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for

INTERNATIONAL COLLABORATION

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JIRCAS

JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Toward Sustainable Management of Forest Resources in the Tropics

Forests of the world

The forest has important roles in providing various goods and services to people and our society. Forest areas of the world, however, have been remarkably decreasing because of rapid economic and population growth. Particularly, in developing countries, deforestation or forest degradation has become severer than ever and has caused serious impacts on lives of people and the environment on local and global scales.

The FAO issue entitled "State of the World's Forest 2001" states that out of an estimated 3,870 million ha of the world's forest land, 95% consists of natural forests and only 5% of artificial forests. Deforestation and degradation of tropical forests in many parts of the world are negatively affecting the function of forests. While the forest area in non-tropical areas has stabilized and is even slightly increasing, deforestation has continued in many tropical areas in the last decade.

There exist some causes of deforestation or forest degradation: conversion of land for agricultural, industrial and urban uses after excessive logging. More than 9.4 million ha of forests disappear each year.

Approximately 47% of forests of the world are distributed in the tropics, and during the last decade, 15.2 million ha, 94.4% of deforestation of natural forests has occurred in the tropics. It is very apparent that most of the deforestation problems exist in this region.

There is a global trend to supply more timber from artificial forests. Especially, in Southeast Asian countries, afforestation work has been conducted very extensively, and approximately 62% of the work was concentrated in this region. However, some work resulted in failure due to the inappropriate introduction of technologies developed in temperate or boreal zones and a shortage of knowledge and information on tropical forest ecosystems and social systems. Accordingly, it is very urgently needed that we conduct extensive research for acquiring knowledge on forest ecosystems, eco-physiological traits of tree seedlings, and socio-economical aspects of the community, as well as adoption of tree species adaptable to each environmental condition, and technologies for planting and raising tree seedlings.

Our research strategies

JIRCAS has focused on developing technologies for rehabilitation of degraded forest and grass lands and sustainable use of forest products in Southeast Asia, and we reviewed our activities and placed our research goal for "**Sustainable Use of Forest Resources in the Tropics**" in the mid-term or 5-year research plan established in 2000. Moreover, we established three themes to attain our goal.

1. Development of regeneration technology in consideration for preservation of forest environment functions

In order to enhance the natural regeneration of forest vegetation after logging or thinning, we are developing a new logging and harvesting system with limited impacts instead of the bulldoze-system, and its effect will be verified by using hydrological analyses. Eco-physiological studies are also being pursued in order to introduce more suitable tree species, mitigate the competition among tree seedlings and other vegetation, and to improve planting methods of tree seedlings after thinning or logging.

2. Development of technology for improvement of forest quality

In order to improve the quality of mono-cultured forests and deteriorated secondary forests, we are developing a technology for growing valuable native tree species by introducing mixed-planting or inter-planting systems.

3. Development of processing technology for effective use of unexploited forest resources

In order to reduce the impacts of logging in natural forests, we are researching unexploited or unknown forest resources, evaluating their commercial values, and developing a new processing technology.

As described above, our research activities focus on a

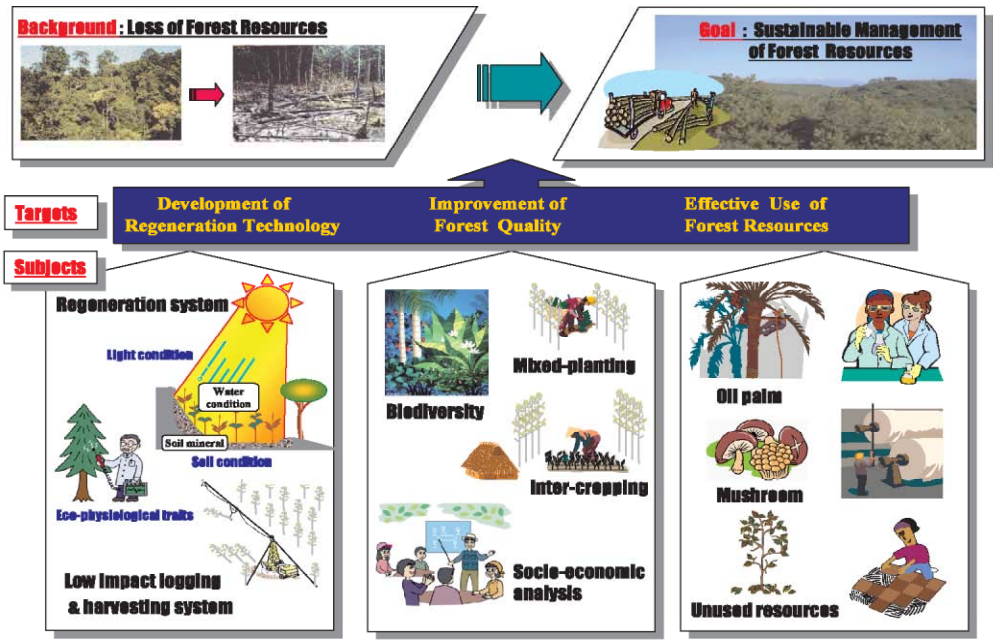

Figure (right). A schematic representation of JIRCAS's goal and strategies for forest research.

Cover photo: Young girls of a hill tribe in north Thailand working for bottom weeding in a forest plantation. (Photo by K. Nakashima) wide range of issues from production to end-use. In order to attain our goal, we are emphasizing the enrichment and rehabilitation of deteriorated forests and grasslands as an initial step of our research.

Comprehensive project

Various factors cause the degradation and destruction of tropical forests and we need to analyze them from various disciplines. For instance, in the tropical forests of Southeast Asia, oil palm and rubber tree plantations or fast-growing species such as *Acacia* and *Eucalyptus* have been expanding very rapidly and extensively. There exist some concerns that these concentrated and mono-cultured forest plantations would have adverse effects on biological diversity, forest functions, and sustainability in the near future. Moreover, many people living along or in forests deeply depend on benefits from forests, and it seems very important to establish and maintain better relationships between inhabitants and forests.

The Forestry Division of JIRCAS initiated a comprehensive research project entitled "Development of Agroforestry Technology for the Rehabilitation of Tropical Forests" in 2000, which is aimed at mitigating agriculture-forestry conflicts as well as promoting environmental conservation and sustainable management of forest resources. The project was started in collaboration with UPLB of the Philippines. The Forest Department of Sabah, Malaysia joined the project in December 2001, and a research site was established in Sandakan under the auspices of the Sabah Forest Research Centre. Three JIRCAS scientists on long-term assignments have been engaged in studies on forest ecology, soil science and mushroom cultivation since December 2001.

Kiyoshi Nakashima
Director, Forestry Division, JIRCAS

New Concept of Reforestation in the Philippines

The Philippines used to hold larger forest acreage and be a leading timber exporting country to Europe in the 17th century. But at present, forest area occupies only around 5% of the national land due to the extensive harvesting of timber during the Spanish colonial period, its share being the lowest in Southeast Asian countries. Ruined forest areas widely spread over the mountains of the nation and sometimes cause serious floods and menace the life of people living in lowlands. Reforestation is, therefore, one of the most important social tasks, not only to restore forest resources but also to protect the life of rural people.

Forest rehabilitation activities have been conducted in the Philippines over a long period of time, but various tall grass species rapidly grow in tropical deforested areas and disturb the establishment of tree seedlings. The tree planting methods of this country were mainly introduced directly from the temperate regions but are not suitable for this region; for instance, the preference for timber producing species typified by *Diptercarpaceae*, or the adoption of low-height seedlings for planting, which are not suited for the hard environmental conditions of mountainous grassland areas.

JIRCAS initiated a collaborative research project entitled "Studies on the Establishment of Cover Forest for the Logged-Over Tropical Forests in the Philippines" in 1999 in order to promote the technical development of reforestation methods for the mountainous logged-over area, most of which was transformed to grassland, causing the regeneration of tree species to be severely disturbed. The project is conducted in close collaboration with the Institute of Renewable Natural Resources, University of the Philippines at Los Banos (IRNR-UPLB) and Southern Luzon Polytechnic College (SLPC) and consists of three study components: the establishment of simplified pre-germination treatments of leguminous tree species, the evaluation of drought and low light intensity tolerance of native species at seedling stage, and the establishment of an integrated agroforestry system.

We first improved the direct sowing method for trees conventionally practiced by the farmers. The trees of *Leguminosae* and *Mimosaceae* are popularly used for reforestation, but the seeds have a water-blocking coat. Suitable pre-germination treatments by heating have been found to greatly improve their water absorption capacity. Although the farmers usually sow the seeds and burn the grassland to heat the seeds, we found that seed boiling treatments were more effective for maintaining temperatures specifically needed for the species. Our improved method of sowing the treated seeds and burning the grasslands succeeded in ensuring establishment of seedlings.

Twenty-six tree species are now being evaluated for their tolerance to the above-mentioned environmental stresses. An experimental agroforestry plantation of 12 ha was also constructed at the foot of Mt. Banahao (2,177 m) located in southern Luzon Island. In the plantation, 36 combinations of indigenous native tree species and fruit species were planted in a manner such that tree species would serve as shelters for fruit species. The growth and survival rates, and some physiological traits are now being monitored. Soil temperature and moisture are also being monitored to evaluate the shelter effects of the tree species.

Kazunori Takahashi
Forestry Division, JIRCAS

Experimental agroforestry planting site at Mt. Banahao, Luzon Island.

Mass Mortalities Associated with Viral Nervous Necrosis in Hatchery-Reared Orange-Spotted Grouper in the Philippines

Aquaculture in Southeast Asia has made considerable progress with respect to broodstock management and hatchery production of some marine species with high commercial value such as mangrove red snapper *Lutjanus argentimaculatus*, sea bass *Lates calcarifer*, and orange-spotted grouper *Epinephelus coioides*. The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD), Iloilo, Philippines is developing technologies for culturing new marine fish species including orange-spotted grouper. In 2001, there occurred a disease outbreak with mass mortalities characterized by anorexia and abnormal swimming behavior in the hatchery-reared larvae of the grouper in AQD. The daily mortality rate was 5 - 10% and subsequently became 100% in 10 days. The etiological study of this epidemic was therefore, conducted using histopathological examination, virus isolation technique utilizing SSN-1 cell lines, reverse transcription-polymerase chain reaction (RT-PCR) test, and electron microscopy.

Initial clinical signs of the affected larvae were the decline in feeding activities followed by increase in pigmentation and subsequent darkening of skin. Diseased fish became lethargic, often lying with their abdomens-up and rising to the surface of water. Abnormal swimming behaviors such as rotating, spinning, and horizontal looping were observed. At necropsy, the digestive tract was seen to be empty and transparent due to reduced feed intake, but no apparent lesions were observed. Neither dominant bacteria nor parasites were detected in the diseased fish. Light microscopic observation revealed heavy vacuolation in the tissues of the brain (Fig. 1), spinal cord and retina, and no apparent lesions in other organs. The viral nervous necrosis (VNN)-specific cytopathic effects (CPE) were observed in SSN-1 cells 2 days after inoculation with the filtrate of affected grouper and were characterized by the formation of cytoplasmic vacuoles (Fig. 2). The viral titer of the filtrate from the diseased moribund fish tissue was $10^{9.0}$ $TCID_{50}$ ml^{-1}. The PCR test conducted using the primer-set used for the amplification of RNA 2 gene of striped jack nervous necrosis virus produced approximately 430 base pairs in samples obtained from both the naturally diseased fish tissue and the SSN-1 cell culture inoculated with the filtrate from the diseased fish tissue. The size of the PCR product was consistent with that of other piscine nodaviruses when the same primer set was used. Small spherical, non-enveloped virus particles with diameters of 20-25 nm arranged in paracrystalline arrays or in membrane-bounded vesicles were abundantly observed in the cytoplasm of the diseased cells by electron microscopy (Fig. 3).

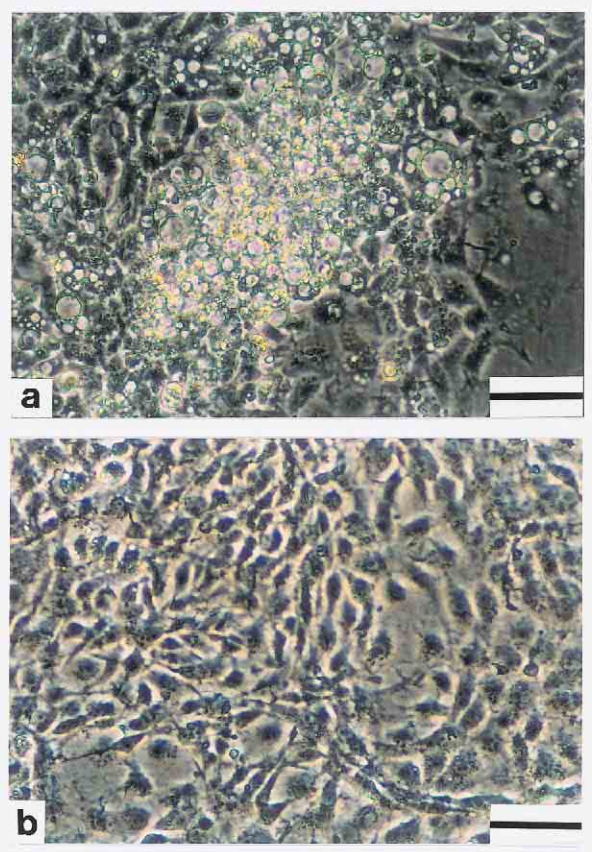

Fig. 2. Cytopathic effects in SSN-1 cells. Scale bar = 50 μm
(a) SSN-1 cells inoculated with the filtrate of diseased fish tissue samples.
(b) Normal SSN-1 cells.

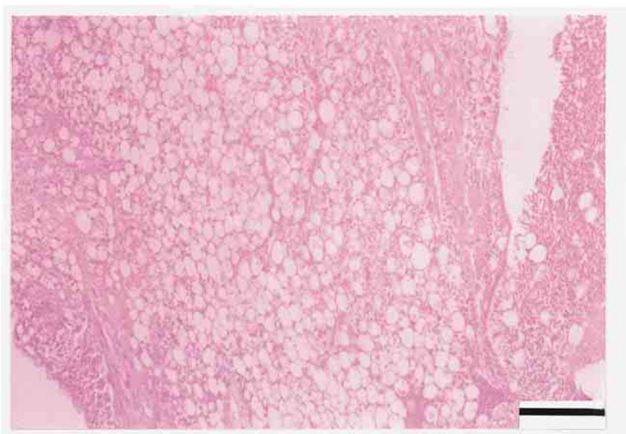

Fig. 1. Vacuolation in the brain tissue of diseased fish. Haematoxylin and eosin stain. Scale bar = 100 μm

The clinical signs and histopathological lesions observed in moribund orange-spotted grouper were very similar to those observed in other VNN-affected fish species. Infected SSN-1 cell cultures of this grouper also developed the VNN-specific CPE, and the isolated virus was identified as piscine nodavirus according to RT-PCR test and electron microscopic observation. Furthermore, the inoculation of the isolated virus produced the same clinical signs and the virus was re-isolated from experimentally infected fish. It became clear that the mass mortality of larval grouper was caused by VNN: this is the first documented outbreak of VNN among hatchery-reared larvae of orange-spotted grouper in the Philippines.

Piscine nodavirus infection has been associated with high mortalities in cultured grouper species in Southeast Asia, and consequently has the potential to cause severe economic losses to aquaculture in this region. Hence, there is an urgent need to determine the host range of this virus, and such studies are ongoing in the collaborative project between JIRCAS and SEAFDEC/AQD entitled "Studies on Sustainable Production Systems of Aquatic Animals in Brackish Mangrove Areas." The present study also highlights the urgent need for continued epidemiological surveillance of piscine nodaviruses and the development of effective prevention and control measures, with a particular emphasis on the screening of healthy broodstock and the larvae that they produce.

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Fisheries Division, JIRCAS

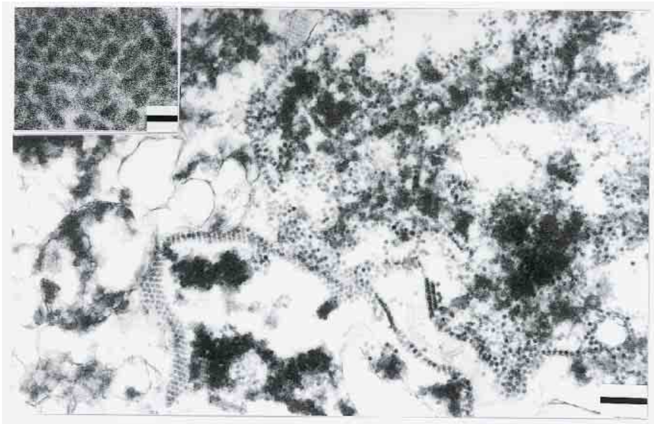

Fig. 3. Electron micrograph of SSN-1 cells 5 days after inoculation with the filtrate of diseased fish tissue. Scale bar = 200 μm, and that in inset = 50 nm

Stabilization of Sugarcane Production in Northeast Thailand through the Improvement of Tillage and Planting Methods

The soil in Northeast Thailand is mostly sandy and coarse in texture with low organic matter content, low water holding capacity, and low cation exchange capacity. The annual precipitation varies from 800 to 1,400 mm, most of which is concentrated in the 6 month-long rainy season. Under these natural conditions, cassava and sugarcane rather than cereal crops are produced to avoid drought. Especially, the acreage of sugarcane has remarkably increased during the last two decades.

As the continuous cropping of sugarcane has become predominant, soil compaction or the formation of soil hardpan due to extensive use of heavy machinery has gradually become apparent. Sugarcane production is categorized into dry season-type and rainy season-type productions in Thailand; however, the former is by far prevalent in this region. In this type, sugarcane is harvested twice in every three years; that is, initial planting is practiced at the end of rainy season, ratooning is practiced only once, and when a second harvest is finished, a fallow period lasts as long as 7 months. During this period, most heavy machinery work such as incorporating crop residues in soil, weeding, water harvesting, land preparation, and ridging are practiced. Only less than 10% of farmers own machinery, most machinery work is carried out by contractors, and this contract work also affects the formation of soil hardpan.

Compaction in sandy soil will occur more easily under conditions of low organic matter content and poor aggregation of soil particles. Typical soil hardpan with bulk density of more than 1.7 g cm^{-3} is usually observed at a depth of 30-45 cm, and crop roots can hardly penetrate this hardpan. The hardpan sometimes magnifies environmental stress through the restriction of crop root development and soil water percolation.

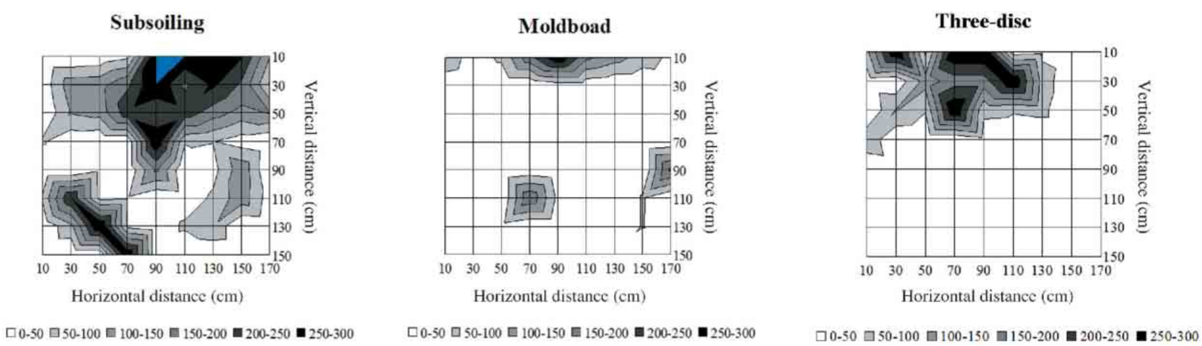

Fig. 1. Effects of various tillage treatments on the root distribution of sugarcane.

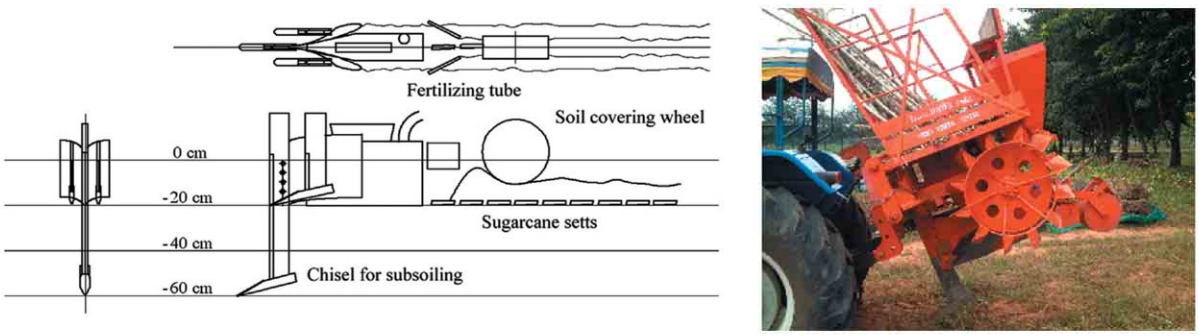

Fig. 2. A newly developed sugarcane planter with subsoiling chisel.

Since 1999, JIRCAS has conducted research aimed at improving agricultural practices in sugarcane production, tillage methods of upland crops and water dynamics, and developing new equipment for minimum tillage system.

In the experiment, subsoiling was considerably effective for breaking hardpan layer and improving water percolation, reducing erosion, improving root development and yield of upland crops (Fig. 1).

Moreover, a new machine was developed by modifying a commercial sugarcane planter (Fig. 2). This machine could simultaneously carry out both subsoiling and planting, and work under conventional tillage and no-tillage conditions of dry season. Working hours and fuel consumption could be markedly reduced by using this new machine especially under no-tillage condition (Fig. 3). In addition, the new machine resulted in lower mortality of seedlings in dry season and higher stalk yield of sugarcane as compared with the conventional method (Table).

The new machine is promising for stabilizing the sugarcane production in this region, and further improvements for crop residue handling, and weed control are being extensively pursued by Thai researchers.

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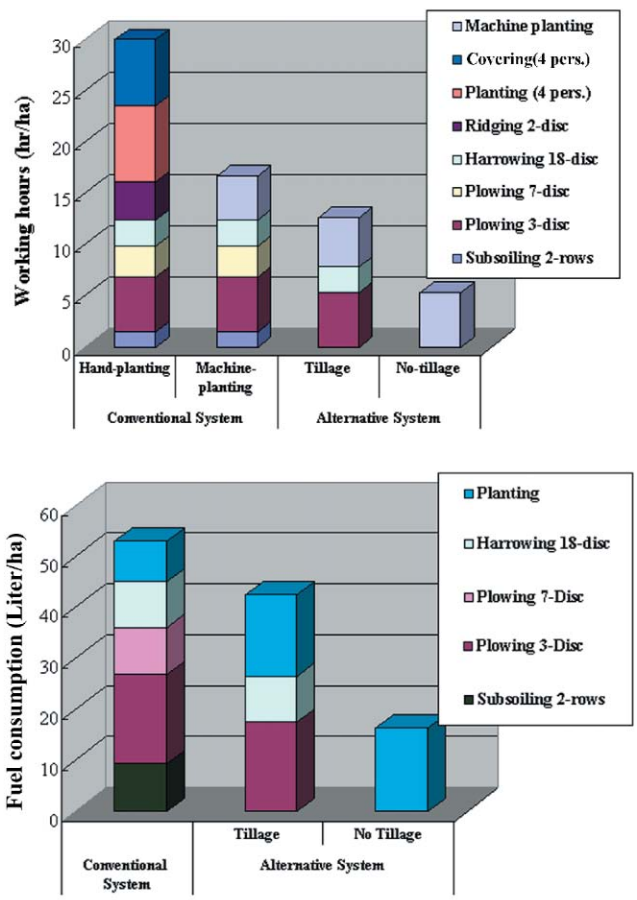


Fig. 3. Working hours and fuel consumption of conventional and alternative tillage systems.

Table. Effects of planting methods with/without tillage on sugarcane growth

Tillage practices		F.W. of stalk (t/ha)	No. of stalks (/m²)	Stalk length (cm)	Stalk diameter (mm)
Tillage	Hand planting	63.7±12.6	5.0±0.7	206±17	27.5±1.3
	Commercial planter	47.0±10.2	4.9±0.6	178±20	28.3±0.7
	Developed planter	89.3±13.8	6.0±0.3	234±21	29.9±0.3
No-tillage	Commercial planter	65.1± 5.2	5.9±0.3	186±10	26.9±0.7
	Developed planter	99.6± 7.0	5.8±0.2	248± 6	29.9±0.9

Note: Stalk samples were collected on Sept. 10, 2002. Stalk diameter was determined at the middle of stalk. The values in the table indicate average ± S. E. (n=4). F.W.: Fresh weight.

Joint Workshop "Coping against El Niño for Stabilizing Rainfed Agriculture: Lessons from Asia and the Pacific"

A workshop "Coping against El Niño for Stabilizing Rainfed Agriculture: Lessons from Asia and the Pacific" was held in Cebu, Philippines on September 17-19, 2002, and jointly organized by ESCAP/CGPRT Center, Philippine Department of Agriculture, JIRCAS, Australian Center for International Agricultural Research (ACIAR), and International Water Management Institute (IWMI).

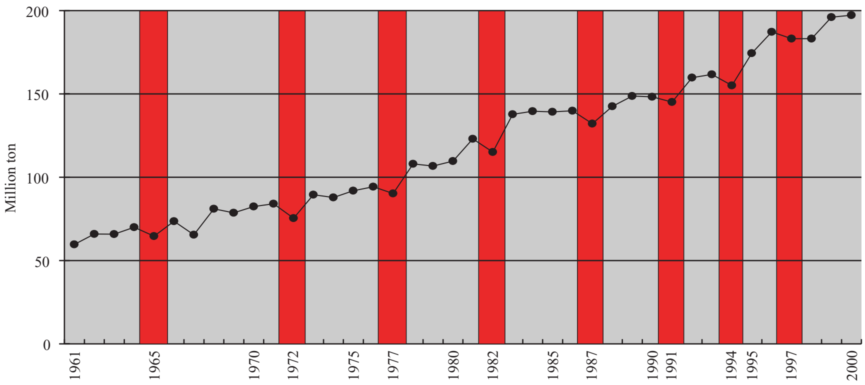
The main purpose of the workshop was to exchange and disseminate the results of the research project entitled "Stabilization of Upland Agriculture and Rural Development in El Niño Vulnerable Countries (ELNIÑO)," which is currently being conducted by ESCAP/CGPRT Center and funded by the government of Japan. Over 60 participants from seven countries and three international organizations attended the workshop.

At the opening session, the inaugural message was read on behalf of Dr. Takahiro Inoue, the President of JIRCAS, conveying the significance of El Niño study and the importance of technological development for crop production under unfavorable climate conditions.

On the first day of the workshop, four prominent scientists delivered keynote presentations related to climate change and disaster mitigation systems. Dr. Felino P. Lansigan from IWMI introduced a method of systems analysis for evaluating effects and impacts of climate variability and initiatives in coping with climate variability. Dr. Jeff F. Clewett from the Department of Primary Industries, Australia, presented the case study based on the development and application of "Australian Rainman," a computer package which aims at developing skills for managing climate variability in agriculture by analyzing effects of El Niño on rainfall. Dr. Masaharu Yajima from National Agricultural Research Center for Tohoku Region, Japan, introduced the "Climatic Early Warning System" against cool summer damage. Mr. Shigeki Yokoyama, CGPRT Center, presented ENSO impacts on food crop production and the role of CGPRT crops in Asia and the Pacific, characterizing the production loss of major food crops in El Niño years (Figure).

On the second day, five national experts (from Indonesia, Malaysia, Papua New Guinea, Philippines, Thailand) presented their country's reports concerning impact of El Niño and coping mechanisms, and specialists from these countries delivered supplementary comments. Through the subsequent discussions, the participants reached a consensus that a socioeconomic approach as well as agronomical and plant physiological approaches were important to deeply understand the vulnerability of Asian and the Pacific regions to El Niño-induced weather changes. They finally concluded that the findings of the project should be translated to technical information diffusible to farmers, and that the further estimation of cost effectiveness of mitigation measures would be useful to policy makers.

Tomohide Sugino
Research Planning & Coordination Division, JIRCAS



Note:
$ln y = -43.12 + 0.031x - 0.080D$
(R^2 + 0.98, significant at 1% level)
y: The total cereal production (metric ton)
x: Years
D: El Niño dummy
Data source: FAOSTAT

Figure. Changes in cereal production and El Niño occurrence in Asia and the Pacific region from 1961 to 2000. (by courtesy of Mr. Shigeki Yokoyama, CGPRT Center)

JIRCAS Scientists Joined Johannesburg Summit

Two JIRCAS scientists, Dr. Ryoichi Ikeda, Director, and Dr. Hiroshi Tsunematsu, a rice geneticist of Biological Resources Division, joined the World Summit for Sustainable Development held in Johannesburg 26 August - 4 September 2002. Dr. Ikeda gave a speech on collaborative research with West Africa Rice Development Association (WARDA) for developing NERICA (New Rice for Africa). Moreover, two varieties of NERICA were served to participants for tasting in Japan Pavilion.

At present, JIRCAS has dispatched two scientists including Dr. Tsunematsu to WARDA, and they are conducting studies on variety improvement, and the socio-economics of rice production in West Africa.

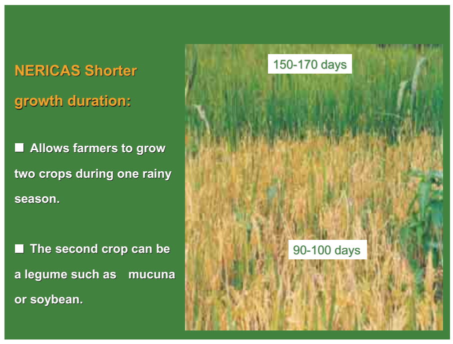


Figure. A NERICA cultivar at maturity (front).

9th JIRCAS International Symposium Value-Addition to Agricultural Products

On October 16-17, 2002, JIRCAS held its 9th International Symposium on "Value-Addition to Agricultural Products - Towards increase of farmers' income and vitalization of rural economy" in cooperation with National Agricultural Research Organization (NARO), National Food Research Institute (NFRI), Fisheries Research Agency (FRA), P*h*Action and Food Forum Tsukuba. A total of 209 scientists, administrators and technical experts of both public and private sectors from 40 countries participated in the symposium and exchanged views on the issues addressed by 2 keynote speakers, 18 oral and 49 poster presenters.

In the light of the United Nations' prediction that the world population would reach 8 billion in 2030, food production, the major role of farmers and rural areas, will increase in importance. However, farmers in many countries are suffering from low incomes due to low price of their products. Value-addition to agricultural products holds the potential for increasing farmers' income and generating off-farm employment in rural areas, and eventually vitalizing rural economy. The present symposium focused on these issues and directions to be pursued by various disciplines.

The symposium began with the opening address by Dr. Inoue, President of JIRCAS, followed by the welcoming remarks by Mr. Nagayama, Research Councilor, Agriculture, Forestry and Fisheries Research Council Secretariat, MAFF. In the keynote speech, Dr. Mrema of FAO pointed out the impact on post-harvest sector of urbanization, trade liberalization, commodity chains integration, biotechnology development and food safety and quality concerns of consumers, and stressed the potential contribution of value-addition to agricultural development and rural economic growth. Dr. Poulter of University of Greenwich, chair of P*h*Action, which is a global forum in the field of post-harvest, presented the forum's initiative "Linking Farmers to Markets."

In Session 1, "Current status of rural economy and measures for increasing farmers' income and vitalization of rural economy" were reported from representative developing regions: China by Dr. Li (CAAS), the Philippines by Dr. Manalili (SEARCA), Vietnam by Dr. Le Van To (PHTC), Indonesia by Dr. Mahendra (University of Udayana), South Asia by Dr. Hodges (NRI) on behalf of Dr. Hall (DFID-CPHP), Latin America by Mr. Ospina (CLAYUCA), and Africa by Dr. Ferris (IITA). Session 2 dealt with "Systems for ensuring high quality and safety" - the key factors to increase marketing and sales opportunities. International standards and requirements including Codex and HACCP were examined by Dr. Yamada, NFRI, Dr. Nicolaides, NRI and Ms. Battaglia, FAO. Mr. Rickman, IRRI, and Dr. Watabe, The University of Tokyo, reported on quality control technologies at post-harvest stage for rice and pre-harvest stage for fish. Session 3 assessed the traditional fish industry in Southeast Asia (Mr. Tan Sen-Min, SEAFDEC), the development of intermediate foodstuff from freshwater fish in China (Dr. Wang, Shanghai Fisheries University), value-adding technology in Thailand (Dr. Gassinee, Kasetsart University), inventory of bioactive plants and minor crops (Dr. Nakahara, JIRCAS), functionalities of traditional foods in China (Dr. Li, China Agricultural University), and functional foods in Japan (Dr. Shimizu, The University of Tokyo).

In the General Discussion chaired by Dr. Mrema, FAO, and Dr. Hayashi, JIRCAS, the crucial points that emerged from the previous sessions were reviewed and the participants confirmed the importance of socio-scientific approaches including institutional considerations, market and supply chains analysis, in addition to technological approaches. Dr. Kainuma, former President of JIRCAS, suggested that collaborative work with international forums be essential in future dissemination of the results obtained in the present symposium. Finally, the chairs emphasized three directions inevitable for future post-harvest research: 1) re-evaluation of traditional foods (functionalities, safety etc.), 2) survey of diets including indigenous plants and minor crops, and 3) non-food use of agricultural products.

The symposium was concluded by the closing remarks delivered by Dr. Le Van To of PHTC, Vietnam.

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