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▲Sheep and goats grazing near Darhan, Mongolia in the summer of 2005 (Photo by S. Oniki)

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JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Towards the Formulation of the Next Mid-Term Plan
(April, 2006 to March, 2012)

Shinobu Inanaga
President, JIRCAS

Last April, I transferred from the Arid Land Research Center, Tottori University to JIRCAS, the only national research institution in Japan now that continues to contribute to the alleviation of problems in agriculture, forestry and fisheries of developing countries through research. My decision was mainly prompted by my great desire to become a part of JIRCAS's commitment in the promotion of the development of excellent commercial varieties resistant to targeted hostile environments, which involves sharing its research outputs on breeding of plants resistant to various unfavorable, including dry, environmental conditions with CGIAR Centers, and also, its program to nurture young, promising Japanese researchers to attain world-class caliber through dispatch to CGIAR Centers. In September 2003, I served as a member of the Evaluation Committee of the MAFF Research Council and participated in an evaluation meeting where the "***Promotional Policy for International Agricultural Research- A Japanese Challenge: Finding Solutions to Food and Environmental Problems-***" was put together, and what I have learned then has also greatly influenced my decision.

JIRCAS's objective is to contribute to the improvement of technology relating to agriculture, forestry, and fisheries in tropical and subtropical regions as well as in other developing regions through technological research and experiments on agriculture, forestry and fisheries in these regions. This year marks the end of the First Mid-Term Plan (April 2001 to March 2006) designed to achieve the said objective.

JIRCAS received an A-rank, a very high overall evaluation rating, from the MAFF Evaluation Committee, Subcommittee on Agricultural Technology, for its excellent performance within the past three fiscal years until 2003. For this achievement, JIRCAS is greatly indebted to the efforts and cooperation of all JIRCAS staff as well as to the valuable support of its research partners and collaborators. On the other hand, the same committee pointed out that, in order for JIRCAS to move further forward towards achieving its future goals, the following improvements should be carried out: (1) Research and its related collaborations and linkages should be prioritized. (2) Evaluation of research performance should also include a cost-based one, (3) Research achievement should be reflected in research resource allocation and in staff management, (4) Hiring for term-based researchers should be expanded, and (5) The need to appeal aggressively and in simple manner to the Japanese public about JIRCAS mission and accomplishments should be addressed. To realize (1) to (4), research must be given greater emphasis. In order to accomplish this, global research, one of the pillars of JIRCAS research mandate, particularly those concerning trend analysis and understanding of developmental situation of agriculture, forestry and fisheries should be narrowed down and specifically directed. Research results obtained are expected to clarify the true picture of the research issues, which JIRCAS needs to deal with. Cognizant of the above, JIRCAS accomplishments achieved until this spring were compiled and published in a report entitled "***Strategy for International Research on Agriculture, Forestry and Fisheries- JIRCAS Role.***"

In addition to this, another pillar of JIRCAS research, namely, that relating to sustainable development in agriculture, forestry and fisheries in developing countries must be examined very closely in the future. Each issue related to developmental research must be scrutinized and prioritized, and research outputs likewise subjected to rigid evaluation. Based on the assessment, JIRCAS has to endeavor to distribute and allocate human and financial resources according to level of importance, as well as strive to improve the working conditions of its research staff. In order to realize (5), JIRCAS's public information system and its linkages with the mass media should be strengthened. At the same time, in the transmission of information, JIRCAS should always ensure that details that would arouse public concern are included and that expressions that would elicit understanding are used.

Throughout the year, all JIRCAS staff would also be working hard together to formulate the next mid-term plan. We certainly hope that our research partners and collaborators will continue to support us.

Prevention of Postharvest Pests Using Aromatic Plants Growing in the Tropics

One of the major causes of postharvest losses in tropical countries is the chronic occurrence of stored grains' pests. This not only causes quantity loss but also gives serious damage to the quality of the products. Currently, at rice warehouses and polishing factories in tropical countries, synthetic chemicals are usually used to eliminate storage insect pests. However, as their negative impact to the environment and the increase of resistant pests are widely recognized, and likewise the concern that residual chemicals might affect human health, alternative technologies are imperative. Moreover, at small-scale rice warehouses in rural areas or at small-scale retailers and at rice noodle manufacturing factories in urban areas, there are not enough countermeasures against the occurrence of insects under both economical and technological restrictions. As one measure to solve these problems, utilization of natural plant resources that are abundant in Southeast Asia is probable.

Actually, in Thailand a wide variety of plant materials such as aromatic plants, certain kinds of grasses, trees and peels of fruits (wastes) have long been used to prevent various harmful insects and microorganisms (mainly for hygienic purposes). Besides, most of these materials are easily available and quite inexpensive. Previous studies suggest that some kinds of plants are effective on a relatively wide variety of insects and it is presumed that there would be some plants that are likewise effective toward eliminating stored grains' insect pests. The advantages in utilizing natural materials to eradicate harmful insects are as follows:

1) There is hardly any possibility of causing negative effects to the environment due to minimal loading.
2) As toxicity to mammals is generally low, farmers, retailers and manufacturers can work safely, and even if by any chance the natural materials should be mixed into the food, it is not very hazardous.
3) Effects are not too drastic, therefore resistant pests can not generate very often.

Thus, by applying natural materials, we aim to develop a method of exterminating stored grains' insect pests which meets the economic situation of developing countries, which is also safe for both producers and consumers and environmentally friendly.

First, we determined the growth-inhibiting effects of four selected aromatic plants, which are traditionally used as insect repellant or fumigant, citronella grass (*Cymbopogon nardus*), lemon grass (*Cymbopogon citratus*), peels of pomelo (*Citrus grandis*) and rhizomes of fingerroot (*Boesenbergia pandurata*) against maize weevil (*Sitophilus zeamis*) and 9 fungal strains which are sometimes detected in Thai rice. Among four plants, citronella grass showed the highest inhibitory effects on the growth of weevil. Citronella grass (Fig. 1, *Cymbopogon nardus*) is a perennial grass growing mainly in South and Southeast Asia. The essential oil extracted from citronella grass is called citronella oil, which has a characteristic rosy and herbaceous-citrus aroma, and is used for some industrial purposes. Then, the chemical composition of citronella oil (steam-distilled) was analyzed through the capillary gas chromatography and the gas chromatography / mass spectrometry. Major volatile components of the sample, obtained in Bangkok, Thailand, were geraniol (35.7% of total volatiles), *trans*-citral (22.7%), *cis*-citral (14.2%), geranyl acetate (9.7%), citronellal (5.8%) and citronellol (4.6%).

The growth inhibitory activity of major components of citronella oil and structurally related compounds against weevil was determined through the following method. Randomly selected 250 adult maize weevils were reared with polished rice (410 g) at 30ºC, 75% R. H. for 7 days. Then, eggs of weevils deposited in 10 g of rice grains were then transferred into a glass container with a volume of 0.57 L, and incubated for 8 weeks with seal. Each compound was directly dropped inside the container at a concentration of 15.4 ppm at the beginning of the experiment. The inhibitory activity was evaluated by the number from which have emerged adult descendants. Nine out of 19 compounds examined suppressed more than 50% of the emergence of adult weevils from egg. Especially, three monoterpenes, menthone, *trans*-geraniol and citronellal showed a strong inhibitory effect (Fig. 1).

The antifungal activity of components of citronella oil and related compounds was determined by the vapor-agar contact method as follows. Tested fungal strains were *Aspergillus candidus, A. flavus, A. versicolor, Eurotium amstelodami, E. chevalieri, Penicillium adametzii, P. citrinum, P. griseofulvum*, and *P. islandicum* that are sometimes found from Thai rice. Fungal spores (1.5 x 10^3) were incubated on potato-dextrose agar plates in a sealed chamber with volatiles. Antifungal activity was evaluated by measuring the diameter of the formed colony. Two monoterpenes, citronellal and linalool exhibited a complete inhibition on the growth of all 9 tested fungal strains at a dose of 112 ppm.

Meanwhile, since terpenes that showed growth inhibitory activity against weevil as well as antifungal activity have specific flavors, there is a concern that the adsorption of these substances into the rice grains would affect the quality of stored rice. However, milling or leaving in open-air, as shown by the adsorption test, removed a large portion of citronellal once adsorbed on surface of rice grains. Additionally, sensory evaluation tests revealed that the residual level of citronellal was lower than the threshold level of Thai panels. These results suggest that some aromatic plants and volatile components of aromatic plants, *e.g.* menthone, *trans*-geraniol, citronellal and linalool, are effective postharvest chemicals that can protect stored food commodities.

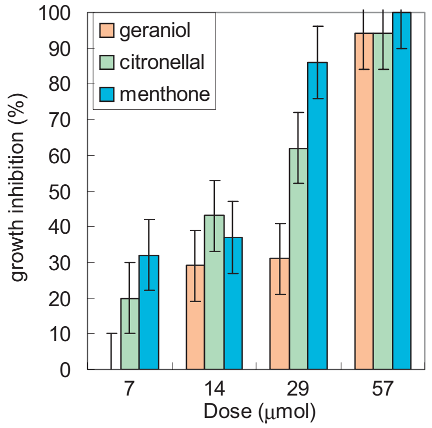

Fig. 1. Growth inhibitory activity of geraniol, citronellal and menthone against maize weevil.

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Does Drought Condition Induce the Aroma Quality of Aromatic Rice?

Khao Dawk Mali 105, the aromatic variety in Northeast Thailand

A large quantity of rice is produced in many areas worldwide to meet the demand of consumers. In fact, aromatic rice varieties are very popular in Southeast Asia. Recently, they have gained a wider acceptance in Europe and the U.S.A. One of the major aromatic varieties, Khao Dawk Mali 105, is mainly produced in Northeast Thailand. The demand for this variety is increasing in both domestic and international markets due to the recognition of its good quality, i.e. pleasant aroma. Although an increase in production is urgently needed, cultivation is limited due to infertile and drought-stricken sandy soils. Erratic rainfall at the beginning of the rainy season and labor shortage for transplanting are other constraints for the production of this variety in Northeast Thailand.

Rice production is a very important activity in Northeast Thailand, where Khao Dawk Mali 105 is the most popularly produced variety. However, it is important as well to maintain the quality of this variety. It is assumed that the aroma quality depends on cultivation conditions and postharvest practices.

2-Acetyl-1-pyrroline, potent flavor compound in aromatic rice

A "popcorn"-like flavor compound, 2-acetyl-1-pyrroline, has been reported as the characteristic flavor component of aromatic rice, which has lower odor threshold (less than 0.1 ppb in water) than other volatile compounds in aromatic rice varieties. This compound has also been isolated and identified from pandan (*Pandanus amaryllifolius* Roxb.) leaves and popcorn. Moreover, this compound contributed to the aroma of roasted beef and crusts of wheat and rye breads. We discovered that this compound is formed in aromatic rice at temperatures below that of thermal generation in bread baking and formed in the aerial part of aromatic rice with proline as the nitrogen precursor. Also, the result of the storage test indicated that this compound in aromatic rice kernels can exist as complex compounds within the hydrophobic region of starch crystalline.

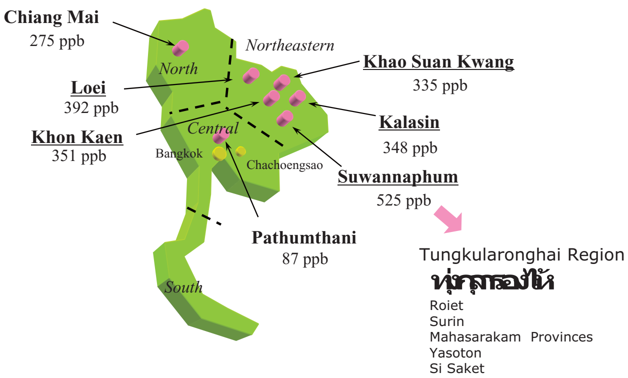

Fig. 1. Area dependency of 2-Acetyl-1-pyrroline content in Thailand.

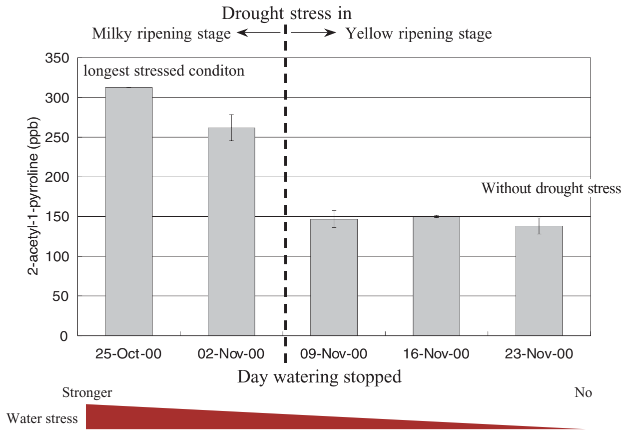

Fig. 2. Relationship between 2-Acetyl-1-pyrroline and drought stress.

Water stress induces high quality Khao Dawk Mali 105?

The aim of our study was to elucidate the factors which influence the final aromatic quality of Khao Dawk Mali 105 during cultivation. Some factors, such as osmotic stress during the ripening and nitrogen fertilizer application were considered to be effective for the increase of free proline concentration in rice kernels during ripening.

The effect of these factors on 2-acetyl-1-pyrroline content in harvested brown rice was studied in Northeast Thailand. In the case of water stress, as in osmotic stress, the stress during the milky ripening stage increased drastically the 2-acetyl-1-pyrroline content, whereas the stress after yellow ripening stage didn't cause any effect at all. Experiment on nitrogen fertilizer application indicated that zero fertilizer application lead to slightly lower 2-acetyl-1-pyrroline content. These results enabled the possibility of controlling the aroma quality of aromatic rice through cultivation, especially during the ripening stage. Appropriate application of water stress during the milky ripening stage may increase the quality of the aromatic variety, Khao Dawk Mali 105 in Northeast Thailand. However, water stress during the milky ripening stage also induces lower productivity.

Actually, the best Khao Dawk Mali 105 production area, which is called "Tungkularonghai" in Thailand, is famous for lower productivity due to drought during the milky ripening stage and soil salinity which can cause osmotic stress. Therefore, the rice production in this region is affected by the stresses during the milky ripening stage. Further research is therefore needed to elucidate the balance between "quality" and "yield" on aromatic rice variety in various regions as well.

Tadashi Yoshihashi
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Processing of High Quality Rice Noodles in China

Rice noodles are part of traditional cuisine, widely consumed in the South of China and Southeast Asia. Various kinds of rice noodles, such as "mixian" (rice vermicelli, extruded type) and "hefen" (rice noodle sheet, steamed type), have been produced during the long history of food processing. Most manufacturing in China has been carried out by small producers or shops (Photo 1), and the quality varies with processing conditions. Almost all of the rice noodles have been produced depending on the experiences and perception of workers on the shop floor without elucidation of the mechanisms. It is thus necessary to accumulate basic scientific and technological knowledge for the rice noodle processing.

Rice is the main ingredient used. However, not all varieties of rice can give a good quality product. Rice noodle structure depends on the gelatinization and retrogradation properties of the starch. Higher amylose content in rice is believed to be an important factor contributing to noodle quality. To determine the influence of amylose content on different rice varieties, correlation analyses between the amylose content and rice noodle qualities were performed on 2 japonica varieties, 5 indica varieties, and 3 hybrid indica varieties. We found that the rice noodles from the higher amylose (more than 20%) indica varieties obtained high scores in sensory evaluation (Fig. 1).

Desirable qualities of rice noodles are low cooking loss and appealing eating quality, which are dependent on the extent of starch damage and the particle size of rice flour, respectively. Therefore, the method of preparation of rice granules should be one of the important factors governing rice noodle quality. Thus, we tried to determine the effects of dry and wet milling of rice granules. It was discovered that the damaged starch content of rice flour after dry milling was higher than that after wet milling. The rice granules reached plateaus in their water absorbency after 2 hr soaking. Furthermore, the cooking loss of rice noodles was remarkably decreased by the soaking treatment. Likewise, rice noodles made from wet milled flour had higher values in gel strength.

The natural fermentation of the material rice is a traditional technology used in producing rice noodles with specific functional properties and high quality in China. Little research has been done on the effects of fermentation on the physicochemical characteristics of rice starch and so the effect of fermentation on rice noodles is not yet clear. Thus, we also investigated the influence of the fermentation of rice granules on the physicochemical characteristics of rice starch and the rheological properties of rice noodles. Based on results, 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 increased during fermentation. The rice noodles made from fermented samples had a lower maximum stress and higher maximum strain and had a white, transparent appearance and favorable chewy mouth-feel compared to the control sample.

Nowadays, the daily life of the Chinese has dramatically changed due to westernization and diversification. Consumers' demands have been shifting from food quantity to quality, safety, and functionality. Therefore, the development and modernization of the traditional food-processing factory is required. To promote rice noodle consumption, more extensive research efforts need to be intensified for developing standard methods of processing, manufacturing and packaging.

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Photo 1. Rice noodle processing in China (A: Beijing, B: Hunan).

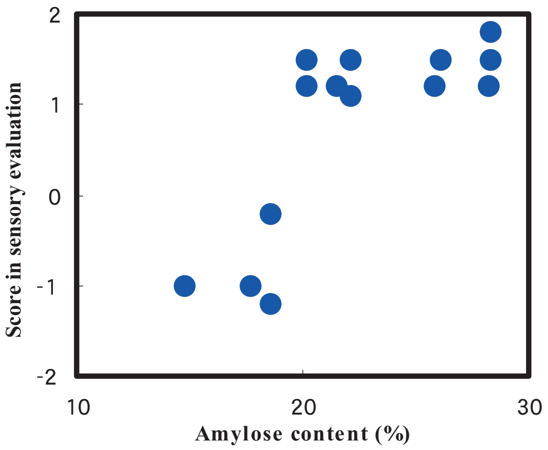

Fig. 1. Correlation between amylose content of rice and rice noodle quality.

Suitable Forest Environment for Plant Establishment in Agroforestry

Every time, my flight between Sandakan and Kota Kinabalu over Northern Borneo provides me with the uncomfortable opportunity to observe the degraded tropical lands below except for the special moment when I can view the stunning peak of Mount Kinabalu rising over Sabah, the "Land Below the Wind." The degraded lands include shifting cultivation areas, degraded secondary forests, oil palm plantations and others. However, the most unpleasant scenery is the spreading belt of muddy water in the deep-blue tropical sea near the mouths of rivers. All these indicate how badly the lands are degraded.

A well-developed natural forest is virtually the most important component in a landscape for a stable environment as well as a source of various ecological resources. In Sabah, the undisturbed natural forests account for below 9% of the total land, so that rehabilitation of forest ecosystem is the key issue for enhancing the environment as well as the forests. However, rehabilitating forests usually takes much time. To overcome the slow progress of time in the rehabilitation process, one solution would be agroforestry which utilizes space for both planting and harvesting useful short rotation plant species to ensure a source of intermediate income while simultaneously planting and growing indigenous tree species to establish the forest for a long-term perspective. Agroforestry would enhance the living conditions of the local people as well. As the tropic is a rich area for plant species, it is also the most suitable place for conducting agroforestry.

We are conducting an agroforestry experiment to establish the mix-indigenous species forest in the experimental sites of the Sabah Forest Research Centre, near Sandakan (latitude 5º54'N, longitude 118º04'E), Sabah, Malaysia within the framework of the international project entitled "Development of agroforestry technology for rehabilitation of tropical forests." In this research, we planted 14,000 plants of 25 plant species including tree species for high quality wood production such as *Dipterocarpaceae*, indigenous fast-growing tree species, other tree species for non-wood production, fruit tree species, medicinal plants and cash crops in the same area as the14 year-old *Acacia mangium* plots thinned in two thinning directions, East to West and North to South and two widths, 6 m and 9 m and also in non-thinning plots (ca 1.6 ha). These species were also planted in areas of thinned secondary forest plots with two thinning directions, East to West and North to South with widths of 4 m (ca. 2.9 ha), likewise in 6 exotic species (*A. mangium, Araucaria cunninghami, Pinus caribaea, Paraserianthes falcataria, Swietenia macrophylla, Terminalia ivorensis*) stands; and in the clear-cutting sites (2 ha), from February to March 2002.

The growth and survival of seedlings are monitored every 4 months after planting in order to clarify the suitable shading conditions and thinning method for the initial establishment of various plant species in the process of creating the mixed forests. As weeding is crucial for the productive growth of seedlings in the species-rich area like the tropics, we likewise study the undergrowth biomass, amount of time spent on weeding and weeding conditions (ascertained through questionnaires on weeding conditions and heart pulse rate measurements of weeding operators).

The results obtained in the initial experiments are as follows:

A majority of the plant species had higher survival rates in thinned plots of *A. mangium* stand and secondary forest (RLI: 10-20%) and under canopies of exotic tree species than in cleared forest sites. Especially, *Dipterocarpaceae* species showed much higher mortality rates in cleared forest plots (33% to 67%) than in thinned plots (0% to 16%). Except for the shade-intolerant tree species, most plant species including *Dipterocarpaceae* showed significantly higher growth rates in thinned plots than in cleared plots (Photo 1, 2), and significantly higher growth rates in thinned linear plots with the direction of North to South than in thinned linear plots with the direction of East to West.

Morinda citrifolia, a medicinal plant showed both high survival rate and growth rate in thinned plots of *A. mangium* as well as in the cleared site. This suggested that *M. citrifolia* can become a useful short rotation plant species for intermediate income.

Among the exotic species studied, *A. mangium, P. falcataria* and *T. ivorensis* would provide suitable shading conditions for facilitating the seedlings to become established.

Based on the recorded amount of time spent on weeding, as well as 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 thinned sites than in cleared sites.

These results suggest that moderate shade (RLI: 10-20%) cast by forest canopies can facilitate seedling establishment and reduce the amount of necessary weeding, and thus save weeding costs in comparison with conventional planting in cleared forest sites. It is therefore suggested that instead of planting on cleared sites, one vital option for reforesting degraded land would be to plant *A. mangium* first, then to thin the stands after *A. mangium* trees become sufficiently large and plant the indigenous tree species seedlings. After the seedlings become large, the *A. mangium* trees should be harvested to release the seedlings.

Koichi Kamo
Forestry Division, JIRCAS
(Present: Shikoku Research Center, FFPRI)

Photo 1. Growth of planted seedlings in thinned *A. mangium* plots at 8 months after planting.

Photo 2. Initial growth of planted seedlings in cleared site at 8 months after planting.

JIRCAS International Symposium in Ishigaki

Problems and Research Perspectives of Agricultural Environment in the Tropical and Subtropical Islands

Ishigaki Island is one of the subtropical islands of Japan. It is small in area but composed of various ecosystems ranging from mountains, uplands, lowlands, rivers, brackish water mangrove zone and beautiful coral reefs. Here, various human activities such as farming, animal production and fishery are being carried out. Subtropical islands of Japan are presently exposed to many problems such as soil erosion resulting in possible damage to coral ecosystems; nitrate pollution of ground water caused by chemical fertilizers, livestock excreta, etc.; high temperatures and drought in summer; and strong wind, highly intensive rainfall and salt-wind damage by typhoons. A small diurnal range in temperature of the islands also causes problems in crop growth. These problems are emerging at other tropical and subtropical islands in the Pacific Ocean as well.

Entrance of the JIRCAS Okinawa Subtropical Station.

JIRCAS Okinawa Subtropical Station (JIRCAS-OSS) sponsored the JIRCAS 2005 International Symposium in Ishigaki on March 11, 2005. Seikai National Fisheries Research Institute-Ishigaki Tropical Station, Okinawa Prefectural Agricultural Experiment Station and the Research Institute for Subtropics also co-sponsored the activity. Three lecturers were invited from the Philippines, Fiji and New Caledonia as representative islands in the Pacific Ocean. This international symposium which was the first undertaking of this kind in Ishigaki Island was held at the Conference Room of Yaeyama Branch Office in Ishigaki City of Okinawa Prefecture. To discuss the problems and research perspectives of the agricultural environment in the tropical and subtropical islands, about two hundred participants including JIRCAS-OSS collaborative foreign researchers and the citizens of Ishigaki Island participated in the international symposium.

In the symposium, many discussions were held which mainly focused on the following subjects:

- Characteristics of the coral islands and influences of agricultural practices on their ecosystems.
- Diversity of island soils and the management measures (comparison between Philippines and Okinawa).
- World trend of research on multipurpose cover crops and the research perspectives.
- Techniques for effective use of water in crop cultivation. Finally, all participants unanimously agreed to set up a future collaborative network. JIRCAS will publish the proceedings of the symposium shortly.

On March 10, 2005, a day before the symposium, Mr. Shigeru Motai (President, Agriculture, Forestry and Fisheries Research Council of Japan) planted a memorial tree and visited the research institutes in Ishigaki Island. The excursion tour around the Ishigaki Island was held later on March 12, 2005.

Kazuo Shibano
Okinawa Subtropical Station, JIRCAS

General discussion session at the symposium in Ishigaki Island.

Presentation of research results.

Scenes of Research Activities

Crop Production and Environment Division

Cultivation of the NERICA rice in Guinea

Weather survey equipment installation

Paddy rice NERICA cultivation

Slash and burn method of NERICA cultivation

Fisheries Division

Various marine resources in brackish water mangrove area

Net fishing

Shellfish collecting along the muddy tidal flat

Green mussel culture along the muddy tidal flat

PEOPLE

Dr. Kazuyuki Itoh, former Research Coordinator of the National Agricultural Research Center of Tohoku Region, was appointed as Executive Advisor & Auditor of JIRCAS. **Dr. Toshihiro Senboku**, former Director of Research Planning and Coordination Division of the National Agricultural Research Center of Western Region, was also newly appointed as Director of the Okinawa Subtropical Station.

Dr. Kazuyuki Itoh

Dr. Toshihiro Senboku

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