Fig. 1). As no gene related to low-tillering has been reported yet in this region of chromosome 8, the genes found in Aikawa1 and Shuho plants were tentatively designated as *Ltn* (t).

The near isogenic line (NIL) that introduced *Ltn* (t) into the elite Indica-type varieties IR64 and IR72 were developed from the advanced recurrent backcrosses of progenies to clarify yield ability of low-tiller plant types and to incorporate more detailed genetic and physiological analyses (Fig.2). Partial sterility and malformed palea in the panicles of NILs were observed; this may have occurred due to the multiple effects of *Ltn* (t). Information on genetic mechanisms and mapping of low-tiller genes will be used for breeding programs using marker-aided selection or map-based cloning of *Ltn* (t); NILs will also be useful as breeding materials for Indica-type varieties.

(Y. Fukuta)

CROP PRODUCTION AND ENVIRONMENT DIVISION

The goal of the Crop Production and Environment Division is to develop sustainable agricultural production technologies based on the adaptation of the diversified functions of crops and microbes, and the judicious utilization of natural resources. The Division consists of five research groups; materials cycling, crop management, plant physiology and nutrition, water resource management and plant protection. Nearly one-third of our scientists in the Division are dispatched on long-term assignments to partner organizations worldwide in order to conduct various comprehensive projects organized by JIRCAS.

The Division is responsible for the following three research themes as stated in the institute's mid-term plan: 1) evaluation of material cycling for nitrogen and improvement of soil amelioration technology in diversified agro-ecosystems, 2) development of labor- and resource-saving crop production technologies for rice and upland crops in Thailand, Vietnam, Laos and other countries of this region, and 3) elucidation of the current status of the occurrence of major pests and diseases of rice and soybean in Southeast Asia and South America. Each research theme is divided into eight specific sub-themes. In Fiscal Year 2003, 36 separate research activities were carried out by 18 scientists in the Division.

Major research highlights relating to each research theme are as follows. In theme (1), the main focus has been on technological development to reduce the impact of agricultural activities on the environment. It was demonstrated that ammonia emissions, both in upland and lowland fields in China, have significant environmental impact; however, our research indicates that these emissions can be substantially reduced by the application of slow-release nitrogen fertilizers. A study in the Mekong Delta showed that rice yields were unaffected in plots where 60% of the recommended chemical N fertilizer was replaced with rice straw compost at a rate of 6 t/ha. The application of compost also resulted in the reduction of blast damage as opposed to the application of chemical fertilizers. In theme (2), intensive cropping of irrigated rice

showed that growth inhibition of subsequent cropping caused by soil-drying during fallow periods could be reduced by soil-wetting and rice straw application. For intensive vegetable cultivation in the West Java highlands, the effectiveness of crop rotation in reducing clubroot damage was monitored for three crop cycles with three different crops per year. In research on plant physiology and nutrition, a bioassay-guided fractionation of leaf tissue extract from *B. humidicola* led to the purification of two bio-active compounds that showed inhibitory effects on nitrification. NMR and MS data identified these two compounds as linoleic acid and linolenic acid. It was also revealed that the inhibitory compounds isolated from leaf tissue are likely to be different from the inhibitory compounds responsible for nitrification-inhibitory activity of the root exudates. The chromosome regions responsible for acid soil tolerance and excess iron tolerance were identified using the Koshihikari rice lines whose chromosome region was partially substituted by those from Kasalath lines. Research on water resource management demonstrated through field measurements, that a significant difference in the fluctuation patterns of water levels in farm ponds exists depending on their location. A new method was developed by combining balance sheets of radon and water in order to make quantitative estimations of groundwater inflow into the farm pond and outflow through percolation; the effectiveness of this method was verified in a farm pond in Japan. For sub-theme (3), a demonstration experiment in a farmer's field in Chong Chin Shi, Xiu Shan Xian, China was conducted in order to demonstrate the validity of the proposed rice cropping system in which rice varieties tolerant to whitebacked planthoppers were used, with reduced application of insecticides. The rice plants were sprayed only once, and grown without any additional control measures except for the farmer's supervision. The results of this experiment demonstrated that cultivation of the tolerant variety without any control measures had advantage over cultivation of hybrid rice, bringing increased economic benefits to the farmers. In research conducted to develop technologies for the biological control of *Helicoverpa armigera*, commonly known as corn ear worm or cotton bollworm, the population dynamics of natural enemies in the field was monitored and the ecological characteristics of these natural enemies grown under artificial conditions were investigated.

A farmer on oxcart with his harvest of pearl millet in the Fakara region of Niger.

Major natural enemies were thereby identified and fluctuation patterns in the number of cases of *H. armigera* and mortality rates of natural enemies were obtained.

TOPIC 1

Nitrogen export via surface water from an agriculture watershed in the Taihu Lake area, China

The People's Republic of China is the world's largest producer and consumer of food. Although conditions have been improved substantially in order to meet China's impressive demand for grain through introduction of new technologies and reform policies, the adverse environmental effects of intensive modern agriculture have recently become apparent, making the sustainability of land resources and environment a cause for concern. Environmental problems due to intensive farming, including land degradation, shortage of irrigation water, and pollution of

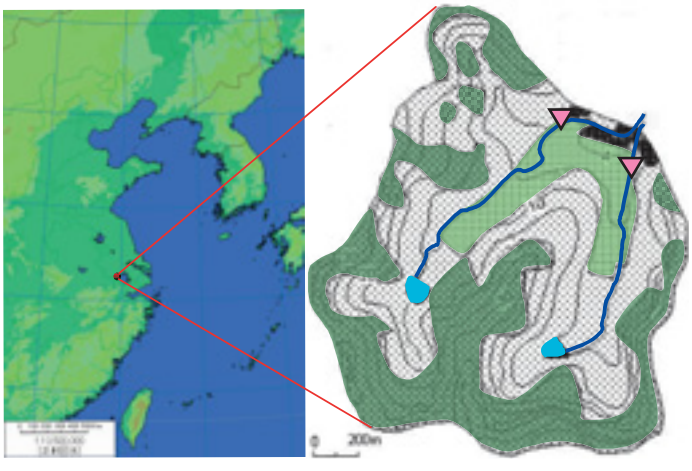


Fig. 1. Location, land use and topographical map of the Meilin Watershed, Yixing City, Jiangsu Province, China. A typical agriculture watershed on the west coast of Taihu Lake was targeted, with paddy fields ( ) at the bottom of valleys around two channels ( ); upland fields and orchards ( ), and bamboo and other woods ( ) near the slopes. The lower reaches of channels are populated areas ( ), but almost no habitation can be found above the weirs ( ), where water flux and quality were investigated.

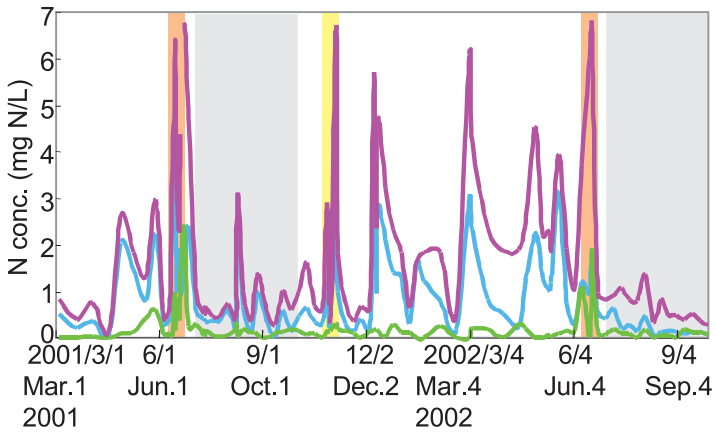


Fig. 2. Nitrate (—), ammonium (—) and total (—) nitrogen concentrations in outlet channel water from the Meilin Watershed (see Fig. 1). Channel water was sampled at the weirs on a weekly basis during baseflow, and more intensively for 14 hours after significant rainfall events. □: July-September when rice was in its full growing season, □: basal fertilizer application for rice, □: basal fertilizer application for rape and wheat.

air and water, have become serious issues in various parts of China. Many of these problems are the result of overloading farmlands with nutrients, particularly nitrogen. Indeed, consumption of nitrogen fertilizer in China has been the highest in the world since 1989 and a total of 22.4 x 10^6 tons of nitrogen (27.4% of the world consumption) was consumed in 2001. There are numerous health and environmental issues associated with excess nitrogen in the environment. Health issues include diseases such as blood disorder methemoglobinemia, or poisoning due to nitrate found in drinking water; environmental issues range from decreases in freshwater and estuary productivity to increased greenhouse gas emissions and acid rain.

To assess these environmental problems, JIRCAS launched a seven-year collaborative research sub-project entitled "Evaluation and development of methods for sustainable agriculture and environmental conservation," with two Chinese research institutes: the Chinese Academy of Agricultural Sciences' Soil and Fertilizer Institute, and the Chinese Academy of Sciences' Institute of Soil

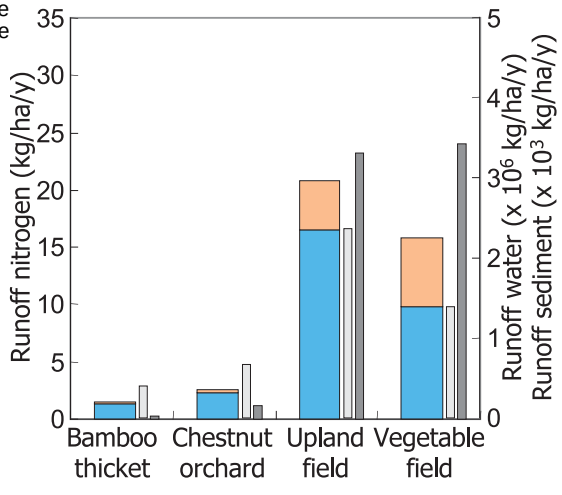


Fig. 3. Effects of typical upland water usage for bamboo thickets, chestnut orchards, upland fields and vegetable fields, at slope areas showing amounts of runoff water (□), sediment (■), sediment-associated nitrogen (□) and water-associated nitrogen (□) observed for a year in 2002 when remarkable runoff events were observed 12 times following heavy rainfall events. Vertical bars indicate the SDs of duplicate measurements.

Science. The project, which began in 1997, involves conducting both field experiments and regional analysis for nitrogen cycling at research sites in four major agricultural regions in China.

A regional analysis for nitrogen cycling in the Tai-hu Lake Region, one of the most important rice- wheat cropping areas in China, was carried out at a typical agricultural site on the west coast of Taihu Lake: the Meilin Watershed in Yixing City, Jiangsu Province (31˚20´N, 119˚51´E; 1.22 km²; Fig. 1). Situated in the center of the Yangtze River Delta, one of China's most developed economic zones, Tai-hu Lake has become severely eutrophicated. The Chinese government has resolved to combat pollution of the lake by closing a large number of heavy-polluting enterprises around the lake, and by banning the distribution and use of P-bearing detergents in its catchment area. Nevertheless, water quality of the lake has not shown any significant improvement in recent years. Increased nutrient loss from arable land due to the nutrient surplus in agricultural systems was suggested as the main reason for the water quality deterioration of the lake. However, the information on nutrient losses from arable land in the area had been very limited.

In the Meilin Watershed, temporal changes in nitrogen concentrations in stream water (Fig. 2) and stream discharge, as well as sediment and nitrogen losses from erosion plots with different land uses (Fig. 3), were investigated. The highest overland runoff loads and nitrogen losses were measured under upland fields at the foot of a convergent slope. Much higher runoff, sediment and nitrogen losses were observed under upland cropping and vegetable fields than under chestnut orchards and bamboo thickets (Fig. 3). Sediment-associated nitrogen losses accounted for 8-43.5% of total nitrogen discharge via overland runoff. N lost in dissolved inorganic nitrogen forms (NO_3^--N + NH_4^+-N) accounted for less than 50% of total water-associated nitrogen discharge.

Agricultural practices and weather-driven fluctuation in discharge were main reasons for the temporal variations in nutrient losses via stream discharge (Fig. 2). Significant correlation between the total nitrogen concentration and stream discharge load was monitored. Simple regression models could yield satisfactory results for predicting total nitrogen concentrations in stream water and can be used for better quantifying nitrogen

losses from arable land. Nitrogen losses from the studied watershed via stream discharge between mid-May 2002 and mid-May 2003 were estimated to be 20.3 kg N/ha. From farmers' interviews, it was estimated to be equivalent to 8.5% of the applied nitrogen in this area. This indicates that 16 mg of N was loaded into each liter of water in Taihu Lake per year, if we assume that there was the same intensity of N load from the whole Taihu Lake catchment and that all the N was accumulated in the lake.

Combined with the results of township-level investigation obtained at Xuyan, Wujin City, about 27 km East-Northeast from the Meilin Watershed, the intensities of N load from agricultural land, village, town centers and poultry raising enterprises were estimated at 48, 40, 10 and 2%, respectively, suggesting that agricultural activity was the leading source of N pollution in this region.

TOPIC 2

Growth suppression of rice caused by water drainage during fallow season in the tropics

Intensive rice ecosystems producing two crops of rice per year are important agricultural improvements that increase rice yield in tropical areas. In a long-term rice cultivation experiment at the International Rice Research Institute (IRRI), water drainage during the fallow season suppressed the growth of paddy rice. In this study, the mechanisms underlying this suppression were analyzed.

Research was conducted on four subplots within the research site. At the main subplot, W0, the field was not supplied with irrigation water, while at subplot W1, the field was flooded throughout the fallow season. In subplot S0, all rice straw was removed from the field after harvesting crops of the previous season, whereas in subplot S1, rice straw was left on the field, and was incorporated into the soil one month before transplanting. In the latter field, 50 kg/ha of nitrogen (N) was applied irrespective of season; neither phosphorus (P) nor potassium (K) was applied.

The growth suppression that was observed during both the wet and dry seasons became more prominent in the W0 and S0 subplots (Fig. 1). Throughout the 2001 dry season, the 2001 wet season, the 2002 dry season, and the 2002 wet season, the rice yields in the W0 and S0 subplots were significantly lower than those of the other plots. This indicates that growth suppression during the early stages of cultivation at the W0 and S0 subplots lead to the decrease in yield of rice (Fig. 2). The N, K, and Zn content in the leaves did not differ among the plots (data not shown), although P content in the growth-suppressed rice (W0 and S0 subplots) was lower than that of the rice not subjected to growth suppression (Fig. 3a). These findings suggest that one of the factors that suppresses rice growth is phosphorus deficiency in the plants. From the data for the growth-suppressed plots, it was concluded that growth suppression is associated with low Fe(II) content (Fig. 3b) and/or high levels of soil pH (Fig. 3c).The small Fe(II) content of the soil was attributed to the high soil pH as there was a negative correlation between soil pH and Fe(II) content. Water drainage during the fallow season decreased the amount of Fe(II) in the soil since Fe(II) is oxidized to Fe(III) under such conditions. During the subsequent cultivation season, this low Fe(II) content in the soil maintained the soil pH at a high level. The application of rice straw improved rice growth because of the decrease in soil pH. CO_2, which formed as the terminal product of straw decomposition, presumably decreased the pH levels. The P deficiency of growth-inhibited rice was associated with a small amount of available P due to the high soil pH and/or low Fe(II) content in the soil.

(T. Nozoe)

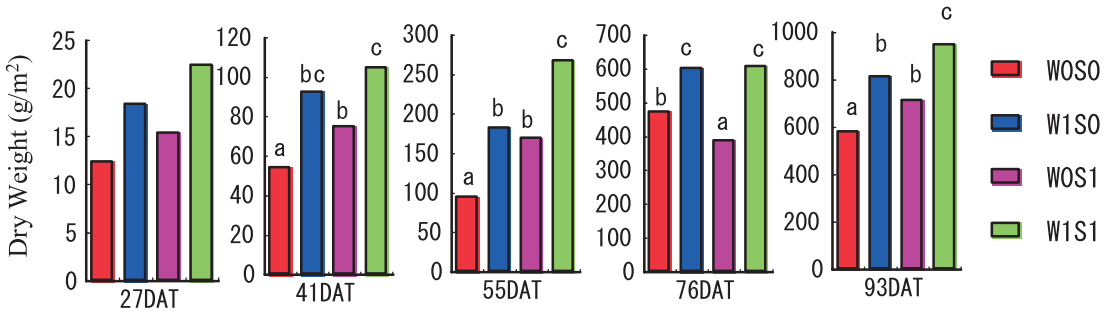


Fig. 1. Changes in dry weight (2001 wet season). Symbols with differing letters denote significant differences at the 5% level. (Same as below)

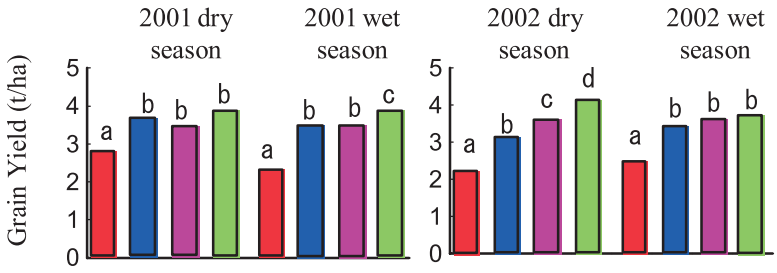


Fig. 2. Grain yield. The colors for each plot are as given in the legend for Fig. 1.

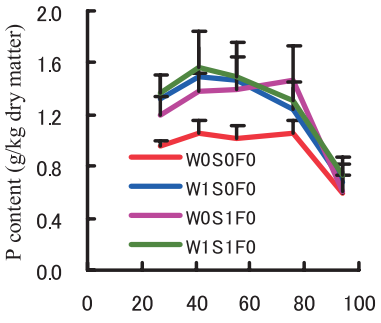


Fig. 3a. Changes in P content in leaves. Vertical bars indicate standard deviation.

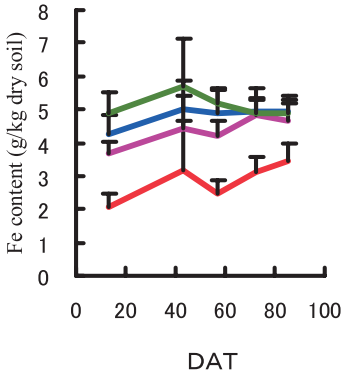


Fig. 3b. Changes in Fe(II) content in soil.

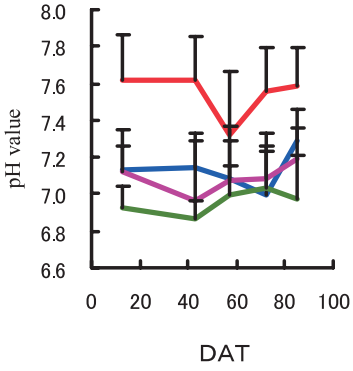


Fig. 3c. Changes in pH levels.

TOPIC 3

QTL analysis of lodging resistance-related properties in paddy rice

In the Jiangnan District of China, where alternate cultivation of Indica and Japonica rice varieties is common, lodging of the plant greatly influences the crop quality of the following harvest due to escape seeds. In recent years, direct sowing is rapidly spreading due to changes in industrial structure, and lodging of the falling type has become a serious problem. Therefore, it is necessary to investigate the lodging resistance mechanisms in relation to the root system and shoot morphology, as well as to create lodging-resistant varieties. In this study, we performed quantitative trait loci (QTL) analysis of lodging resistance-related properties, including resistance to pressure and morphological characteristics of the root system, using 127 double haploid lines derived from Indica/Japonica crosses.

The research results can be summarized as follows. Correlations between the degree of lodging and each of the aboveground parts (plant height, height of the center of gravity, shoot weight, terrestrial moment) was highest, followed by correlation between degree of lodging and pressure resistance over shoot weight and correlation between degree of lodging and shoot/root ratio. Correlations between degree of lodging and root system morphology and root activity were rather low. The correlation between pressure resistance and heading date was highest, followed by correlation between pressure resistance and shoot morphology and correlation between pressure resistance and root morphology.

The QTL of degree of lodging resided on the second and sixth chromosomes, of which the latter was in the same position as that of the shoot/root ratio. Plant height QTL were on the fourth, eighth, tenth, and twelfth chromosomes, and QTL of the center of gravity height were on the fourth, eighth, ninth, and tenth chromosomes, of which the loci on the fourth, eighth, and tenth chromosomes were at the same positions. Among the other characteristics (root morphology, root activity, pressure resistance, lodging index, heading date, shoot morphology), at least one QTL was found on more than one chromosome for each characteristic (Fig. 1).

These QTL were classified by the sign of the correlation coefficient between each character and the degree of lodging into the QTL that increase the lodging resistance and

the QTL that decrease the lodging resistance of the plants. The results clearly indicate that the QTL increasing the lodging resistance are on the third, fifth, sixth, and seventh chromosomes, and the QTL decreasing the lodging resistance are on the first, second, fourth, eighth, ninth, tenth, and twelfth chromosomes (Fig. 1).

Special attention should be paid to the following points for further studies and application of these results: the information obtained in this study will serve as a basis for the generation of varieties with substitutions for regions found to increase or decrease the lodging resistance and for further studies on their effects on lodging resistance; since the above results were obtained from one population of rice, further studies using other populations are necessary; and, since the effects of plant height on the lodging resistance are great, it is necessary to develop populations having similar plant heights for further analysis.

From this study, it was concluded that QTL of the characteristics related to lodging resistance, such as pressure resistance, morphological characteristics of aboveground parts, and morphological characteristics of the root system in the double haploid lines created from Indica and Japonica crosses, reside on scattered positions in differing chromosomes, while pressure resistance QTL are located on the seventh and eighth chromosomes.

(H. Fujimoto)

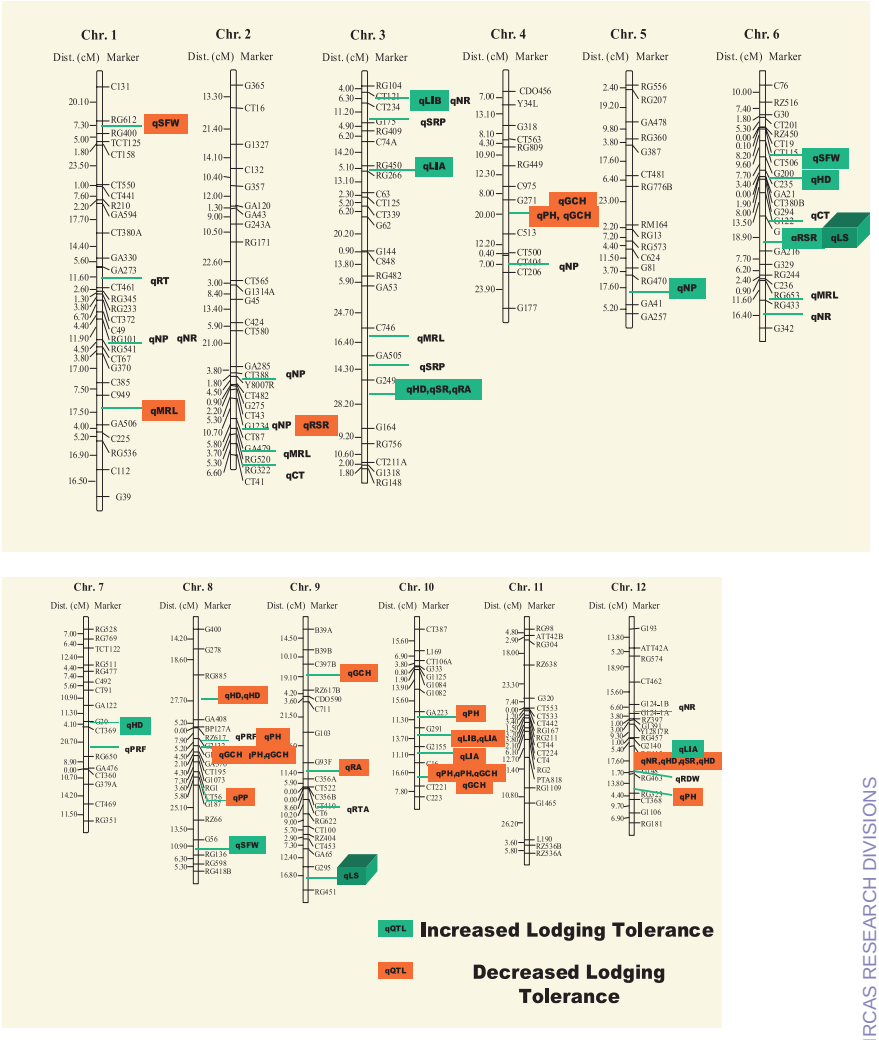


Fig. 1. QTL map in relation to lodging tolerance.

TOPIC 4

Interspecific difference in the utilization of proteinaceous nitrogen among gramineous crops

In the developing regions such as Sub-Saharan Africa, farmers use only small quantities of chemical fertilizers and instead utilize organic materials such as manure and crop residues as alternate sources of nitrogen (N). When organic N is applied to soil, the amount of proteinaceous N, the most common form of available N in soil, temporarily increases. In order to develop a practical and efficient method for the integrated use of organic and inorganic materials, it is necessary to understand the mechanisms behind the utilization of differing forms of N by crop species. Thus, the properties of proteinaceous N utilization by four globally important gramineous crops–sorghum, upland rice, maize and pearl millet–were elucidated in this study.

As a field experiment, equal amounts of N (150 kg N/ha)were applied in both inorganic (urea) and organic (a mixture of rice bran and rice straw, C/N=20) forms, and its effects on the growth of the four gramineous crops were monitored. Based on the data, the four crops were divided into two groups in terms of their response to organic N application. Sorghum and upland rice displayed more prominent growth under organic N treatment than under inorganic N treatment, whereas maize and pearl millet did not show significant difference in growth under the two treatments. A similar pattern was also observed in the N uptake of these crop species. Sensitivity towards organic N in upland rice had previously been revealed, but that of sorghum was newly discovered through this experiment.

In pot experiments, the same amount of N (500 mg N/kg) was applied in the form of (1) ammonium nitrate, (2) rice bran (C/N=12),

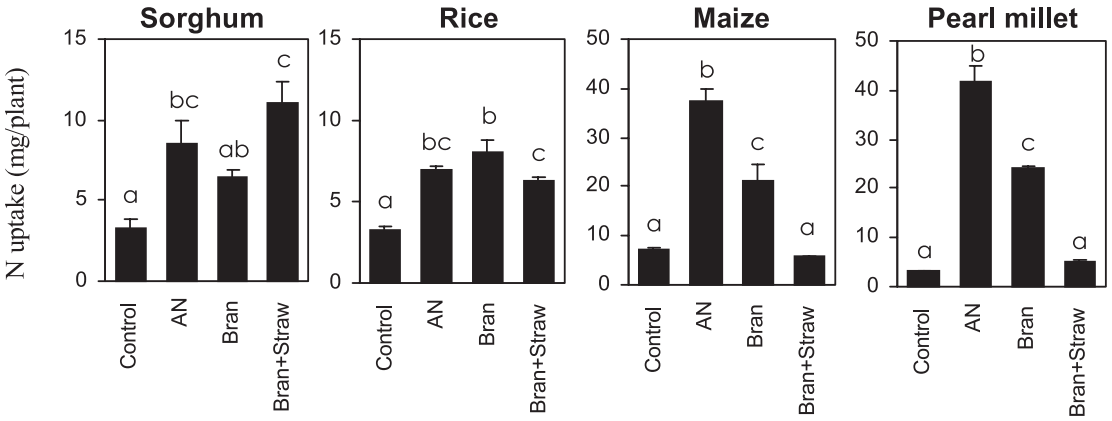


Fig. 1. N uptake by the four gramineous crops under differing N treatments (pot experiment). Differing letters indicate significant differences ($p < 0.05$). (AN: ammonium nitrate)

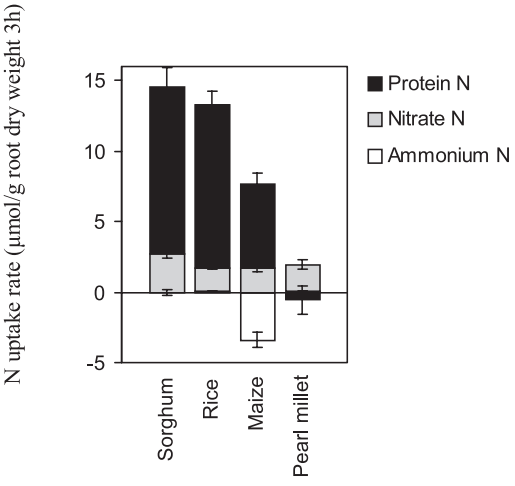


Fig. 2. Nitrogen uptake rates of the four crop species when N was applied to the root bathing solution in the form of proteinaceous N. Vertical lines indicate standard deviations.

and (3) a mixture of rice bran and rice straw (C/N=20). N uptake of each of the four crops was compared 21 days after transplanting. The four crops were again divided into the same two groups. Sorghum and upland rice absorbed similar quantities of N from both organic and inorganic N treatments, while maize and pearl millet absorbed more N from inorganic N treatment than from organic N treatment (Fig. 1). These results reflected the proteinaceous N and inorganic N content in the soils under each treatment.

In the same pot experiment, root morphological characteristics such as root length, surface area, and fractal dimension of the plants remained equal regardless of treatment. Thus, the differing growth rates of the crops caused by N uptake as mentioned above, can be attributed to differing absorption rates of N per unit root length.

Uptake rates of proteinaceous N were directly measured from a solution culture system. Proteinaceous N, extracted from field soil treated with a neutral phosphate buffer and purified through dialysis, was added to the solution; decreases in levels of proteinaceous N in the solution was used as a means of measuring N uptake by the plant roots. Absorption rates of proteinaceous N was much higher in sorghum and upland rice than in maize, and no proteinaceous N was absorbed by pearl millet roots (Fig. 2). These results suggest that the above-mentioned responses to organic N application among crops are due differing absorption rates of proteinaceous N from the soil.

(K. Okada)

TOPIC 5

Physiological mechanisms of aluminum resistance of rice varieties and the development of a rapid screening method for resistant genotypes

Upland rice is an important crop for small farmers in developing countries. The growth of upland rice is often reduced by the soil acidity of highly weathered soils (Oxisols and Ultisols) that are widely distributed in tropical regions. Since many farmers cannot apply high levels of lime to correct soil pH due to economic constraints, the development of genotypes resistant to soil acidity is necessitated. Few studies have been conducted for the acid-soil resistance of upland rice compared to those of other crops such as wheat. A previous study conducted by JIRCAS in the savannas of South America revealed that calcium (Ca) plays a major role in the genotypic differences of upland rice that are responsible for resistance to soil acidity in Oxisols. In this study, the mechanisms of resistance to acid soils in rice was elucidated in relation to Ca in comparison to cases of wheat, and a new efficient screening method was proposed.

The major inhibitory factor in acid soils is

Al. The first symptom caused by Al is the inhibition of root elongation. Thus, the degree of Al resistance of rice was measured based on the relative root growth in a culture solution containing Al. The degree of Al resistance in differing upland rice species was as follows: Toyohatamochi (73%) > Oryzica Sabana 6 (53%) > IR72 (28%) > IR36 (19%) > Kasalath (16%) (Fig. 1). Increasing Ca concentration in the solution recovered root growth in all genotypes, and the recovery rates were greater in susceptible genotypes (Fig. 1).

In the case of rice, the addition of barium (Ba), the congeneric element to Ca, to Al-affected roots further reduced root elongation (Fig. 1). However, in the case of wheat (Atlas cultivar 66), the addition of Ba recovered Al-affected roots (data not shown). These results, regarding the contrasting effects of Ba on Al-affected roots of rice and wheat suggest that the mechanisms of their resistance to Al differ.

For wheat, the hematoxylin staining method which determines Al content in root tissue, has been used as a proven screening method for Al resistance. However, it is not possible to apply this methodology to rice, most likely due to the differing mechanisms of Al resistance in the two plant species as mentioned above. Keeping in mind that the relative adsorption of Al and Ca on root cell walls is directly related to the mechanisms of Al resistance in rice, a rapid screening method using pyrocatechol violet (PCV) was developed. In this method, the roots are first immersed in Al solution for 15 min, and then treated with Ca solution. The easily exchangeable Al is displaced by Ca in this process, allowing the detection of the hardly exchangeable Al at the root surface by PCV staining. Under this method, the root tips of susceptible varieties were more strongly stained than the three resistant varieties (Fig. 2). These results coincide with the results of root elongation (Fig. 1). When the Ca solution which displaces adsorbed Al was omitted from the process, differences in the degree of staining among the varieties became unclear (data not shown). In addition, the use of this method allows the rapid evaluation of Al resistance in rice varieties. Further tests should be carried out for the validation of this technique, through comparison of results with the growth rates of rice varieties planted in acid-soil fields.

(K. Okada)

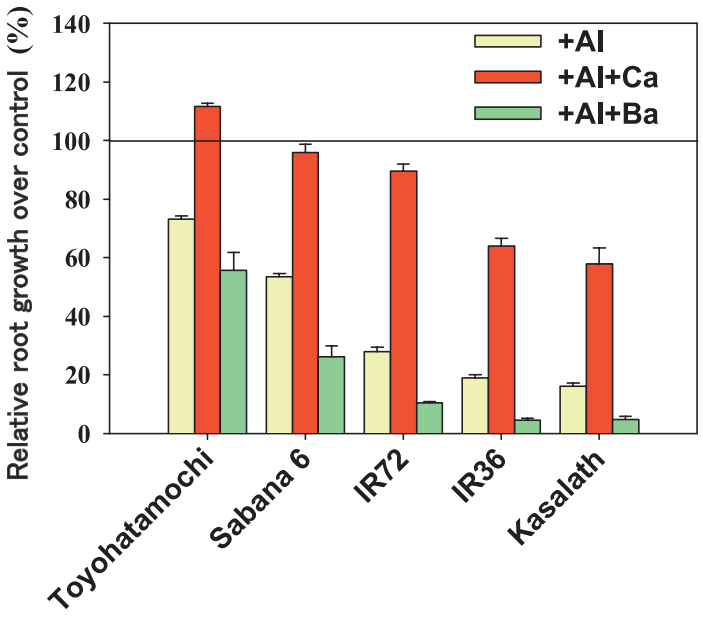


Fig. 1. Effects of the addition of Ca and Ba on the relative root growth of Al-affected rice roots.
[Control]: 50 µM Ca; [+Al]: 50 µM Ca + 20 µM Al; [+Al+Ca]: 500 µM Ca + 20 µM Al; [+Al+Ba]: 50 µM Ca + 450 µM Ba + 20 µM Al.

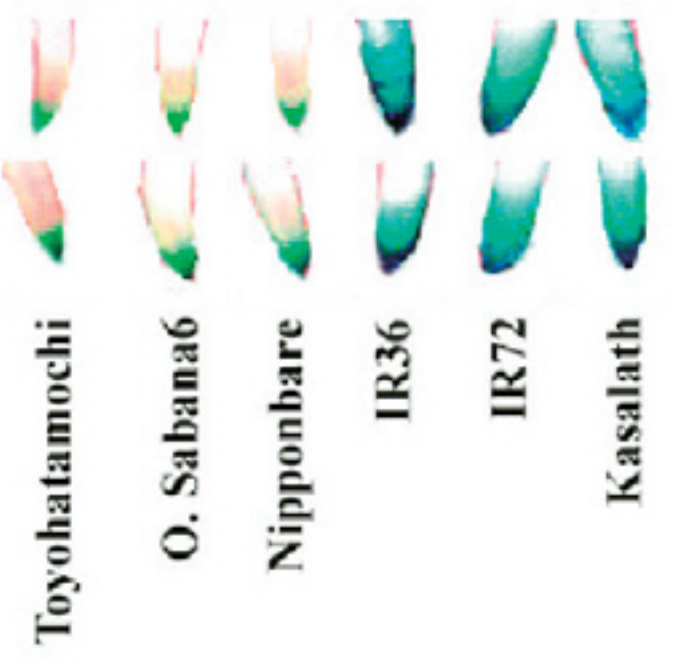


Fig. 2. Results of PVC staining of the roots of rice varieties after they were treated for 15 min with solutions containing 50 µM Ca + 100 µM Al, followed by a 45 min treatment with solutions containing 500 µM Ca. Two replications of each variety is shown.

Quantitative analysis of groundwater effluent and reservoir water influent in a pond using ^{222}Rn- and water-balance equations

It is essential to quantify groundwater effluent and reservoir water influent in ponds in order to use water resources effectively and to predict water quality. However, conventional methods measure only the amount of surface water inflow and outflow, and can only reveal differences between groundwater effluent and reservoir water influent. It is not possible to quantify both parameters simultaneously. In this study, we concentrated on the radon-222 (^{222}Rn) content in the environment and developed an analytical method using ^{222}Rn- and water-balance equations.

^{222}Rn is a radioactive gas generated by the decay of radium-226 (^{226}Ra) in strata. It dissolves in water while it decays, having a half-life of 3.8 days. In this way, ^{222}Rn concentration in groundwater reaches an equilibrated value, which depends on the content of ^{226}Ra and specific surface areas of strata. Since the origin of ^{222}Rn is underground ^{226}Ra, ^{222}Rn concentration in groundwater is higher than that of surface water.

Fig.1 shows ^{222}Rn- and water-balance in a pond. Although groundwater influent and reservoir water influent are unknown quantities, it is possible to quantify them both by constructing ^{222}Rn- and water-balance equations. The dispersion of ^{222}Rn into the atmosphere, an important factor contributing to ^{222}Rn loss, is calculated assuming that there is a stagnant film between water and air. The thickness of this stagnant film was empirically estimated to be 830 μm.

The developed method was applied to a pond near a landslide-prone area in Japan, where it is considered that reservoir water influent is a major cause of landslides. Table 1 shows the results of the field investigation. Using these data, we constructed ^{222}Rn- and

Table 1. Results of field investigation.

	Discharge (L/s)	^{222}Rn conc. (Bq/L)	Amount of ^{222}Rn (Bq/s)
Spring	0.11	6.54	0.72 (discharge×conc.)
Surface water	0.15	0.00	0.00
Groundwater effluent	x	6.54	6.54x (dischage×conc.)
Radioactive decay			3.74 (decay const.×volume×conc.)
Dispersion			1.00 (area×diffusivity×conc./thickness of stagnant film)
Reservoir water outflow	0.43	0.41	0.18 (discharge×conc.)
Reservoir water influent	y	0.41	0.41y (discharge×conc.)
Evaporation	0.09		

The area of the pond is 1550 m^2. The average depth is 2.8 m. The thickness of stagnant film is 830μm. ^{222}Rn concentration in groundwater equals that of the spring.

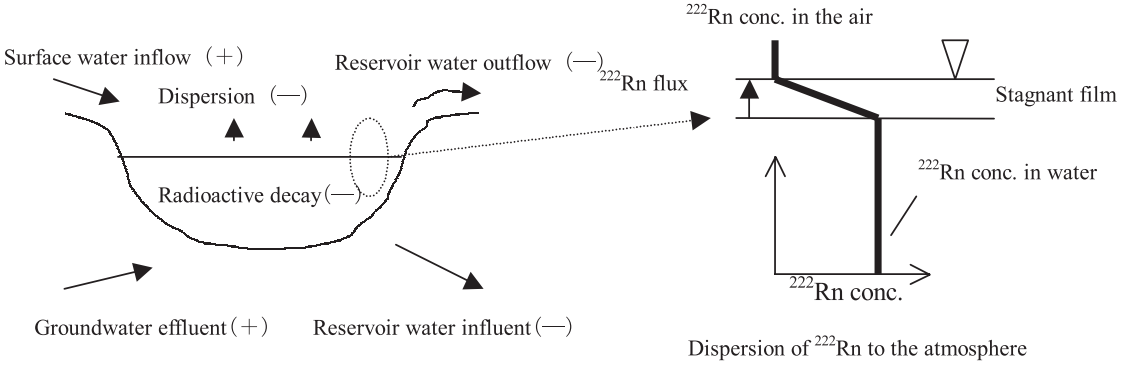


Fig. 1. ^{222}Rn- and water balance in a pond (+: supply, –: loss.). Water balance was maintained (water level remained constant) when the amount of surface water inflow and groundwater effluent was equal to the amount of reservoir water outflow, evaporation, and reservoir water influent. ^{222}Rn balance was maintained (concentration remained constant) when the amount of surface water inflow and groundwater effluent equaled the amount of radioactive decay, dispersion, reservoir water outflow, and reservoir water influent.

water-balance equations, and groundwater effluent and reservoir water influent were calculated to be 0.67 L/s and 0.41 L/s, respectively. As stated above, conventional methods could not quantify groundwater effluent and reservoir water influent simultaneously, but our new method has made this possible.

The on-site application of the method is expected to facilitate effective water use, predict water quality, and prevent landslides.

(H. Hamada)

ANIMAL PRODUCTION AND GRASSLAND DIVISION

In many different capacities, domesticated animals are beneficial to the lives of people in developing countries. Livestock not only supply meat, milk, wool, and hide that are essential to daily life and serve as important sources of income, but also contribute to efficient agricultural farming systems through nutrient recycling, in which less profitable biomass is converted to additional products of value and manure is utilized as environmentally-friendly organic fertilizer for infertile land. Thus, livestock play an essential role within the social fabric of a community, especially in developing countries, where demands for meat and milk rapidly increase with each successive year. However, livestock can produce negative effects on the environment as well, causing water and land pollution, environmental degradation and disease outbreak due to over-grazing and inappropriate management. Against this background, in order to develop appropriate methods of livestock management, the Animal Production and Grassland Division focuses on research that will provide means to enhance the efficient use of natural resources, manage grasslands to secure feed resources, increase the utilization of agro-industrial by-products, control invasive animal diseases, and improve management practices in developing regions of the world.

In Fiscal Year 2003, the Division conducted research on 13 subjects, dispatching a total of 13 researchers overseas, of which six were sent on long-term assignments, and seven on short-term assignments. At the National Center for Research on Beef Cattle (CNPGC-EMBRAPA) in Brazil, collaborative work was carried out to develop means of sustainable management and utilization of grasslands in agropastoral systems and to clarify the interactions between the presence of anthills on the grasslands and how this affects grazing animals. Concurrently, in a joint research project with the National Institute of Agronomic Technology (INTA) in Argentina, researched focused on the development of new and improved uses of soybean by-products, focusing on processing methods of soybean as ruminant feed. Under the international comprehensive project with Cantho University in Vietnam "Development of new technologies and their practice for sustainable farming systems in the Mekong Delta" research was conducted to improve the meat quality of pigs using substitute feed resources, to elucidate the bacteriological characteristics of pathogenic *Escherichia coli* found in piglets suffering from diarrhea and edema disease, to establish precise methods for the diagnosis of swine viral diseases such as classic swine fever, and to assess the economic losses associated with swine disease. In collaboration with the Department of Agriculture (DOA) and Kasetsart University in Thailand, several types of promising lactic acid-producing bacteria were selected for use in the production of high-quality silage. Joint research with the Khon Kaen Animal Research Center and the Department of Livestock Development (DLD) in Thailand was carried out to evaluate the nutritional value of drought-tolerant forage crops such as *Erianthus* spp. and to improve animal performance. The project also involved estimating the quantity of methane emission from several types of ruminant feeds. Through collaborative work with the

Cattle grazing in Jilin, China
(Photo: M. Amari)

Chinese Agricultural University and the Jilin Academy of Agricultural Science, evaluation and processing methods of corn by-products in China were developed. With the International Livestock Research Institute (ILRI) in Kenya, studies were carried out to clarify the mechanisms of infection and development of trypanosomosis using mice lacking trypano-tolerant genes. Domestic research at JIRCAS's Tsukuba premises was conducted to develop an experimental model for evaluating *in planta* colonization of nitrogen-fixing endophytes in gramineous plants.

TOPIC 1

Termite activities increase the productivity and nutrient value of grasses and grazing frequency by cattle around termitarias

Termites play leading roles in organic matter decomposition and nutrient cycling in tropical and subtropical zones. It is important, therefore, to understand the effects of termite activity on soil fertility, grass growth and cattle grazing in subtropical pastures, in order to predict the dynamics of agropastral systems and to enhance their productivity and sustainability. Soil fertility, productivity and nutrient value of grass, *Brachiaria decumbens*, as well as the grazing behavior of cattle in areas near termite mounds populated by the species *Cornitermes cumulans* were compared with those of control areas free of mounds in subtropical pastures of Brazil.

The total carbon and nitrogen content of the surrounding soil increased as the distance to the mounds decreased in the lower soil layers, whereas a clear pattern could not be deduced for upper soil layers. The rates of height elongation, dry matter production and crude protein production of grass per unit area were approximately 1.4, 1.6 and 2.1 times higher, respectively, around termite mounds than those of control areas (Fig.1). It was observed, using cameras with infrared ray sensors, that cattle grazed in these nutritious and productive grasses around the mounds with much higher frequency than in control areas (Fig. 2). As a result, the height of the grass always remained lower within a 68 cm radius, on average, of the margins of termite mounds.

In areas surrounding termite mounds, increases in productivity and nutrient value of grasses due to soil nutrient enrichment is expected to induce the frequent and preferential grazing of cattle. This suggests that the presence of termite mounds exerts significant influence on the grazing behavior and intake of nutrition, especially crude protein, of cattle and therefore affects beef quality of cattle raised in subtropical pastures. It is crucial for this to be taken into consideration when managing subtropical pastures in which C_4 grasses with low crude protein content are predominant and where supplying legumes as major nitrogen sources for cattle is often difficult.

(E. Fukuda, T. Kanno, M. C. M. Macedo, C. H. B. Miranda and T. Nakamura)

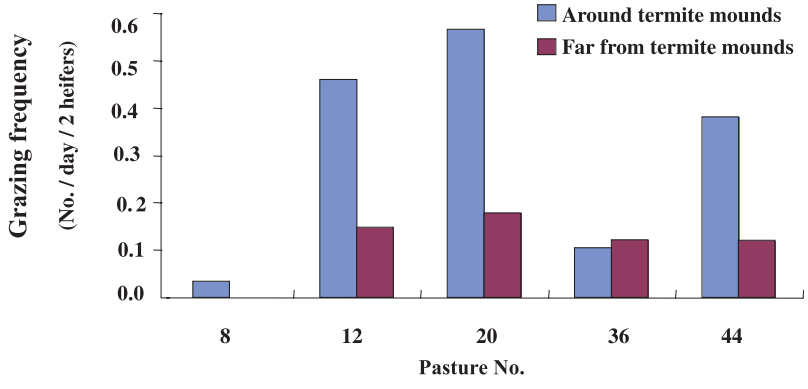


Fig. 1. Grazing frequency of two heifers per day.

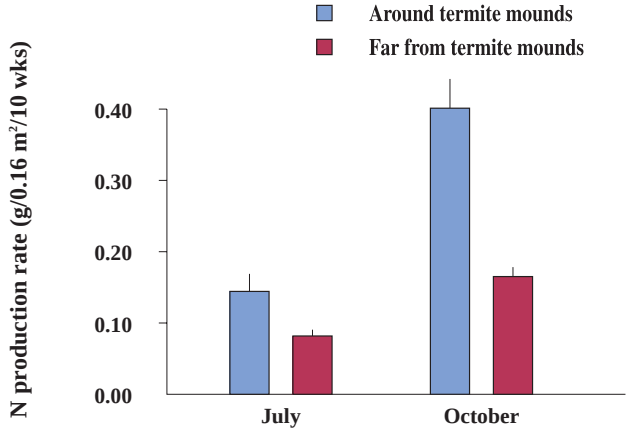


Fig. 2. Nitrogen production rate (N g/0.16 m²/10 wks) near and far from termite mounds in a *Brachialia decumbens* pasture. Vertical bars indicate +1 SE for 12 repetitions.

Development of an experimental model for the evaluation of *in planta* colonization of nitrogen-fixing endophytes in rice plants

We have previously reported that large quantities of nitrogen-fixing endophytic bacteria symbiotically inhabit the tissue of gramineous plants. Currently, we have isolated a number of bacteria having nitrogen-fixing abilities, such as *Azospirillum* sp., *Klebsiella* sp., and *Herbaspirillum* sp. from various grasses. However, it remains necessary to establish a means of inoculation testing in order to investigate the colonization dynamics of these bacteria and elucidate how they contribute to the growth of important plant species. Hence, as an experimental model with which to verify the effectiveness of a new inoculation test method, we chose the bacteria *Herbaspirillum* sp. A46, originally isolated from *Panicum maximum* and rice plants. If successful, this method will serve as a foundation for analyzing the behavior of nitrogen-fixing bacteria within plants.

Herbaspirillum sp. A46, marked with transposon-based *gusA* gene, was evaluated for its ability to colonize fodder rice. A total of three rice varieties were used as hosts: Sprice, which is a rice cultivar now used as silage, and two other traditional varieties, Tetep and Koshihikari. The bacteria, which possibly enter through cracks in the emerging lateral root of cv. Sprice, were localized in the inter- and intra-cellular areas of the cortical cells and the xylem vessels of the root; bacteria then systemically spread into the shoot portions, where they were found in the intercellular spaces of adjacent cells in the leaf vascular bundle (Figs. 1 and 2). Colonization began as early as two days after inoculation with numbers ranging from 10^5-10^7 per gram fresh weight. The population of isolated herbaspirilla remained constantly larger than of the bacteria isolated from the shoot 2 to 21 days after inoculation. In the case of bacteria isolated from shoots within the same sampling period, the population tapered only at 30 days after inoculation in all three varieties accompanied by a consequent increase in numbers of bacteria. Among the three cultivars, no significant differences were observed in the number of herbaspirilla isolated from the inner tissues except at seven days after inoculation, when the fodder rice, cv. Sprice, harbored the highest numbers of bacteria. The addition of 10 µM NH_4Cl inhibited the colonization of all three rice cultivars, of which cv. Koshihikari showed the highest sensitivity. Nitrogenous activity was detected in all three varieties in the absence of carbon sources until seven days after inoculation.

(Y. Ando)

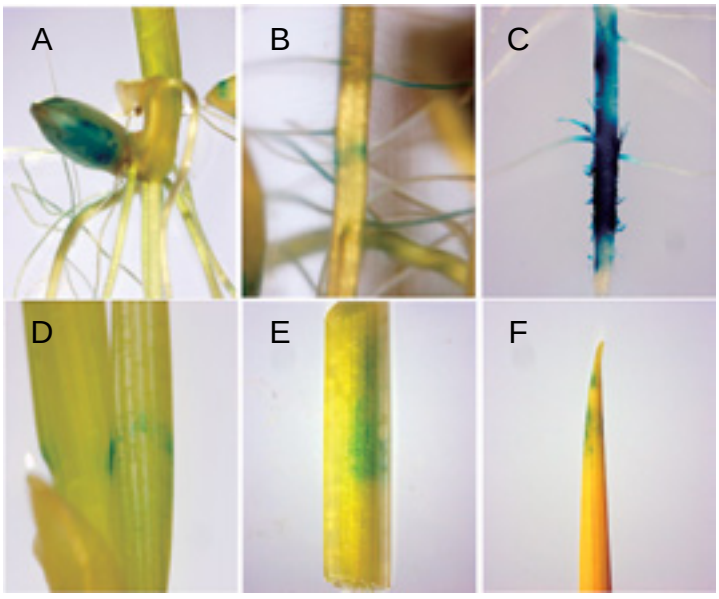


Fig. 1. Light micrographs of cv. Sprice roots 7 days after inoculation. Roots inoculated with *Herbaspirillum* sp. A46 showing gus staining in the seeds (A); lateral root and root junctions (B); heavily stained root tip region (C); stem (D&E); leaf sheath (E); and, leaf blade (F).

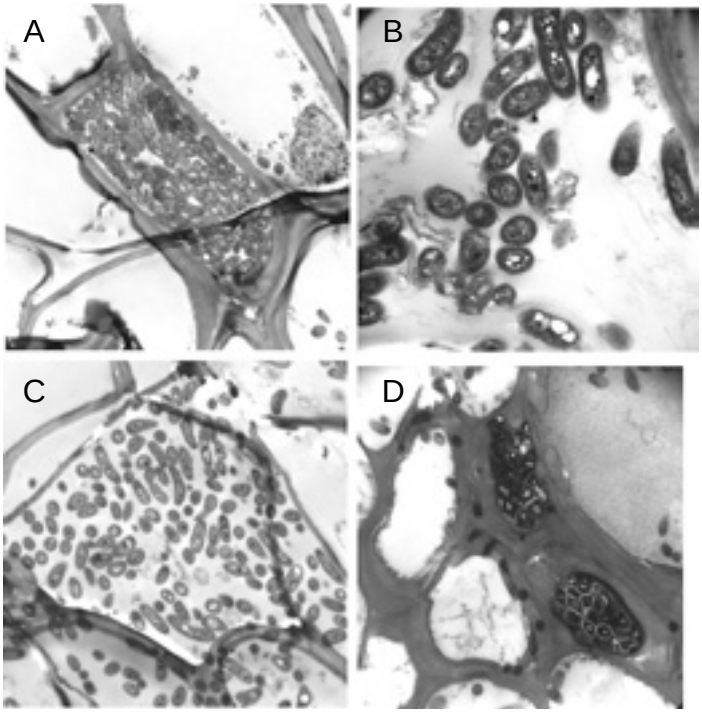


Fig. 2. Transmission electron micrographs (70 nm sections) of cv. Sprice roots inoculated with *Herbaspirillum* sp. A46 at 7 days after inoculation showing bacteria colonizing the intra- (A, B), inter-cellular (C) portion of the cortical cells and protoxylem vessels of the vascular bundle (D).

TOPIC 3

Isolation of lactic acid bacteria strains suitable for producing high quality silage in Thailand

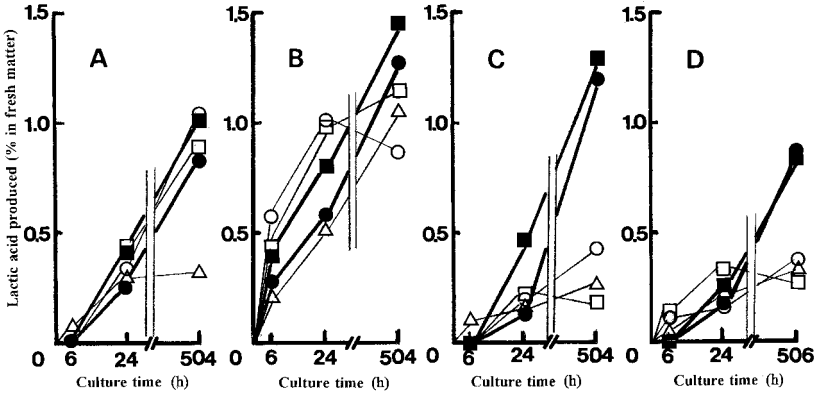
Silage feeding is an effective and easily adaptable technique despite its limited application in Thailand. The use of high quality silage is a highly dependable means of increasing and stabilizing the quantity of raw milk production; however, succesful results are not always ensured if ensilage depends on natural fermentation. In order to address this problem, lactic acid bacteria (LAB) strains suitable for silage making in Thailand were screened.

Previously, 13 LAB strains having culture filtrate pH levels less than 4.0 at 45˚C were selected out of 215 strains isolated from 14 silage samples prepared in Thailand. Each strain was carefully monitored for silage fermentation inoculants, using the modified pouch method to simulate a tropical environment. The various profiles of lactate production in the four isolates, CS 1-8, CS 5-5, KS 1-9 and SP 1-3, were confirmed. The time courses of lactate production in the cultures using the modified pouch method with various inoculum sizes are shown in Fig. 1. The most important property of LAB strains in terms of silage making is their high ability to produce lactate during the silage fermentation process, which is a type of solid-mixed, non-sterilized fermentation. This property becomes further apparent when using the modified pouch method. Strain SP 1-3 isolated from corn silage and tentatively assigned to *Lactobacillus plantarum* exhibited an inherent tolerance for high incubation tempertures and lactate. Strains CS 5-5 and KS 1-9, isolated from corn silage and tentatively assigned to *Pediococcus* sp., also exhibited similar properties to strain SP 1-3, but they showed weaker lactate tolerance than that of strain SP 1-3. Strain CS 1-8, isolated from TMR silage and assigned to *Pediococcus* sp., displayed steady growth during the early stages of silage fermentation, but did not accumulate much lactate by the end of the long-term fermentation.

Based on these results, laboratory-scale silage of Napiergrass inoculated with strain SP 1-3 and/or CS 1-8 was prepared. The fermentation quality of silage inoculated with LAB strains significantly increased the quantity of lactate produced (close to double the amount) and reduced counts of coliform bacteria and yeast. From these results, both SP 1-3 and CS 1-8 were considered to be suitable strains for use as silage fermentation inoculants in tropical regions.

(S. Ohmomo)

Fig. 1. Time course of lactate production by typical isolates using various modified inoculum sizes. Inoculum size (cfu/ml): A (LAB 10^2, CFB 10^2, yeast 10^2); B (LAB 10^5, CFB 10^2, yeast 10^2); C (LAB 10^2, CFB^5, yeast 10^2); and D (LAB 10^2, CFB 10^2, yeast 10^5). Symbols: ■ (strain SP 1-3); ● (strain CS 5-5); ○ (strain CS 1-8); △ (strain LS 2-38); and □ (strain KS 1-9).



TOPIC 4

Improvement of feeding management and meat quality of pigs by using locally-available under-utilized feed resources in the Mekong Delta region of Vietnam

The Mekong Delta region is one of Vietnam's two major agricultural areas. There, many forms of rice-based farming systems have taken root, and swine production has become an important component of these farming systems. Most swine production in the region is carried out by small-scale farmers who depend on pork as an important means of income-generating activity. However, a nutritional imbalance in the pigs' diet has become apparent, due to the high percentage of rice bran used in their feed. To compensate for this imbalance, farmers also use commercial protein-concentrate feed (concentrate feed for short) as a protein supplement, but the additional costs of concentrate feed often become a financial burden for the producer. In addition, the meat quality of swine produced at small-scale farms tends to be lower, having higher fat content compared to that of swine produced at large-scale farms. Moreover, especially in the city areas, increasingly affluent consumers have begun to choose the higher-priced lean pork over the cheaper pork having higher fat content. Thus, in this research, a study was conducted with the aim of reducing feed costs while simultaneously improving pork quality.

Ideal due to their abundance and low costs,

two species of natural water plants were evaluated for their potential as alternative feed sources. Water hyacinth (*Eichrornia Crassipes*, Fig. 1), a floating plant that grows rapidly throughout the year, and water spinach (*Ipomoea aquatica*), which grows beside canals and is easy to collect, were fed raw to pigs. First, the effects of their replacement in the diet on growth performance factors, such as daily weight gain and feed conversion ratio, were determined. There was enough of each plant to supply up to 5-6% of the feed and replace concentrate feed without significant reduction of growth performance. Next, the effects of the diet supplementation of each plant on pork quality and economic value were examined (Table 1). Both the fat content and meat quality were significantly improved by replacing the concentrate feed with water hyacinth. The iodine value in pig fat remarkably improved in pigs fed with water spinach, and the unit price of pork in pigs fed with water hyacinth and water spinach were higher than those of the pigs fed with the control diet improving cost-benefit performance. An agricultural by-product, sweet potato (*Ipomoea batatas* L.) vine, was also tested using the same methods as the water plants, and also showed positive results.
It was revealed from the above results that these local feed resources could be used at the majority of farms in the regions. However, it is recommended to observe the following three key points when utilizing these feed resources: 1) the plants do not need to be cooked when feeding them to the pigs; 2) the resources have nutritional value comparable to concentrate feed; and, 3) the substitution of concentrate feed with these plants lowers feed costs, and improves meat quality. Yet, farmers should take caution not to substitute more than 5-6% of the pigs' diet with these plants; doing so will cause the decreased ingestion of nutrients and thus result in the decrease of growth performance.

(S. Yamasaki)

Fig.1. Water hyacinth floating on the Mekong River.

Table 1. The effects of feeding water hyacinth and water spinach on the back-fat thickness, meat quality and economic value of pigs.

	Water hyacinth[1)]		Water spinach[1)]	
	control	test	control	test
Back-fat thickness, mm[1)]	18.0[a]	15.7[b]	–	–
Meat quality				
Crude protein, %	20.7[a]	21.4[b]	21.1	21.3
Iodine value of the back-fat	63.9[a]	54.7[b]	34.4[a]	32.9[b]
Economic value/head, %[2)]				
Selling price	100	105	100	110
Feed cost	100	90	100	95
Profit[3)]	100	110	100	127
Cost performance[4)]	100	89	100	94

[a, b] Mean values in the same row labeled with differing letters are significantly different at $P<0.05$.
1) The effects of each of the coupled diets, control and test, were determined. Proportions of commercial protein concentrate feed of control diets were reduced and that of water hyacinth or water spinach were increased in the test diet. 2) Relative to the controls. (Control = 100). 3) The selling price subtracted by the feed cost. 4) Selling price/live weight.

Diagnosing and developing control measures for classical swine fever in the Mekong Delta region of Vietnam

Swine production developed dramatically in Vietnam in the 1990's (a 7% annual increase) and by 2000, the pig population in the region reached 20 million heads. One of the two major agricultural areas of Vietnam, the Mekong Delta region produced more than 2.9 million pigs in 2000, while making use of abundant rice by-products. A typical pigsty is found in the farm backyard; pigs are fed with rice bran and water spinach, and sewage from the pen is drained into adjacent fishponds or irrigation canals as nutrient-rich fertilizing material.

Pig production accounts for a substantial percentage of cash income for a typical farm household; however, farmers' operations are hampered by extremely high piglet mortality rates. We suspected outbreaks of classical swine fever (CSF), a highly contagious and fatal viral disease, but differential diagnoses had not been made, even in cases that had occurred in vaccinated herds. Diseased pigs are often treated with antibiotics, but antibiotics often have adverse effects on pigs, such as intermittent death and/or retarded growth of the whole litter. Therefore, our primary objective of the study was to diagnose CSF through laboratory examination and investigate vaccination practices to develop appropriate control measures.

Between July 2002 and June 2003, we visited ten farms with fatal disease outbreaks in the Cantho Province and interviewed farmers on case history. The clinical symptoms frequently observed - shivering, constipation and mild fever - were identical to those of *Pho Thuong Han* (the Vietnamese name for salmonellosis). Another symptom, an epidemic diarrhea incurable by antibiotics, was recognized as that of *Dich Ta Heo* (the Vietnamese name for CSF). However, the farmers categorized all of these symptoms as CSF symptoms. Average mortality or cull rate of the farms was 53% and there were 13 fatal cases per farm. The symptoms were initially recognized in 44-day-old piglets and the sow was in her first parturition, which may suggest a lack or depletion of maternal antibodies. This necessitates revisions of the pre-natal booster shot program implemented in the Mekong Delta.

Through viral examination of plasma, tonsils and spleens of piglet corpses using CPK cell cultures, the CSF virus (CSFV) antigen was clearly detected on seven farms using fluorescent antibody tests (Table 1). Using RT-PCR targeting 5´ NTR, highly conserved among all the pestiviruses, and by either restriction fragment length polymorphism (RFLP, digestion with Bg1I) analysis or sequencing of the product, CSFV genes were identified on all 10 farms.

Histo-pathological examination of major organs, lymph nodes, the ileum-cecum

Table 1. Results of CSF virus (CSFV) detection tests and vaccine history.

Farm			I	II	III	IV	V	VI	VII	VIII	IX	X	Total
CSF vaccine boostered			None (partly unknown)						N		C	F	
Litter/lot number affected			1	2	1	3	2	2	2	2	1	2	18
CSFVAg (FA)	Piglet	n	1	1	1	1	3	1	1	1	1	2	13
		pos.	1	1	0	w	3	1	w	1	1	2	10
RT-PCR for Pestivirus (5´NTR)	Piglet	n	1	2	1	4	3	1	2	1	1	3	19
		pos.	1	2	1	4	3	1	2	1	1	3	19
	Sow	n	nt	nt	1	1	1	nt	nt	nt	nt	2	5
		pos.			0	0	0					1	1
CSFV confirmed by RFLP (BglI) or sequence	Piglet	n	1	2	1	4	3	1	1	1	1	3	18
		pos.	1	2	1	4	3	1	1	1	1	3	18
	Sow	n	nt	nt	nt	nt	nt	nt	nt	nt	nt	1	1
		pos.										1	1

nt: not tested; w: weak/doubtful; N: Navetco; C: CEVA; F: Fort Dodge; Ag: antigen; FA: fluorescent antibody test; RT-PCR: reverse transcriptase polymerase chain reaction; RFLP: restriction fragment length polymorphism analysis.

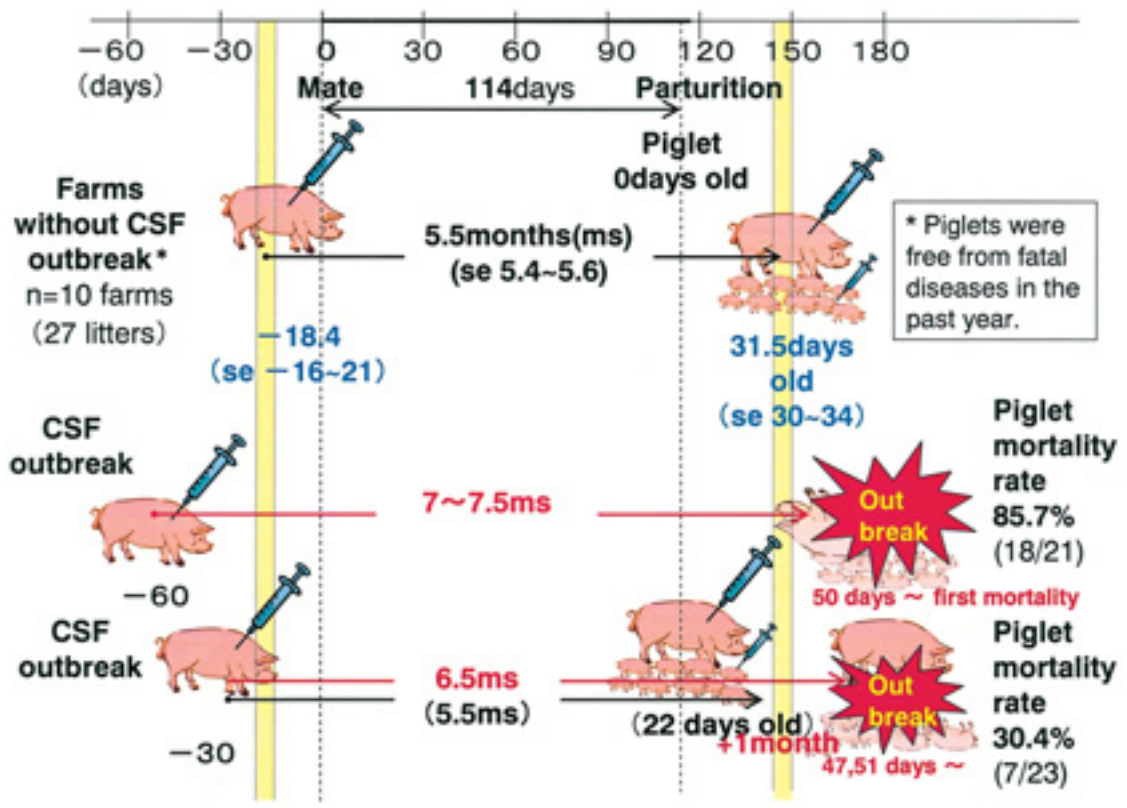


Fig. 1. Classical swine fever (CSF) outbreaks and the vaccine program (Vietnam N company vaccine: widely used in southern Vietnam).

junction and the brain revealed typical but various types of CSF lesions, such as peri-vascular cuffing (non-suppurative encephalitis), proliferation of reticular cells, necrosis of lymphoid tissue and hystiocytic hyperplasia by stages, and those of severe secondary infection, while depletion of lymphocytes in spleen and lymph nodes were observed in all cases.

Out of a total of 10 farms diagnosed with severe cases of CSF (Table 1), six farms had not applied booster vaccines to the sow or provided growers with unclear vaccination histories; two farms used the most popular domestic (N company) vaccine 30 to 60 days preceding gestation (Fig. 1) and the other two farms applied imported (C&F company) vaccines having different potencies 30 days preceding gestation. These two farms followed a customary practice in which sows are simultaneously vaccinated when piglets are near their weaning age. Farms that practiced N company vaccines and were free from fatal disease cases in the previous year had vaccinated piglets when they were 31.5 days old on average, which is 18.4 days prior to gestation for the sow.

From examination of disease records and vaccination histories of farms with diseased pigs, it was recommended, firstly, to standardize the vaccine and second, for the prevalent N vaccine suppliers to provide instructions together with vaccines, and to advise farmers to vaccinate sows every six months just prior to gestation, and to piglets one month after birth (Fig. 1).

To increase the efficiency of the recommended vaccination program, a larger amount of free samples should be distributed. Otherwise, measures should be taken to neutralize post-vaccination antibodies.

(A. Kamakawa)

FOOD SCIENCE AND TECHNOLOGY DIVISION

Recently, there has been increased emphasis on the agri-food sector, which focuses on improving food quality and safety, storage, beneficial processing, product differentiation, marketing, and distribution, due to a number of emerging global trends such as urbanization, globalization, and consumer concerns for food quality and safety. The operations 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 traditional Chinese fermented foods and indigenous plants and minor crops in Southeast Asia. These traditional or indigenous foods and food materials have potential to become the ingredients of substances with body-modulating abilities, which may lead to the development of the so-called "functional foods." The functions of such foods include improving gastrointestinal conditions, preventing age-related diseases, lowering high blood glucose and cholesterol levels, and treating hypertension. Investigating foods with such potential would be beneficial not only for consumers but also for farmers, by adding value to their products. Along these lines, some Chinese fermented foods have such useful properties, but their mechanisms of actions have not yet been clarified; hence, this presents challenging research themes, which could result in the development of new food-processing technologies.

In addition to studies on potential functional foods, the Division is currently conducting a research project entitled, "Development of low-input technology to reduce post-harvest losses of staples in Southeast Asia" in collaboration with universities and government research institutions in Thailand. The purpose of the project is to develop new methods of rice-disinfestation using natural enemies and bioactive botanical substances, and to develop low-input drying technologies using natural energy sources such as solar energy. The outcome of this project will contribute to minimizing losses associated with agricultural products that occur during handling, storage and transportation.

In addition to the above-mentioned research, the quality and characteristics of Japanese wheat are being studied in terms of its glutenin allele composition.

Fermented rice noodle production at a local factory in Changde, in Hunan Province, People's Republic of China.

TOPIC 1

Influence of natural fermentation on the physico-chemical characteristics of rice noodles

The natural fermentation of *Indica* rice is a traditional method used in producing high-quality rice noodles having specific functional properties in China. However, rice noodles produced in small, labor-intensive factories rely heavily on the worker's skill, and quality greatly varies with processing conditions. Little research has been done on the effects of fermentation on the physico-chemical characteristics of rice starch, and hence the effects of fermentation on rice noodles have not yet been elucidated. Thus, it is necessary to conduct studies in order to understand the relationship between fermentation and the rheological properties of rice noodles, as well as to standardize and increase the efficiency of its production. In addition, testing the fermentation technology for other rice cultivars and applying it to other starchy crops such as maize would contribute to increasing the value of raw grain materials. The overall objective of this study, therefore, was to investigate the influence of fermentation of whole-milled rice granules on the physico-chemical characteristics of rice starch and the rheological properties of rice noodles.

Rice granule samples were fermented at 35˚C for 27 h in an incubator until the pH value of the soaking water reached 4.0; samples soaked for 3 hours were used as a control, and were very similar to non-fermented rice noodles. Fig. 1 shows that the pH of the fermented supernatant decreased to a minimum of 4.0 over 18 hours. The maximum acidity reached was about 1.1 mg/mL (lactic acid) when fermented for 27 hours. Fermentation did not have a significant effect on the starch and amylose content of rice granules; protein, lipid and ash content decreased, whereas free fatty acid levels increased during fermentation. The rice noodles made from fermented samples had lower maximum stress of 54 kPa, and higher

Table 1. Rheological properties and sensory evaluation of rice noodles.

Samples	Fermentation	Control
Maximum tensile stress σ (kPa)	54.0 ± 2.0^{b}	144.9 ± 2.3^{a}
Maximum strain ε (%)	10.8 ± 0.4^{a}	8.2 ± 0.4^{b}
Apparent elasticity index E (kPa)	$4.99 \pm 10^{2} \pm 6.3^{b}$	$1.77 \pm 10^{3} \pm 68.3^{a}$
Break power W (N·cm)	0.33 ± 0.02^{b}	0.66 ± 0.03^{a}
Sensory evaluation results	Softy, pliable, clear, white and chewy	Firm, opaque, crumbly and not pliable

[a-b] mean values in each horizontal row followed by different superscripts are significantly different, as determined by Duncan's Multiple Range Test ($P < 0.05$).
All data are the means of 5 values ± standard deviation.

maximum strain of 10.8%, and had a white, transparent appearance and favorable chewiness compared to control samples (Table 1). From these results, we concluded that fermentation decreases protein, lipid and ash content, freeing complex starch and increasing its expansion, thus facilitating the formation of hydrogen bonds. In general, it is considered that rice stored previously for more than 6 months makes better rice noodles than newly-harvested rice. This may be due to a similar protein and lipid content decrease, or an increase of free fatty acid content during the storage period.

(E. Tatsumi and M. Saito)

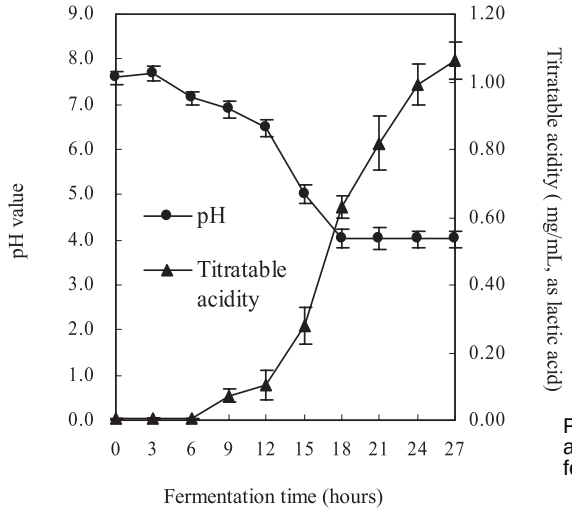


Fig. 1. Changes in pH values and titratable acidity of the fermented supernatant (n=3).

TOPIC2

Predatory ability of *Joppeicus paradoxus* Puton, a predator of stored-product insect pests

Methyl bromide (MeBr) is the one of the most useful chemical agents for insect control in stored products. Fumigation with MeBr, however, may have negative effects in terms of human health. More importantly, the use of MeBr has been found to lead to ozone depletion, and for this reason will be banned from use in most cases by 2005 in developed countries and by 2015 in developing countries. It is therefore urgent that we develop alternative methods and adopt integrated pest management (IPM) techniques. Biological control is thus being regarded with increasing interest, due to its nontoxic, human-safe, environment-friendly properties. The use of natural enemies (predators and parasitoids) in controlling stored-product insect pests has also been studied by various researchers worldwide.

The predacious bug, *Joppeicus paradoxus* is the only member of the Joppeicidae family (Fig. 1). There have been records of *J. paradoxus* in the Middle East and northern Africa, Egypt, Sudan, Ethiopia and Israel. Recently, *J. paradoxus* was also discovered in a stored-product environment, in a bean storage area in Thailand, which was coincidentally, one of the research sites for our project.

Fig. 1. An adult female *Joppeicus paradoxus*, known by its common Thai name, "Puton." Body length: 3 mm

In order to utilize *J. paradoxus* as a natural enemy, feasible insect pests in food-storing environments must be examined. Feasibility was checked for nine species of insect pests of the orders Coleoptera and Lepidoptera (Table 1). According to the results, *J. paradoxus* is able to attack many species of stored-product insect pests and prefers insect pests in their young larval stages to ones in their later stages of life.

The predatory ability of *J. paradoxus* towards two stored-product insect pests, *Tribolium confusum* in its last-instar larval stage, and *Plodia interpunctella* in its second instar larval stage, were examined. *J. paradoxus* adults were left unfed for three days and then placed individually into plastic containers containing different prey densities. The assay was carried out at 30˚C for 1 day. The predation index increased with the concentration and saturation of prey species (Tables 2 and 3). Especially toward the last instar larvae of *T. castaneum*, the mean predation activity index was six, which is three-fold higher than the mean predation index of *Xylocoris flavipes*, which is already on the U.S. market. These results suggest that *J. paradoxus* has a higher potential as natural enemy. A joint patent application among JIRCAS, the National Food Research Institute (NFRI), and Thai Department of Agriculture (DOA) for the elucidation of *J. paradoxus* as a bio-insecticide towards stored product insect pests and its application methodologies was submitted to the Japan Patent Office in January 2004.

(A. Miyanoshita and T. Imamura)

Table 1. Prey range of *J. paradoxus* on stored-product insect pests.

	Developmental stages			
Species	Eggs	Young larvae	Older larvae	Adults
Coleoptera				
Tribolium castaneum	○	○	○	
Tribolium confusum	○	○	○	
Tribolium freemani	○	○	○	
Oryzaephilus surinamensis		○	○	
Lepidoptera				
Ephestia elutella		○		
Ephestia kuehniella		○		
Ephestia cautella		○		
Corcyra cephalonica		○		
Plodia interpunctella		○		

○: feasibility as prey for J. paradoxus

Table 2. Mean values of predation on last-instar larvae of *T. castaneum*.

Prey density	4	8	12	16	20	24	28
	Number of predations						
J. paradoxus ♀	2.7	4.5	5.6	4.3	4.1	4.8	6.2
J. paradoxus ♂	2.4	4.9	6.9	7.5	5.7	6.1	6.0

Table 3. Mean values of predation on second-instar larvae of *P. interpunctella*.

Prey density	4	8	12	16	20	24	28
	Number of predations						
J. paradoxus ♀	2.8	4.1	8.5	9.2	10.7	12.7	13.5
J. paradoxus ♂	3.7	4.8	6.0	7.8	10.3	10.1	13.5

The specific glutenin *Glu-1* allele frequencies of Japanese hexaploid wheat (*Triticum aestivum* L.)

The quality of hexaploid wheat (*Triticum aestivum* L.), a grain favored for making high-quality bread and/or noodles, is strongly affected by the components of seed storage protein, particularly high molecular weight (HMW) glutenin subunits. The HMW glutenin 2.2 subunit controlled by the *Glu-D1f* allele is frequently found among Japanese hexaploid wheat varieties and landraces. According to a study of the worldwide distribution of *Glu-1* alleles in hexaploid wheats, the *Glu-D1f* is rare. However, the *Glu-D1f* allele was the most abundant hexaploid Japanese wheat seed storage protein allele (Table 1, Fig. 1).

The HMW glutenin 2.2 subunit controlled by the *Glu-D1f* allele was frequently found among improved cultivars as well as in Japanese landraces. The present study revealed the specific differences in frequency of the *Glu-D1f* allele for Japanese hexaploid wheat varieties and landraces. The allelic frequency of this subunit was shown to have a 35% excess among improved Japanese cultivars and 25.3% among Japanese landraces, while it was found in only 1.8% of 274 Chinese wheats targeted in this study. It is well known that the Chinese wheat has contributed to the development of Japanese landraces, and Japanese landraces led to the emergence of modern varieties now found Japan. However, from this study, it has become apparent that Japanese and Chinese hexaploid wheats differ a great deal in the frequencies of the *Glu-D1f* allele (Table 1).

As a consequence of its dissemination, adaptation and phenotypic refinement, Japanese hexaploid wheat has developed a unique composition of *Glu-1* glutenin alleles and a narrow hexaploid wheat genetic base (Table 2). Cultivars harboring superior bread-making quality have higher *Glu-1* quality values and tend to have limited genetic variation in their *Glu-1* loci, such as the *Glu-D1d* gene. This demonstrates a narrowing of genetic glutenin-protein variability when breeding hexaploid wheat for high-quality bread-making. It is also well known that the rich genetic diversity of hexaploid wheat landraces are resistant to multiple diseases, able to withstand environmental adaptations, and have agronomic traits of economic significance. There is a general understanding that *Glu-1* alleles could serve as markers for genes involved in adaptation. The range of *Glu-1* allelic variation in seed storage proteins that is currently available to wheat breeders is being extended by the introgression of glutenin alleles from primitive landraces and from alien hexaploid wheats. Linkage studies using SDS-gel electrophoretic screening to determine the relationship between seed endosperm glutenin protein genes and genes for other agronomic characters may enable the incorporation of desired traits into new hexaploid wheat cultivars. Desirable traits include improved cold tolerance, disease resistance and improved quality for Japanese soft noodle-making. The variability released by both environmental and genetic factors could easily lead to different subvarieties of the original species. This, in turn, could lead to the establishment of more than one reproductively-isolated population from a single base-species through population genetic mechanisms of hexaploid wheat. Under natural or human-induced factors, certain subspecies with desired traits can be selected for greatly reducing populations of non-selected groups and liberating available resources. Each of these bottlenecks is followed by a flush of rapid population growth, so once again there are optimal conditions to include genetic alterations. With this design from China, the hexaploid wheats were exposed to a selective bottleneck induced by the external environment, as well as a founder effect (since all populations went through small bottlenecks). Consequently, the selective bottleneck was extremely intense and, in fact, most ancestral populations may become extinct in Japan. It should also be pointed out that although the selective bottlenecks discussed in this study were primarily induced by genetic environment, most of the predictions made in this study would also apply if the selective bottlenecks were induced by external environments. The HMW-GS allele pattern of Japanese hexaploid wheat cannot be explained solely by the founder effect because the pattern was also affected by the artificial selection of bread-making or soft noodle-making quality in hexaploid wheat breeding programs. The ease with which genetic changes occur in Japan strongly implies a lack of genetic variability in natural populations of Japanese hexaploid wheats. The theory presented here has increased the explanatory powers of the wheat genetic revolution model of speciation and,

more importantly, has generated testable hypotheses that can be investigated in both natural and artificial selections using current methodologies and systems.

(H. Nakamura)

Table 1. Frequencies (%) of alleles for loci *Glu-A1*, *Glu-B1* and *Glu-D1* in Japanese and Chinese varieties.

Locus and Allele		Subunit	Chinese	Japanese improved	Japanese landraces	Published data distributed worldwide
Glu-A1						
	a	*1*	*5.2*	*12.2*	*4.6*	*32.8*
	b	*2**	*14.4*	*13.7*	*8.6*	*30.9*
	c	*Null*	*80.4*	*74.1*	*86.8*	*36.3*
Glu-B1						
	a	*7*	*12.3*	*0*	*1.7*	*12.9*
	b	*7+8*	*71.9*	*83.2*	*94.1*	*25.2*
Glu-D1						
	a	*2+12*	*84.6*	*55.0*	*70.1*	*52.9*
	d	*5+10*	*10.5*	*1.5*	*3.4*	*40.8*
	f	*2.2+12*	*1.8*	*35.1*	*25.3*	*rare*

Fig. 1. SDS-gel electrophoresis of common wheat seed storage proteins.

Table 2. Identification of Japanese and Chinese varieties with respect to HMW glutenin allele composition.

Chinese : Large genetic base

29 different glutenin HMW subunit compositions in *Glu-A1,-B1,D1*

a,a,a b,d,a c,b,f a,a,d b,f,a c,c,a a,b,a b,k,a c,c,b a,b,b c,a,a c,d,a a,b,d c,a,c c,e,a b,a,a c,a,d c,f,a b,a,d c,b,a c,g,a b,b,a c,b,b c,i,a b,b,f c,b,c c,i,f b,c,a c,b,d

Japanese: Narrow genetic base

17 different glutenin HMW subunit compositions in *Glu-A1,-B1,D1*

a,b,a b,g,a a,b,b c,b,a a,b,c c,b,d a,b,f c,b,f a,c,c c,c,a a,d,c c,c,f a,i,a c,e,a b,b,a b,b,f b,c,d

FORESTRY DIVISION

The increasing demand for food is compelling farmers to exploit larger amounts of arable land, leading to the massive decline of natural forests, particularly in 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 aimed to achieve the rehabilitation and sustainable management of forest areas therefore remains an urgent necessity. In order to keep forest decline in arrest, forest production systems and postharvest technologies should be improved and refined.

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

In tropical regions, mahogany and teak are considered to be among the most valuable and important commercial tree species. Insects such as the mahogany shoot borer, *Hypsipyla robusta*, and the teak beehole borer, *Xyleutes ceramica*, however, have infested plantations producing these tree species. In order to establish insect pest control methods, the Forestry Division proposed a new project in collaboration with the Royal Forest Department (RFD) of Thailand, initiated in Fiscal Year 2003. In this project, we aim to determine the chemical structure of sex pheromones of those insects so that we may utilize sex pheromones to monitor and control both species.

With the collaboration of the Forest Research Institute of Malaysia (FRIM), studies concerning sustainable management of hill forests were conducted in Peninsular Malaysia. Studies on the evaluation of the environmental impact of logging on hill forests were carried out at the Pasoh Forest Reserve in Negeri Sembilan State. Another study focused on sustainable production of *Shorea* is also being conducted in the hill forests of Semangkok Forest Reserve in Selangor State. Based on a growth survey of these six *Shorea* species planted under various topographies, sites suitable for their growth were recommended.

A mahogany plantation infested with shoot borer, *H. robusta*, at the Phu Thai Forest Station in Supanburi Province, Thailand. (Photo: K. Nakashima)

In addition, the Forestry Division initiated a joint research project entitled "Development of agroforestry technologies for the rehabilitation of tropical forests" in Fiscal Year 2000. The project was implemented mainly in collaboration with the Forest Research Center (FRC) of the Forestry Department of the State Government of Sabah, Malaysia. Through periodical measurements carried out at experimental sites at the GumGum, Kolapis and Segaliud-lokan research stations of the FRC, the growth and survival rates of various species planted under differing conditions of light are being investigated.

TOPIC 1

Techniques for recovering cleared forests in Semangkok, Malaysia.

In Malaysia, natural regeneration is a common method for recovering forests after the harvesting of commercial tree species such as *Shorea curtisii* and other *Shorea* species. Because most of the regenerated

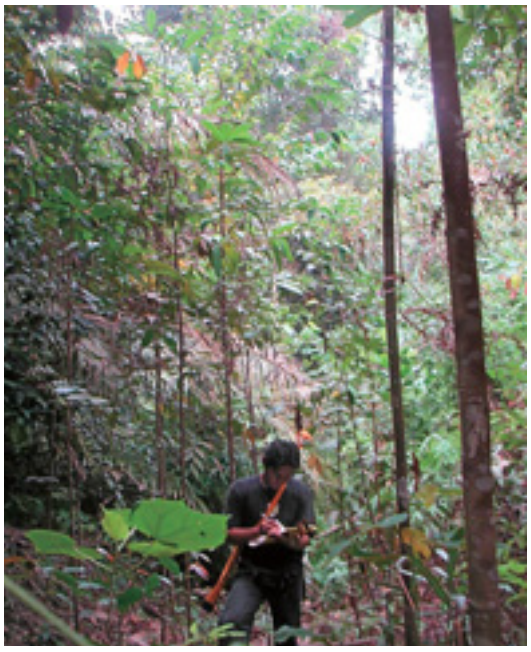


Photo 1. Trees planted on sloping ridges.

seedlings of these species, especially *S. curtisii*, are distributed on the upper areas of sloped regions rather than on the lower areas, only a few regenerated seedlings can be found in the lower sloped regions. Such areas require enrichment planting. Thus, it is necessary to investigate the growth of seedlings planted in the upper-sloped regions in order to evaluate the growth of seedlings planted in lower sloped regions.

Based on previous studies, the research site located in Compartment 28 of the Semangkok Forest Reserve, 60 km north of Kuala Lumpur, Malaysia, was considered to have favorable conditions suitable for the fast growth of seedlings. Planting sites were selected along a cleared forest road. The seedlings of six *Shorea* species were each planted on a level ridge, a sloping ridge, and in the lower parts of sloped regions in June 1997 (Photo 1). The scientific and common indications of the planted trees are the following: *Shorea curtisii* or Seraya; *Shorea leprosula* or Meranti Tembaga; *Shorea macroptera* or Meranti Melantai; *Shorea parvifolia* or Meranti Sarang Punai; *Shorea ovalis* or Meranti Kepong; and *Shorea acuminata* or Meranti Rambai Daun.

Examination of the average height of seedlings after six years of growth revealed that all species grow with greatest speed on sloping ridges that are located slightly lower than level ridges (Fig. 1). These results show that sites suitable for natural regeneration differ from sites that are suitable for enrichment planting. Among the six species, *Shorea parvifolia*, displayed the highest growth rates on level and sloping ridges, as well as in the lower parts of the slope, followed by *S. leprosula* and *S. acuminata. S. acuminata*, however, grew to be the tallest out of all the species on the lower slope regions where seedling growth is low. Based on these results, it can be concluded that in order to achieve the most efficient production of these species, natural regeneration should be conducted on the upper slope regions, whereas enrichment planting should be done on the lower slope regions. It is therefore recommended that *S. acuminata* be planted on the lower parts of sloped regions.

This study has provided basic knowledge for promoting the recovery of cleared forests. Production on the upper slopes can be recovered by natural regeneration, whereas lower sites can be recovered with enrichment planting. However, most of the planted trees were damaged by fern and climbers. In order to achieve the most satisfactory results, weeding and proper tending of the trees must be continued for more than ten years after planting.

(Y. Ochiai)

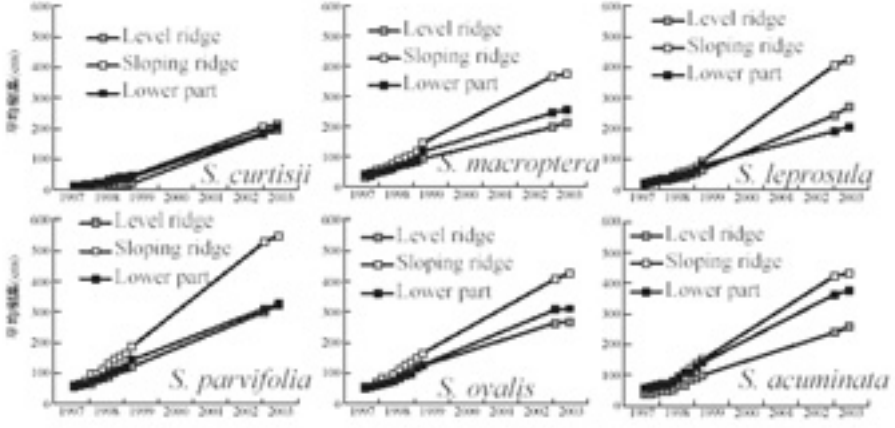


Fig. 1. Growth data for the six *Shorea* species planted in Semangkok, Malaysia.

Agroforestry experiment for rehabilitating tropical forests: Effects of forest canopies on initial seedling establishment and tending

Large-scale logging and excessive shift cultivation in Malaysian Borneo have led to the deterioration of natural forests, which were once rich in biological diversity and various renewable ecological resources. Such natural forests have been replaced with degraded land areas, oil palm plantations, degraded secondary forests, and fast-growing planted forests having less biodiversity, and fewer ecological resources and environmental functions. It is therefore necessary to enhance the quality of these degraded lands and forests. One method is to introduce various functional tree species and non-tree species, and convert them into mixed forests of high value. Such forests can provide a source of intermediate income or yield for establishing forests and are expected to contribute to improvements in the standard of living for local people. This study aims to develop an agro-silvicultural system in order to convert existing degraded natural forests and fast-growing planted forests into mixed forests.

We planted around 14,000 plants corresponding to 25 plant species including tree species suitable for high quality wood production such as *Dipterocarpaceae*, indigenous fast-growing tree species, tree species intended for non-wood production, fruits tree species, medicinal plants, and cash crops. The species were planted in thinning *Acacia mangium* plots (1.6 ha); secondary forests (2.9 ha) with lateral thinning plots in two directions, east to west and north to south; a sample plot planted with 6 exotic species; and in cleared forest sites (2 ha) from February to March 2002. Half of the plots were supplied with charcoal to examine effects on plant growth. The growth and survival of seedlings and light conditions were monitored every four months in order to investigate suitable thinning methods and nurse tree species, as well as suitable anchor species and companion crop species for establishing mixed forests. The necessary degree of weeding, which is crucial for the productive growth of seedlings, was studied as well. The results obtained in the initial experiments are as follows:

1) A majority of the plant species had higher survival rates in thinning plots (RLI: 10 to 20 %) and under canopies of exotic tree species than in cleared forest sites during the first 8 months after planting. In particular, *Dipterocarpaciea* species, except for *Parashorea tomentella*, showed much higher mortality rates in cleared forest plots (33% to 67%) than in thinning plots (0% to 16%) (Fig. 1).

2) Except for shade-intolerant tree species, including *Octomeles sumatrana* and some fruit tree species, most plant species including *Dipterocarpaceae* showed significantly higher growth rates in thinning plots than in cleared plots, and significantly higher growth rates in lateral thinning plots extending from north to south than lateral thinning plots extending from east to west (Fig. 2).

3) Among the exotic species studied, *A.*

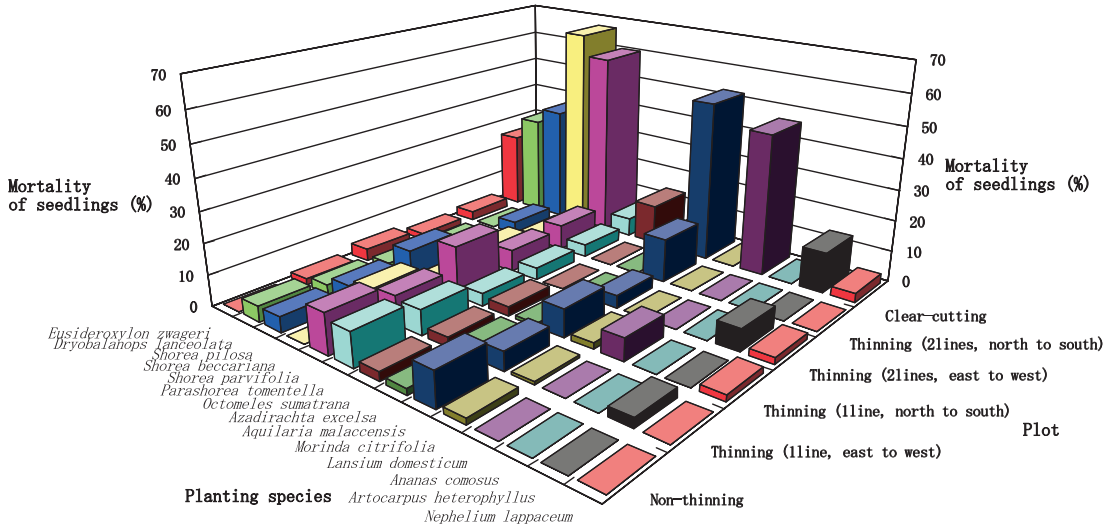


Fig. 1. Seedling mortality rates in thinning, non-thinning and cleared forest plots, eight months after planting.

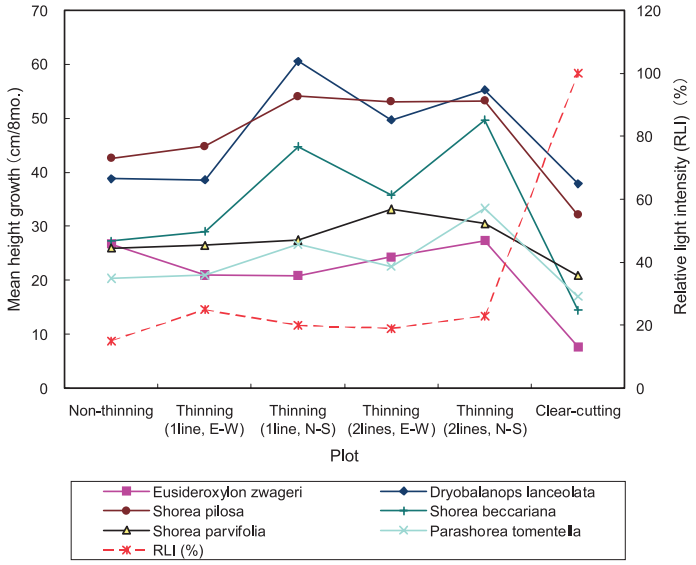


Fig. 2. Height growth of seedlings in thinning, non-thinning and cleared plots, eight months after planting.

mangium, *Paraserianthes falcataria*, *Pinus caribaea*, and *Terminalia ivorensis* provide suitable canopies in order to facilitate seedling establishment, based on the growth and survival rates of planted seedlings and undergrowth under exotic forest canopies.

4) Based on the recorded amount of time spent on weeding, questionnaires on weeding conditions in various sites, and pulse rate measurements of people conducting the weeding, it was found that weeding time was around 40% shorter and weeding conditions became less harsh in thinning sites than in cleared sites.

5) *Morinda citrifolia* came into bearing around eight months after planting in thinning plots as well as cleared plots (Fig. 3). This medicinal plant species had a high growth rate in thinning plots as well as in cleared plots. In addition, none of its fruits were eaten by wildlife, whereas all pineapple fruits were devoured by wild pigs prior to harvesting in both thinning and cleared plots. From these results, *Morinda citrifolia* is expected to be a promising medicinal companion species for planting in our research sites as long as initial growth stage in taken into consideration.

Fig. 3. *Morinda citrifolia* fruits in a thinning plot.

These results suggest that moderate shade (RLI: 10-20%) cast by forest canopies may facilitate seedling establishment and reduce the amount of necessary weeding, and thus saving weeding costs in comparison with conventional planting in cleared forest sites. The results of initial monitoring also suggest that many tree species and fruit tree species planted in experimental sites may possibly be used as anchor (crop) species, while *Morinda citrifolia* would be a useful companion species for sustainable medicinal fruit production in the establishment of sustainable mixed forests.

(K.Kamo)

FISHERIES DIVISION

The JIRCAS Fisheries Division holds the following two objectives regarding domestic and overseas research: firstly, to support stable food security in developing countries by utilizing basic and applied research; and secondly, to develop an efficient means of conserving bio-resources while allowing for their utilization.

Some of the goals of the first objective have been achieved through a project promoting the utilization of freshwater fishes in China. As part of an international project "Development of Technology for Utilization and Processing of Freshwater Fisheries Resources" which was launched in 1997 due to a sharp increase in inland aquaculture production in China (reaching 15 million tons in 2001), a subproject was produced as the result of the discussion on bio-resource utilization systems between the Shanghai Fisheries University and JIRCAS. Consequently, production methods of "surimi" (fish paste) using freshwater fish such as silver carp have already been established. Fish wastes, which are usually discarded after the removal of edible parts, are a source of environmental pollution, and their utilization in preparing fishmeal is now being investigated in a follow-up project. The outcome of this project is expected to allow the effective utilization of bio-resources from catch to consumption, without exacerbating problems of environmental pollution in the

process.

Regarding the Division's second objective, the utilization of bio-resources in many areas has developed in absence of appropriate economic planning, resulting in a continuous decrease in catch. This trend has been particularly noticeable around mangrove areas in tropical and subtropical countries. We have therefore initiated a project elucidating the life cycles and ecology of fish and shellfish species of economic value, aiming to develop a means of maintaining and restoring the environment and rehabilitating bio-resources in the brackish water areas of Malaysia, the Philippines and Thailand. In addition, in order to promote the coexistence of aquaculture ponds and mangrove forests, research examining how water exchange can be performed between these two entities, leading to a stabilization of environmental conditions and reduction of the effects of aquaculture effluent in the environment. More specifically, in a simulation experiment, water from aquaculture ponds containing organic matter was allowed to flow into a mangrove enclosure; in turn, the aquaculture ponds received plankton-rich water from the mangrove enclosures. This procedure was found to be useful in preventing environmental deterioration in both entities.

Through cooperative work in the Philippines with the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD), tropical and subtropical mangrove fish species were found to harbor high levels of arachidonic acid in fry and adult fish in comparison with those of fish species living in cold or temperate waters. It was thereby revealed that arachidonic acid has nutritional significance in relation to egg development and larval growth; thus, high levels of the acid reflect high egg quality and fecundity. Currently in a follow-up project, research is being focused on promoting the cultivation of high quality mangrove fish species through the incorporation of arachidonic acid in the diet of female parents in seed production operations.

Finally, in order to develop freshwater prawn seed production and aquaculture technology suitable for use in the Mekong Delta region of Vietnam, JIRCAS initiated collaborative research with Vietnam's Cantho University in 1994, which was concluded during this fiscal year. During the course of this project, usable technology was realized, contributing to the further development of the freshwater prawn culture industry in Vietnam. In addition, basic studies at JIRCAS's Tsukuba premises have been conducted on reproductive and osmoregulatory mechanisms in support of the above project.

Participants of the workshop "Development of Technology for Utilization and Processing of Freshwater Fisheries Resources" pose for a group photograph in Shanghai.

The importance of arachidonic acid in fry production of tropical/subtropical fish species

The mass production of marine fish fry used in aquaculture and aqua-ranching has progressed remarkably due to the discovery of the nutritional importance of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) to marine fish, and the establishment of cultivation technologies of EPA/DHA-enriched feeds. As of now, most studies on essential fatty acids in relation to fry production have been focused on EPA and DHA. However, emphasis has not been previously placed on the importance of arachidonic acid (ArA), since ArA is found in only small quantities in cold/temperate water fish. In a preliminary study, we discovered that the eggs and larvae of the mangrove red snapper (*Lutjanus argentimaculatus*) contain relatively high ArA contents compared to fish living in cold/temperate waters. Moreover, information on the fatty acid composition of eggs and gonads of tropical and subtropical fish has been relatively limited until the present. We thus investigated ovarian fatty acid composition of aquacultural fish in the central Philippines and southern Japan, paying special attention to ArA and EPA content. Ovarian polar lipids were found to have intermediate or high ArA levels, but relatively low EPA levels; consequently, high ArA/EPA ratios (>4.0) were observed in wild mangrove red snapper, two species of rabbitfish (*Siganus guttatus* and *S. canaliculatus*) and coral trout (*Plectropomus leopardus*), all of which were sampled in the central Philippines (Fig. 1). Similar trends were observed in wild coral trout, rabbitfish (*S. guttatus*), humpback snapper (*L. gibbus*), ornate jobfish (*Pristipomoides argyrogrammicus*) and brassy chub (*Kyphosus vaigiensis*) in southern Japan (Fig. 2). Not only ovaries, but also muscle and liver contained relatively higher ArA levels than EPA levels in all species in the present study, regardless of the sample source (data not shown). Fig. 3 shows ArA and EPA levels of polar lipids in wild-caught and hatchery-produced mangrove red snapper fry (whole). The hatchery-produced fry displayed lower ArA levels and higher EPA levels than did wild-caught fry. Overall, aquacultural species in central Philippines and southern Japan show high ArA and low EPA content, thus having high ArA/EPA ratios relative to cold/temperate water fish. The present results indicate that ArA is not a minor component of the eggs and larvae of tropical and subtropical fish, suggesting that ArA may have greater nutritional significance in relation to egg development and larval growth in tropical/subtropical fish than in cold-water fish. This information can be utilized in formulating guidelines for the future

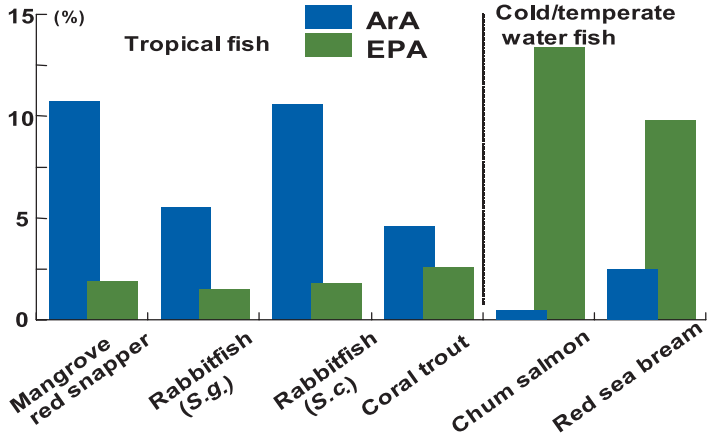


Fig. 1. ArA and EPA levels (%) of ovarian polar lipids in tropical fish in the Philippines (mangrove red snapper, rabbit fish and coral trout), cold-water fish (chum salmon) and temperate water fish (red sea bream).

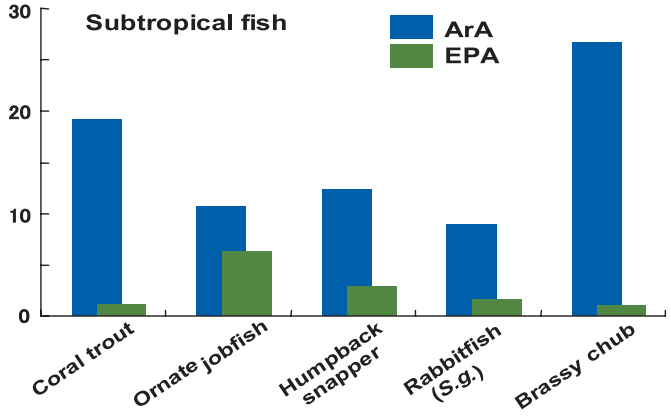


Fig. 2. ArA and EPA levels (%) of ovarian polar lipids in subtropical fish (southern Japan).

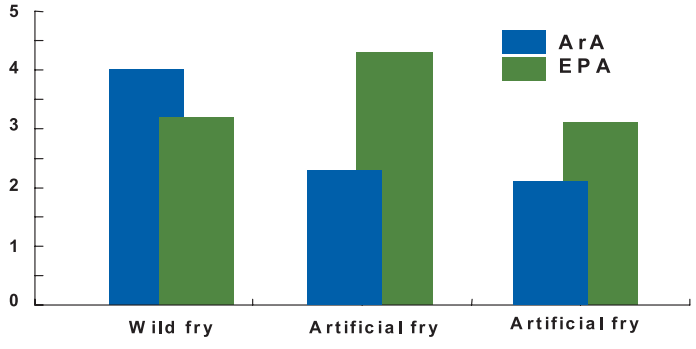


Fig. 3. ArA and EPA levels (%) of wild-caught and hatchery-produced mangrove red snapper fry.

development of appropriate broodstock cultivation technology and larval diet development in tropical and subtropical areas. As of yet, the present findings on the potential value of ArA have not been applied to fry production technology in tropical/subtropical areas, but broodstock management and larviculture technologies based on the nutritional traits of tropical fish should be developed as rapidly as possible in order to stabilize fry supply and availability. Along these lines, we have initiated a follow-up project on the effects of dietary ArA on egg/larval quality in mangrove red snapper.

(H.Y. Ogata)

TOPIC 2

Elucidation of natural purification capabilities in mangrove ecosystems

The brackish waters of mangrove areas are of significant importance to the growth of marine organisms; productivity in these areas is high due to an abundant supply of nutrients derived from the land, allowing the formation of diverse ecosystems. In some developing countries, the over-establishment of shrimp aquaculture ponds has led to a decline in the self-purification capabilities of the brackish waters, resulting in the decline of mangrove areas and the deterioration of the coastal environment. Disease outbreaks and the phenomenon of pond abandonment have accompanied the above problems. In order to develop an environment-friendly aquaculture system utilizing the natural purification capabilities and high productivity of mangrove brackish waters, water was circulated between aquaculture ponds and mangrove enclosures. The continuous flow of water from aquaculture ponds maintained water and mud quality, while aquaculture ponds received plankton-rich water from the mangrove enclosures (Fig. 1).

The experiment was conducted at the Samut Songkhram Coastal Aquatic Research Station, Faculty of Fisheries, Kasetsart University, Thailand. Three ponds were used for shrimp cultivation and two were planted with mangroves. Ten thousand shrimp larvae (*Penaeus monodon* at PL-15 stage) were stocked in Ponds 1 and 5, and 20,000 larvae were stocked in Pond 2. One-year-old mangrove trees (*Rhizophora mucronata*) had been planted in Ponds 3 and 4. Pond 1 was the control pond, in which the water was left unchanged. About 30% of the water in Ponds 2 and 5 were circulated into the mangrove enclosures every Thursday, and the same quantity was returned to the shrimp ponds every Monday.

Survival rate was highest, and the feed conversion ratio (quantity of feed per unit weight increase) was lowest in Pond 5, in which larvae were stocked at low density, and the water was exchanged with mangrove water. Thus, Pond 5 achieved the most efficient level of aquacultural production.

In Pond 1, about 14% of total phosphorus (P) provided was consumed by the shrimps

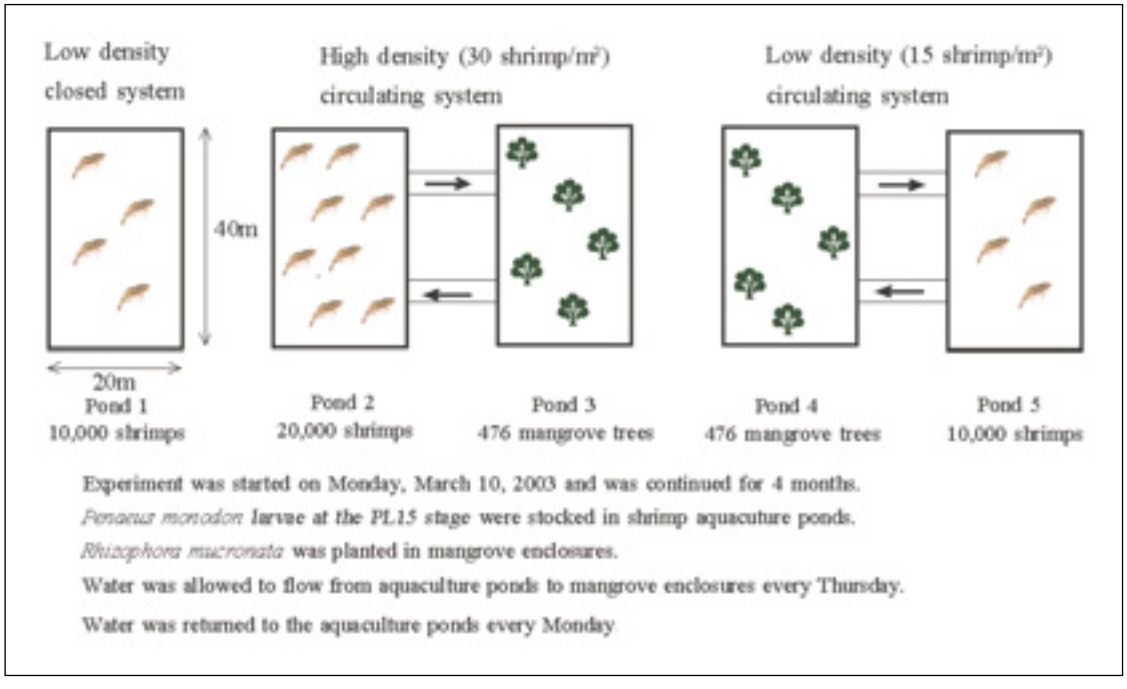


Fig. 1. Outline of the water exchange experiment.

(Table 1), and P content in the mud exceeded the amount provided in the feed. As a result, the P budget for Pond 1 was negative. This suggests that extra P was supplied from another source. We believe that anoxia was responsible for the release of P from the lower depths of the ponds. In Pond 2, 11% of the provided P was consumed by the shrimps. The budget results suggest that 1.55 kg of P flowed into the mangrove-planted pond. In Pond 5, about 15% of the provided P was consumed by the shrimps. Although the budget results were negative, it was higher than that of Pond 1. If the same quantity of P in Pond 1 had been supplied in Pond 5 from the lower depths of the pond, about 0.43 kg of P should have flowed into the mangrove ecosystem. As a result, deterioration in the lower pond environment was reduced in Ponds 2 and 5 via the circulation of water between the shrimp and mangrove ponds, in comparison to the control. Because the P budget was higher in Ponds 2 and 5 relative to the control, environmental burden in the ponds was reduced.

(T. Shimoda)

Table 1. Phosphorus budget in each shrimp pond.

		Pond 1	Pond 2	Pond 5
Input	Phosphorus supplied from feed	2.09	4.36	2.19
Stored	Accumulated phosphorus into shrimp at harvest	0.29	0.48	0.32
	Phosphorus in snails	0.26	0.24	0.00
	Phosphorus in barnacles	0.03	0.02	0.04
	Phosphorus in water	0.08	0.20	0.07
	Phosphorus in soil	2.97	1.86	2.86
	Budget (input−stored)	−1.54	1.55	−1.11

OKINAWA SUBTROPICAL STATION

The Okinawa Subtropical Station was originally established in 1970 on Ishigaki Island as a branch facility of JIRCAS's predecessor, the Tropical Agricultural Research Center (TARC). Ishigaki Island, the largest among the southernmost islands of the Ryuku Islands, is located at 24˚N and 124˚E longitude, thus having environmental conditions similar to that of tropical and subtropical regions of the world. The International Collaborative Research Section was additionally established at the Station in October 1993, at which point TARC was reorganized as the Japan International Research Center for Agricultural Sciences (JIRCAS). In addition to this Section, the Station currently consists of five laboratories: the Islands Environment Management Laboratory, the Environmental Stress Laboratory, the Tropical Crop Breeding Laboratory, the Tropical Fruit Crops Laboratory and the Plant Protection Laboratory. A total of 22 researchers, in addition to administrative staff, and a number of visiting research fellows resided at the Station during Fiscal Year 2003. Researchers and visiting fellows conducted research aiming to develop technologies for sustainable agricultural production in the tropical and subtropical regions of the world, making full use of the natural and environmental conditions of the Ishigaki Island,.

From the perspective of global climatic and environmental changes, the Station is now serving in a novel role in relation to promoting the sustainability of island environments. A new experimental facility, the Islands Environment Technology Center, was opened in July 2003. The facility includes large-scale lysimeters, which are capable of accurately measuring the transpiration of crops, evaporation and infiltration of soil water, and water movement in a soil-crop continuum. In run-off plots sloped at 2, 3.5 and 5 degrees, the effects of soil management and planting of different crop varieties on erosion mechanisms is now being examined in a new research project. The results of this study will allow the innovation of increasingly effective countermeasures. The addition of these facilities is now contributing to the bolstering of research activities at the Station and is expected to lead to a better understanding of tropical and subtropical island environments, and consequently, the development of more sustainable agricultural production in those regions.

Citrus Huanglongbing (HLB) or greening is a serious disease threatening citrus production not only in Southeast Asian countries, but also in the southwestern islands of Japan. The Plant Protection Laboratory, which has been conducting studies on this disease, will be fully involved in a new project, starting in April 2004 for five years, entitled, "Development of new technologies for control of Citrus Huanglongbing (HLB) in Southeast Asia." Topic 5 of this section describes a newly established method for the quantification of pathogens residing in citrus trees. The other four topics highlight research results obtained during Fiscal Year 2003 at the Station are as follows: estimated runoff of soil, nitrogen and phosphorus in the Miyara River on Ishigaki Island; possible reduction of nitrogen fertilizers in sugarcane cultivation by using controlled release fertilizers; characterization of powdery mildew resistance found in wild-grown relatives of adzuki bean; and developmental growth of cotton stainer bugs fed with various plant seeds including those of wild species.

Large-scale lysimeters at the Islands Environment Technology Center. Inset: recording equipment in the basement of the facility automatically measures temperatures and moisture levels of the soil.

TOPIC 1

Runoff of suspended solids, nitrogen and phosphorus estimated from catchment basins of Miyara River on Ishigaki Island

It is commonly known that large amounts of eroded red soil, which flow into the seacoast via rivers from agricultural fields and other various bare lands adversely affect natural ecosystems such as coral reefs and fisheries in the subtropical islands of Japan. Marine pollution, which is caused by nitrogen and phosphorus emitted from chemical fertilizers and animal wastes, have recently become an increased threat to the environment, particularly in these coastal areas.

There is little data available on the actual amounts of suspended solids, nitrogen and phosphorus that flow into the island ecosystems. Therefore, concentrations of these chemicals and the flow volume of the Miyara River in Ishigaki Island were monitored for 3.5 years from May 1999 to December 2002. The quantities of these substances carried by the river were directly related to the actual flow, which increased with the increase in rainfall runoff, and with the increase in nitrogen and phosphorus usage. The amounts of applied chemical fertilizers and produced livestock excretions were calculated based on the agricultural statistics of Ishigaki City.

Total nitrogen concentrations were low in the upper reaches of the river and rose gradually with the decrease in distance from the river mouth (Fig. 1), most likely because many forests are located upstream, and the main sources of nitrogen, such as agricultural fields, are located downstream. In addition, the data in Fig. 1. implies that nitrogen pollution was brought about by animal

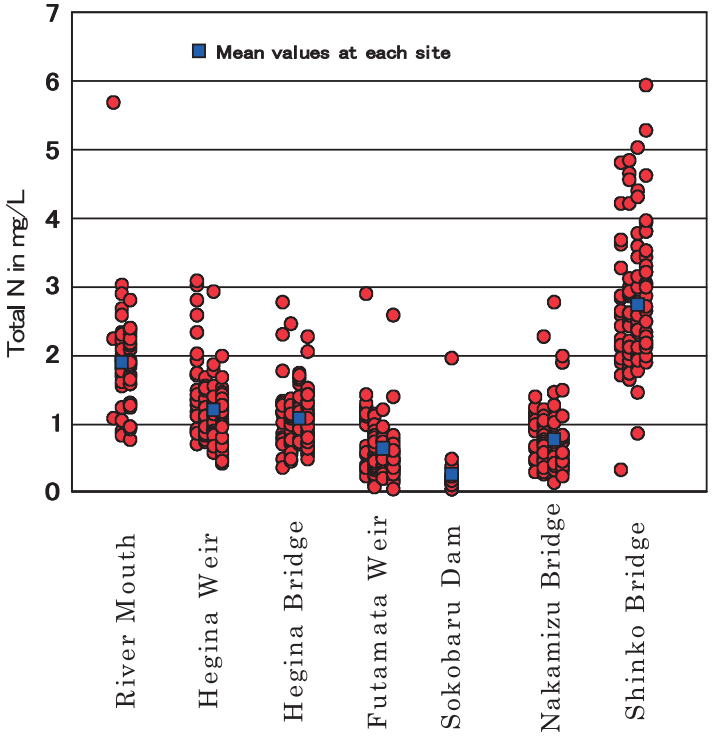


Fig.1. Changes in total N concentrations from the river mouth to the upper reaches of the Miyara River.

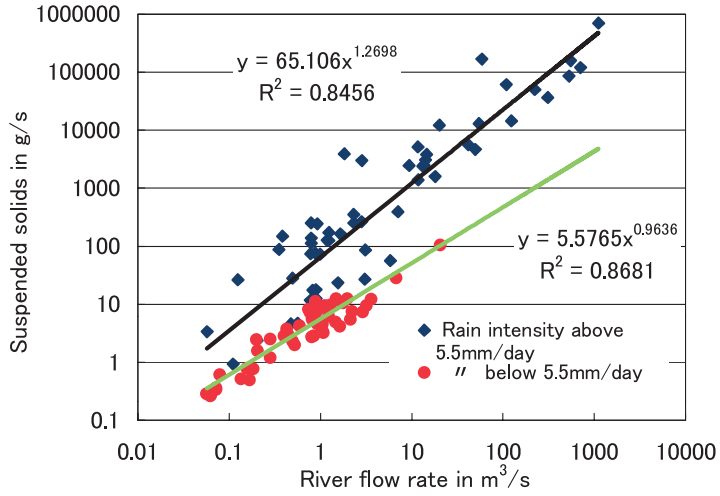


Fig. 2. Relation between river flow rates and quantity of suspended solids.

husbandry practices; the results show higher total nitrogen concentrations at the Shinko Bridge near the river tributary, where a large livestock breeding complex is located, in comparison to the lower concentrations recorded at the Nakamizu Bridge, located upstream near paddy fields.

According to the results, there are direct correlations between the flow rate of suspended solids and river flow rate (Fig. 2), and between nitrogen flow rate and river flow rate. Thus, we were able to calculate the flow rates of suspended solids and nitrogen based on river flow rates and regression equations. Two regression equations were derived from data for the flow rates of suspended solids, with an upper threshold value of 5.5 mm /day rainfall.

The quantity of suspended solids, nitrogen and phosphorus, which flow through the Miyara River, into the seacoast per year were estimated to be 1882 tons, 68 tons and 7 tons, respectively. Based on this data, 0.2 mm of surface soil are calculated to erode from agricultural fields in a period of one year, and 25% and 6% of the total amounts of nitrogen and phosphorus used in agriculture and discharged from livestock excretions will flow into Miyara River in one year.

(K. Banzai, K. Nakamura, A. Khondaker, F. Nagumo)

TOPIC 2

Improved sugarcane cultivation in the subtropical islands of Japan using controlled-release N-fertilizers

Nitrate pollution in ground water has become a serious problem worldwide; one of its causes is known to be the excessive use of nitrogen fertilizers in agricultural production (Fig. 1). Using water containing nitrate-nitrogen concentrations above the standards of the World Health Organization's (WHO) (10 mg/L) leads to agricultural products becoming unsuitable for human consumption, particularly for infants ("blue baby disease"). Nitrate pollution has become much more serious in the past few years at Miyako Island, Okinawa Prefecture, where people are entirely dependent upon subsurface dam water, which is currently polluted with nitrate. Sugarcane is the dominant crop in the subtropical southwestern islands of Japan, occupying about 60% of cultivated land area; consequently, reduction of nitrogen fertilizers used in sugarcane cultivation may help reduce levels of nitrate pollution in ground water. Field trials were therefore conducted using the sugarcane variety "Norin No. 8" and controlled-release N-fertilizer, LPS160, on yellow soil at the Okinawa Subtropical Station in order to develop practical procedures for reducing nitrogen loss from sugarcane fields.

LPS160 is a form of coated urea. In the experiments, nitrogen was gradually percolated over a period of 160 days along a sigmoid curve, which nearly fits the nitrogen requirement curve for sugarcane growth. The trials were carried out as follows. Plant density was set at nine plants per plot (1.4 m×3.0 m = 4.2 m^2), with 1.4 m row spacings and 0.35 m plant hill spacings using two plots. Sugarcane was planted in February 1999 and harvested in January 2000. In the control plot using conventional treatment, ammonium sulfate was applied at a rate of 60 kgN/ha in March as the basal dressing and 60 and 80 kgN/ha for the top dressing in April and June, respectively, coming to a total of 200 kgN/ha. In the LPS160 treatment, 60 kgN/ha of coated urea (controlled-release N-fertilizer) was combined with 200 mL of vermiculite and used for seedling establishment in February 1999; the seedlings were then transplanted to experimental plots in March, with 60 kgN/ha of ammonium sulfate basal dressing. The trials showed that about 40% of nitrogen fertilizer usage could be cut down without causing reduction in expected sugar yield (Table 1). The weight of sugarcane stalks, Pol percent cane (sucrose content of juice) and expected sugar yield did not decrease in the LPS160 treatment (40% reduced nitrogen) compared to those of plants that underwent conventional fertilizer treatments.

In the following growing season, February

2000 to January 2001, the labeled ^{15}N tracing technique was used to determine how much nitrogen is absorbed by sugarcane from each nitrogen source. The apparent nitrogen absorption rates were estimated as 57.7% in conventional and 90.9% in LPS160 treatments (Fig. 2), and labeled ^{15}N absorption rates were calculated as 22.4% and 38.8%, respectively. Judging from these results, it seems possible to reduce nitrate-nitrogen leaching to ground water by application of LPS160.

(T. Masuda, Y. Katsuta, K. Sugahara, K. Banzai, and K. Shibano)

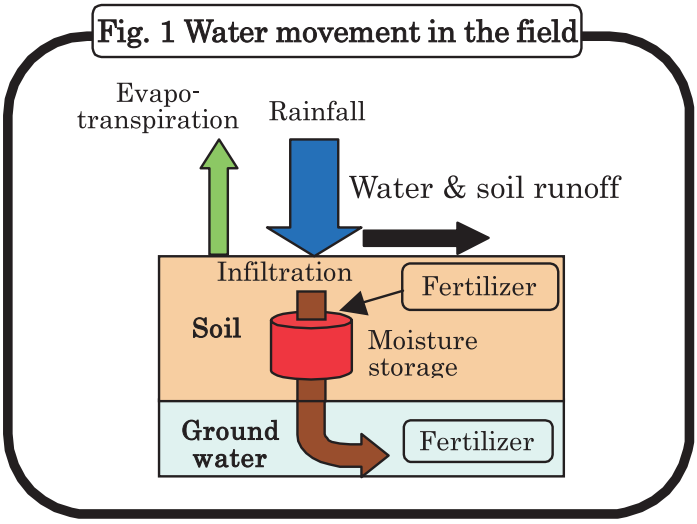


Table 1. Comparison of sugarcane yields between plants grown with conventional and LPS160 (40%-reduced nitrogen) treatments in spring planting.

Treatment	Nitrogen dose (kgN/ha)	Weight of stalks (ton/ha)	Pol percent cane (%)	Expected sugar yield (ton/ha)
Conventional	Basal dressing (60) + Top dressing (60) + Top dressing (80)	94.3	15.05	13.2
LPS160 (40% reduced nitrogen)	Basal dressing (60) + LPS(60)	89.5	14.96	12.5

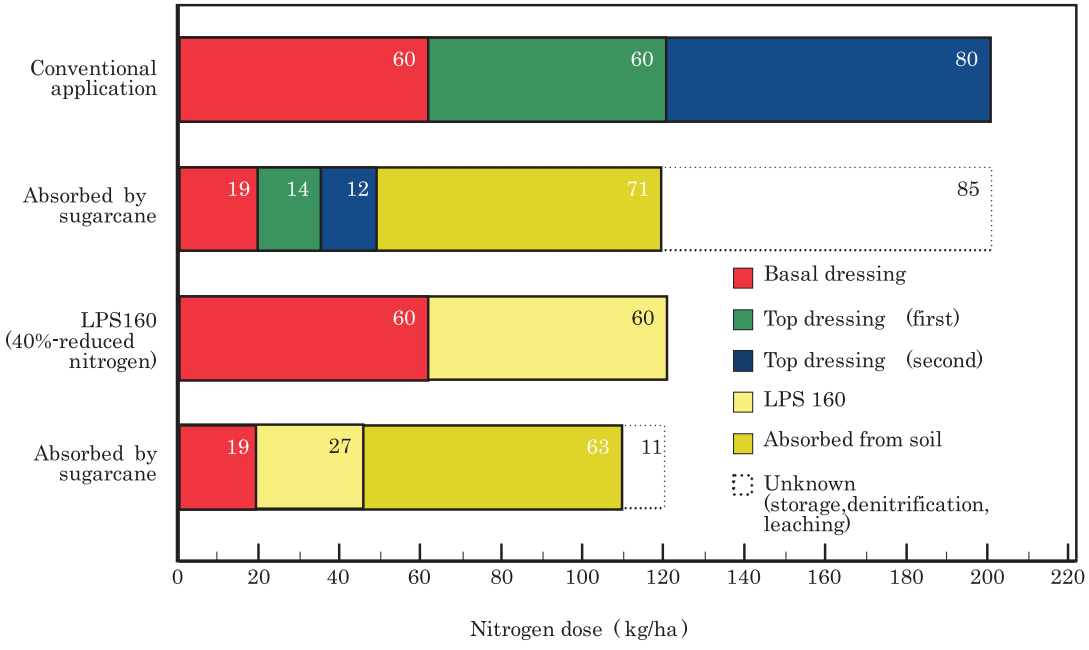


Fig. 2. Sources of nitrogen absorbed by sugarcane.

Development of powdery mildew-resistant adzuki bean using wild adzuki bean germplasm

Powdery mildew, or *Podosphaera phaseoli*, is a serious fungal disease threatening the cultivation of adzuki bean in tropical and subtropical regions. At present, resistant genotypes have not yet been detected in cultivated adzuki bean germplasm. In a greenhouse screening trial at the Okinawa Subtropical Station, we inoculated wild adzuki bean germplasm accessions (mainly collected by JIRCAS) with powdery mildew during their seedling stages by dusting them with spores of infected leaves using a soft brush.

Cultivated and wild ancestral forms of adzuki bean (*Vigna angularis* var. *angularis* and var. *nipponensis*, respectively), *V. nakashimae* and *V. riukiuensis* were highly susceptible to the disease, whereas *V. hirtella* exhibited resistance (hypersensitivity). *V. hirtella* was discovered to have high cross-compatibility with adzuki bean, and we have successfully obtained fertile F_1 hybrids from them. These F_1 hybrids exhibited resistance like that of *V. hirtella* when artificially inoculated (Fig. 1). Types of reactions to powdery mildew pathogens on primary leaves of 8 day-old BC_1 plants obtained from adzuki bean and *V. hirtella* were segregated into 24 resistant types (R) and 21 susceptible types (S), with the $\chi 2$ value for 1:1 segregation being 0.2 (0.7>p>0.5)(Fig. 2).

Judging from this ratio and the resistance found in the F_1 plants, it was concluded that a single dominant gene is responsible for the resistance exhibited by *V. hirtella*. Since the resistance was verified by artificially inoculating all progeny plants, it is anticipated that resistant adzuki bean varieties will be easily obtained through successive backcrossing to commercial cultivars. Currently, we are recurrently backcrossing to cv. 'Erimo shozu' to develop new powdery mildew-resistant adzuki bean varieties.

(Y. Egawa, K. Kashiwaba, H. Ohmae and M. Shono)

Fig. 1. Types of reactions to the powdery mildew pathogen, *Podosphaera phaseoli* on F_1 plants derived from adzuki bean and *V. hirtella* (left: resistant) and adzuki bean cv. 'Erimo shozu' (right: susceptible).

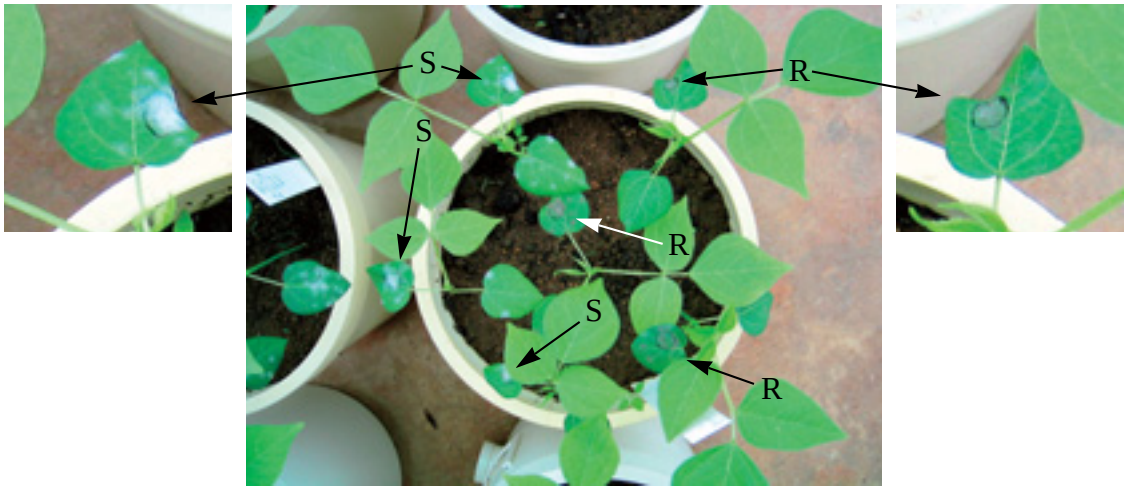


Fig. 2. Types of reactions to the powdery mildew pathogen, *Podosphaera phaseoli* on primary leaves of 8-day-old BC_1 plants obtained from adzuki bean and *V. hirtella* 5 days after inoculation. Resistant leaves are indicated by the letter 'R' while susceptible leaves are marked with the letter 'S.'

Effects on the growth of the cotton stainer bug *Dysdercus cingulatus* when fed various host plant seeds including those of wild species

Cotton is the world's most widely-used natural fiber. One of the major obstacles hindering cotton production is insect pest infestation; cotton stainers (*Dysdercus* spp.; Heteroptera: Pyrrhocoridae), in particular, are difficult to control by insecticide application in cotton fields because they are very mobile and have many alternative host plants. Among them, *Dysdercus cingulatus* (Fig. 1) is the most serious pest species of cotton in southeast Asian countries, having many alternative host plants species, including malvaceous and bombacaceous plant species. Therefore, investigation of the developmental properties of bugs fed with host plants other than cotton is crucial for the prediction of the time of invasion into cotton fields and for effective pest control utilizing insecticide application. In addition, the growth of *D. cingulatus* including its temperature dependency was examined when fed with seeds of cotton, okra, and several other wild and ornamental plant species which are common host plants of *D. cingulatus* in southeast Asia and on Ishigaki island.

Seeds of commercially-cultivated species (cotton plant *Gossypium arboreum* and okra plant *Abelmoschus esculentus*), wildly-grown species (musk-mallow *A. moschatus*, portia tree *Thespesia populnea*, Sakishima cotton-rose *Hibiscus makinoi*, sea hibiscus *H. tiliaceus* and Indian mallow *Abutilon indicum*), and ornamental species (wood cotton *Chorisia speciosa*) were provided as experimental feed to examine the growth properties of *D. cingulatus*. The survival rates of bugs in their nymphal stages and developmental rates when fed respective plant species displayed significant correlations ($p < 0.05$ by Kendall's t); species that exhibited faster nymphal development also exhibited higher nymphal survival rates and vice versa. Thermal requirements for the development of *D. cingulatus* were estimated from data for 20, 22.5, 25, 27.5 and 30 ˚C and 14L–10D when fed with seeds of eight different plant species are shown in Table 1. These results suggest that ornamental species (*Ch. speciosa*) and a few wild species, *Th. populnea* and *H. makinoi* in particular, are good host plant species for *D. cingulatus* as well as commercially cultivated species. Since all examined wild plant species excluding *H. makinoi* are commonly distributed in southeast Asian countries, of which *Th. Populnea* is judged to be an especially suitable host plant species for *D. cingulatus*, the results of this study and information on the occurrence of *D. cingulatus* on these plant species will form a solid foundation for the determination of insecticide application in cotton fields of southeast Asian countries.

(K. Kohno)

Fig. 1. Cotton stainer bugs (*Dysdercus cingulatus*) sucking ripe cotton bolls.

Table 1. Thermal requirements for the development of *Dysdercus cingulatus*, estimated from data for 20, 22.5, 25, 27.5 and 30 ˚C and 14L–10D when fed seeds of eight plant species.

Stage	Host plant	Regression equation	r^2	Lower threshold temperature (˚C)	Total effective temperature (day·˚C)
Egg		$v = -0.21469 + 0.013629\,t$	0.979	15.8	73.4
Nymph	Wood cotton (*Chorisia speciosa*)	$v = -0.04704 + 0.003260\,t$	0.976	14.4	306.7
	Cotton (*Gossypium arboreum*)	$v = -0.03950 + 0.002850\,t$	0.991	13.9	350.8
	Okra (*Abelmoschus esculentus*)	$v = -0.03730 + 0.002661\,t$	0.957	14.0	375.8
	Musk-mallow (*A. moschatus*)	$v = -0.03632 + 0.002563\,t$	0.964	14.2	390.2
	Portia tree (*Thespesia populnea*)	$v = -0.03628 + 0.002593\,t$	0.984	14.0	385.6
	Sakishima cotton-rose (*Hibiscus makinoi*)	$v = -0.03507 + 0.002501\,t$	0.959	14.0	399.8
	Sea hibiscus (*H. tiliaceus*)	$v = -0.03037 + 0.002174\,t$	0.979	14.0	459.9
	Indian mallow (*Abutilon indicum*) *	$v = -0.02076 + 0.001556\,t$	0.997	13.3	642.8

* based on data measured under conditions of 22.5, 25, 27.5, and 30˚C

Quantification of citrus-greening disease pathogens using competitive PCR

Huanglongbing (HLB, also known as citrus greening) is one of the most severe diseases affecting citrus production in tropical and sub-tropical regions of the world, and has recently spread to citrus orchards in southern areas of Japan. Diagnosis of this disease is usually conducted through symptom observation and PCR detection, but these methods do not allow the quantification of pathogen numbers.

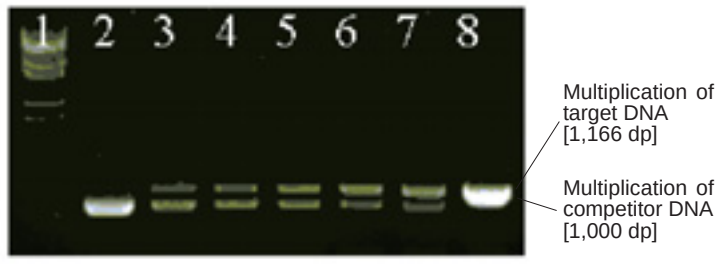


Fig. 1. An example of competitive PCR. Lane 1: DNA size markers (λ - Eco T141 digest). Lane 2: Multiplication of competitor DNA. Lane 3-7: 1pM target DNA and competitor DNA, concentrations of each lane are 100pM, 10pM, 1pM, 100nM, and 10nM, respectively. Lane 8: Multiplication of target DNA.

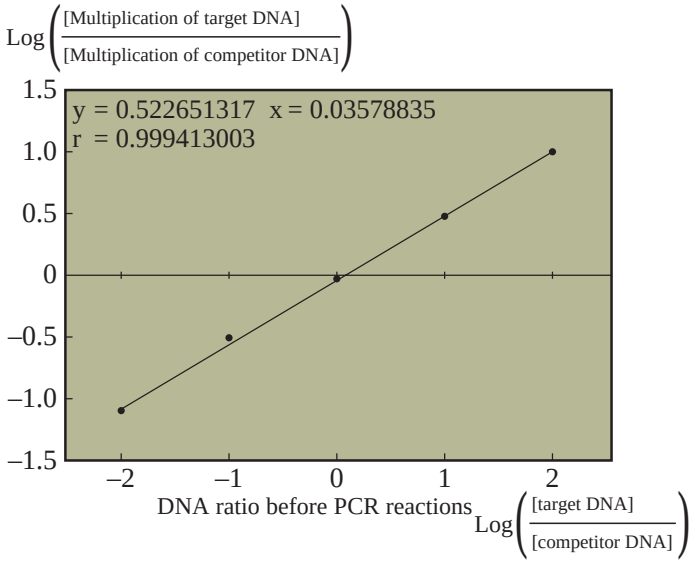


Fig. 2. Competitive reactions between target DNA and competitor DNA.

Table 1. Quantity of pathogens in infected citrus leaves.

Cultivar name (in Vietnam)		Quantity (fmol/g・fw)*2			
		Max.	Min.	Avg.	S.D.
Cam Sanh	47	92.9	0.0	35.3	23.5
Nam Roi*1	33	22.0	1.1	5.6	4.1

*1 "Nam Roi" is thought to be tolerant to citrus-greening disease.
*2 Midlibs of infected citrus leaves were collected. DNA was extracted using the CTAB method from the base parts of each midlib of fixed length, 1cm.

The quantification of pathogens is crucial for analyzing the process of disease development. Based on recent research results, we have developed a quantification system for Huanglongbing pathogens, utilizing a competitive PCR method. This system consists of conventional PCR equipment and competitor DNA, and is less expensive than equipment used in real-time PCR systems, which currently is the most popular method for quantification of PCR-detectable materials. Thus, this system will be more easily incorporated into agricultural research activities in developing countries.

The conventional PCR method multiplies specific target DNA through chain reactions. The concept of the competitive PCR method is to create competition between target DNA multiplication and competitor DNA multiplication. The ratio of multiplied DNA from target DNA and competitor DNA is expected to correlate with the original ratio of each type of DNA before multiplication. We designed competitor DNA that has PCR-primer recognition sequences identical to target DNA. Using this competitive DNA, the competitive PCR reaction showed reasonable results (Fig. 1). After plotting data on a logarithmic graph, the multiplication ratios of each DNA formed nearly perfect straight lines (Fig. 2). Based on these results, the quantity of target DNA, pathogen-originated DNA, as well as the estimated quantity of disease pathogens can be calculated.

There are several substances known to interfere with PCR DNA multiplication. Quantification systems using competitive PCR are thought to be less affected by such inhibitors. Starch is known to have accumulated in Huanglongbing infected leaves, and have inhibitory effects against PCR multiplication. We tested the quantification system with soluble starch in order to examine the reliability of measured values in the presence of such inhibitory substances. Favorable results were obtained from our quantification system as expected based on the concepts of the competitive PCR method.

Infected citrus leaves collected in southern Vietnam were applied in this quantification system, and significant differences in pathogen quantity were observed in leaves

between two selected areas (Table 1). Fewer amounts of pathogen-related DNA were detected from the tissue of citrus cultivars that were believed to have higher tolerance against Huanglongbing than that of susceptible cultivars. This suggests that the suppression of pathogen multiplication in tolerant citrus cultivars may enhance its tolerance.

We plan to utilize this quantification system in analyzing Huanglongbing disease prevalence, both in Japan and Vietnam, in a new international project to be initiated in April 2004 entitled, “Development of new technologies for control of Citrus Huanglongbing (HLB) in Southeast Asia.”

(K. Kawabe)

MISCELLANEOUS PROJECTS OUTLINE

In addition to international comprehensive 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 Environment, as well as other organizations, and special allotment projects.

OVERSEAS PROJECTS

Research on the uses of lactic acid-producing bacteria in agricultural products in Thailand's agricultural industry
(At Kasetsart University, 2000-2003)

Evaluation of the nutritive and active components of Southeast Asian indigenous vegetables
(At Asian Vegetables Research and Development Center, 2000-2003)

Evaluation of environmental impact associated with the construction of logging roads
(At Forest Research Institute of Malaysia, 2001-2004)

Innovation of cultivation technologies and agricultural systems to control clubroot disease in the West Java highlands
(At Asian Vegetables Research and Development Center, 2003-2004)

Socio-economic research for the technological advancement of various agricultural systems
(At Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific [CGPRT Centre] and 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 West Africa Rice Development Association [WARDA], 2003-2005)

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

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

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 in an effort to support its international collaborative projects.

JIRCAS further enhances 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 which support ongoing collaborative projects abroad. In addition, these programs also promote positive relationships between JIRCAS and foreign institutions and facilitate future exchanges 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) technology development for the utilization of animal resources; 4) crop tolerance to low temperatures, drought, and blight; 5) circulation of nitrogen in soil; 6) the utilization of remote sensing technology for evaluating environmental resources; 7) technology 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.

Development of technologies to strengthen the functional components of fruit
(Okinawa Subtropical Station, 1996-2003)

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

Elucidating the molecular mechanisms of plant responses and resistance to low temperature stress
(Biological Resources Division, 1998-2003)

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

Development of trench planting technology for vegetable and fruit tree protection against high temperatures and typhoons
(Okinawa Subtropical Station, 2001-2003)

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

Development of a PCR marker for EST mapping of wheat
(Biological Resources Division, 2002-2004)

Development of widely usable, stable 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

Application of inter-specific hybrids for stable rice production in West Africa: Evaluation of potential properties of African rice (*Oryza glaberrima*) using chromosome substitution lines
(Biological Resources Division in cooperation with Kyushu University, 2001-2003)

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)

Studies on genes and breeding techniques related to the deep root characteristics of rice
(Biological Resources Division, 2003-2004)

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

In cooperation with the Ministry of Environment

Evaluation of water supply and function in logged areas
(Forestry Division, 2002-2004)

Research on techniques used to evaluate the relationship between environmental changes and tropical forest ecology and function
(Forestry Division, 2002-2004)

Fragility of the Sahelian farmers and soil degradation: a consideration of policy intervention
(Development Research Division, 2003-2005)

Development of green house-gas sink/sources 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 Cooperation

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
(Development 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)

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

Development of transgenic crops tolerant to environmental stresses
(Biological Resources Division, 2000-2004)

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

In cooperation with Japan Society for the Promotion of Science

Development of a model reflecting the influences of increased atmospheric carbon dioxide on the environment
(Crop Production and Environment Division, 2003-2004)

MAFF SPECIAL RESEARCH ALLOTMENTS

Physio-genetic studies on yield determination and ecological adaptability for sustainable agriculture
(JIRCAS in cooperation with the International Rice Research Institute [IRRI], 1999-2003)

Physiological and ecological studies for the development of IPM for economically important pests in Africa
(JIRCAS in cooperation with the International Centre of Insect Physiology and Ecology [ICIPE], 2000-2004)

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 administrator from counterpart organizations. These programs facilitate the exchange of information and opinions concerning agriculture, forestry and fisheries administration while strengthening international research ties among scientists and administrators in other countries. Current programs are described in greater detail below.

1) Administrative Invitation

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 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-six individual visits to JIRCAS were made during FY 2003 under the Administrative Invitation Program, including seventeen invitations to the International Symposium. Invited administrators and their home institutions are listed below.

Administrative Invitation FY 2003

Ramadjita Tabo	Principal Scientist and Sub-Regional Coordinator (West and Central Africa) Desert Margins Program (DMP) International Crop Research Institute for Semi-Arid Tropics (ICRISAT) Niger	May 25-June 1, 2003
Nteranya Sanginga	Director Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT) Kenya	May 26-31, 2003
Lamourdia Thiombiano	Senior Soil Resources Officer Regional Office for Africa Food and Agriculture Organization of the UN Ghana	May 26-31, 2003
Andre Bationo	Soil Scientist and Coordinator for African Network of Soil Biology and Fertility Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT) Kenya	May 26-31, 2003
Bounthong Bouahom	Director General National Agriculture and Forestry Research Institute (NAFRI) Laos PDR	Oct. 26-30, 2003
Roderick David Bruce Lefroy	Regional Coordinator CIAT-Asia Laos PDR	Nov. 15-21, 2003
Bikram S. Gill	Professor, Director Wheat Genetics Resource Center Department of Plant Pathology Kansas State University USA	Feb. 7-12, 2004

Maarten van Ginkel	Head CIMMYT Fusarium Research Unit International Maize and Wheat Improvement Center (CIMMYT) Mexico	Feb. 8-14, 2004
Masa Iwanaga	Director General International Maize and Wheat Improvement Center (CIMMYT) Mexico	Feb. 9-12, 2004
Yue Jin	Assistant Professor Cereal Disease Laboratory United States Department of Agriculture (USDA)-Agricultural Research Service University of Minnesota USA	Feb. 9-13, 2004
James A. Anderson	Assistant Professor Department of Agronomy and Plant Genetics University of Minnesota USA	Feb. 9-13, 2004
Jeannie Gilbert	Senior Researcher, Assistant Professor Cereal Diseases, Agriculture and Agri-Food Canada Cereal Research Center Canada	Feb. 9-14, 2004
Thomas Miedaner	Assistant Professor State Plant Breeding Institute University of Hohenheim Germany	Feb. 9-15, 2004
Peidu Chen	Professor Cyto-genetics Research Institute Nanjing Agricultural University People's Republic of China	Feb. 9-15, 2004
Etienne Duveiller	Principal Scientist Wheat Program International Maize and Wheat Improvement Center (CIMMYT) South Asia Nepal	Feb. 10-14, 2004
Zhang Zhong Jun	Vice Director Division of Asia & Africa Department of International Cooperation Ministry of Agriculture People's Republic of China	Mar. 1-5, 2004
Jiang Wen Sheng	Officer Department of Planning Ministry of Agriculture People's Republic of China	Mar. 1-5, 2004

Tang Huajun	Director Institute of Natural Resources & Regional Planning Chinese Academy of Agricultural Sciences (CAAS) People's Republic of China	Mar. 1-5, 2004
Peter Kerridge	Former CIAT-Asia Project Leader International Tropical Agriculture Center (CIAT) Australia	Mar. 8-12, 2004
Marcelo Tolchinsky	Director National Institute for Agricultural Technology (INTA) EEA-Marcos Juarez Argentina	Mar. 8-12, 2004
Nguyen Minh Chau	Director General Southern Fruit Research Institute (SOFRI) Vietnam	Mar. 15-20, 2004
Nguyen Thang Phuong	Vice Dean College of Agriculture and Fisheries Cantho University Vietnam	Mar. 15-20, 2004
Vo Tong Xuan	Rector Angiang University Vietnam	Mar. 15-20, 2004
Duong Van Ni	Head Hoa An Research Station Mekong Delta Farming System Research & Development Institute Cantho University Vietnam	Mar. 15-20, 2004
Nguyen Huu Huan	Vice Director General Department of Plant Protection Ministry of Agriculture and Rural Development Vietnam	Mar. 15-20, 2004
Mohamed Bazain Bin Idris	State Attorney-General State Attorney-General's Chambers Malaysia	Mar. 15-23, 2004
Vincent Fung Yick Khiang	Head Licensing and Agreement Division Forestry Department Malaysia	Mar. 15-23, 2004
Hong-Ji Su	Professor Emeritus National Taiwan University Republic of China	Mar. 17-21, 2004
Shamsudin Ibrahim	Director Natural Forest Division Forest Research Institute Malaysia (FRIM) Malaysia	Mar. 21-27, 2004

International Symposium Invitees, FY2003		
Gilles Saint-Martin	Director European and International Relations Centre de Coopération Internationale en Recherché Agronomique pour le Dévelopment (CIRAD) France	Nov. 13-22, 2003
Francisco Reifschneider	Director Consultative Group on International Agricultural Research (CGIAR) USA	Nov. 15-21, 2003
Klaus Frohberg	Director Center for Development Research Bonn University Germany	Nov. 16-20, 2003
Rod Lefroy	Regional Coordinator for Asia Centro Internacional de Agricultura Tropical (CIAT) Laos PDR	Nov. 16-21, 2003
Josef Schmidhuber	Senior Economist Global Perspective Studies Group Economic and Social Department Food and Agriculture Organization of the United Nations (FAO) Italy	Nov. 16-22, 2003
Conde Cheik Kessery	Director International Coordination Section Institut de Recherché Agronomique de Guinée (IRAG) Republic of Guinea	Nov. 16-26, 2003
Xiaoqing Xu	Deputy Director Department of Rural Economics Development Research Center of the State Council (DRC) People's Republic of China	Nov. 17-21, 2003
Simmathiri Appanah	National Forest Programme Advisor FAO Regional Office for Asia and the Pacific Thailand	Nov. 17-21, 2003
Khunying Prapaisri Pitakpaiwan	Inspector General Office of Permanent Secretary Ministry of Agriculture and Cooperatives (MOAC) Thailand	Nov. 17-21, 2003
Montague W. Demment	Director Global Livestock Collaborative Research Support Program University of California USA	Nov. 17-21, 2003

Dae-Guen Oh	Director International Technical Cooperation Center Rural Development Administration (RDA) Republic of Korea	Nov. 17-21, 2003
Junichiro Okamoto	Deputy Secretary-General Southeast Asian Fisheries Development Center (SEAFDEC) Thailand	Nov. 17-21, 2003
A.H. Zakri	Director Institute of Advanced Studies United Nations University Japan	Nov. 17-21, 2003
Yonosuke Hara	Professor Interfaculty Initiative in Information Studies Institute of Oriental Culture The University of Tokyo Japan	Nov. 17-21, 2003
Koji Tanaka	Director, Professor Center for Southeast Asian Studies Kyoto University Japan	Nov. 17-21, 2003
Cynthia S. Bantilan	Global Theme Leader SAT Futures and Global Pathways International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) India	Nov. 17-23, 2003
Stephen Tyler	Team Leader Community-Based Resource Management International Development Research Centre University of Victoria Canada	Nov. 18-21, 2003

2) Counterpart Researcher Invitation

The Counterpart Researcher Invitation Program provides invitations for periods of up to six months to researchers engaged in collaborative work with members of the JIRCAS research staff. Counterparts conduct in-depth research at JIRCAS, at other 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-one researchers were invited under the Counterpart Researcher Invitation Program during FY 2003. Invited researchers, their affiliated research organizations, and their research activities are summarized below.

Counterpart Researcher Invitation FY2003

At JIRCAS, National Food Research Institute and National Agricultural Research Center for Hokkaido Region, National Agricultural Research Organization, Apr. 1-May 30, 2003

Jaitip Uraichuen	Researcher Postharvest Technology Institute Department of Agriculture (DOA) Thailand	Ecology of natural enemies of stored product insect pests

At JIRCAS, National Institute of Livestock and Grassland Sciences and National Agricultural Research Center for Kyushu Okinawa Region, National Agricultural Research Organization, May 6-July 1, 2003		
Ittiphon Phaowphaisal	Researcher Animal Nutrition Division Khon Kaen Animal Nutrition Research and Development Center Thailand	Effect of physical characteristics of roughage in milking cow
At JIRCAS and Hiroshima Prefectural University, May 12-July 18, 2003		
Vipa Surojanametakul	Specialist Institute of Food Research and Product Development Kasetsart University Thailand	Structure analysis of a water soluble polysaccharide in rice and its effects on gelatinization
At JIRCAS, National Institute of Livestock and Grassland Sciences, National Agricultural Research Organization and Tokyo University of Agriculture & Technology, May 26-July 11, 2003		
Lucia Cristina Arakaki	Laboratory Head Instituto Nacional Technologia Agropecuaria (INTA) - Castelar Argentina	Livestock production using available agricultural by-products
At JIRCAS, National Agricultural Research Center for Hokkaido Region, National Agricultural Research Organization and Shizuoka-Seiki Co., Ltd., June 23-Aug. 1, 2003		
Yutthana Tirawanichakul	Assistant Professor Plasma and Laser Technology Laboratory Faculty of Science Prince of Songkla University Thailand	Development of low-input drying technology and biological control of stored product insects using natural enemies and products
At JIRCAS and National Institute of Livestock and Grassland Sciences, National Agricultural Research Organization, July 23-Oct. 3, 2003		
Marco Antonio Rondon	Project Leader Climate Change Project Centro Internacional de Agricultura Tropical (CIAT) Colombia	Methodology development and characterization of root exudates from *B. humidicola* for N_2O suppression
At JIRCAS, National Institute of Crop Science and National Agricultural Research Center for Kyushu Okinawa Region, National Agricultural Research Organization, July 28-Oct. 24, 2003		
Dong Guo Jun	Research Associate China National Rice Research Institute People's Republic of China	Structure of panicles in high yielding lines with a super-panicle weight type
At JIRCAS and National Institute of Animal Health, National Agricultural Research Organization, Aug. 19-Oct. 16, 2003		
Ho Thi Viet Thu	Lecturer Department of Veterinary Medicine College of Agriculture Cantho University Vietnam	Isolation and identification of porcine reproductive and respiratory syndrome virus

At Pusan, Republic of Korea, Aug. 26-30, 2003		
Asanee Kawtrakul	Associate Professor, Head Natural Language Processing and Intelligent Information Technology System Laboratory (NAiST Lab.) Department of Computer Engineering Faculty of Engineering Kasetsart University Thailand	APAN/NR-JIRCAS Joint Workshop on Multilingual Services over Asia Pacific
At Pusan, Republic of Korea, Aug. 26-30, 2003		
Tran Than Thi Ngan Hoa	Information Specialist Information Centre for Agriculture and Rural Development (ICARD) Ministry of Agriculture and Rural Development (MARD) Vietnam	APAN/NR-JIRCAS Joint Workshop on Multilingual Services over Asia Pacific
At JIRCAS, National Research Institute of Aquaculture, Fisheries Research Agency and Hiroshima University, Aug. 26-Oct. 4, 2003		
Leobert D. de la Pena	Scientist Aquaculture Department Southeast Asian Fisheries Development Center (SEAFDEC) The Philippines	Phylogenetic studies and development of diagnostic methods for shrimp viral diseases
At JIRCAS and National Institute of Livestock and Grassland Sciences, National Agricultural Research Organization, Sept. 1-30, 2003		
Zhou Xuying	Associate Professor Institute of Natural Resources & Regional Planning, Chinese Academy of Agricultural Sciences People's Republic of China	Trends in supply and demand of livestock products
At JIRCAS and National Institute of Crop Science, National Agricultural Research Organization, Sept. 17-Dec. 12, 2003		
Francisco Horacio Fuentes	Senior Researcher Soybean Section Instituto Nacional de Tecnologia Agropecuaria (INTA)-EEA Argentina	Analysis of the loci for Soybean Sudden Death Syndrome (SDS) resistance using recombinant inbred lines (RILs) and near isogenic lines (NILs)
At JIRCAS, Sept. 1-Nov. 21, 2003		
Yang Zhenyu	Research Assistant Laboratory of Soybean Breeding Soybean Research Institute Jilin Academy of Agricultural Sciences People's Republic of China	Evaluation of seed components and genetic uniformity of the northeasten soybean germplasm using DNA markers

At JIRCAS and National Institute of Livestock and Grassland Sciences, National Agricultural Research Organization, Sept. 29, 2003-Jan. 22, 2004		
Duong Minh Vien	Lecturer Soil no Science Department College of Agriculture Cantho University Vietnam	Effects of organic matter application on soil fertility
At JIRCAS, JIRCAS Okinawa Subtropical Station and Forestry and Forest Products Research Institute, Oct. 16-Nov. 13, 2003		
Chia Fui Ree	Research Officer Sabah Forest Research Centre Malaysia	Development of cultivation techniques for tropical mushrooms
At JIRCAS, National Institute of Livestock and Grassland Sciences and National Agricultural Research Center for Hokkaido Region, National Agricultural Research Organization, Oct. 15-Nov. 21, 2003		
Liu Yi	Lecturer Non-Conventional Feed Institute Key Laboratory of Modern Precision Agricultural System Integration Department of Agricultural Engineering China Agricultural University Ministry of Education People's Republic of China	Analysis and quality evaluation of silage
At JIRCAS, Nov. 17-Dec. 6, 2003		
Christophe Le Page	Scientist Département Territoires, Environnement, et Acteurs (TERA) Centre de Coopération Internationale en Recherché Agronomique pour le Développement (CIRAD) France	Project research for the development of a prototype CORMAS model adapted to rainfed agriculture
At JIRCAS and National Food Research Institute, Dec. 22, 2003-Mar. 22, 2004		
Lu Zhanhui	Associate Professor College of Food Science and Nutritional Engineering, China Agricultural University People's Republic of China	Improvement of rice noodle texture by fermentation
At JIRCAS and National Research Institute of Aquaculture, Fisheries Research Agency, Jan. 27-Mar. 7, 2004		
Esteban Suarez Garibay	Research Asistant Breeding Section Aquaculture Department Southeast Asian Fisheries Development Center (SEAFDEC) Philippines	Comparative studies on fatty acids and fat-soluble vitamins of milkfish under different rearing conditions
At JIRCAS and Forestry and Forest Products Research Institute, Feb. 26 - Mar. 6, 2004		
Junjiro Negishi	Graduate Student Department of Geography National University of Singapore Singapore	Annual meeting and workshop for the project "Evaluation of water supply and function in logged areas"

3) JIRCAS Visiting Research Fellowship Program at Okinawa

The Okinawa Visiting Research Fellowship Program was initiated in FY 1992, prior to the reorganization of the Tropical Agricultural Research Center (TARC) into JIRCAS. The program invites post-doctoral scientists to conduct research at the Okinawa Subtropical Station for a period of one year. Researchers must focus 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 characterization of tropical and subtropical fruits, 4) evaluation and utilization of useful traits in sugarcane and sweet potato, and 5) integrated pest management of tropical and subtropical crops.

Okinawa Fellows in 2003 pose for group photograph.

JIRCAS Visiting Research at Okinawa (October 2002 to September 2003)

Nur Ahamed Khondaker	Planning and Evaluation Division Bangladesh Agricultural Research Council Bangladesh	Water saving and water use efficiency under differing micro-irrigation depths
Samuel M. Contreras	Water Resources Management Division Bureau of Soils and Water Management The Philippines	Analysis of effects of hardpan ploughing on sub-soil stored water use in sugarcane
Prakash Chandra Nautiyal	National Research Centre for Groundnut (NRCG) Indian Council of Agricultural Research (ICAR) India	Heat tolerance of transgenic tomato with small heat shock protein gene(s)
Shang Qingmo	Institute of Vegetables and Flowers Chinese Academy of Agriculture Sciences (CAAS) People's Republic of China	Physiological studies on heat tolerance in snap bean
Efendi	Faculty of Agriculture Syiah Kuala University Indonesia	Development of efficient transformation methods and introduction of useful genes in sugarcane
Muchdar Soedarjo	Research Institute for Legume and Tuber Crops (RILET) Indonesia	Isolation and characterization of anthocyanin transcriptional activator genes from cDNA
Bui Thi Ngan	Research Institute for Cotton and Fibre Crops Vietnam	Monitoring and evaluation of the life cycle of thecotton stainer bug (*Dysdrercus cingulatus*), and utilization of a natural predator (*Antilochus coqueberti*) against *D. cingulatus*
Wanphen Srithongchai	Plant Virology Section Division of Plant Pathology and Microbiology Department of Agriculture Thailand	Purification of organisms affected with citrus greening and analysis of pathogen-specific proteins

JIRCAS Visiting Research at Okinawa (October 2003 to September 2004)

Roland Nuhu Issaka	CSIR-Soil Research Institute Ghana	Effects of slope and tillage practices on soil erosion and soil properties

Meiru Li	South China Institute of Botany The China Academy of Sciences People's Republic of China	Transformation of *HANA* into the rice genome via *Agrobacterium*-mediated methods
Ashok Kumar	CCS Haryana Agricultural University, HISAR India	Plant water relations of snap bean (*Phaseolus vulgaris* L.) in high temperature stress environment
Mohammad Abul Kashem Chowdhury	Patuakhali Science and Technology University, HISAR Bangladesh	Searching for RAPD marker linked to wild spine trait in pineapples (*Ananas bracteatus* and *Pseudoananas sagenarius*)
Winarso Drajad Widodo	Institut Pertanian Bogor (IPB) Bogor Agricultural University Indonesia	Effects of low temperature and photoperiod on flower bud differentiation of 'Irwin' mango trees in subtropical regions
Efendi	Faculty of Agriculture Syiah Kuala University Indonesia	Development of efficient transformation methods using sonication in sugarcane (*Saccharum spp.*) hybrids
Shuzhen Zhang	Chinese Academy of Tropical Agricultural Sciences People's Republic of China	Cloning and expression analysis of anthocyanin transcriptional activator genes of sweet potato
Azoy Kumar Kundu	Bangabandhu Sheikh Mujibur Rahman Agricultural University Bangladesh	Purification of organisms affected with citrus greening organisms and analysis of pathogen-specific proteins
I. Made Sudiana	Biological Research Center The Indonesian Microbiology Institute of Science Indonesia	Detection of diversity of citrus greening organisms (*Liberibacter*) by DGGE of 16s rDNA

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. This Fellowship program consists of the following two types: the long-term program held at JIRCAS, and the short-term program held at the National Institute of Agrobiological Sciences (NIAS). Under the long-term program, ten researchers are invited to conduct research in Tsukuba for a period of one year. For the short-term program, four researchers are invited to carry out five-month projects at the NIAS. Starting from October 2002, a total of nineteen researchers have been invited under the long-term program: ten from Oct. 2002 to Sept. 2003, and nine from Oct. 2003 to Sept. 2004. Under the short-term program, four researchers have been invited from October 2003 to February 2004. Recent invitees and their research activities are listed below.

More information on the Okinawa and Tsukuba Visiting Research Fellowship Program can be obtained by contacting the International Relations Section, Japan International Research Center for Agricultural Sciences, 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)

Tsukuba Fellows in 2003 pose for group photograph with JIRCAS International Relations Section staff members.

JIRCAS Visiting Research Fellowship at Tsukuba (JIRCAS type: October 2002 to September 2003)		
Omer Elgaili Elsheikh	Agricultural and Resource Economics The University of Tokyo (from Sudan)	Returns to agricultural research investment of rice production in West Africa: The case of Nigeria and Côte d'Ivoire
Wang Lei	China National Rice Research Institute Agricultural Economics and Information People's Republic of China	Development of methods for monitoring agricultural land use and crop production by using MODIS data
Lam-Son Phan Tran	JIRCAS Fellow (from Vietnam)	Functional analysis of drought-inducible genes for transcription factors containing a NAC DNA binding domain in plants
Maxim Petre	Research Institute for Cereals and Industrial Crops Romania	Studies on mapping of brittle rachis genes and their contribution to agronomic traits in wheat
Haiyan Chu	Laboratory of Material Cycling in Pedosphere People's Republic of China	Effect of N fertilization management on microbial properties of soil and atmospheric environment
Md. Samiul Alam	Agricultural and Environmental Biology The University of Tokyo (from Bangladesh)	Physiological mechanisms of iron toxicity in rice
Adel Elsayed Elbeltagy	Laboratory of Microbiology Botany Department Faculty of Agriculture Minufiya University Egypt	Molecular characterization of endophytic nitrogen-fixing bacteria in rice
Molay Kumar Roy	JIRCAS Fellow (from Bangladesh)	Cell cycle disregulation in cancer cells caused by food components
Leh Cheu Peng	Wood, Paper and Coatings Technology University Science Malaysia Malaysia	Studies on chlorine-free bleaching for pulp production from tropical lignocellulosic resources
Safiah Jasmani	JIRCAS Fellow (from Malaysia)	Elucidation of osmoregulatory mechanisms in giant freshwater prawns, *Macrobrachium rosenbergii*, and their relationship to the reproductive process

JIRCAS Visiting Research Fellowship at Tsukuba (JIRCAS type: October 2003 to September 2004)		
Huoyan Wang	Institute of Soil Science The Chinese Academy of Sciences People's Republic of China	What triggers NI (nitrification inhibitory) activity in root exudates of *Bracharia humidicola*?
Yin Lijun	China Agricultural University People's Republic of China	Production of functional materials by the control of enzymatic reactions during food processing
Xiuqing Wang	China Agricultural University People's Republic of China	Grain yield response to climatic factors in China (1985-2002)
A.K.M. Mohiuddin	Bangladesh Rice Research Institute Bangladesh	Development of biotechnology to improve abiotic stress tolerance using leading varieties of Japonica rice

Adel Elsayed Elbeltagy	Laboratory of Microbiology Botany Department Faculty of Agriculture Minufiya University Egypt	Molecular analysis of endophytic nitrogen-fixing bacterial community associated with rice plants
Oladimeji Idowu Oladele	University of Ibadan Nigeria	Impact of extension services on rice yield gap in Asia and West African countries
Kashfia Ahmed	Ibaraki University (from Bangladesh)	Physiological and nutritional studies on important aquaculture species
Xu Hua	Institute of Soil Science The Chinese Academy of Sciences People's Republic of China	The effects of soil moisture on CH_4, CO_2, N_2O and NO emissions of paddies
Safiah Jasmani	JIRCAS Fellow (from Malaysia)	The role of hormones in the control of meiotic resumption during oocyte maturation in *Macrobrachium rosenbergii*

JIRCAS Visiting Research Fellowship at Tsukuba (NIAS type: October 2003 to Feb. 2004)

Mohammad Pourkhairandish	Faculty of Agriculture Guilan University Iran	Construction of BAC contig covering the vrs1 gene of barley
Rasamee Dhitikiattipong	Rice Patholopgy Research Group Rice Research Institute Department of Agriculture (DOA) Thailand	Phylogenetic analysis of rice-pathogenic bacteria and its applications
Katarzyna Snigorska	Biology and Earth Sciences Jagiellonian University Poland	Identification of useful genes by applying insect genome information
Ahsol Hasyim	Plant Protection Division Solok Research Institute for Fruit Indonesia	Research and development of useful strains of *Cotesia plutellae*, a larval parasitoid of the diamondback moth, through the application of biotechnological procedures

5) 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 post-doctoral and sabbatical fellows in national research institutes throughout Japan according to research theme and prior arrangement with a host scientist for a term of generally one month to three years. Fellowships can be undertaken in any of the ministries and many fellows are currently working at various Incorporated Administrative Agencies affiliated to the Ministry of Agriculture, Forestry and Fisheries (MAFF). In 2003, the following visiting scientists resided at JIRCAS: Dr. Nguyen Van Dong (Vietnam), Biological Resources Division; Dr. Selina Ahmed (Bangladesh), Biological Resources Division; Dr. Nur Ahamed Khondaker (Bangladesh), Okinawa Subtropical Station.
In addition, four Japanese fellows, Dr. Y. Osakabe and Dr. Y. Fujita, Biological Resources Division; Dr. K. Suzuki, Development Research Division; and Dr. C. Oguchi, Crop Production and Environment Division, also conducted research at JIRCAS.

SYMPOSIA AND WORKSHOPS

1) INTERNATIONAL SYMPOSIA

Between 1979 and 1993, the Tropical Agriculture Research Center (TARC), JIRCAS's predecessor, sponsored annual international symposia in order to promote scientific exchange while accurately gauging and responding to agriculture, forestry, and fisheries needs of the world's developing regions. Since its transition from TARC, 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 10th JIRCAS International symposium, held in November 2003, focused on "Prospects for Food Security and Agricultural Sustainability", and the program appears below.

10th JIRCAS International Symposium
Prospects for Food Security and Agricultural Sustainability in Developing Regions: New Roles of International Collaborative Research

In Fiscal Year 2003, JIRCAS held a commemorative symposium at the U Thant Conference Hall of the United Nations University in Tokyo on November 18-19 on the occasion of the institute's 10th anniversary following its reorganization from the former Tropical Agricultural Research Center. Approximately 240 participants from more than 30 developing and developed countries as well as international organizations attended and covered very broad disciplines ranging from international cooperation, collaborative research policy making, and strategy development to field work.

Program:
Opening address and welcoming remarks
- Inaugural address by Dr. Mutsuo Iwamoto, President, Japan International Research Center for Agricultural Sciences (JIRCAS), Japan
- Welcoming remarks by Mr. Hans van Ginkel, Rector, United Nations University (UNU), Japan

Keynote addresses
- "Reconsidering the roles of agriculture in the century of sustainable development: the 21st Century" by Dr.Yonosuke Hara, Professor, Graduate School of Interdisciplinary Information Studies and Director of the Institute of Oriental Culture, The University of Tokyo, Japan
- "Japan-CGIAR Partnership: Working together for good news from the field" by Dr. Francisco Reifschneider, Director, Consultative Group for International Agricultural Research (CGIAR), Washington, D.C.

Session 1 : Perspectives for achieving international development goals
Session 2 : Perspectives and issues for sustainable development of agriculture, forestry and fisheries in developing regions
Session 3 : Strategies for international collaborative research activities
Session 4 : Strategic themes for international collaborative research activities
Session 5 : Integration and synthesis

2) SPECIAL PROGRAMS

Final evaluation meeting for the project "Development of sustainable production and utilization of major food resources in China"

JIRCAS held a final evaluation meeting for the research project entitled "Development of sustainable production and utilization of major food resources in China" on March 2-3, 2004 at its Tsukuba premises. The project, conducted in collaboration with many research institutes allied to the Ministry of Agriculture of the People's Republic of China, including China Agricultural University and the Shanghai Fisheries

University, attained numerous research results during its seven-year research period, in which many scientific papers were published and new cultivars were developed. The project was also proven to be useful in enhancing counterpart researchers' capacities in many areas of study.

Mr. Kunio Takase, Advisor at the International Development Center; Dr. Naohiro Kitano, Assistant Professor at Kyoto University; and Dr. Tokio Inbe, Director of the Rice Research Division, Crop Research Institute, Japan, were invited as external reviewers; during the meeting, they commented that the valuable results achieved under individual research subjects should be utilized in policy planning in China, and that future studies on Chinese agricultural issues should be implemented from new perspectives, keeping in mind the main achievements of the project. Representatives of Chinese counterpart organizations also stressed that the project produced valuable results which can be directly applied for use on-site.

Program:

Opening address

- Welcoming remarks by Dr. Yoshinori Morooka, Vice-President, Japan International Research Center for Agricultural Sciences (JIRCAS)

General Session

- Explanation of the meeting objectives and overview of project results by Mr. Osamu Koyama, Director, Development Research Division, JIRCAS
- Addresses from Chinese Invitees
  "Rural reforms and development in China" by Mr. Zhongjun Zhang, Department of International Cooperation, Ministry of Agriculture, China
  "Views of Chinese research organizations" by Dr. Huajun Tang, Institute of Agricultural Resources and Regional Planning, China

Participants in the final evaluation meeting for "Major food resources in China" project pose for a group photograph.

Mid-term evaluation meeting on "Comprehensive studies on the development of sustainable soybean production technology using agro-pastoral systems in South America"

This project known by its abbreviated form as the "Soybean Project", had its first mid-term evaluation meeting in March 2001 to report on its progress from 1997 until Fiscal Year 2000. This research project had originally been implemented under the title of "Comprehensive studies on soybean improvement, production and utilization in South America". The Soybean Project has since been re-organized under the title of "Comprehensive studies on the development of sustainable soybean production technology using agro-pastoral systems in South America" as of Fiscal Year 2003, with the incorporation of several research activities from a related project entitled, "Comprehensive studies on the development of sustainable agro-pastoral systems in the subtropical zone of Brazil," which was completed in Fiscal Year 2002. The second mid-term evaluation meeting for this project was held on March 9-10, 2004, at JIRCAS's Tsukuba premises in order to review the research activities conducted between Fiscal Years 2001 and 2003.

Evaluation was carried out in accordance with the new research framework, which consists of the following three primary subjects: 1) development of new breeding technologies for soybean and grasses; 2) agro-ecological and physiological characteristics of agro-pastoral systems; and, 3) development of improved agro-pastoral systems. Studies are being conducted by JIRCAS in collaboration with the Brazilian Agricultural Research Corporation (EMBRAPA), the National Federation of Agricultural Cooperative Associations for Colonization (JATAK), the International Center for Tropical Agriculture (CIAT), and the Ministry of Agriculture and Livestock (MAG) of Paraguay; the Japan International Cooperation Agency (JICA), and the National Institute of Agricultural Technology (INTA) of Argentina; and other Japanese research organizations. The meeting was held in order to discuss means for advancing the Soybean Project toward its completion as a 10-year project. Dr. Peter C. Kerridge, former Coordinator of International Center for Tropical Agriculture (CIAT)-Asia office; Prof. Kazuo Kawano, Kobe University; Prof. Makie Kokubun, Tohoku University; Dr. Muneo Oikawa, the Japan Grassland Farming Forage Seed Association; and Dr. Shinji Sakai, the National Agricultural Research Center for Tohoku Region were invited as project reviewers, while Dr. Koji Hashimoto, the former JICA project leader; Dr. Tetsuo Shioya representing JATAK; and Ing. Agr. Marcelo Tolchinsky of INTA, were invited as guest commentators.

The second mid-term evaluation meeting of the "Soybean Project", held at JIRCAS's International Conference Room on March 9-10, 2004.

Program:

- Opening remarks by Dr. Mutsuo Iwamoto, President, Japan International Research Center for Agricultural Sciences (JIRCAS), Japan
- Project overview by Dr. Kazuhiro Suenaga, Biological Resources Division, Japan International Research Center for Agricultural Sciences (JIRCAS), Japan

Session 1 : Development of breeding technologies for soybean and grasses
Session 2 : Improvement of agro-pastoral systems
Session 3 : Agro-ecological and physiological characterization in agro-pastoral systems

MINI-WORKSHOP ON "FRESHWATER PRAWN PRODUCTION TECHNOLOGY IN SOUTHEAST ASIA: RESEARCH AND DEVELOPMENT"

Freshwater fisheries is one of the most important rural industries in Southeast Asia and provides a major source of dietary protein and opportunities for income enhancement to people in the region. In this context, freshwater prawn culture has become an important focus of aquaculture activity throughout the region.

As a component of JIRCAS's two-phase comprehensive project focusing on farming systems in the Mekong Delta region of Vietnam from 1994-2003, the Japan International Research Center for Agricultural Sciences (JIRCAS) and Vietnam's Cantho University have implemented collaborative research focusing on the giant freshwater prawn, *Macrobrachium rosenbergii*, which is commonly cultured in rice fields, ponds, orchard gardens and pens along river banks of the Mekong Delta region. Studies were carried out on various aspects relating to the establishment of *M. rosenbergii* seed production and culture technology and were concluded in fiscal year 2003. During the course of the project, new technologies were developed and successfully transferred to hatchery operators and farmers, leading to an expansion of the freshwater prawn culture industry in Vietnam.

With the hope that many aspects of our experience with this project would be useful to other countries in the region wishing to establish or improve their freshwater prawn culture industry, the mini-workshop was held as part of JIRCAS's annual international workshop on "Development of new technologies and their practice for sustainable farming systems in the Mekong Delta" on November 25-26, 2003. The program for the mini-workshop is shown below.

Program:

Opening remarks

- Dr. Mutsuo Iwamoto, President, Japan International Research Center for Agricultural Sciences (JIRCAS)

Session Topics

- Reports from the JIRCAS Mekong Delta II project on freshwater prawn research
- Country reports on prawn culture/fisheries in Southeast Asian Regions (Vietnam, Cambodia, Laos, and the Philippines)
- General discussion

Workshop on the development of low-input technology for reducing postharvest losses of staples in Southeast Asia

On February 20, 2004, a workshop was held in Bangkok, Thailand, in order to promote the JIRCAS project entitled "Development of low-input technology for reducing postharvest losses of staples in Southeast Asia", which has been conducted since 2000 in collaboration with the Thai Department of Agriculture, Kasetsart University, King Mongkut's University of Technology, and Japanese institutions such as the National Food Research Institute and the National Agricultural Research Organization. The project was implemented in order to develop disinfesting methods for rice by utilizing natural enemies and bioactive botanical substances, and to develop low-

input paddy-drying technologies using solar energy and agricultural residue such as rice husks and straw as moisture absorbents, with the aim of minimizing post-harvest losses at an affordable cost. A total of 49 scientists and technical experts from member institutions as well as from Kohn Kaen University, Prince of Songkla University and the National Institute of Vegetable and Tea Sciences of Japan, participated in the workshop to present papers and hold discussions on the results obtained in the project. Research topics to be completed in Fiscal Year 2004, the final project year, were proposed and confirmed by project

Program:

- ***Opening*** by Dr. Toru Hayashi, Director, Food Science and Technology Division, Japan International Research Center for Agricultural Sciences (JIRCAS)
- ***Status of postharvest technology in Thailand*** by Dr. Jirakorn Kosaisawee, Director, Post-harvest and Products Processing Research and Development Office, Department of Agriculture
- ***Project outline*** by Dr. Toru Hayashi, Director, Food Science and Technology Division, JIRCAS

Session 1 : Use of natural enemies for control of stored product insects
Session 2 : Natural product use for stored product pests
Session 3 : Development of simple and low-input rice drying technology
Session 4 : Rice quality evaluation for elucidation of aging mechanisms

Workshop participants in Bangkok, Thailand, on February 20th, 2004.

Research Seminar on African Agriculture

The JIRCAS research seminar on African agriculture held on November 28, 2003 focused on the issues raised in the third Tokyo International Conference on African Development (TICAD III) on the development of rice production, improvement of New Rice for Africa (NERICA), and the International Year of Rice. The purpose of the seminar was to provide a comprehensive overview of the research and technological development in rice production in Africa achieved through the rice cultivation project "Improving food security in West Africa through increased productivity in rainfed rice systems" implemented by JIRCAS from 1998 to 2002, and also to discuss future plans for rice research in Africa. The seminar focused on the present situation and development of rice production technology and included two sessions, consisting of presentations by seven guest speakers.

The first session addressed problems related to water and soil, which are major limiting factors in increasing the productivity of various ecosystems. In the second session, the problem of dissemination and technology

and research development were discussed. The topics raised in these sessions were discussed during the general discussion to promote ideas for future activities on rice research in Africa.

About 80 specialists on agricultural development in Africa representing the Japan International Copoeration Agency (JICA), universities, national agricultural institutes, NGOs, consulting companies, and Japan's Ministry of Agriculture, Forestry and Fisheries attended this seminar. At the culmination of the seminar, it was concluded that future research efforts should be focused on improving rainfed lowland and small-scale irrigation systems because of their high potential, and enhancing sustainable rice cultivation in Africa. With upland ecology occupying 40% of the total land area cultivated with rice, it was also considered important to develop this ecology along with rainfed lowland systems.

Program:

Opening address

- Dr. Kunihiko Kato, Executive Advisor, Japan International Research Center for Agricultural Sciences (JIRCAS)

Session Topics

- Utilization of production environments and genetic resources for rice cultivation in Africa
- Directions of technology and research development for rice cultivation in Africa

Research seminar on African agriculture being held at JIRCAS's International Conference Room on November 28, 2003.

International workshop "Toward more effective and efficient international collaborative research for sustainable east Asian agriculture and rural development"

The Japan International Research Center for Agricultural Sciences (JIRCAS), in collaboration with the Department of Agriculture, Thai Ministry of Agriculture and Cooperatives, and Center for Applied Economic Research, Kasetsart University held an international workshop in Bangkok on February 19-20, 2004. The aim of this workshop was to exchange views on various international collaborative agricultural research activities for development as well as technology innovation, exploring the possibilities of developing new partnerships with institutions in both developing and developed countries, and establishing a more effective and efficient project/program.

Forty participants working in East Asia attended, including those from developed countries such as Japan, France and Germany, as well as those from international organizations such as the Coarse Grains, Pulses, Roots and Tuber Crops in the Humid

Tropics of Asia and the Pacific (CGPRT), the Asian Vegetable Research and Development Center (AVRDC) and the Food and Agriculture Organization of the United Nations (FAO). Participants gave comprehensive presentations on the present status of their international collaborative research and came to a consensus that various research efforts seeking similar goals had been made in the region; hence, participants agreed that more sophisticated, efficient and effective collaboration frameworks combining these different research efforts should be developed.

During the general discussion session, the following ideas were proposed:

- To increase communication in order to pinpoint areas of interest, benefits of participation in collaborative work, and needs and niches of research.
- To develop an information center to combine updated inventories of research and development programs as well as existing databases from the FAO, the Asia Pacific Agricultural Research Information System and other relevant websites.
- To combine existing research networks into a single common network.
- To increase the participation of young scientists in research programs.

This workshop was the first attempt to strengthen regional collaborative efforts to achieve common goals being sought by various stakeholders working in the region. JIRCAS President Dr. Iwamoto concluded the workshop with the announcement of the institute's plans to upgrade JIRCAS's Bangkok Office into a regional office, as an initiative towards fulfilling the proposed goals.

Program:

Opening Remarks

- Dr. Mutsuo Iwamoto, President, Japan International Research Center for Agricultural Sciences (JIRCAS), Japan
- Dr. Chakarn Saengruksawong, Director General, Department of Agriculture, Ministry of Agriculture, Thailand
- Dr. Supreeya Kuandachakupt, Dean, Faculty of Economics, Kasetsart University, Thailand

Session I: Technological development and integration, and socio-economic improvement for less-developed areas of East Asia

- Part 1: Focusing on natural resource management, new farm income sources, farming systems, and participatory research
- Part 2: Focusing on human and community empowerment and institutional improvement

Session II: Technology innovation and structural improvement for the more-developed regions of East Asia: Focusing on value-addition, market-oriented production, non-food production, food safety and bio-security

Session III:General discussion and synthesis: Toward a new perspective of international collaborative research in East Asian regions

- Part 1: Comments from international organizations and other key stakeholders
- Part 2: Discussion and synthesis

THE 3rd USM-JIRCAS JOINT INTERNATIONAL SYMPOSIUM 'LIGNOCELLULOSE: MATERIALS FOR THE FUTURE FROM THE TROPICS'

JIRCAS has organized international symposiums in collaboration with Universiti Sains Malaysia (University Science Malaysia, USM) since 1998, for the purpose of conducting collaborative research on the utilization of tropical lignocellulosic materials. This year's symposium, entitled "The 3rd USM-JIRCAS Joint International symposium 'Lignocellulose: Materials for the future from the tropics'" was held at Penang, Malaysia, on March 9-11, 2004.

At the opening ceremony, Dr Kiyoshi Nakashima, Director of JIRCAS's Forestry Division, delivered an opening speech on behalf of JIRCAS, and the official opening was declared by the Deputy Vice-Chancellor of USM. During the three-day symposium, a total of 78 presentations were delivered in five

categories as listed below, including four keynote addresses. More than 120 participants from various countries attended, including those from Canada, Finland, Australia, the Philippines, Malaysia and Japan. At the symposium, a great deal of valuable information on lignocellulose was presented through oral and visual presentations, leading to much opinion exchange and debate during the course of the workshop.

Program:

Keynote addresses

- "Biomethanol production from lignocellulosic resources in the tropical and subtropical Asia." By H. Nakagawa (Japan International Research Center for Agricultural Sciences (JIRCAS)), and T. Harada, Forestry and Forest Products Research Institute, Japan
- "O-Paper or e-paper? The future of lignocellulosics in paper products." By R.E. Johnston, Australian Pulp and Paper Institute
- "Development of the utilization technology for Melaleuca Wood – A case of wood cement blocks." by M. Sato, N. Okuda, K. Kungsuwan, University of Tokyo, Japan; N. Laemsak, Kasetsart University, Thailand; T. Arima, Wood Utilization Research Center of Miyazaki, Japan; and M. Okuma, the Japan Housing and Wood Technology Center
- "Forest resources in the tropics – A reality check." by K. Law, University of Quebec in Trois-Rivières, Canada

Session topics

- Environment and energy resources
- Pulp, paper and cellulose derivatives
- Bio-based composites
- New technological developments
- Resources, properties and characterization

A group photograph of the joint international symposium participants.

3) INTERNATIONAL RESEARCH WORKSHOPS

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

November 14, 2003 — Workshop on "Development of food technologies for improved utilization and distribution of major food resources in China." Tsukuba, Japan
Attended by representatives of JIRCAS, Japan; China Agricultural University, China.

November 25-26, 2003 — Annual workshop on "Development of new technologies and their practice for sustainable farming systems in the Mekong Delta." Cantho, Vietnam
Attended by representatives of JIRCAS, Japan; Cantho University, Cuu Long Delta Rice Research Institute, and Southern Fruit Research Institute, Vietnam

February 20, 2004 — Annual workshop on "Development of low-input technology for reducing postharvest losses of staples in Southeast Asia." Bangkok, Thailand
Attended by representatives of JIRCAS, National Food Research Institute and National Agricultural Research Organization, Japan; Thai Department of Agriculture, Kasetsart University, King Mongkut's University of Technology, Kohn Kaen University, and Prince of Songkla University, Thailand

March 9-10, 2004 — Mid-term evaluation meeting for 2001-2003
Comprehensive studies on "Development of sustainable soybean production technology using agro-pastoral systems in South America." Tsukuba, Japan
Attended by representatives of JIRCAS, Japan, National Center for Soybean Research and National Center for Beef Cattle Research, the Brazilian Agricultural Research Corporation (EMBRAPA); JATAK International Center for Agriculture Technology, Brazil; Instituto de Patobiology, Marcos Juarez Agricultural Experiment Station, the National Institute for Agricultural Technology (INTA), Argentina; Instituto Agronomico Nacional, Ministry of Agriculture and Livestock (MAG), Centro Regional de Investigacion Agricola,; JICA Agricultural Technology Center in Paraguay, Paraguay; and International Center for Tropical Agriculture (CIAT)

March 2-3, 2004 — Final evaluation meeting for 1997-2003
Collaborative research project on "Development of sustainable production and utilization of major food resources in China." Tsukuba, Japan
Attended by representatives of JIRCAS, Ministry of Agriculture, and Institute of Natural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China

March 16-17, 2004 — Final evaluation meeting for 1998-2003
Collaborative research project on "Development of new technologies and their practice for sustainable farming systems in the Mekong Delta." Tsukuba, Japan
Attended by representatives of JIRCAS, Japan; Cantho University and Southern Fruit Research Institute, Vietnam

March 18, 2004 — Preliminary evaluation meeting for the international collaborative research project on "Development of new technologies for control of Citrus Huanglongbing (HLB) in Southeast Asia." Tsukuba, Japan

Attended by representatives of JIRCAS, Japan and Southern Fruit Research Institute, Vietnam

4) INTERNATIONAL RESEARCH SEMINARS

International research seminars are held throughout the year, either on JIRCAS premises or overseas. During these seminars, foreign guests five presentation on topics of importance related to international agricultural research. The following twenty-four seminars were held in FY 2003.

May 14, 2003	The Mangrove red snapper: An emerging aquaculture commodity. *Arnil Cabading Emata*
May 21, 2003	Strategy for rebirth of AVRDC as the World Vegetable Center. *Thomas Lumpkin*
June 24, 2003	Studies on the tolerance to iron and aluminum toxicity in rice plants. *Md. Samiul Alam*
July 4, 2003	Introduction of SEAFDEC and its recent activities. *Niwes Ruangpanit*
July 31, 2003	Preliminary study on moisture adsorption of wheat by rice husk. *Yutthana Tirawanachakul*
August 27, 2003	Diagnosis and challenge of improving the potential production of rice in Côte d'Ivoire. Kossonou *Guillaume Anzoua*
August 28, 2003	Desertification and agriculture in Sudan and Israel. *Salih H. Salih and Keren Rami*
October 1, 2003	Root exudates from *Brachiaria humidicola* as nitrification inhibitors in soils. *Marco A. Rondon*
October 3, 2003	Phylogenetic studies and development of diagnostic methods for shrimp viral diseases. *Leobert D. de la Pena*
October 8, 2003	NEPAD and agricultural development in Africa. *Tshikala Tshibaka*
October 8, 2003	Development of rice production in Africa and dissemination of NERICA. *Nguu Nguyen*
October 17, 2003	Porcine reproductive and respiratory syndrome (PRRS) in Cantho, Vietnam. *Ho Thi Viet Thu*
November 13, 2003	Evaluation of seed components and genetic uniformity of soybean germplasm in Northeastern China using DNA genetic markers.*Yang Zhenyu*
November 13, 2003	Progress of research on stress resistance in crop germplasm in China. *Weng Yuejin*
November 17, 2003	Overview of the FFTC. *Torng-Chuang Wu*
December 5, 2002	Design and purposes of an agent-based model of farming activities in Ban Nong Saeng, Khon Kaen, Thailand. *Christopher Le Page*
December 11, 2002	Analysis of loci for SDS resistance using recombinant inbred lines (RILs) and near isogenic lines (NILs). *Francisco Horacio Fuentes*

January 22, 2004	Anaerobic nitrogen-mineralization of paddy soils under application of composted rice straw and survey of arbuscular myccorhizas in Mekong Delta soils of Vietnam. *Duong Vinh Vien*
February 13, 2004	Grain yield response to climatic factors in China (1985-2002). *Wang Xiuqing*
March 5, 2004	Milkfish aquaculture in the Philippines and fatty acid composition of milkfish fry/juvenile reared under different conditions. *Esteban Garibay*
March 8, 2004	Texture improvement of rice noodles by fermentation. *Lu Zhanhui*
March 11, 2004	Soybean production in Argentina: Our main concerns. *Marcelo Tolchinsky*
March 11, 2004	Assessment of genetic diversity in hexaploid wheat using molecular markers for Fusarium Head Blight resistance genes. *Syed Shahinshah Gilani*
March 19, 2004	History and perspective of farming systems research in the Mekong Delta. *Vo-Tong Xuan*

5) JIRCAS RETURN SEMINARS

At JIRCAS, researchers returning from overseas dispatches or research projects give an oral presentation accompanied by a written summary of activities that is distributed to JIRCAS staff. These sessions are termed "JIRCAS Return Seminars" and are held during the interim or upon the completion of research projects or dispatch assignments. Such seminars are ordinarily held twice per 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. 37 - No. 2, No. 3, No. 4 Vol. 38 - No. 1
2) Annual Report	No. 9 (2002)
3) JIRCAS Newsletter	No. 35, No. 36, No. 37, No. 38
4) JIRCAS Working Report Series	No. 33 English Textbook: PASTURE FARMING IN KAZAKHSTAN (with fundamental ecology)
	No. 35 Sustainable Production Systems of Aquatic Animals in Brackish Mangrove Areas
	No. 36 Development of Sustainable Agro-Pastoral Systems in the Subtropical Zone of Brazil

In Japanese

1) JIRCAS News	No. 35, No. 36, No. 37, No. 38
2) JIRCAS Working Report Series	No. 32 Ecological, Physiological and Molecular Biological Analyses for High Sucrose Breeding in Sugarcane
	No. 34 African Agriculture Seminar in 2002 and 2003 "Agricultural Characteristics of Sub-Saharan Africa"
3) JIRCAS Research Highlights	No. 10

LIBRARY ACQUISITIONS

April 1, 2003 - March 31, 2004

	Books			**Periodicals (titles)**			**Materials (Proceedings, maps and other)**		
Language	Purchased	Gifts	Total	Purchased	Gifts	Total	Purchased	Gifts	Total
Japanese	175 (48)	85 (0)	260 (48)	54 (27)	271 (67)	325 (94)	17	271	288
Foreign	50 (9)	19 (0)	69 (9)	89 (14)	335 (29)	424 (43)	11	175	186
Total	225 (57)	104 (0)	329 (57)	143 (41)	456 (96)	749 (137)	28	446	474

( ) Indicates separate acquisitions of the Okinawa Subtropical Station

RESEARCH STAFF ACTIVITY 2003-2004

Journal articles, book chapters, and monographs

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Fujii, H. (2004). Hydrological survey and water balance of the Cambodian floodplain in the Mekong River. Technical Report of the National Institute for Rural Engineering, 202: 1-14. (J)

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(J) Denotes articles written in Japanese; (C) denotes articles written in Chinese; (V) denotes articles written in Vietnamese; bold lettering indicates JIRCAS staff members.
Information regarding published proceedings, conference presentations and other publications may be requested from the Publication and Documentation Section (pubj@ml.affrc.go.jp).

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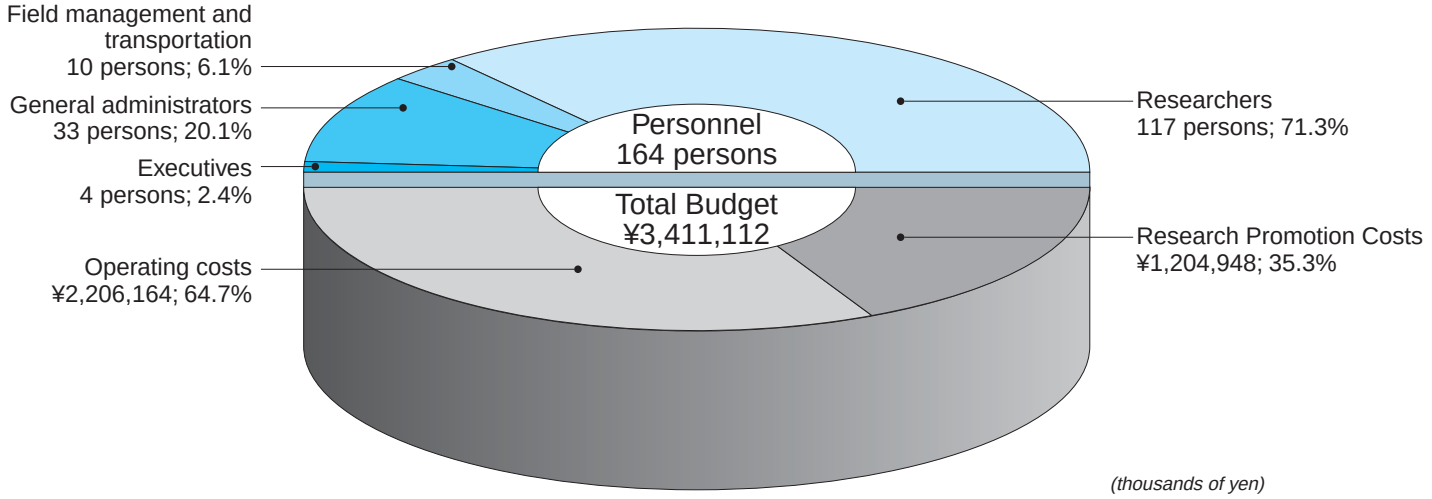
FINANCIAL OVERVIEW

Fiscal Year 2003

	thousands of yen
TOTAL BUDGET	**3,411,112**
OPERATING COSTS	**2,206,164**
Personnel (164)	1,766,270
President (1), Vice President (1), Executive Advisor & Auditor (2)	
General administrators (33)	
Field management and transportation (10)	
Researchers (117)	
*Number of persons shown in ( )	
Administrative Costs	439,894
RESEARCH PROMOTION COSTS	**1,204,948**
Research Development	290,136
Overseas Dispatches	283,209
Research Exchange/Invitation	9,818
Research Information Collection	114,180
International Collaborative Projects	337,532
Fellowship Program	170,073

Budget FY 2003 (Graph)



TENETS OF THE JIRCAS MID-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 five-year Mid-Term Plan approved by the Ministry of Agriculture, Forestry and Fisheries (MAFF). The tenets of this Mid-Term Plan, divided into research and administrative operations, are detailed in the following outline.

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 research status in Japan and overseas, and elucidation of trends in technology development

1) Analysis of trends in world food supply and demand, and development of mid-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 mid-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 based on 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 production technology for 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, 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 having 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 environment-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 for determining basic characteristics of food resources prior to harvest, and during postharvest processing and distribution. Factors affecting quality changes will be identified.
   2. Development of methods for the prevention of quality deterioration and methods for the improvement of processing technology
      Technology for low-input drying and storage of food commodities will be developed in order to reduce postharvest losses. Local processing technology will be improved in order 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 environment-friendly utilization of aquatic products will be developed while considering the state 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 having 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 of crops such as rice, wheat and soybean related to disease and insect pest resistance 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 environment-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 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 having 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 technology will be developed for quality evaluation and for 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 the 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 response 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 consultations
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 Mid-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 Mid-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 based on 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 their utilization 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 context of the objectives of the Mid-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, including 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 for exchanging information and opinions concerning 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 as well as from municipal, district and prefectural organizations.

ADVISORS AND PRINCIPAL STAFF

Advisors

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

JIRCAS External Evaluation Committee

Haruo Inagaki	Counselor, Japan Food and Agriculture Organization (FAO) Association
Keiji Ohga	Professor, Graduate School of Agricultural and Life Sciences, the University of Tokyo
Naoto Owa	Professor, Department of Applied Biological Chemistry, Faculty of Agriculture, Niigata University
Yoshiharu Yasunaga	Technical Advisor, Overseas Fishery Cooperation Foundation
Katumi Musiake	Professor, Fukushima University
Seiichi Murayama	Professor, Department of Bioproduction, Faculty of Agriculture, University of the Ryukyus
Hiroko Morishima	Professor, Department of Agriculture, Faculty of Agriculture, Tokyo University of Agriculture
Hitoshi Yonekura	Professor, Graduate School of Agricultural Science, Tohoku University
Hiroyuki Watanabe	Professor, Graduate School of Agriculture, Kyoto University

External Reviewers for International Collaborative Projects

Development of sustainable production and utilization of major food resources in China

Yoshihiro Kaida	Professor (former), Kyoto University
Kunio Takase	Advisor, International Development Center of Japan
Naohiro Kitano	Associate Professor, Graduate School of Economics, Kyoto University
Tokio Inbe	Director, Department of Rice Research, National Institute of Crop Science, National Agricultural Research Organization (NARO)

Comprehensive studies on soybean improvement, production and utilization in South America (multinational)

Peter Kerridge	CIAT Asia Program, Lao PDR Office, Centro Internacional de Agricultura Tropica (CIAT)
Kazuo Kawano	Professor, University Farm, Faculty of Agriculture, Kobe University
Shinji Sakai	Director, Department of Integrated Research for Agriculture for the Kanto and Tokai Region, National Agricultural Research Center, National Agricultural Research Organization (NARO)
Makie Kokubun	Professor, Graduate School of Agricultural Science, Faculty of Agriculture, Tohoku University

Development of new technologies and their practice for sustainable farming systems in the Mekong Delta (Phase II)

Vo-tong Xuan	Rector, An Giang University
Tetsuo Shioya	Professor, University Farm, Faculty of Agriculture, Tokyo University of Agriculture and Technology
Yoshiaki Kano	Director, Tsukuba International Center, Japan International Cooperation Agency (JICA)
Michiko Takagaki	Lecturer, Faculty of Horticulture, Chiba University

Development of low-input technology for reducing postharvest losses of staples in Southeast Asia

Greg Johnson	Australian Center for International Agricultural Research (ACIAR)
Toshinori Kimura	Professor, Institute of Agricultural and Forest Engineering, the University of Tsukuba
Yoshimi Hirose	Professor Emeritus, Kyushu University
Tadashi Miyata	Professor, Department of Biological Resources and Environmental Sciences, School of Agricultural Sciences, Nagoya University

Development of agroforestry technology for the rehabilitation of tropical forests

Minoru Kumazaki	President, Gifu Academy of Forest Science and Culture, Gifu Prefecture
Hideki Miyakawa	Director, Forestry and Natural Environment Cooperation Department, Japan International Cooperation Agency (JICA)
Mitsuyoshi Yatagai	Professor, Graduate School of Agricultural and Life Sciences, the University of Tokyo
Yoshiya Tadaki	Director, Ecological Research Center, PREC Institute Inc.
Fujio Kobayashi	Vice-Chairman, the Japan Forestry Association

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

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

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

Paiboon Pramopjanee	Associate Professor, Department of Soil Science, Faculty of Agriculture, Kasetsart University; Visiting Professor, Ritsumeikan Asia-Pacific University
Tawachai Na Nagara	Advisor and Former Director, Soil Science Division, Department of Agriculture, Ministry of Agriculture and Cooperatives
Sakol Ooraikul	Agricultural Economics Specialist, Department of Agriculture, Ministry of Agriculture and Cooperatives
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
Akira Goto	Professor, Environmental Engineering, Faculty of Agriculture,

Utsunomiya University

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

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

JIRCAS STAFF FY 2003

President

Mutsuo Iwamoto

Vice-President

Yoshinori Morooka
(Akinori Noguchi; from April 1, 2003)

Executive Advisor & Auditor

Kunihiko Kato
Akimi Fujimoto

Research Planning and Coordination Division

Akinori Noguchi, Director
(Masami Yasunaka; from April 1, 2003)

Research Planning Section
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(Shuichi Asanuma*, Section Head)
Kumi Yasunobu, Senior Researcher
Takeshi Urao, Senior Researcher
Marcy N. Wilder, Senior Researcher in Fisheries Division, Joint Appointment

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Hitoshi Nakagawa, Section Head
Hiroshi Komiyama, Senior Researcher

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Hiroko Takagi-Watanabe, Plant Breeding
Kazuhiro Suenaga, Wheat Breeding

Public Information Officer
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(Sho Kosugi*, Agricultural Economics)

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Hiromi Miura, Librarian

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Takashi Komatsu, Field Operator

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Yasuhiro Onozaki, Section Manager
Masae Kudo, Section Officer
Nobuo Ueno, Section Officer
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Ryo Okamoto, Personnel Officer
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(Tomoko Maeno*, Facilities Officer)

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Development Research Division

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Kazunobu Toriyama, Soil Science

Research Staff
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Kazuo Nakamoto, Agricultural Economics
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Ryoichi Matsunaga, Legume Breeding
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Hiro Nakamura, Cereal Chemistry and Plant Breeding
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Tadashi Yoshihashi, Food Evaluation

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Shoji Noguchi, Forest Hydrology
Yukihito Ochiai*, Silviculture
Takayuki Ohta, Silviculture
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Yasuhiro Yokota, Social Forestry

Fisheries Division

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Research Staff
Yoshimi Fujioka, Coastal Ecology
Masaki Kaneniwa, Food Chemistry
Ikunari Kiryu, Fish Pathology
Hiroshi Ogata, Fish Nutrition
Yasuki Ogawa, Crustacean Zoology
Toru Shimoda, Coastal Ecology
Marcy N. Wilder, Crustacean Biochemistry

Okinawa Subtropical Station

Shuichi Asanuma,Director
(Masaaki Suzuki*, Director)
Kazuo Shibano, Associate Director for Research

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Mitsuyuki Saito, Section Chief
Fumihiko Hisada, Section Manager
Shuji Hirose, Section Officer
Takao Ohga, Accounting Manager
Yoshiyuki Hoshinoya, 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
(Yoshinobu Egawa*, Plant Genetic Resources, Head)
Kouichi Kashiwaba, Plant Breeding
Hide Ohmae, Plant Physiology

Tropical Crop Breeding Laboratory
Makoto Matsuoka, Plant Breeding, Head
Koshun Ishiki, Plant Breeding and Genetic Resources
Mitsunori Sato, Sugarcane, Breeding, Agronomy
Yasuaki Tamura, Rice, Breeding
Masahiko Tanio, Wheat, Breeding

Tropical Fruit Crops Laboratory
Kazunori Ogawa, Plant Chemistry, Head
Hiroshi Fukamachi, Pomology
Hidenori Kato, Plant Physiology

Plant Protection Laboratory
Masatoshi Ohnuki, Plant Virology, Head
Kunimasa Kawabe, Plant Virology
Katsuyuki Kohno, Entomology
Tadafumi Nakata, Entomology

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

Researchers on Loan to Other Organization

International Maize and Wheat Improvement Center (CIMMYT)
Masaru Iwanaga, Director General

International Rice Research Institute (IRRI)
Yoshimichi Fukuta, Rice Breeding
Takuhito Nozoe, Soil Chemistry
Seiji Yanagihara, Plant Breeding

Japan International Cooperation Agency (JICA)
Takasuke Ishitani*, Postharvest Technology (China)

Part-Time informal employees
Nearly 100 persons are working at JIRCAS as non-permanent staff. They serve as editorial advisors for many of JIRCAS's publications, perform much of the institute's secretarial work, function as laboratory technicians, and maintain the buildings and laboratories. Their services to JIRCAS are highly valued.

* Indicates transfer within JIRCAS, relocation, or retired during the Fiscal Year covered by this Annual Report.

( ) Indicates previous position holder

THE JAPANESE FISCAL YEAR AND MISCELLANEOUS DATA

The Japanese Fiscal Year and about Annual Report 2003

The Japanese fiscal year is defined as a period of fiscal activity occurring from April 1 through March 31 of the following year. Thus, Fiscal Year (FY) 2003 covers the period from April 1, 2003 through March 31, 2004. Annual Report 2003 is intended to summarize the full extent of JIRCAS activities that occurred during this time period. The following Annual Report will detail events and activities from April 1, 2004, through March 31, 2005 (FY 2004).

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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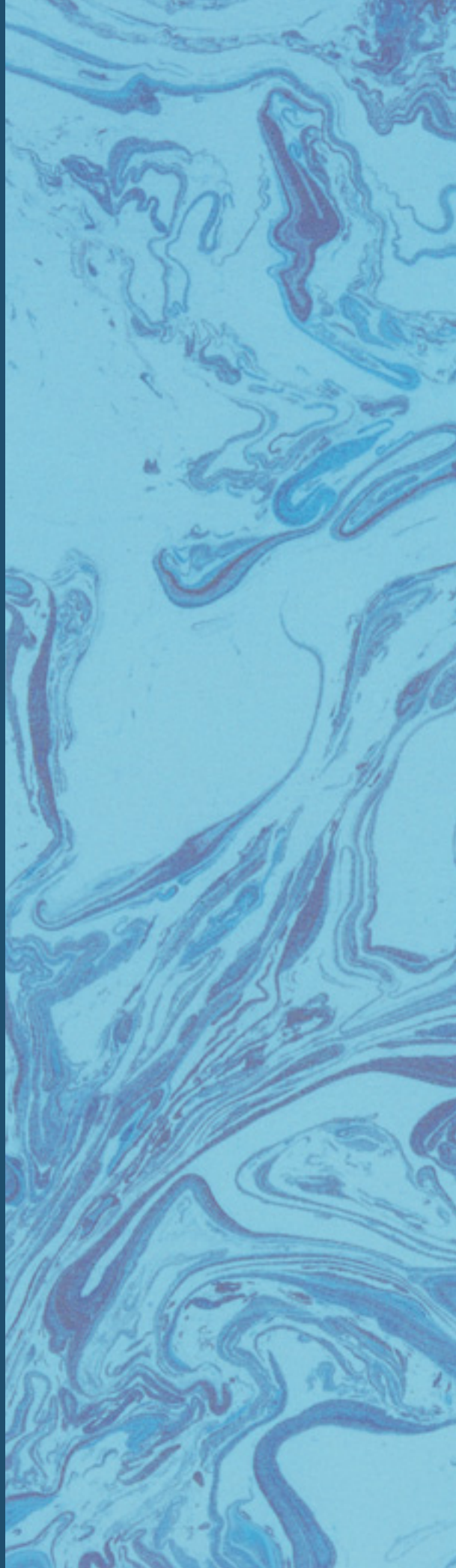

JAPAN INTERNATIONAL RESEARCH CENTER
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