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City market at Vientiane, Laos (Photo by T. HIDAKA)

NEWS LETTER

JIRCAS

Japan International Research Center for Agricultural Sciences

For International Collaboration

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27

Contents

Message from the President of JIRCAS

President : Takahiro Inoue

"New JIRCAS" - Structural Reorganization -

Within the framework of the administrative reform enacted by the Japanese Government for the reorganization of government-affiliated research organizations, on April 1, 2001, Japan International Research Center for Agricultural Sciences (JIRCAS) became an Independent Administrative Institution (a semi-autonomous agency) under the supervision of the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF).

The introduction of the new system of Independent Administrative Institutions (IAI) is at the core of the administrative reform. This system has been introduced to enhance the effectiveness, quality and transparency of technological development by separating the administration functions into an implementing function and a planning and drafting function, by transferring the implementing function of the national research institutions to the IAI, each of which has its own independent judicial status. Therefore, under the new system, JIRCAS should implement not only autonomous and flexible programs, but also commit itself to a strict *ex post facto* evaluation and review of its performance, and disclosure of various issues.

In many developing countries, although the demand for food is increasing due to population increase and the improvement of the dietary habits, agricultural production remains at a low and unstable level. As a result, hunger and poverty are still important problems. Moreover, concern about the deterioration of the global environment has generated the need for sustainable development of agriculture, forestry, and fisheries, in harmony with the natural ecosystems. The mandate given to JIRCAS by the Japanese Government does not change fundamentally from the previous one in which JIRCAS was entrusted with the mission of promoting sustainable development of agriculture, forestry and fisheries compatible with the preservation of the environment in developing regions of the world through the implementation of integrated collaborative research programs.

The most distinctive feature of the new IAI is the semi-autonomy with limited prior control from outside and the *ex post facto* evaluation by which the IAI itself strictly evaluates its own performance to apply the results of the evaluation for subsequent activities. In the new system, MAFF defines JIRCAS mid-term objectives, which "New JIRCAS" should achieve during a five-year period. The mid-term objectives include issues related to the enhancement of the efficiency of the research activities, improvement of the quality of the research programs and of financial performance. Based on the mid-term objectives, the IAI drafts a mid-term plan to achieve these objectives autonomously.

The performance of the research activities evaluated by the IAI itself will be periodically evaluated additionally by the IAI Evaluation Committee established in MAFF which is composed of experts who do not belong to the public sector. Each fiscal year, the IAI Evaluation Committee will investigate and analyze the achievements of the mid-term objectives during the given fiscal year. The results of the evaluation will be subjected to structural modifications in terms of operational and financing systems for the next fiscal year.

Since the research activities need to be fully executed, the Government will allocate, within budgetary limitation, most or all of the financial resources required to carry out the defined objectives. Moreover, JIRCAS should make utmost efforts to receive financial support from either any other governmental offices or the private sector, etc. to fulfill the mid-term objectives.

Role and Research Strategy

Since the role of JIRCAS is to promote the development of agriculture, forestry and fisheries in developing regions of the world through integrated collaborative research programs, the priorities identified by "New JIRCAS" for the research strategies are as follows: 1) Development of production and utilization systems for sustainable agriculture, forestry and fisheries in harmony with the environment by carrying out research on the development of stress-tolerant crops, technologies for preserving arable land environments, new farming systems for ensuring profitability for the producers and technologies for efficient postharvest management and utilization, and 2) Rehabilitation, maintenance, improvement and utilization of the natural environmental resources, with emphasis placed on tropical forest and coastal ecosystems.

In order to complete the mid-term objectives within the above research strategy, "New JIRCAS" carries out its main activities through the implementation of 1) International collaborative research programs in developing regions by sending researchers on a long-and short-term basis, 2) Collaborative research with researchers invited from developing regions, 3) Research in Japan to further enhance international collaboration, 4) Accumulation and analysis of research information for supporting the collaborative work, 5) Organization of international symposia, workshops and seminars, 6) Technical assistance for food and environmental issues, 7) Advice to national organizations involved in overseas development assistance as a think tank function.

In conclusion, the reorganization of JIRCAS into an IAI should enable JIRCAS to gain more flexibility in the implementation of its research programs, in the hiring procedures since it will be possible to recruit researchers from universities or institutes which do not belong exclusively to the public sector and in financial aspects since funds could be obtained from both the public and private sectors. At the same time, the strict evaluation of the performance of the Center may contribute to the enhancement of the quality of the research programs and to a more efficient utilization of the financial resources to further promote collaborative activities compatible with the needs of the developing regions.

Biological Functions of Proline in Osmotolerance Revealed in Antisense Transgenic Plants

Proline (Pro) is a major organic molecule that accumulates in many plants exposed to environmental stresses such as drought, high salinity, high temperature, freezing, UV radiation, and heavy metals. Under stressed conditions, Pro has been considered to play an adaptive role in mediating osmotic adjustment and protecting the subcellular structure. In particular, many studies in plants have focused on the roles of Pro in defense mechanisms against impairments caused by osmotic stress. Some reports have indicated a positive correlation between the accumulation of Pro and stress tolerance in plants. However, in other reports, it was suggested that the increase in the free Pro level merely resulted from stress. Thus the roles of Pro in osmotolerance in plants still remain controversial, and there have been few practical demonstrations of the function and the mechanism of action of Pro throughout plant growth.

In higher plants, Pro is synthesized via both the glutamic acid (Glu) and ornithine (Orn) pathways. The former is considered to be a major pathway, especially under osmotic stress. In the Glu pathway (Fig. 1), Pro is synthesized from Glu via 2 intermediates, glutamic-γ-semialdehyde (GSA) and Δ^1-pyrroline-5-carboxylate (P5C). Two enzymes catalyze this pathway, P5C synthetase (P5CS) in the first step and P5C reductase (P5CR) in the final step. Genes encoding P5CS and P5CR have been isolated from various plants, and their expression and the functions of their products have been characterized. As a result, it has been shown that P5CS is the rate-limiting enzyme in Pro biosynthesis in higher plants. On the other hand, Pro is metabolized to Glu via P5C and GSA. Two enzymes catalyze this pathway, proline dehydrogenase (ProDH) in the first step and P5C dehydrogenase (P5CDH) in the final step.

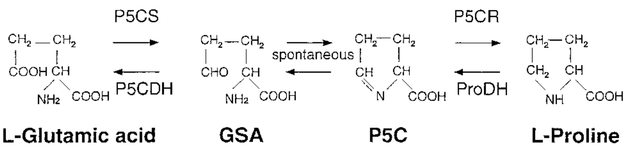

Fig. 1. Metabolic pathway of Pro in plants (the Glu pathway). GSA, glutamic-γ-semialdehyde; P5C, Δ^1-pyrroline-5-carboxylate; P5CS, P5C synthetase; P5CR, P5C reductase; ProDH, proline dehydrogenase; P5CDH, P5C dehydrogenase.

Arabidopsis accumulates Pro in response to osmotic stresses due to drought, high salinity, and chilling. Stress-induced Pro accumulation in *Arabidopsis* is caused by the activation of Pro biosynthesis, and by the inactivation of Pro degradation. The elevated expression of an *AtP5CS* gene encoding the P5CS protein in *Arabidopsis* precedes the accumulation of Pro in response to these stresses. In contrast, the expression of the *AtProDH* gene is repressed during the stress conditions. Gene expression of *AtP5CS* and *AtProDH* corresponds well to Pro accumulation, suggesting that metabolic regulation is essential for the control of endogenous Pro level.

To investigate the function of Pro biosynthesis and degradation in the accumulation of Pro and to further elucidate the roles of Pro in growth and stress tolerance in plants, we generated antisense transgenic *Arabidopsis* plants with an AtP5CS and an AtProDH cDNA, respectively. The AtP5CS antisense transgenic plants exhibited morphological changes and were susceptible to osmotic stress. Mutated phenotypes in both morphology and osmotolerance were suppressed by the application of exogenous L-Pro but not by that of D-Pro, suggesting that Pro plays other roles in addition to being a compatible osmolyte in terms of osmotolerance in plants. We further investigated the specific effect of Pro deficiency on protein biosynthesis in the AtP5CS antisense transgenic plants. We observed a significant reduction in the Pro and hydroxyproline (Hyp) contents in hydrolysates of a purified cell wall fraction but not in the Pro content of hydrolysates of soluble proteins in transgenic leaves. These results show that Pro deficiency specifically leads to a defect in biosynthesis of the cell wall structural proteins in the transgenic plants. That is, Pro may act as a major constituent of structural proteins of cell walls in osmotolerance as well as morphogenesis of plants.

On the other hand, the AtProDH antisense transgenic plants showed an enhanced accumulation of Pro, providing evidence for a pivotal role of ProDH in Pro degradation. These transgenic plants were tolerant to freezing and high salinity, indicating the efficiency of suppressing Pro degradation in Pro accumulation, and the contribution of Pro to stress tolerance in higher plants (Fig. 2).

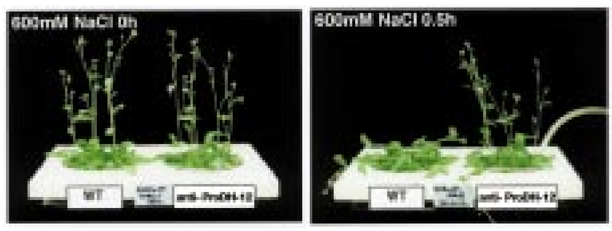

Fig. 2. Salinity tolerance of the AtProDH antisense transgenic plants. Phenotype of plants exposed to salinity stress for 0.5 h. Plants used for the analysis were wild-type (WT) and anti-AtProDH-12 transgenic plants.

In our study, we not only confirmed the key roles of two enzymes, P5CS and ProDH, in the regulation of Pro accumulation, but also revealed a positive correlation between Pro and osmotolerance in higher plants using transgenic technologies. Moreover, we identified a new function of Pro in growth and osmotolerance in plants.

Kazuko Yamaguchi-Shinozaki
Biological Resources Division, JIRCAS

Utilization of *Panicum maximum* in Agropastoral Systems in the Brazilian Savannas

Since the 1970s, *Brachiaria* spp. of African origin, such as *B. decumbens* and *B. brizantha* have been rapidly introduced into the Brazilian savannas. However, extensive pasture utilization without fertilizer application has led to the degradation of more than 50% of the pastures into which the grasses had been introduced. Recently, the adoption of agropastoral systems (sustainable crop-pasture rotation systems) has been considered to be an alternative for pasture renovation in the savanna regions. The major improvement in agropastoral systems for forage production is the residual effect of fertilizer applied to the preceding crops. Moreover, it is also expected that the residual effect of fertilizer applied to annual crops will enable to utilize high quality forage species even in the savanna soils with a low fertility. *Panicum maximum* is a promising forage species with a high productivity and high nutritive value. Therefore, in this study, the suitability of the use of *P. maximum* in agropastoral systems was examined in the Brazilian savannas.

Photo: Grazing experiment on the *Panicum maximum* pastures established after 4-year cultivation of soybean (front) and 4-year rotation of summer soybean with winter millet (back)

At first, a greenhouse experiment was conducted to compare the growth response of *B. decumbens*, *B. brizantha*, and *P. maximum* to different P (0, 25 and 50 kgP/ha) and N (25, 150 and 300 kgN/ha) application rates. P application increased the dry matter yield of the 3 species, and their response to the P application was very similar. On the other hand, an increase of N application up to 300 kg/ha resulted in the increase of the dry matter yield of *P. maximum* linearly, while the dry matter yield of *B. decumbens* and *B. brizantha* reached a plateau at 150 kgN/ha. Their external N requirement was in the following order: *P. maximum* > *B. brizantha* > *B. decumbens*. It appears that the high N external requirement of *P. maximum* may be associated with its high soil fertility requirement.

Furthermore, a grazing experiment was conducted at the National Beef Cattle Research Center of the Brazilian Agricultural Research Corporation in Campo Grande, Brazil. *P. maximum* pastures were established after 2 different cropping sequences: in one previous cropping sequence, soybean had been cultivated for 4 years in summer (SO-PM), and in the other, a 4-year rotation of summer soybean with winter millet for grazing (SO/MI-PM) had been adopted. The average soybean yield in the previous 4 years was 2,559 kg/ha. During a period of 253 days, herbage samples were harvested at 6-week intervals, and the dry matter productivity was evaluated. Table 1 shows the average value of total biomass (plant top + existing litter) during the experimental period. The average biomass in the SO-PM system was significantly higher than that in the SO/MI-PM system. Total dry matter production in the SO-PM system was much higher than that of the SO/MI-PM system. During the investigation period, leaf samples were taken 2 times to evaluate the nutritive value. Significant differences were observed in the contents of crude protein and nitrogen. *In vitro* digestibility of SO-PM was also higher than that of SO/MI-PM. These data indicated that dry matter productivity and forage quality of SO-PM were much higher than those of SO/MI-PM. Based on the soil analysis, it is considered that, in the rotation of summer soybean with winter millet, soil nitrogen was immobilized into the plant residues of millet, and that *P. maximum* after the rotation could not utilize the soil nitrogen. Thus, the growth and forage quality of *P. maximum* were limited after the rotation of soybean and millet, because of its high nitrogen requirement.

However, in farming practices, rotation of summer soybean with winter millet is more rational than continuous soybean cultivation from the point of view of economic profit, weed management, and sustainability of the soil nitrogen content. Therefore, to achieve a high productivity and enhance the nutritive value of *P. maximum* even after the rotation of soybean with millet, application of a small amount of nitrogen fertilizer could be effective. It is also considered that the use of species other than *P. maximum* (such as *Brachiaria* spp. with a lower external N requirement) could be an alternative for the development of a sustainable agropastoral system.

Table 1. Average biomass, dry matter production and nutritive value of *Panicum maximum* pastures established after 4-year cultivation of soybean and 4-year rotation of summer soybean with winter millet

	Average biomass	Dry matter production	Crude protein	*In vitro* digestibility	Nitrogen
	(DM t/ha)	(DM t/ha/253 days)	(%)	(%)	(%)
After soybean	12.7	16.6	12.7	56.0	1.92
After soybean+millet	9.0	10.3	8.6	51.8	1.31

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Technology Selection in Mekong Delta Project

For the implementation of research projects dealing with technology development, attention should be paid to the kind of technology required for meeting farmers' needs. In particular, in the case of comprehensive research projects, component technology should be integrated. In our project, in order to meet farmers' needs for technology development and to integrate component technology within the whole farming systems, we applied a farming systems research and extension approach for selecting the technologies to be developed in the project. The study site is representative of the irrigated alluvial soil area in the Mekong Delta, Vietnam. In the above approach, the first step is the diagnosis stage and the second step, the design stage. In the first step, problems and requirements were identified and compiled. In the second step, we applied the AHP-Method for evaluating the technology. In the AHP-Method (Analytic Hierarchy Process), the decision-making process is applied when there are options with some of the criteria conflicting with each other.

The results were as follows. As shown in Table 1, among the problems, those related to the farming systems were as follows: 1) "Difficulty in adoption of VAC systems," "Difficulty in crop selection and combination," 2) Optimum waste disposal," 3) Waste pollution," and 4) " Optimum way of selecting chemicals." Besides these problems, there are various kinds of individual problems in each component such as rice-fish, livestock, fruit trees and fisheries.

Based on the above data, we listed up the technology required to address these problems. We compared each technique with the criteria. The criteria suitable for technology assessment (evaluation) included "effects," "technology level" ("possibilities"), "ease of adoption for farmers (to learn technology),"and " research cost." For each criterion, the respective techniques were scored. Fig. 1 shows the results of the analysis.

In this figure, IPNM technology was evaluated. IPNM stands for integrated pest and nutrient management. IPNM technology includes: "Comparison of sustainability of double and triple rice cropping," "Development of measures to maintain or improve soil fertility," "Development of fertilizer application methods," "Utilization of resistant varieties," "Renewal of varieties," "Utilization of natural enemies," "Protective methods associated with labor-intensive management," "Development of rice-duck system," "Development of rice-fish system." IPNM technology is one of the important technologies for farming systems and one of the possible solutions to address problems such as "Optimum waste disposal" and "Optimum way of using chemicals." Among the IPNM techniques, "Development of measures to maintain or improve soil fertility (fruit tree gardens and paddy fields)" includes manure production and composting technology, evaluation of fish pond and canal deposits as fertilizer, and evaluation of fermented liquid from bio-digester as fertilizer. "Protective methods associated with labor-intensive management" refer to the development of water control methods which include land leveling and deep water management for weed control. "Development of rice-fish system" aims at weed control and reduced use of chemicals. "Development of rice-duck system" aims at the control of the golden apple snail. Among these, "Development of measures to maintain or improve soil fertility" had the highest total score. Especially the scores of effects and technology level were much higher compared with others.

On the other hand, we obtained the results of evaluation from farmers. As it is too difficult for farmers to answer in the form of AHP-Method, we decided to ask them to score each research topic. As a result, "Development of measures to maintain or improve soil fertility" had a higher score. Therefore, we selected this technology for development in the project. Likewise, we also selected technologies in other research fields.

In the above process, we identified the technologies to be applied in the Phase 2 of the Mekong Delta project. The objective of the project is to develop sustainable farming systems by technology development for environmental

Table 1. Main problems relating to farming systems

1 <Difficulty in VAC systems adoption / Difficulty in crop selection and combination>

It is difficult to adopt VAC systems due to the lack of resources / capital. I do not know how to select and combine components. It is difficult to invest due to the difficulty in borrowing money.

2 <Optimum waste disposal>

I do not know what is the optimum amount of wastes in ponds and ditches. There are problems about the decrease in soil fertility. But, there is neither enough knowledge nor enough materials to make manure.

3 <Waste pollution>

Livestock wastes cause environmental problems such as decrease of water quality and bad smell. On the other hand, it is difficult to use the bio-digester.

4 <Optimum way of using chemicals>

I do not know the optimum way of applying fertilizers and of spraying pesticides and herbicides.

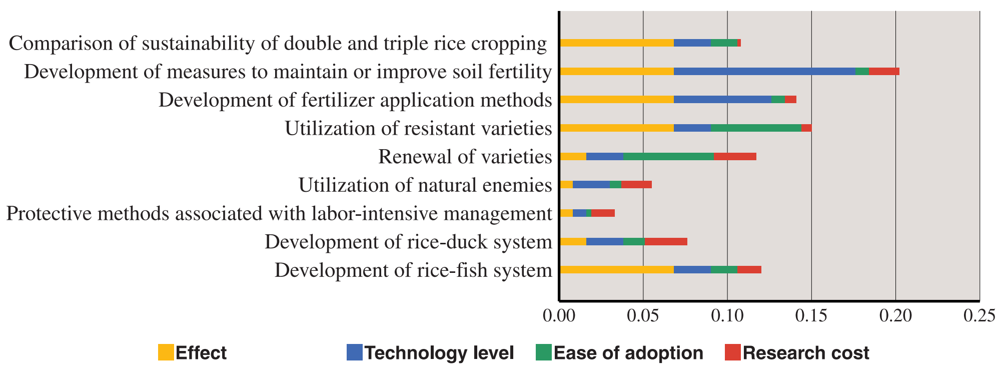


Fig. 1. Technology evaluation by AHP (IPNM).

conservation, including bio-digester technology, technology for soil fertility preservation, and water control technology. At the same time, component technology will be developed as follows: 1) In the rice component, direct seeding technology, IPM technology, rotation technology, and drying technology, 2) In the pig component, feeding technology by using local resources and disease control technology, 3) In the fruit tree component, IPM technology, 4) In the aquaculture component, farming technology and seed production technology. These technologies were selected based on farmers' requirements identified at the diagnosis stage. At the design stage, we considered four important criteria such as "effects," "technology level" ("possibilities"), "ease of application for farmers (to learn technology)," and "research cost." The procedure described above may enable to minimize the risks of failure of technology development and to increase the possibility of integrating each technology for the implementation of the comprehensive research project.

Ryuichi Yamada
Development Research Division, JIRCAS

Symposium

International Symposium on "Lignocellulose - Material of the Millennium: Technology and Application"

A joint international symposium between JIRCAS and Universiti Sains Malaysia (University Science Malaysia, USM) was held at Penang, Malaysia, during the period of March 20 ~ 22, 2001. The symposium was titled: "Lignocellulose - Material of the Millennium: Technology and Application." The purpose of the symposium was to exchange information on the latest achievements in research works on lignocellulose and related materials through paper presentations and discussions.

More than 100 participants attended the symposium, including 20 from Japan, 60 from Malaysia, and others from Europe, North America and Asian countries. There were 39 oral presentations, including 5 lectures and 40 posters.

Professor Mohd. Azemi Mohd Noor (Chairman of the Symposium, USM) and Dr. Terunobu Suzuki (Director of Forestry Division, JIRCAS) delivered the opening addresses, followed by the declaration of official opening of the symposium by Y. Bhg. Dato' Professor Dzulkifli Abdul Razak (Vice Chancellor, USM). Session I included 5 presentations on pulp, paper and cellulose derivatives. Session II was held in the afternoon with 7 papers relating to food, feed and medical applications of lignocellulosic materials (Session II-A) and 7 presentations on lignocellulose-based composites (Session II-B). On the morning of the second day, Session III-A dealt with the properties and characterization of lignocellulose materials and products (6 papers), while Session III-B with lignocellulose composites (8 papers). Sessions II-B and III-B differed in terms of processing and utilization of lignocellulosic fibers, namely fiber-reinforced composites (II-B) and chemical reaction on fibers (III-B). After Session III, a poster session with 40 papers was held. Session IV included 6 presentations on new technological developments in lignocellulose research, followed by the closing ceremony with a speech by Professor Azemi and closing remarks by Dr. Suzuki. On the last day, March 22, a visit to a wood-based board factory, including briefing of Penang Island, was organized for all the participants. The symposium was very successful due to the strong commitment of the experienced staff of USM.

During the symposium, participants exchanged views and opinions on a wide range of research works related to wood and non-wood lignocellulosic materials. A large number of papers presented during the symposium involved studies on the extraction of lignocellulose materials from plant by-products such as oil palm wastes, rubber wood and banana fibers, which are often discarded after collection of the main products. The current project between JIRCAS and USM, indeed, dealt with such materials, especially by-products from oil palm. The presentations indicated that there is a great potential for the utilization of these wastes as raw materials for the production of pulp, paper, composites and plastics in addition to food and feed resources. It was also noted that the relationship between JIRCAS and USM had been strengthened through this joint symposium.

Ryohei Tanaka
Forestry Division, JIRCAS

Opening ceremony

Audience during an oral presentation

International Workshop on Nitrogen Fertilization and the Environment in East Asian Countries

The use of nitrogen fertilizers has significantly contributed to the remarkable increase of the production and yield of various staple crops since the Green Revolution. However, in recent years, the beneficial effect of nitrogen fertilization on crop production has been somehow offset by the occurrence of adverse effects on the environment. Excessive use of nitrogen fertilizers often induces pollution of soils, water and the atmosphere by the emission of nitrogen compounds. Such environmental problems have recently become serious in the countries of East Asia, namely China, Korea and Japan, which are characterized by intensive agriculture with high input due to recent economic development and high population density.

The international workshop on "Nitrogen Fertilization and the Environment in East Asian Countries" held on February 5-9, 2001 addressed the issues related to nitrogen fertilization and the environment in East Asian countries and aimed (1) to exchange views on the issues, (2) to identify gaps in knowledge, and (3) to discuss future research needs and possible forms of cooperation. The workshop hosted by the Environmental Resources Division of JIRCAS included an international symposium, a planning meeting for the environmental component of the JIRCAS China project, and a field excursion tour.

A total of 100 scientists from 15 countries participated in the 2-day's international symposium. After the opening address delivered by Dr. T. Inoue, Director General of JIRCAS, Dr. A. Mosier of USDA-ARS and three other leading scientists from China and Japan presented keynote lectures to outline the issues in East Asian countries and the world. Then followed 6 general sessions with 25 reports by researchers from Japan, China, Korea, UK, Germany and USA. The symposium was closed by discussion sessions both in the break-out groups and synthesis and closing remarks by Dr. Minami, Director General of the National Institute for Agro-Environmental Sciences.

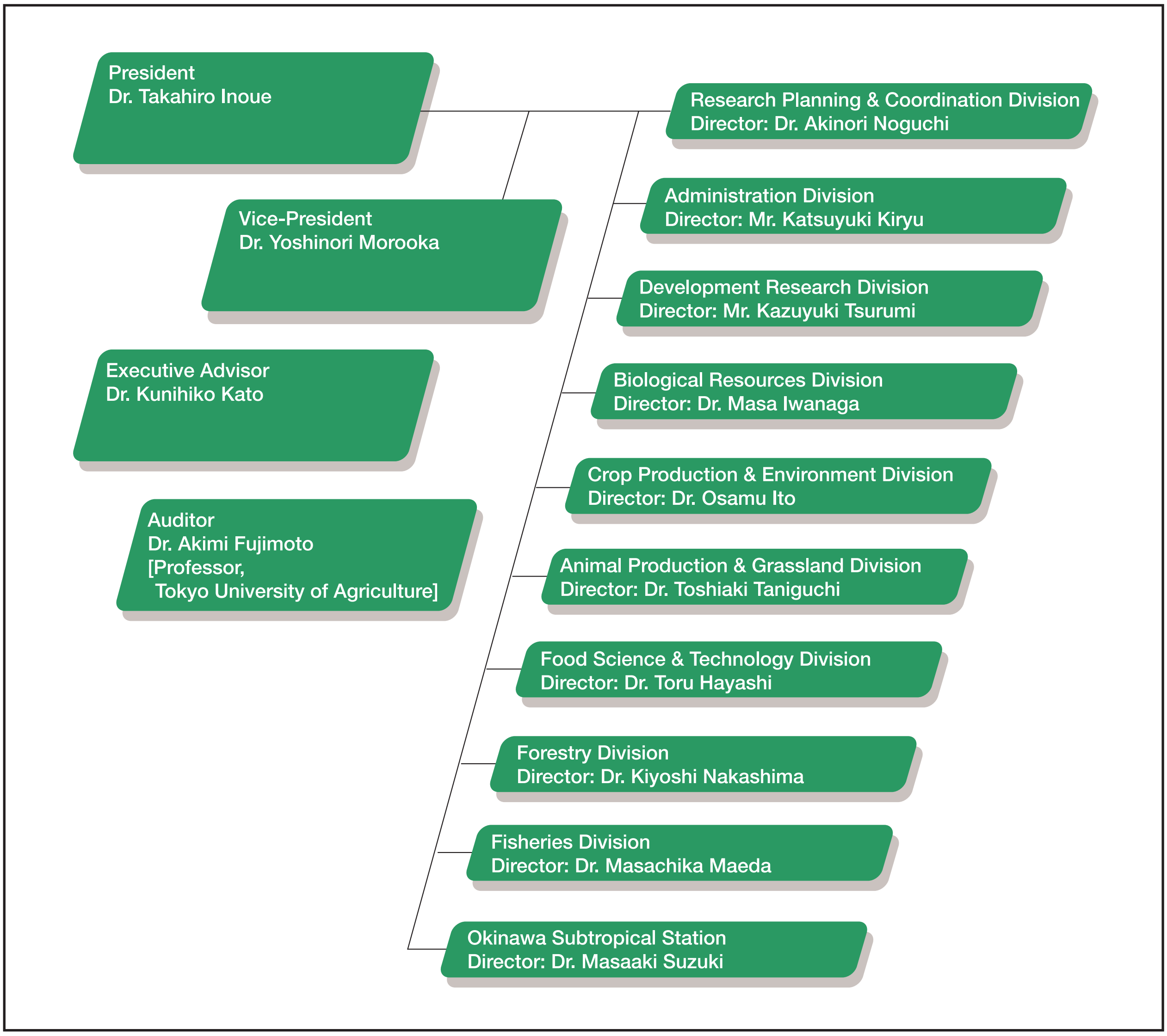
During the 4th planning meeting for the environmental component of the JIRCAS China project titled: "Evaluation and development of methods for sustainable agriculture and environmental conservation," discussions were held on the results and future plans of the project with participants outside of the project in addition to the counterparts. During the excursion tour, the participants visited JIRCAS experimental fields, Shizuoka Prefecture Tea Experiment Station, and Shizuoka Prefecture Agricultural Experiment Station and exchanged views on recent studies conducted in Japan and technologies applied for minimizing the impact of nitrogen fertilization on the environment.

This was the first international workshop focused on nitrogen fertilization and environment in East Asia. We consider that this workshop gave a good opportunity to promote the development of technologies or policies that maximize the use of land, water, soil, and biota resources without exerting an adverse impact on the environment, by the development of research networks in East Asian countries and the world.

For further details, please visit our web site (http://www.jircas.affrc.go.jp/EANWS/EANWStop.html)

Kazuyuki Yagi
Environmental Resource Division, JIRCAS
(Present, National Institute for Agro- Environmental Resource)

Participants in the workshop



The 8th JIRCAS International Symposium

The 8th JIRCAS International Symposium with the tentative title of "Water for Sustainable Agriculture in Developing Regions" will be held at Epochal Tsukuba, Tsukuba, Japan during the period of November 27-28, 2001.

For further information, please contact:**Dr. Masaharu Yajima**
Secretary of the Organizing Committee for the 8th JIRCAS International Symposium

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