ISSN 0919-8822

2002 September

No.32

JIRCAS Newsletter

for

INTERNATIONAL COLLABORATION

CONTENTS

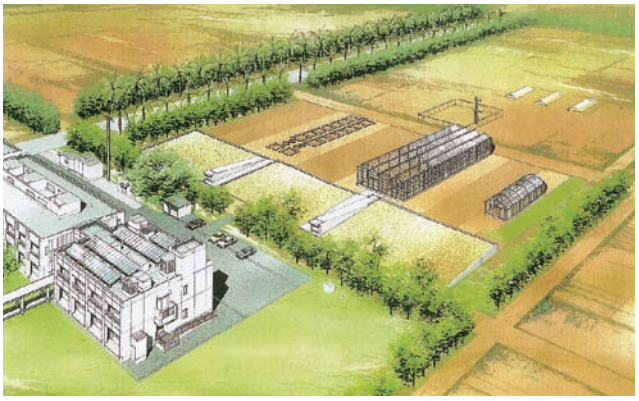
JIRCAS

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Okinawa Subtropical Station: Present and Future

Unique features

The JIRCAS Okinawa Subtropical Station has two unique features. First, it is the only national research institution located in the subtropical climate zone of Japan. This makes it possible to conduct experiments with many tropical and subtropical crops either in open fields or in slightly heated greenhouses of the Station. Similar climatic conditions can be simulated only in heavily heated greenhouses or climate chambers in other Japanese research institutions. The Station has, therefore, served as a center for conducting research on tropical and subtropical crops as well as the gateway for introducing and acclimatizing tropical crops. Second, the Station is located in Ishigakijima Island, a small coral island of which the environment typifies the subtropical and tropical insular regions of the world. Special socioeconomic and technological considerations are indispensable for the development of agriculture in these regions, and the Station has served as a key research station to develop agricultural technologies adaptable to these regions.



An air view of insular environment and technology development facilities.

The Station, at present, consists of five laboratories as well as the International Collaborative Research Section. The Island Environment Management Laboratory is the leading laboratory and is expected to develop technologies for attaining sustainable agricultural production in insular environments. The Environmental Stresses Laboratory is studying mainly the mechanisms of heat tolerance in vegetable crops and evaluating useful genetic resources that could be utilized for domestic and foreign breeding programs. The Crop Breeding Laboratory is developing useful breeding materials for sugarcane and tuber crops using biotechnology and is producing breeding materials for rice and wheat crops by rapid generation advancement techniques using advantageous climatic conditions. The Tropical Fruit Crops Laboratory is developing technologies for culturing tropical fruit crops in subtropical conditions and evaluating the eating quality of fruits. This laboratory is also developing new technologies for the mass production of fruit tree seedlings. The Plant Protection Laboratory is developing technologies for controlling important tropical pests and diseases such as citrus greening disease by introducing an integrated pest management method. Finally, the International Collaborative Research Section serves as a receiving office for research fellows from tropical and subtropical countries. At present, 10 post-doctoral fellows have been invited from Indonesia, China, Egypt, etc. and are conducting pioneer research in the above-mentioned laboratories.

Future prospects

More collaborative work within the Station is essential to contribute more effectively to the development of technologies for small islands in developing regions. We are now constructing a new building with a large-scale lysimeter, where the transpiration of crops, evaporation and infiltration of soil water, and the water movement in a soil-crop continuum can be measured accurately. Furthermore, by using the runoff plots, the mechanism of erosion can be studied more precisely and countermeasures can be proposed. The addition of these new facilities is expected to give a boost to the research in the Station and would hopefully lead to a better understanding of the tropical and subtropical island environments. One of the major problems facing such islands is the sustainable production of food. The JIRCAS Okinawa Subtropical Station hopes to contribute toward alleviating and solving this problem.

Masaaki Suzuki
Director, Okinawa Subtropical Station, JIRCAS

Cover photo: Pineapple is a very popular crop near the Okinawa Subtropical Station. The fresh fruit is sold as typical souvenir for sightseers.
(Photo by M. Suzuki)

Farm land in Ishigakijima Island.

Physiological Mechanism of Crop Heat Tolerance and Development of Heat-Tolerant Crops

Heat stress is one of the most important constraints of crop production in tropical and subtropical regions, and the severity of the situation is growing worse each year due to increasing global warming. The JIRCAS Okinawa Subtropical Station has conducted research on physiological responses to high temperature conditions in various crops such as snap bean, adzuki bean, and tomato. Our research is financed in part by Japanese Bio-oriented Technology Research Advancement Institution (BRAIN).

Physiological characteristics of heat-tolerant snap bean 'Haibushi'

Flower and pod abscission occur easily under high temperature conditions in snap bean. The Station has successfully developed a heat-tolerant cultivar 'Haibushi' by screening more than 350 accessions of germplasm. 'Haibushi' was able to produce more fertile pollen and higher yield under high temperatures than other existing cultivars. The cultivar keeps withdrawing and transpiring water under high temperature and intense light conditions, and this seems to be a main reason why it is able to exhibit an excellent performance. The cultivar also lowered water potential in floral organs under high temperature conditions more gradually than a heat-sensitive cultivar. The cultivar was registered in the National Catalogue of Agricultural Crops in 1998.

Heat-tolerant snap bean 'Haibushi' developed by the JIRCAS Okinawa Subtropical Station.

Utilization of heat-tolerant germplasm for breeding programs

Wild plant germplasm generally exhibits a wide range of genetic diversity including responses to various environmental stresses. We found that Southeast Asian wild adzuki bean *Vigna minima* could set pods and produce viable seeds under high temperature conditions and can hybridize with adzuki bean. We are now developing isogenic lines of heat-tolerant adzuki bean cultivar by recurrent backcrossing and selection, and plan to conduct comparative research on these isogenic lines.

Transgenic tobacco lines introduced MT-sHSP gene.

Function of small heat shock protein

Plants usually produce small heat shock proteins (sHSPs) in response to heat stress. Mitochondrial (MT)- and endoplasmic reticulum (ER)-located sHSP genes have been successfully cloned from tomato, and it was observed that both genes worked specifically in stigmas under heat stress at the flowering period. In tomato flowers, MT-sHSP was produced more quickly at 40℃ treatment as compared with ER-sHSP. These sHSPs have a molecular chaperon function which can enhance the renaturation of chemically denatured citrate synthase *in vitro*. We have also successfully produced transgenic tobacco and tomato plants by introducing MT- and ER-sHSP genes, and found that the MT-sHSP transgenic tobacco plants enhanced heat tolerance during vegetative growth stage. We are now evaluating how MT-sHSP gene works during reproductive growth stage.

Yoshinobu Egawa, Mariko Shono, Katsumi Suzuki, Tadashi Tsukaguchi, Kazutuka Sanmiya
Okinawa Subtropical Station, JIRCAS

The First Report of a Sodium-Pump (Na^+-ATPase) Gene in Plant Cells

Salinity is a major abiotic stress in agriculture worldwide and more than 40% of irrigated lands are affected by salinity. Breeding of salt tolerant crops through genetic engineering is considered as one of the effective methods of solving salinity problems especially when land reclamation is very difficult.

Recently, several genes have been proved to be crucial for salt tolerance in plants. We have conducted research to develop a salt tolerant plant by introducing a gene related to Na^+-pump which can prevent the accumulation of sodium ions in the cytoplasm. However, Na^+-pump has been identified only in animal cells so far, and it used to be considered that higher plant cells would not have Na^+-pump. The marine algae *Heterosigma akashiwo*, which we have studied, usually live in brackish water and have a function of expelling sodium ions. Recently, we detected Na^+-ATPase activity in the plasma membranes of algae (Figs. 1, 2).

Moreover, we succeeded in the world's first cloning of cDNA of membrane-bound enzyme Na^+-ATPase (HANA) from these algae. The full-length HANA cDNA was 4,467-bp long and coded for a 1,330-amino acid protein with a molecular weight of 146,306. HANA is a member of P-type ATPases; it has 10 deduced transmembrane domains and conserved domains including phosphorylation sites and ATP binding sites. It showed 40% identity in amino acids with animal Na^+/K^+-ATPase α-subunits. A hydrophilic sequence with 285 amino acid residues existed between the 7th and 8th transmembrane domains. This sequence has not been found in animal cells. Studies on the sequence indicate that HANA has monomeric composition and does not have a β-subunit which animal Na^+/K^+-ATPases usually have. The amounts of cDNA and HANA did not vary when *H. akashiwo* cells were cultured for one week at various concentrations of NaCl solutions ranging from 0.3 to 0.5 M.

The phylogenetic tree of a P-type ATPase family was established by using the neighbor-joining method in GrowTree Phylogram of Wisconsin GCG DNA sequence analysis software. Sequences of ATPases were obtained through the GenBank, EMBL, and SWISS-PROT databases. The tree consists of three major clusters, Ca^{2+}-ATPases, H^+-ATPases, and Na^+/K^+-ATPases, HANA is included in the 3rd cluster (Fig. 3). Therefore, HANA is similar to Na^+/K^+-ATPases of invertebrates such as *Artemia*, *Drosophila*, and *Hydra*. It can be indicated that both HANA and yeast Na^+-ATPases are Na^+-pumps, but that the latter is classified in the cluster of Ca^{2+}-ATPases. This difference indicates that the origin of Na^+-transport system in alga is different from that in yeast. We are now trying to incorporate HANA cDNA into higher plants such as tobacco, and study how Na^+-transporting activity works in these transgenic plants.

Mariko Shono
Okinawa Subtropical Station, JIRCAS

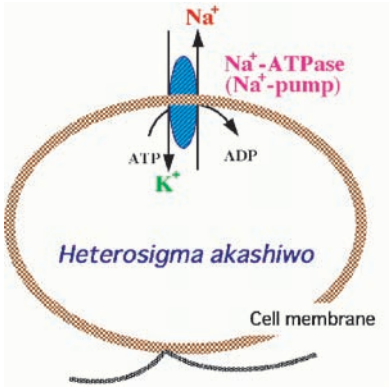


Fig. 1. Na^+-transporter model in the plasma membrane of *Heterosigma akashiwo*.

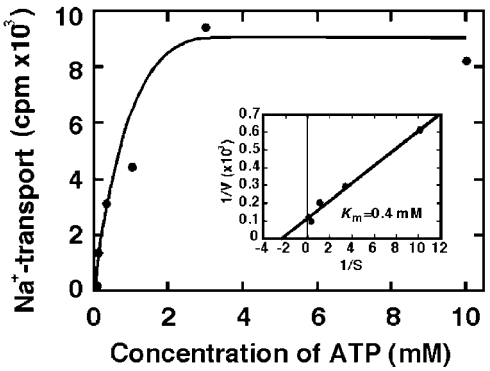


Fig. 2. Na^+-transporting activity in the plasma membrane of *Heterosigma akashiwo*.

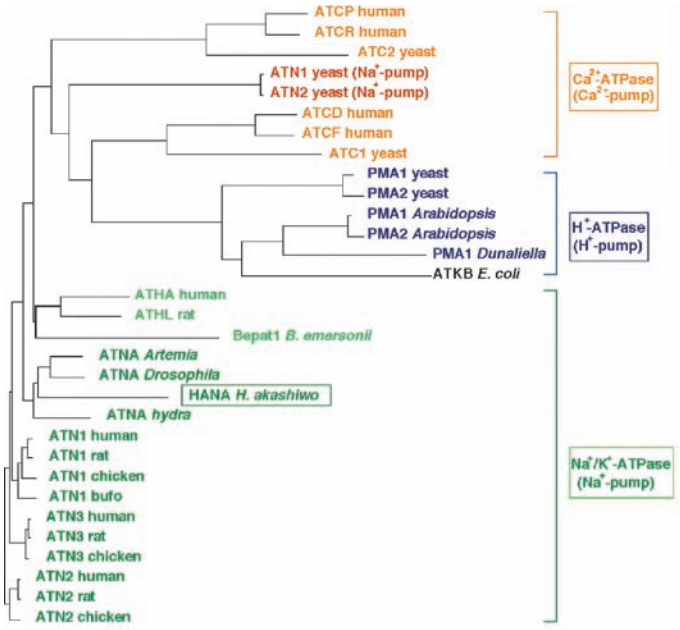


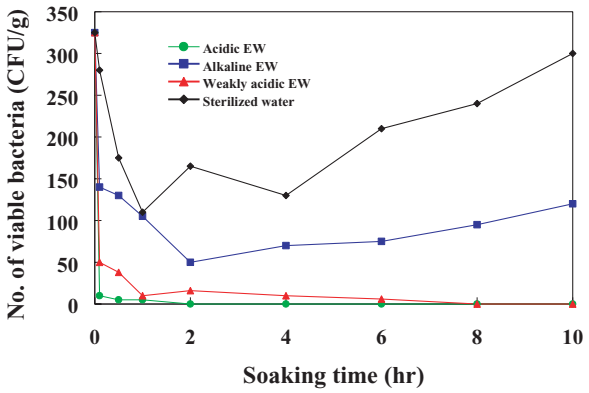
Fig. 3. Phylogenetic tree of P-type ATPases family.

Control of Microbial Contamination by Electrolyzed Water in Tofu Manufacturing

Tofu is a popular processed food in Asia, and recently, it has become popular worldwide as a health food containing high contents of essential amino acids and isoflavone. Since the consumption of tofu is gradually increasing, it becomes very important to maintain hygienic conditions during its manufacture. Especially, the control of heat-resistant spore-forming bacteria, which are predominant on the surface of soybean, is an essential part of tofu manufacturing. This report describes the potential of electrolyzed water to control microbial contamination in tofu manufacturing.

Electrolyzed water

Electrolyzed water can be produced by electrolyzing sodium chloride solution or dilute hydrochloric acid. Electrolyzed water is classified into 3 types: acidic electrolyzed water (germicidal, used for hygienic purposes), alkaline ionized water (having medical effects; drinking water), and alkaline electrolyzed water (lipid-detergent). Scientific evidences concerning electrolyzed water increased in the 1990s and some industrial applications were also developed. Nowadays, acidic electrolyzed water is used to sanitize food-processing equipment and fresh-cut vegetables in food industries.



Changes in viable bacteria populations in soybeans soaked in electrolyzed water.

The electrolyzed water generator introduced in China Agricultural University.

Utilization of electrolyzed water for soaking soybeans

Microbial contamination could be effectively eliminated by using acidic electrolyzed water. We soaked soybean in 3 types of electrolyzed water: acidic electrolyzed water at pH 2.1, 1185 mV oxidation-reduction potential (ORP) and 100 ppm chloride, alkaline electrolyzed water at pH 11.7, -120 mV ORP, and a mixture (weak acidic electrolyzed water) of both waters at pH 6.5, 891 mV ORP, and 50 ppm chloride. Microbial population of the water became negligible after only 30 min. of treatment in acidic electrolyzed water and 1 hour in the mixture, while physico-chemical characteristics of tofu and milk made from soybean thus treated were not changed at all. Electrolyzed water is however very unstable and should be prepared only at the time of use. Moreover, acidic and weak acidic electrolyzed water are easily inactivated when polluted by organic matter; therefore, it is necessary to always protect them from pollution and to preliminarily wash the manufacturing lines with electrolyzed water before use. In order to apply electrolyzed water in processing of other foods, similar analyses of the efficiency, stability, and reactivity (safety) of electrolyzed water in the presence of other organic materials are needed.

Eizo Tatsumi
Food Science & Technology Division, JIRCAS

Effects of electrolyzed water on soybean, soybean milk, and tofu

	Alkaline EW*	Acidic EW	Weak acidic EW	Sterilized water
Water absorbency of soybeans (%)	120.6	112.6	114.0	116.1
Solid content in soaked water (%)	0.51	0.47	0.37	0.32
Yield of soybean milk (ml**)	232.9	230.6	229.1	227.4
Solid content in soybean milk (%)	10.85	11.04	10.60	10.64
Tofu gel strength (kPa)	15.14	15.90	17.68	17.78

*EW: electrolyzed water
**ml : Yield of soybean milk extracted from 50g of dry seed

A Differential System for Rice Blast Disease

IRRI-Japan Collaborative Research Project has been implemented with financial assistance from the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF), and researchers from Japan International Research Center for Agricultural Sciences (JIRCAS) have continued joining the project since 1984. Phase IV of the project 'Physio-genetic studies on yield determination and ecological adaptability for sustainable rice culture' was initiated in October 1999 and will continue until September 2004.

Among our activities, I describe our major progresses in the genetic studies of rice blast resistance.

Blast research now

Blast caused by *Pyricularia grisea* Sacc. is one of the most serious diseases of rice (*Oryza sativa* L.) all over the world. In the lowland areas of tropical Asia, tungro virus and bacterial leaf blight are the most important, and blast used to be considered as the 3rd most important. However, the introduction of new cultivars without blast resistance genes has caused an increased occurrence of this disease. Moreover, as rice production in upland and rainfed areas has become more important, blast has become a more serious problem.

Japan has accumulated a lot of knowledge and technology on rice blast. However, the blast pathogen has a wider genetic variability in pathogenicity in tropical areas, and that requires more comprehensive research. Especially, a differential system of blast, which was developed in Japan, was not adaptable to blast isolated in the tropics, indicating that additional genes are associated with blast resistance.

Since the prevention of pests and diseases using resistance genes is the most important method in developing countries where pesticides are not sufficiently available, the differential system of blast is a very important research area to accelerate the use of resistance genes in rice breeding programs and pest control.

Approach of IRRI-Japan Project

We have developed differential lines, which are useful tools in understanding the pathogenicity of blast isolates. The lines were developed as a result of continuous backcrosses between Japanese differential varieties as donors of resistance genes and three recipient cultivars Lijiangxintuanheigu (LTH), CO 39, and US 2 as recurrent parents as shown in the Table. Since Japonica type cultivars LTH and US 2 have no resistance gene and Indica type cultivar CO 39 has only one gene *Pia*, the pathogenicity of blast isolates can be easily determined using near isogenic lines (NILs) developed from these lines.

Monogenic lines and donor variety parents.

A: LTH (long day condition: LDC),
B: LTH (natural [short] day condition: SDC),
C: Monogenic line, IRBL19-A (LDC),
D: IRBL19-A (SDC),
E: Donor variety, Aichiasahi (SDC)

Four kinds of differential variety series, namely, monogenic lines, LTH NILs, CO 39 NILs, and US 2 NILs have been developed. A total of 24 monogenic lines were derived from backcrossing one to three times with LTH, and self-pollinating at F_{11} to F_{15} generations. Morphological traits of LTH, LTH NIL, and a donor line are shown in the Figure. A total of 17 LTH NILs were developed at generations BC_6F_8 to BC_6F_{10}. LTH NILs still segregate in some morphological characteristics and will need further fixation processes. A total of 18 Indica-type CO 39 NILs were developed and attained relatively uniform traits. Although there still exist some morphological variations, these monogenic lines, LTH NILs, and CO 39 NILs could be used as differential varieties. Unfortunately, seed production using these lines is limited under tropical conditions, and a high yielding line such as US 2 is being developed.

The differential varieties we developed have already been distributed to national institutes and colleges in China, India, Japan, Korea, the Philippines, Thailand, and Vietnam, and pathologists and plant breeders are working with them for blast isolate determination and breeding of resistant cultivars.

Our research provides the possibility of a future global research network for a better understanding of blast disease and resistance genes and enhancing the development of a more concrete differential system and blast-resistance breeding program in related countries.

Yoshimichi Fukuta
International Rice Research Institute (IRRI)

Development of differential varieties for blast resistance

Target resistance gene	Genetic background (including resistance gene)			
	Monogenic lines (-)	LTH NILs (Lijiangxintuanheigu) (-)	CO 39 NILs (*Pia*)	US 2 NILs (Non)
Pia	BC_1F_{15}	BC_6F_8, BC_6F_9	-	BC_6F_2
Pib	BC_1F_{13}	BC_6F_8	BC_6F_9	BC_6F_2
Pii	BC_1F_{15}	-	-	BC_4F_1
Pik	BC_1F_{14}	BC_6F_8	BC_6F_9	BC_6F_2
Pik-h	BC_1F_{13}	BC_6F_8	BC_6F_9	BC_6F_2
Pik-m	BC_1F_{11}	-	BC_6F_9	-
Pik-p	BC_1F_{13}	-	BC_6F_9	BC_6F_2
Pik-s	BC_1F_{15}	BC_6F_8, BC_6F_9, BC_6F_5	BC_6F_9	BC_6F_2
Pish	BC_1F_{13}, BC_1F_{15}	-	BC_6F_9	BC_4F_1
Pita	BC_2F_{13}, BC_3F_{13}, BC_5F_{11}	BC_6F_8, BC_6F_{10}	BC_6F_9	BC_6F_2
Pita-2	BC_1F_9, BC_1F_{11}	BC_6F_6	BC_7F_7, BC_6F_9	-
Pit	BC_2F_{13}	-	-	-
Piz	BC_1F_{15}	BC_6F_8	BC_6F_9	-
Piz-5	BC_3F_{13}, BC_5F_{11}	BC_6F_{10}	BC_6F_9	-
Piz-t	BC_1F_{15}	BC_6F_8, BC_6F_9	BC_7F_7	BC_6F_2
Pi1	BC_3F_{13}	-	BC_6F_9	BC_6F_2
Pi3	BC_2F_{13}	BC_6F_{10}	-	-
Pi5	BC_3F_{13}	BC_6F_{10}	BC_6F_9	BC_6F_2
Pi7	BC_3F_{13}	BC_6F_{10}	BC_6F_9	BC_6F_2
Pi8(t)	-	BC_6F_6	-	-
Pi9	BC_3F_{13}	BC_6F_{10}	-	BC_6F_1
Pi11	BC_2F_{13}	BC_5F_7, BC_6F_{10}	BC_6F_9	BC_6F_2
Pi12	BC_2F_{13}	-	BC_6F_9	BC_5F_1
Pi19	BC_1F_{15}	-	-	-
Pi20	BC_1F_{11}	BC_6F_6	BC_7F_7	-

9th JIRCAS International Symposium
"Value-Addition to Agricultural Products" — Towards increase of farmers' income and vitalization of rural economy —

Date: October 16 and 17, 2002
Venue: Epochal Tsukuba
Organized by: JIRCAS

In cooperation with: National Agricultural Research Organization
National Food Research Institute
Fisheries Research Agency
P*h*Action
Food Forum Tsukuba

PROGRAM

Day 1 (Wednesday, October 16)

Opening Session (9:30-10:00)
Opening address and welcome remarks

Keynote addresses (10:00-11:00)
1. Status of postharvest development and the potential future contribution of value addition to rural economy (Geoffrey Mrema, FAO)
2. Linking farmers to markets - P*h*Action Initiative (Guy Poulter, Chair of P*h*Action, NRI, UK)

Session 1 (11:15-15:20)
Current status of rural economy and measures for increasing farmers' income and vitalization of rural economy

1. China (Li Suoping, CAAS, China)
2. The Philippines (Nerlita M. Manalili, SEARCA, The Philippines)
3. Vietnam (Le Van To, Post-Harvest Technology Center, Vietnam)
4. Indonesia (Made S. Mahendra, UNUD, Indonesia)
5. South Asia (Andy Hall, CPHP, India)
6. Latin America (Bernard Ospina, CLAYUCA, Colombia)
7. Africa (Shaun Ferris, IITA, Uganda)

Session 2 (15:35-17:55)
System for ensuring high quality and safety

1. Codex standards and food safety (Yukiko Yamada, NFRI, Japan)
2. Systems for ensuring production quality and safety for small rural agro-enterprises - the way forward (Linda Nicolaides, NRI, UK)
3. Grain Quality-storage to market (Joseph Rickman, IRRI, The Philippines)
4. Safety of feed and animal products (Andrew Speedy, FAO, Italy)
5. Extension of fish pre-rigor state by enhancing mitochondrial ATP synthesis (Shugo Watabe, Univ. Tokyo, Japan)

Day 2 (Thursday, October 17)

Session 3 (9:00-12:30)
Research on value-addition and novel utilization

1. Application of value adding technologies in Thailand (Gassinee Trakoontivakorn, IFRPD-KU, Thailand)
2. Present status and problems of traditional fish products in Southeast Asia (Tan Sen Min, SEAFDEC, Singapore)
3. Development of intermediate foodstuff from freshwater fish in China (Wang Xi Chang, SFU, China)
4. Inventory of indigenous plants and minor crops in Thailand based on bioactivities (Kazuhiko Nakahara, JIRCAS, Japan)
5. Functionalities of traditional foods in China (Li Lite, CAU, China)
6. Functionalities of foods and their utilization in Japan (Makoto Shimidzu, Univ.Tokyo, Japan)

Poster Session (12:30-14:30)

Session 4 (15:00-16:30)
General Discussion

1. What needs to be done to make postharvest research and development serve the needs of the poor farmers in their efforts to find markets for their products? (Chair: Geoffrey Mrema, FAO)
2. Changing focus of postharvest research - from postharvest losses towards value- addition - re-evaluation of indigenous products and traditional foods (Chair: Toru Hayashi, JIRCAS)

Closing Address (16:30-16:45)

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The 21st Annual Group Meeting on Agricultural Science and Technology Exchange between China and Japan at Kunshan, China

The 21st Annual Meeting on Agricultural Science and Technology Exchange between China and Japan was held at Kunshan, China, from June 3 to 5, 2002. Nine Japanese delegates led by Mr. Akihiko Ohmori, Senior Councilor for Technical Affairs from Ministry of Agriculture, Forestry and Fisheries, and 12 Chinese delegates led by Ms. Jin Sisheng, Deputy Director-General from Department of International Cooperation (DIC), Ministry of Agriculture discussed the results of the previous year's activities, future strategy and direction of agricultural research and technology development, and extension work in both countries. Dr. Y. Morooka, Vice-President of JIRCAS joined the Meeting and also attended the 7th research coordinating meeting, which was held in order to discuss substantial issues on the ongoing comprehensive research project entitled "Development of Sustainable Production and Utilization of Major Food Resources in China." The coordinating meeting was chaired by Mr. Liu Zhangwei, Acting Director of the Asia and Africa Division of DIC, and members from both countries agreed that the project has achieved satisfactory results. Moreover, they exchanged views on suitable topics and schedules for the next project to be prepared, and subjects such as an early prediction and warning system of weather hazards and dietary functions of Chinese traditional foods were suggested. Special emphasis was placed on strengthening the coordinating functions of institutions which were likely to join the upcoming project. The next annual meeting will be held in Tokyo next May.

Masanori Inagaki
Research Planning & Coordination Division, JIRCAS

VISITORS

JIRCAS welcomed Dr. Joachim Voss, Director General of Centro Internacional de Agricultura Tropical (CIAT) on April 25, Dr. Peter Hartmann, Director General of International Institute of Tropical Agriculture (IITA) on June 17, and Dr. Marc Cohen, Special Assistant to the Director General of International Food Policy Research Institute (IFPRI) on July 17. Our staff members have had very fruitful discussions with them.

PEOPLE

Dr. Ryoichi Ikeda joined JIRCAS on June 1, 2002, as Director of Biological Resources Division, succeeding Dr. Masa Iwanaga who left JIRCAS and now is Director-General of El Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Dr. Ikeda has been serving as a rice breeder and research director for 21 years in National Agriculture Research Center, Tohoku National Agricultural Experiment Station and Central Agricultural Experiment Station, all of which now belong in the competence of the newly established independent administrative institution of the government, National Agricultural Research Organization. He was also engaged in international research work as International Research Coordinator in JIRCAS from 2000 to 2001 and a plant breeder in International Rice Research Institute from 1988 to 1993. His new assignment in JIRCAS covers various crops and regions, and he wishes to make every effort to attain the goal of JIRCAS by amalgamating activities of fellow researchers within the division and accelerating collaborative research work with various national and international agricultural research centers.

JIRCAS Newsletter
Japan International Research Center for Agricultural Sciences (JIRCAS)

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