

**JIRCAS**

# Newsletter

*FOR INTERNATIONAL COLLABORATION*

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Cattle raising using maize stalks and leaves in a small farm in Jilin, China  
(Photo by T. Taniguchi)

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# JIRCAS

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

# For Sustainable Livestock Production in Farming Systems

Toshiaki Taniguchi

Director, Animal Production and Grassland Division, JIRCAS

The Animal Production and Grassland Division is currently implementing research projects on 1) Improvement of livestock production using locally available feed resources in Northeast Thailand in collaboration with Khon Kaen Animal Nutrition Center, Thailand, 2) Improvement of swine production in farming systems in the Mekong Delta in collaboration with Cantho University, Vietnam, and 3) Development of grassland management technologies for sustainable agro-pastoral systems in the subtropical zone of Brazil in collaboration with Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), Brazil.

Two of the three projects mentioned above are focused on sustainable development of small-scale farming systems in Southeast Asia. The latter is focused on a sustainable crop and forage rotation system in large-scale livestock and crop production systems in South America. Livestock production remains at low levels throughout the developing world due to constraints such as low genetic potential, poor quality feeds, disease prevalence, harsh climatic conditions, and low management level. In Southeast Asia, the number of native animals, such as swamp buffalo, native cattle and swine (Photo) has been decreasing along with the introduction of exotic breeds for increasing the production of meat and/or milk. However, the introduction of exotic breeds may be frequently faced with low productivity due to malnutrition in the dry season, inadequate feeding management and endemic diseases. On the other hand, livestock play an important role in matter cycling in farming systems, namely the wastes from cattle and swine are used as fertilizer for the cultivation of crops, fruits and vegetables and as fuel in Northeast Thailand and the Mekong Delta. Therefore, removal of constraints in developing areas and maximization of the advantages of livestock are important for increasing the sustainability of livestock production in farming systems and animal industry in these areas.

Another aspect is to consider the efficient utilization of available native animals raised in various areas, because the native ruminants have a superior ability to digest fiber without protein supplements and require less energy to maintain their body weight compared with high performance breeds, as mentioned by Dr. T. Kawashima in a previous Newsletter (No. 24, Sept. 2000). Therefore, the development of a sys-

tem utilizing native ruminants in order to exploit available low quality feed should contribute to sustainable development of animal husbandry in these areas.

The next problem is how to obtain feed quality all the year round. Production of natural grasses and pastures decreases remarkably in the dry season in tropical areas. This is a key constraint on further development of livestock production. In the Mekong Delta, local by-products such as rice bran and meal leavings are used as swine feed. Local by-products such as rice straw and sugarcane stalks are used as good roughages for cattle feeding in the dry season in Northeast Thailand. Especially, wild relatives of sugarcane, such as *Saccharum spontaneum* and *Erianthus* spp. and inter-specific crosses between sugarcane varieties could be used as forage crops, due to the high biomass production with a lower sugar content and attenuated leafy character, in the near future under the collaborative research project between Khon Kaen Field Crops Research Center and JIRCAS. Use of available local feed resources is needed for developing a feeding system which is compatible with the local socio-economic and environmental conditions.

In the Brazilian savannas, decreasing grain yields have recently been observed in the region, as a result of continuous mono-cropping. In conventional mono-cropping systems, the intensive use of disk plows has resulted in the rapid loss of organic matter in most soils. Therefore, agro-pastoral systems (sustainable crop-pasture rotation) are considered to be an effective method of ensuring adequate physical, chemical, and biological soil conditions. It was demonstrated that the introduction of *B. brizantha* into agro-pastoral systems was the optimum solution to improve the quantity and depth distribution of soil organic matter due to the high biomass production of roots. Development of agro-pastoral systems compatible with individual farming systems may contribute to sustainable production of crops and livestock.

Maize stalks and leaves after harvest of maize cobs are also used as roughage for beef and dairy cattle. However, the nutrient level of maize stover is not always sufficient for animal feeding. Therefore, attempts were made to utilize agricultural commodities based mainly on maize and its residues for animal feed as silage in collaboration with the China Agricultural University and Jilin Academy of Agricultural Sciences.

It is also necessary to pay attention to the quality of the feed, including feed safety as roughage for livestock feeding, because, roughage contaminated with pathogens could become a source of infectious diseases and toxicosis in domestic animals.

The value of local feed resources and native animals should be more emphasized for future development of animal husbandry compatible with environmental and socio-economic characteristics in the respective regions.



Photo: A F1 native sow in the Mekong Delta in Vietnam

## Collaborative Research Project

# Comprehensive Project in China Faces Mid-Term Evaluation

*Osamu Koyama*

*Research Planning and Coordination Division, JIRCAS*

Three years have already passed since the new comprehensive collaborative research project conducted in China and titled "Development of sustainable production and utilization of major food resources" started in 1997. In the project, attempts were made to integrate several research activities, which had been separately carried out with Chinese research institutes engaged in different scientific fields, and aimed at solving the food problems in China from comprehensive viewpoints. The research project which was undertaken after the signature of a Memorandum of Understanding by both parties consists of the following five components.

- 1) Socio-economic research component, including research on food policies, impact of new technologies and regional food balance.
- 2) Environmental research component, including studies on material cycling and farming systems aimed at environmental conservation.
- 3) Rice research component, including studies on indigenous genetic resources, new breeding materials and insect pest management.
- 4) Soybean and maize research component, including studies on genetic resources in Northeast China and utilization of maize residues.
- 5) Food processing and distribution research component, including studies on starch and protein food from plants and freshwater fish meat.

For each component, detailed research subjects were drafted, and counterpart institutes were assigned, including ten institutes, such as five research institutes under the Chinese Academy of Agricultural Sciences, China Agricultural University, and Shanghai Fishery University. From the Japanese side too, many research institutes affiliated to the Ministry of Agriculture, Forestry and Fisheries participated in the project in addition to JIRCAS. The project places emphasis on activities in Japan through the invitation of Chinese researchers, in addition to the conventional collaborative work conducted in China by the Japanese researchers dispatched. During FY 1999 (ended in March 2000), 35 researchers including 6 researchers on long-term assignments were sent to China, and 20 Chinese researchers including 11 research

managers were invited to Japan.

The results of the studies have been reported gradually and increasingly, particularly in areas where the research activities had started without any constraint. For example, the socioeconomic analysis based on field surveys, the study on soil nutrition balance focused on nitrogen dynamics, and the studies on processing technologies using materials from freshwater fish, rice and soybeans for such food products as fish meat surimi, rice noodles, tofu, etc. are highly appreciated also in China. Many workshops have been held both in China and Japan for the dissemination of the results and exchanges of views among the wide range of researchers. General audience was also invited to some workshops.

However, the priorities of the project are changing rapidly. Recently China has enjoyed continuous high yields and excess stock has been reported for some commodities such as low-quality cereals. National research institutes are trying to define the future orientation of their activities within the context of economic and organizational reforms. The gap appears between what we expected at the planning stage of the project and what we are currently facing regarding the research organization and the recognition of the problems. On the other hand, however, various attempts are being made to develop sustainable production technologies based on the increasing awareness about environmental degradation, and the need for practical research such as food processing and distribution technologies is rapidly increasing in China. At the end of the fiscal year 2000, halfway in the course of the whole project, mid-term evaluation will be made and the above issues will be discussed.

In addition, cooperation between the project and a new program of technology transfer sponsored by Japan International Cooperation Agency (JICA) is being pursued. It is essential that both projects be effectively conducted through joint ownership of the results, joint utilization of the facilities and exchanges of views among researchers, when grant-aid is allocated and technical cooperation programs in agricultural research are implemented. JIRCAS is participating in the planning of these programs through the exchange of experience and expertise.



Meeting at Beijing, China



Introduction of water-saving irrigation in Shandong province

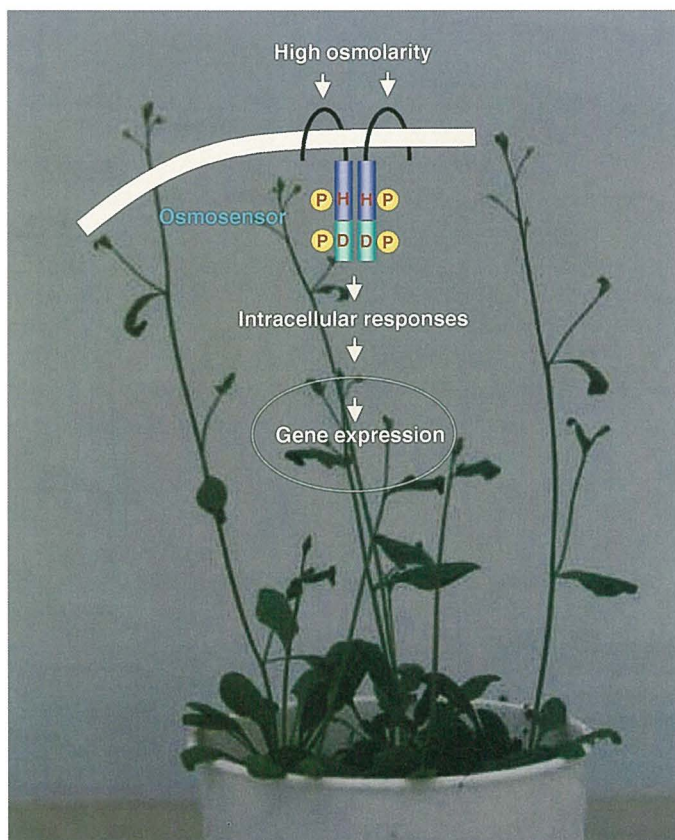
# An Osmosensor as a Molecular Tool for the Genetic Improvement of Drought-Tolerant Crops

Takeshi Urao and Kazuko Yamaguchi-Shinozaki  
 Biological Resources Division, JIRCAS

As the world population rapidly increases, we are now faced with the need to increase and stabilize food production. In marginal or arid lands in developing countries, environmental factors such as drought, high salinity, high temperature, and flooding are serious problems that lead to instability of crop production. To address these problems, development of stress-tolerant plants had so far been conducted by transfer of a gene encoding protective proteins or enzymes involved in stress tolerance from various organisms. However, past efforts yielded limited success due to the genetic complexity of stress responses and adaptation. This indicated that the introduction of a large number of genes into a plant is necessary to confer fully improved stress tolerance. To overcome this limitation, our approach currently being studied is to manipulate a regulatory gene that controls the amounts and timing of numerous effector molecules described above. Under drought conditions, a change in cellular osmotic pres-

sure caused by water loss triggers various intracellular responses, including activation of signal transduction pathways followed by gene expression of osmoprotectants. The first step in this event is the perception of osmotic changes by a sensor or receptor protein(s) at the plasma membrane. Therefore, we aimed at developing an osmosensor as a regulatory gene.

Based on an analogy in bacteria and yeast, histidine kinase(s) was expected to function as an osmosensor in plants, leading us to clone a cDNA encoding a histidine kinase ATHK1 from *Arabidopsis*. RFLP mapping showed that the ATHK1 gene is located on chromosome 2. The ATHK1 mRNA was more abundant in roots than in other tissues and accumulated under high salinity and low temperature conditions. Histochemical analysis of GUS activities driven by the ATHK1 promoter further indicated that the ATHK1 gene is transcriptionally up-regulated in response to changes in external osmolarity. These results suggest that ATHK1 is necessary for efficient sensing of environmental signals such as high salinity and drought stresses. ATHK1 contains two hydrophobic transmembrane regions adjacent to a putative extracellular domain in the N-terminal half, suggesting the presence of a functional similarity to the yeast osmosensor SLN1. Overexpression of the ATHK1 cDNA suppressed the lethality of a yeast *sln1* mutant. By contrast, the substitution of either putative phosphorylation site, His or Asp, failed to complement the *sln1* mutant, indicating that ATHK1 acts as a histidine kinase and that ATHK1 is in an active form in the absence of external signals (e.g. high osmolarity). Moreover, the introduction of the ATHK1 cDNA into a yeast mutant lacking both osmosensors, SLN1 and SHO1, allowed normal growth and activation of the HOG1 MAPK cascade under the high osmolarity conditions, suggesting that the ATHK1 activity changed from the active state to the inactive state in response to increases in external osmolarity. Thus, we demonstrated, by analyzing both sensing (input) and catalytic (output) activities of ATHK1 *in vivo* using the yeast osmosensing-defective mutants, that ATHK1 is able to sense and transduce a signal of external osmolarity to the downstream targets. This is the first evidence that a plant histidine kinase acts as an osmosensor. The ATHK1 gene could be one of useful molecular tools or biological resources for the genetic improvement of drought-tolerant crops. We are currently generating transgenic *Arabidopsis* and rice plants to examine the ability to improve stress tolerance.



Possible function of an osmosensor in intracellular signaling under drought conditions

# Changes in Soymilk Properties after Two-Stage Ohmic Heating

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\*Crop Production and Postharvest Technology Division, JIRCAS, <sup>2</sup>China Agricultural University, China

Thermal processing is a traditional method in the food processing industry. Currently, most of the thermal processing techniques employ indirect heating by thermal conduction and thermal convection. However, these techniques limit the processing of the food material by several-stage heating because of the difficulty in controlling the temperature in a short time. For instance, the external part of a food material needs to be held at a processing temperature for several minutes before the center of the material reaches the required temperature; at that time the rest of the food will have been significantly overprocessed. An alternative technique is direct heating, in which heat is generated within the food material itself. Ohmic heating, which uses the inherent electrical resistance of a material to generate heat, is a relatively new process in food engineering, and has already attracted the attention of some companies. It is important to mention that both the outer and inner parts of a food material can reach a required temperature in a short time.

Soymilk is used to make tofu, which is one of the most popular foods in the world. Usually, soymilk is heated at more than 95°C for several minutes before the addition of a coagulant to make tofu. Almost all the tofu factories and researchers have paid attention to the temperature and time by using one-stage heating because of the technical limitation in the traditional heating procedure. Soymilk was heated under several conditions using a simple ohmic heating system. The rate of increase of the temperature was 40°C/min. Fig. 1 shows that heated soymilk by the standard method (at 95°C for 5 min) had essentially the same viscosity as raw soymilk. However, the viscosity of soymilk heated by the two-stage procedure (at 75°C for 15 min, and then at 95°C for 5 min) was 6 times higher.

During the heat treatment, proteins in soymilk are transformed into a partially denatured conformation. Under the denatured state, some non-covalent bonds of protein molecules

are destroyed and hydrophobicity in the surface area of the molecules increases. In consequence, protein molecules are dissociated and/or associated. We found that many small particles were produced in soymilk after two-stage heating. These observations suggest that the degree of aggregation in protein molecules was quite different between different heating conditions. The denaturation temperatures for 7S and 11S globulin, which are major protein components in soybean milk, are around 75°C and around 85°C, respectively. The dissociation/association of 7S and 11S globulin occurred at the same time under one-stage heating. In the case of two-stage heating, 7S globulin sub-units were dissociated/associated selectively at the first heating stage. During the second stage, 7S sub-units and/or newly dissociated 11S sub-units were associated cooperatively. Consequently, large aggregated molecules, which affected the increase in the viscosity, were produced in heated soymilk.

Partially denatured states of several food proteins are closely related to their functionality, including gelling and emulsifying properties. The tofu gel properties under the different heating conditions were evaluated in terms of consistency, elasticity, and water loss (Fig. 2). We found that the tofu prepared from two-stage heated soymilk was firmer and more elastic although the first step temperature and heating time were slightly lower than those obtained from viscosity analysis. The tofu displayed a lower water loss. That is, moderately associated protein molecules enabled tofu to form a tight gel after the addition of a coagulant.

Ohmic heating in high temperature short time processing has been developed to produce high quality sterile food. From the above observations, we concluded that, unlike traditional thermal processing techniques, several-stage ohmic heating enables us to obtain a more suitable texture for a food material, which contains multiple lipids, carbohydrates, and proteins.

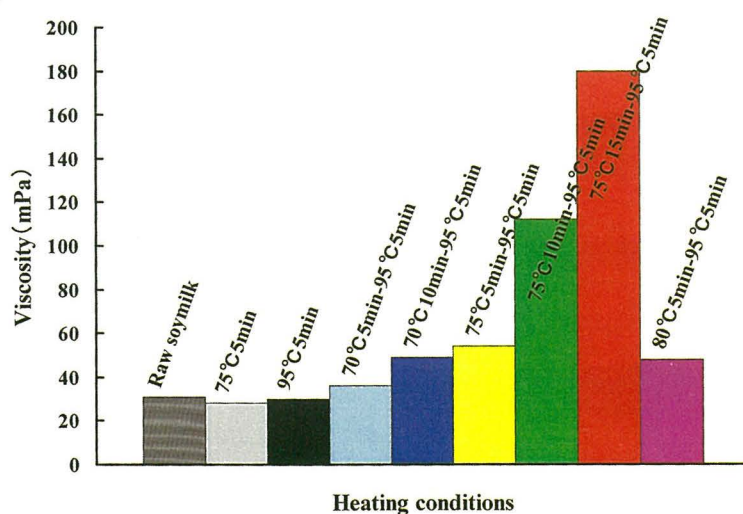


Fig. 1. Viscosity of soymilk after ohmic heating under different conditions.

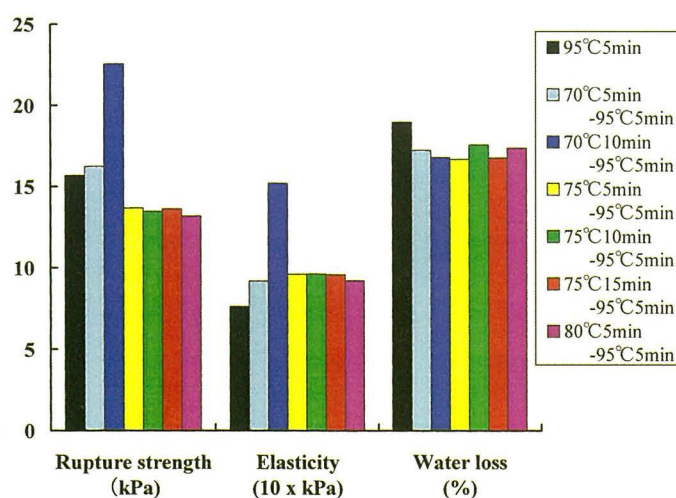


Fig. 2. The quality of tofu gel prepared from soymilk after two-stage ohmic heating.

# Studies on Treatment System for Wastewater from Prawn Aquaculture Pond Using Natural Purification Ability of Mangrove Stand

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In the Southeast Asian countries including Indonesia, prawn aquaculture is actively carried out to acquire foreign currency. Coastal areas, including areas of mangrove forest, have been destroyed to develop aquaculture ponds for this purpose. Moreover, wastewater containing large quantities of nutrient materials is discharged from the aquaculture ponds, causing environmental deterioration in coastal waters.

The present studies were conducted to analyze the effectiveness of improving the water quality of wastewater using mangrove stands and the mangrove ecological system prior to the discharge of wastewater into the environment.

The investigation site is shown in Fig. 1. Wastewater from the prawn aquaculture pond was introduced into a mangrove reforestation area. The mangrove stands consisted of saplings aged 0 to 2 years planted in a pond at intervals of 40 cm. Water that had passed through the mangrove pond was recirculated to the prawn aquaculture pond via an oyster pond and a seaweed pond. Thirty percent of the water in the prawn pond was exchanged once every 3 days. Water evaporation and seepage into the soil were compensated for by supplying river or well water depending on the degree of salinity. Investigations were conducted at the site once every 15 days. Water temperature, salinity, dissolved oxygen, pH, turbidity, and the concentrations of nutrients (ammonia, nitrate, nitrite,

phosphate, and silicate) and chlorophyll *a* were measured.

The water temperature ranged from 25 to 30°C. Salinity exceeded 40(psu) in the dry season and fell below 30 (psu) in the rainy season. From the beginning of the experiment, ammonia (NH<sub>3</sub>) (Fig. 2) and nitrate (NO<sub>3</sub>) concentrations were always high and increased in the oyster pond and the algae pond. The phosphate (PO<sub>4</sub>) concentration was initially high because that of the supplied river water was high. Subsequently, it decreased once, then slightly increased in all the ponds. The silicate (SiO<sub>2</sub>) concentration increased in the oyster pond, the seaweed pond, and the mangrove pond due to the well water supplied. In the prawn pond, on the other hand, after increasing once, it decreased due to the increase in the population of diatoms, which have a silicious skeleton. Chlorophyll *a* (Fig. 2) concentration increased gradually in the prawn pond, and exceeded 160µg/l at the end of the experiment.

In this experiment, the pond in which wastewater was most effectively disposed of was the oyster pond. Since the oysters fed on phytoplankton while excreting ammonia, the phytoplankton concentration was very low after 30 days while the ammonia concentration was high. Therefore, the amount of phytoplankton, an organic material, markedly decreased. The ammonia and phosphate concentrations in the seaweed pond adjacent to the oyster pond were lower than those in the oyster pond, indicating that the seaweed took up nutrients. The ammonia concentration in the mangrove pond was always higher than that in the prawn pond and continued to gradually increase. It is considered that the amounts of nutrients generated from the feed and excreta were greater than those taken up by the mangrove stands, presumably because the area of the mangrove pond was too small compared with that of the aquaculture pond. We will attempt to obtain an afforestation area that corresponds to the area of the aquaculture pond by analyzing the material balance in the mangrove stands and the amount of nutrients taken up per unit area of the mangrove stands.

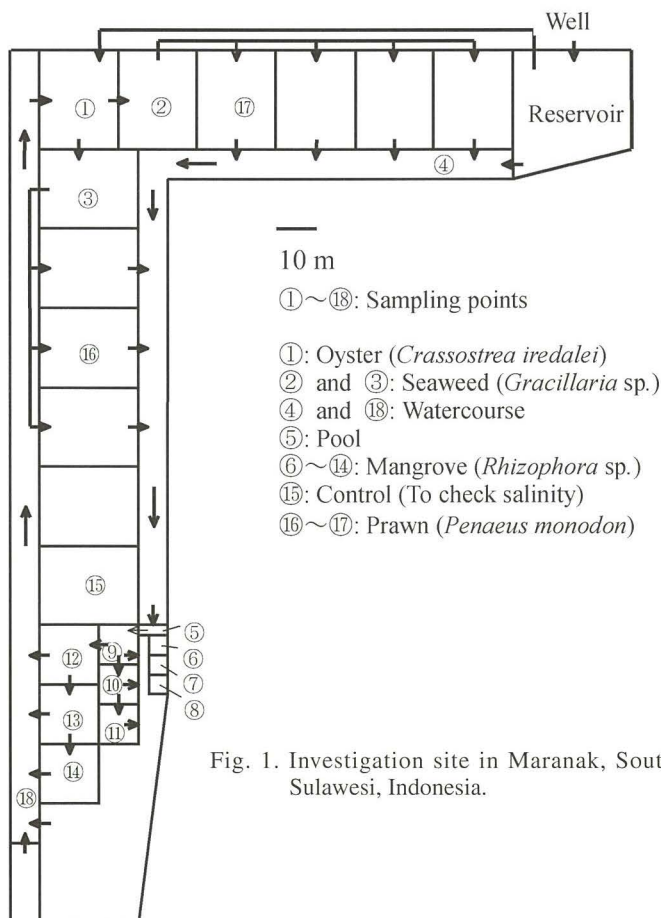


Fig. 1. Investigation site in Maranak, South Sulawesi, Indonesia.

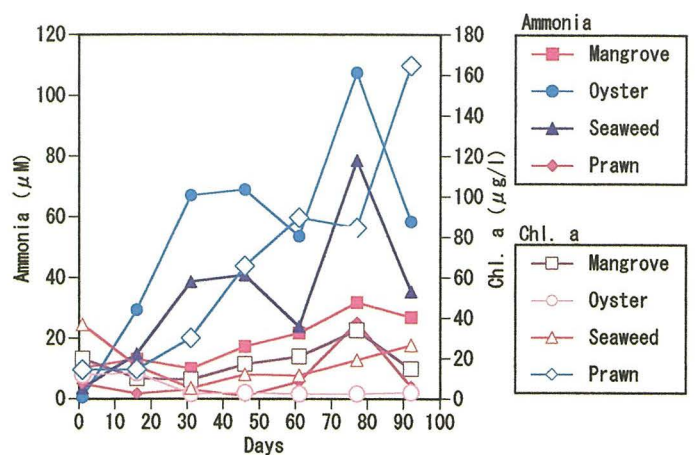


Fig. 2. Changes in ammonia and Chl. *a* concentrations in mangrove, oyster seaweed and shrimp aquaculture ponds.

## Symposium

# JIRCAS 7<sup>th</sup> International Symposium



Session II: Nov. 1

On November 1-2, 2000, JIRCAS held its 7<sup>th</sup> International Symposium, with 300 participants. To mark the 30<sup>th</sup> anniversary of JIRCAS and its predecessor, the Tropical Agriculture Research Center (TARC), and to define the future directions of the activities of JIRCAS and its partners in the new century, a broad theme was selected: “*Agricultural Technology Research for Sustainable Development in Developing Regions.*” The symposium addressed this overall theme in five parts. There were three keynote addresses. Dr. Dar, ICRIAT, reviewed the accomplishments of agricultural technology research from the Green Revolution until today, and presented needs and directions for the future including applications of biotechnology and information technology. Dr. Sanchez, ICRAF, centered his presentation on the key characteristics of agricultural sustainability in the tropics, emphasizing the need to adopt a new approach to find solutions to low productivity and poverty in marginal areas. Dr. Bie, ISNAR, suggested that information technology could contribute to the design of agricultural programs more directly relevant to the needs of farmers. This was followed by three sessions focused on specific areas of research. Session I assessed the development of crop varieties with tolerance to stress and low-input conditions (Prof. Takeda, Okayama Univ.), contributions of molecular biology (Dr. Cantrell, IRRI) and the importance of postharvest technology, with emphasis placed on distribution and processing systems (Dr. Johnson, ACIAR). Session II examined agro-ecological sustainability, consider-



Poster session

ing land (Dr. Craswell, IBSRAM) and water management (Dr. Prathapar, IWMI) for crop production, as well as fisheries management and aquaculture production (Dr. Williams, ICLARM). Session III considered partnerships for technology development, including farmer participatory research (Dr. Caldwell, JIRCAS), contributions of farmer knowledge (Prof. McArthur, Univ.



Opening address: Dr. N. Maeno,  
Director General, JIRCAS

of Hawaii) and changes in institutional structures (Prof. Norman, Kansas State Univ.). The strategy adopted by the Japan International Cooperation Agency (JICA) for the transfer of technology (Mr. Samejima) and the policies of national agricultural research systems (Dr. Fagi, Indonesia; Dr. Carrão-Panizzi, Brazil) were also presented. In the closing session, Dr. Maeno, Director General of JIRCAS, reviewed JIRCAS' contributions to date and offered four research strategies for the coming years: strategic basic research, comprehensive research, postharvest technology research, and strengthening of the collaborative approach. A large part of the general discussion that followed was devoted to the potential contributions and limitations of farmer participation in research. Comments on other topics included the importance of 1) developing human resources, 2) emphasizing the content of information in the field of information technology, 3) emphasizing value-adding in postharvest technology and 4) the importance of animals in agriculture. As for the future orientation of JIRCAS activities, several suggestions were made including: the need to 1) strike a balance between strategic basic research and adaptive research and 2) control of preharvest losses in addition to postharvest losses. It was also suggested that since farmer participation in research is being promoted in many international research centers, JIRCAS could benefit from the experience gained by these organizations for the implementation of some of its programs, while building on its strength in basic strategic and comprehensive research.

(John S. Caldwell)



Poster session

## Topic

# Mr. Motai, Chairman of AFFRC and Mr. Tsuchiya, Director of International Research Division of AFFRC Visited China

Mr. Shigeru Motai, Chairman of the Agriculture, Forestry and Fisheries Research Council, AFFRC, Ministry of Agriculture, Forestry and Fisheries, MAFF, Mr. Tadashi Tsuchiya, Director of the International Research Division, AFFRC/MAFF and Mr. Kazuyuki Tsurumi, Director of the Research Information Division of JIRCAS visited China in September 2000. Their main purpose was to hold discussions with key persons who are concerned with the collaborative research project titled: "Development of sustainable production and utilization of major food resources," on the research direction in the second half of the project, and to visit the research laboratories and fields.

In Beijing, they had the opportunity of meeting with Mr. Liu Jian, Vice-Minister, Ministry of Agriculture, People's Republic of China and Mr. Tang Zhengping, Director General, Department of International Cooperation, Ministry of Agriculture. They also met with Dr. Wang Hongyi, Vice-President of the Chinese Academy of Agricultural Sciences and they exchanged views on the research results so far obtained and future activities relating to the collaborative research project. At the China Agricultural University, they attended the opening ceremony of the Japan-China Food Research Center. Mr. Motai gave an address for the celebration and cut the ribbon to open the center together with Dr. Li Lite, Vice President of China Agricultural University, Dr. Liu Xing Xin, Vice-President of the China Food Oil Society, and Mr. Tsuchiya. About hundred people, including members of the Ministry of Agriculture, Ministry of Education, food oil societies and oil industry associations in Beijing, attended the ceremony. Dr. Li Lite is convinced that this new center will enable to promote research activities in food processing, one of the key sectors in agriculture in China presently.



Cutting the ribbon during the opening ceremony for Japan-China Food Research Center  
(from left, Dr. Liu, Dr. Li, Mr. Motai and Mr. Tsuchiya)

In Jilin, they visited the Jilin Academy of Agricultural Sciences (JAAS) and discussed with Dr. Feng Wei, President of JAAS and Dr. Liu Kai, Director of Soybean Institute of JAAS, various aspects relating to the soybean research activities. The JAAS members explained that they had developed a soybean variety with high fat and protein contents which is now being disseminated in Jilin.

In ZheJiang, they visited the China National Rice Research Institute (CNRRI) and held discussions with Dr. Cai Hong-Fa, Director General of CNRRI and Dr. Zhang Zhi Tao, Vice-Director General of CNRRI on the rice situation in China. CNRRI explained that rice double-cropping cultivation has been decreasing mainly due to the low quality of the first crop and that hybrid varieties account for half of the planted area in China. In Shanghai, they visited Shanghai Fisheries University (SFU) and discussed with Dr. Zhou Ying Qi, President of SFU, and Dr. Hung Shulin, Vice-President of SFU, various aspects relating to fish research activities, particularly the processing sector.

On these occasions, they visited farmers in Jilin and ZheJiang, and noticed that agricultural activities had changed during the last decade. In Jilin, cultivated commodities have been diversified from maize to vegetables and fruits, such as strawberry, watermelon and grape, which are more profitable. In ZheJiang, some farmers have entrusted other farmers with tilling and harvesting activities, particularly in the rural areas where employment opportunities are available in other industries than agriculture.

(Kazuyuki Tsurumi)

## PEOPLE



**Mr. Akira Mizushima** became Director of JIRCAS's Administration Division on September 1, 2000. He was until recently Director of Computer Division of Tsukuba Office, Agriculture, Forestry and Fisheries Research Council Secretariat of MAFF.

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