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NEWSLETTER

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Japan International Research Center for Agricultural Sciences

For International Collaboration

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Contents

World Aquatic Foods and Activities of JIRCAS

Food production capacity of the hydrosphere

When seen from a spacecraft, the hydrosphere of the earth's surface appears as a beautiful blue region. It occupies 70% of the earth's surface and its deepest point is deeper than 10,000 meters. Therefore, the hydrosphere by far surpasses land in its capacity as a potential space where creatures could live. The world's oceanic region, however, despite its huge volumetric capacity, has a lower biological productive capacity than land due to its low nutrient content. As a potential place for food production, land provides cereal and other primary products that form the staple human diet. Unfortunately, it is difficult to utilize the hydrosphere's primary product, phytoplankton, as food. Instead, humans exclusively utilize fish, shellfish, and other higher-order products of the hydrosphere.

Trends in catch quantity

In 1999, the total catch of the world's fisheries reached 137 million tons. This amount was 1.3 times larger than that in 1990, with the increase being greater than the increase in production of cereal grains, which remained at the same level between 1990 and 1999. However, it is generally believed that the ocean's capacity to provide foods will probably run out in the near future. With respect to country-wise distribution of catch quantity in 1999, Japan landed 6.61 million tons, the third highest in the world. Japan's catch at one point was higher than any other country in the world, but it was ousted from its position by China in 1989. China, which landed 47.5 million tons, equivalent to about 35% of the world's entire catch in 1999, harvests more from the hydrosphere, by far, than any other country. Although some economists doubt China's catch statistics, the catch quantities, especially of the freshwater fisheries resources, are dramatically increasing, pushing up the world's total catch. Therefore, the inland water regions of the world are expected to become potential places for development of fisheries. Peru and Chile, South American countries where sardine is a major fisheries resource, landed 8.44 and 5.59 million tons, respectively, becoming the world's second and fifth highest ocean harvesters.

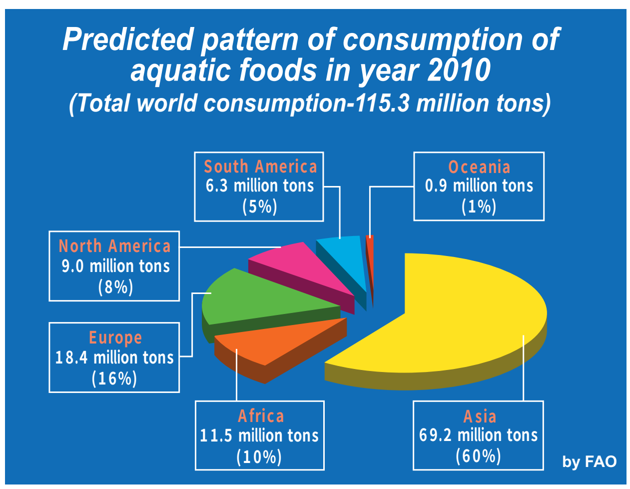
Predicted consumption of fishery products in year 2010 (FAO)

In year 2010, the world's population is expected to reach 7.03 billion. Accordingly, 100 to 120 million tons of aquatic food will be needed. Assuming that about 30% of the total catch is inedible, it is expected that there will be a shortfall of 10 to 40 million tons in aquatic foods. Japan and other Asian countries including China, India, Indonesia, the Philippines, and Thailand consume a particularly large amount of fish products. Various ichthyophagous cultures are now being practised in monsoon regions around Asia where the staple food is rice, while in European countries diets are mainly based on various meat products. Considering the significant increase in personal incomes of people in Asia in recent years, it is estimated that 69 million tons of aquatic foods will be needed around this region by year 2010. In other words, more than half of the world's fisheries products will be consumed in Asian countries (see figure).

Activities of JIRCAS Fisheries Division

In this context, the JIRCAS Fisheries Division is engaged in three international collaborative studies to secure fisheries products in Asia. The first is "Studies on sustainable production systems of aquatic animals in brackish mangrove areas," conducted in cooperation with the Philippines, Malaysia, and Thailand. This study aims to restore fisheries resources and develop the technology of environment-friendly aquaculture using natural nutrients and the environmental protection ability of brackish-water mangrove forests. The second study is "Elucidation of reproductive mechanisms in the giant freshwater prawn, and research aiming to improve prawn-rice farming systems in the Mekong Delta." This study is being conducted in cooperation with Vietnam, and is aiming at the establishment of freshwater prawn aquaculture systems combined with rice growing as part of the conventional complex agriculture in the Mekong Delta of Vietnam. The third study is entitled, "Development of technology for utilization of freshwater fisheries resources." This study is being carried out in cooperation with China, and is aiming at the development of techniques to manufacture frozen minced fish meat (SURIMI) and fishmeal from freshwater fish.

Yutaka Fukuda
Director, Fisheries Division, JIRCAS



Cover photo: A freshwater fish shop in Guangzhou, China. Sliced fish, covered in blood to demonstrate its freshness, is on sale, although freshwater fish is usually sold live in China. (Photo by Y. Fukuda)

Collaborative Research in Vietnam: Development of Farming Systems in the Mekong Delta Area

The Mekong Delta was formed about 10 thousand years ago at the mouth of the Mekong River. Covering roughly four million hectares, the region, except for small hills near the Cambodian border, is less than one m above sea level (Fig. 1). Large-scale flooding follows the rainy season and washes away damaging salt and acid sulfate, providing fresh fertile soil and fish. Depending on the topography, the Delta's soils range from alluvial to acid sulfate to saline. Houses line the banks of the well-developed canal network due to the high elevation and the convenience of waterway transportation (Fig. 2). In addition, ponds are also dug for stocking fish and as a source of soil with which to expand the farm area (Fig. 3).

In the region, the *doi moi* economic renovation program, initiated in the late 1980s, has contributed to rapid economic growth through further development of the traditional and unique agricultural VACR systems (a Vietnamese acronym standing for fruits and vegetables, aquaculture, livestock and rice). They combine fruit and vegetable cultivation, animal husbandry and aquaculture and contribute to sustainable agricultural management by cycling products through several stages of production in order to minimize waste while maximizing benefits.

The major objective of the five-year research project (1999-2003), titled: "Development of new technologies and their practice for sustainable farming systems in the Mekong Delta," is to promote agricultural practices that are not only economically profitable but also ecologically sustainable as farming systems. Research subjects included in the project comprise the development of technology for components of farming systems in the areas of rice, livestock, fruit and aquaculture production. The project also aims to develop and evaluate sustainable farming systems that employ technology for environmental conservation and VACR farming systems and put these technologies into practice through the establishment of model VACR farming and extension systems. For this purpose, the studies have been carried out in collaboration with Cantho University (CTU), Cuu Long Delta Rice Research Institute (CLRRI) and the Southern Fruit Research Institute (SOFRI). So far, in the project, studies for the development of techniques for the breeding of salt-tolerant varieties and development of integrated pest management in rice and rice-based farming systems have been carried out. In the livestock area, techniques for feeding management for pig production and pathological diagnosis of porcine diseases have been improved. A model orchard was established for the improvement of fruit production at the on-farm trial site and basic technology for prawn seed production has also been developed (Fig. 4). Development of methods for the assessment of nitrogen cycling is currently being promoted. In the socio-economic area, farming systems at the research site were classified and the cause-effect relationship of the technical and economic factors in farming systems was analyzed.

The annual Workshop of 2001 was held at CLRRI, Cantho, Vietnam, during the period of November 27 – 29, 2001, to review the results already obtained and to examine the future research direction of the project (Fig. 5). The next annual Workshop of 2002 will be held at the College of Agriculture, Cantho University in November 2002.

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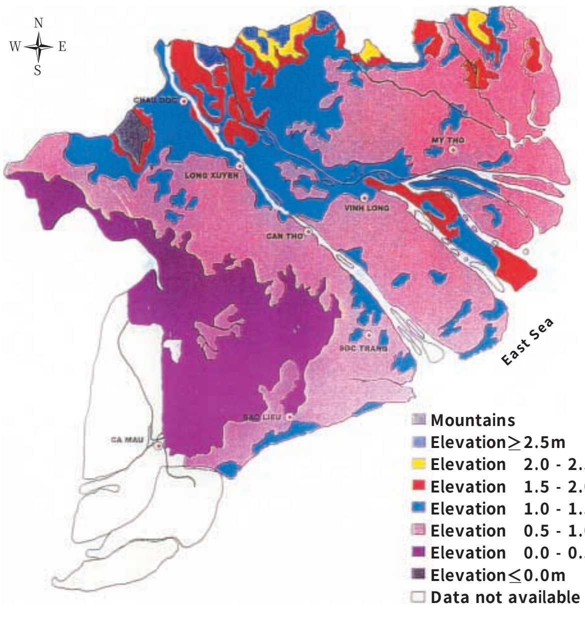

Fig. 1. Topology map of the Mekong Delta (Ministry of Irrigation, 1987).

Fig. 2. A typical farmer's house in the Mekong Delta with a pigsty and a fish pond.

Fig. 3. Farmer's fruit garden with a pond.

Fig. 4. Giant freshwater prawns being cultured at the Institute for Marine Aquaculture, Cantho University.

Fig. 5. The 2001 annual Workshop held at CLRRI, Cantho, Vietnam.

On-Farm Trial to Develop Agropastoral Systems in the Brazilian Savannas

Since 1996, JIRCAS has been implementing an international collaborative project with Brazilian Agricultural Research Corporation (EMBRAPA), for developing agropastoral systems (sustainable crop-pasture rotation systems) in the Brazilian savannas. As a part of the project, an on-farm trial to transfer the technologies and knowledge of the experimental stations to private farms has been conducted. Here, the process and results of the trial are introduced.

The Agricultural Training Center of National Federation of Japanese Immigrant Agricultural Cooperation (JATAK-ATC) was selected as the experimental site of the on-farm trial. JATAK-ATC is located in the Guatapara district of the San Paulo State, which is approximately 300 km northwest from Sao Paulo City. It consists of 570 ha of upland fields and 450 ha of wetland, and is playing an important role to demonstrate and diffuse the advanced agricultural technologies to the small or middle holders in the district. The aims of this study are (1) selection of forage species suitable for intensive grazing on the upland fields, (2) selection of forage species suitable for the wetland pasture, and (3) establishment of key technologies to develop sustainable agropastoral systems in JATAK-ATC.

When the on-farm trial was begun in 1997, most of the upland field area was utilized as sugar cane fields (Fig. 1). However, to avoid soil deterioration by mono-crop cultivation of sugar cane, JATAK increased the cultivated area of corn in 1998. The soil of the upland fields was an Oxisol, which had a very high sand content (80%), and low organic matter content (1.8%). Thus, an agropastoral system combining forage crops with sugar cane and corn seemed to be a good alternative to enhance soil fertility of the upland fields. Until 1997, *Brachiaria decumbens* was the only grass species planted in JATAK-ATC. It is known that *B. decumbens* has tolerance to low soil fertility, but its nutritive value is relatively low. Thus, a grazing experiment was conducted for two years, comparing *B. brizantha*, *B. dictyoneura*, and *Panicum maximum* with *B. decumbens*. Results of the experiment indicated that *B. brizantha* was most suitable for intensive grazing, from the points of view of dry matter productivity, forage quality and persistency of the pastures.

On the other hand, in the wetland, a drainage system was constructed between 1994 and 1997, and the drained areas have been utilized as native pastures. The number of

Grazing cattle on the wetland pasture during dry season.

animals of JATAK-ATC also increased from 197 heads in 1994 to approximately 1,000 heads in 2001. Since 1998, several field experiments have been conducted to select grass species to improve pasture productivity of the wetland. Flooding tolerance was compared between *Brachiaria decumbens*, *B. brizantha*, *B. humidicola*, *Andropogon gayanus*, *Paspalum atratum*, and *Cynodon dactylon*. Only *B. humidicola* and *P. atratum* could survive the flooding during the rainy seasons. In Central Brazil, the producer can buy seeds of *B. humidicola* more easily than *P. atratum*. Thus, *B. humidicol*a was considered to be the most suitable forage species for the wetland of JATAK-ATC. Moreover, results of the seeding experiments indicated that the suitable seeding period of the wetland was the beginning of the dry season when it became possible for a tractor to enter the wetland.

In the Guatapara district, 750 ha of the wetland owned by the small and middle holders remain unutilized. The pasture establishment technologies for *B. humidicola* tested in JATAK-ATC can be adopted by them. Results of this study also suggest that JATAK-ATC can develop sustainable agropastoral systems combining sugar cane and grain production and livestock production in future. Further research will be continued to improve the agricultural sustainability and to enhance the feeding resources of JATAK-ATC.

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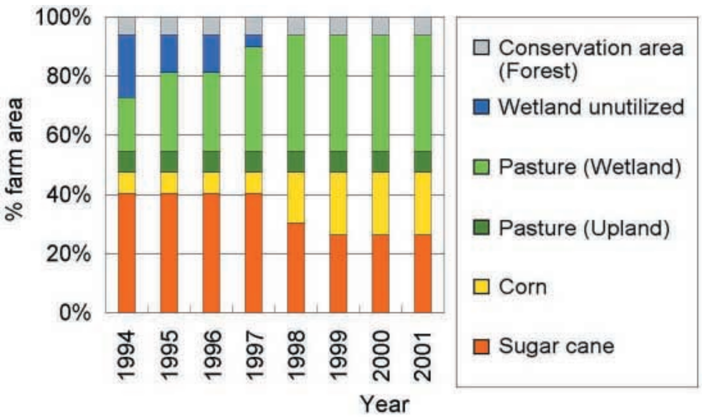

Fig. 1. Change of land use with time in the Agricultural Training Center of JATAK, the Guatapara district, San Paulo State.

Tagging of Leaf Rust Resistance Genes, *Lr34* and *Lr46*, Using Microsatellite Markers in Wheat

Leaf rust, caused by *Puccinia recondita* Roberge ex Desmaz f. sp. tritici Eriks. & E. Henn. is the most serious disease in wheat. Resistant cultivars are very important for sustainable wheat production in developing countries for economic and environmental reasons. Most of the leaf rust resistance genes identified are race-specific, and since they may be overcome by genetic shifts or new virulence in the pathogen population, durable resistance, that is, race-nonspecific and/or slow rusting genes, may be of primary interest to wheat breeders. This resistance may be expressed best at the adult plant stage as a quantitative trait.

Slow rusting genes have small effects, and hence are easily affected by environmental conditions and are difficult to identify due to their race-nonspecificity. Tagging these genes with molecular markers increases the efficiency of selecting leaf rust resistance and facilitates marker-assisted selection.

A doubled haploid (DH) population was produced from cv. Fukuho-komugi×cv. Oligoculm by means of wheat× maize crosses. A full genetic linkage map was constructed using various kinds of molecular markers, such as microsatellite, RFLP, RAPD etc. A framework map with 343 markers was used to perform QTL (quantitative trait loci) analysis for leaf rust resistance in this population. Leaf rust severity was scored at adult plant stage in the field for two seasons, 2000 and 2001, at Cd. Obregon, Sonora State, Mexico (Fig. 1).

Two chromosome regions, 7DS and 1BL, for the putative QTLs were detected by composite interval mapping (CIM) (Fig. 2). These QTLs were considered to be due to the effects of the known slow rusting genes, *Lr34* and *Lr46*, according to their positions. The QTL analysis also indicated that *Lr34* was derived from the Japanese cv. Fukuho-komugi, while *Lr46*, from the Israeli cv. Oligoculm. These QTLs explained about 40% and 26% of the total variation.

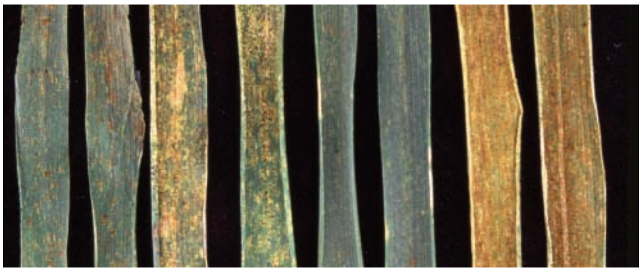

Fig. 1. Symptoms of leaf rust-infected leaves.
From left to right (two leaves each): Fukuho-komugi (*Lr34*), Oligoculm (*Lr46*), resistant and susceptible DH lines.

Microsatellite markers, *Xgwm295.1* and *Xwmc44*, were linked to these QTLs on 7DS and 1BL, respectively. When the population was classified according to the genotypes of these markers, the mean differences in leaf rust severity for *Xgwm295.1* and *Xwmc44* were 40.1% and 25.5%, respectively. The mean severity of the lines, whose genotype was resistant for both *Xgwm295.1* and *Xwmc44*, was 11.3%; this was 61.6% more resistant than the mean of susceptible lines (Table 1), and 19.9% more resistant than the overall mean. Moreover, genotyping using these molecular markers aids in discriminating the lines with *Lr34* and *Lr46* from those with only *Lr34*.

Lr34 and *Lr46* classified as slow rusting genes are widely used in CIMMYT (International Maize and Wheat Improvement Center) breeding program. The results indicated that the molecular markers used in this study facilitate the identification of *Lr34* and *Lr46*, and contribute to pyramiding of the leaf rust resistance genes in the breeding program.

This study was conducted as part of a collaborative program between Biological Resources Division, JIRCAS and Applied Biotechnology Center, CIMMYT from Jan. 1998 to Jan. 2002.

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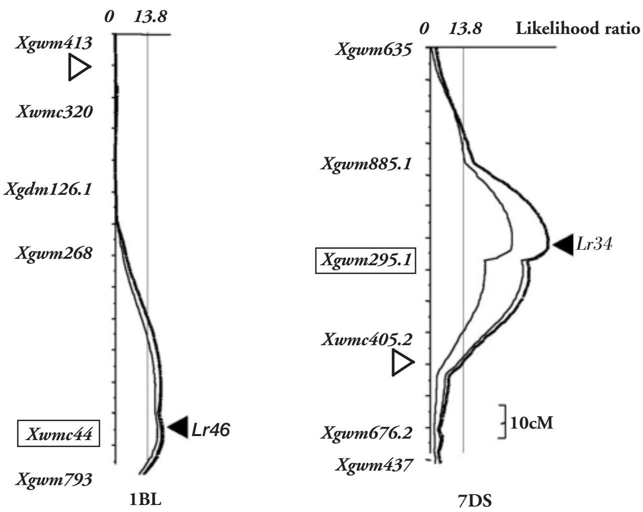

Fig. 2. Likelihood ratio (LR) contour by composite interval mapping for QTL detection of leaf rust severity on chromosome 1B long arm and 7D short arm. Bold contour indicates LR by joint analysis of data for the years 2000 and 2001. LR thresholds, equivalent to LOD=2.5, are 11.5 for a single year and 13.8 for joint analysis. Short arms are toward the top. ▷indicates centromere.

Table 1. Genotypic effects of flanking loci on leaf rust severity (%)

Locus	Genotype[a]	2000	2001	Mean	
Xgwm295.1	F	12.6	10.9	11.9	
(7DS)	O	57.1	46.6	52.1	
	dif.	-44.5	-35.7	-40.1	
Xwmc44	F	47.6	41.4	44.9	
(1BL)	O	23.2	16.8	19.5	
	dif.	24.4	24.6	25.5	
Xgwm295.1	F/O	12.6	10.1	11.3	a[b]
/Xwmc44	F/F	11.6	12.5	12.5	a
	O/O	32.8	25.6	30.2	b
	O/F	80.4	66.4	73.0	c
	dif.(FO vs. OF)	-67.8	-56.3	-61.6	

[a] F, O and dif. indicate Fukuho-komugi, Oligoculm and genotypic difference between F and O genotypes. F and O are resistant and susceptible for *Xgwm295.1*, and susceptible and resistant for *Xwmc44*, respectively.
[b] Mean values with different letters are significantly different (P<0.05).

"Value-Addition to Agricultural Produce and Products"

– Towards increase of farmers' income and vitalization of rural economy –

The 9th JIRCAS International Symposium on "Value-Addition to Agricultural Produce and Products" will be held October 16-17, 2002, in Tsukuba, Japan.

Background and Objectives

The current world population is about 6 billion and it is anticipated that the population will reach 7.5 billion and 8.0 billion by years 2020 and 2030, respectively, according to United Nations' World Population Prospects. Global food production should be increased so as to meet the demands of the rapidly increasing population, with the limited water resources and arable land. Therefore, the roles of rural areas where agriculture and food industry greatly contribute to the production of agricultural produce and products will become more important, from the point of food security. Agriculture is still the largest sector of rural economies, and a majority of the rural population is engaged in agriculture, in developing countries. The incomes of rural people are much lower than the urban ones, and the population has been shifting from the rural to the urban areas seeking better incomes and convenient daily-life. These trends will lead to the reduction of rural potential as a base for food supply and the increase of the poorest in slums in big cities. On the other hand, it is difficult for small-scale rural food companies to compete with big companies of the urban and developed countries. In considering these facts, we have to make efforts to give rural people and enterprises tools to increase their income by adding value to the commodities, in order that they may stay in the rural areas and continue to be engaged in agriculture and food production.

Changes in urban life-style as a result of the increased income and the increasing number of working women have resulted in increased consumers' demand for a more diversified diet, for processed and convenience foods and for animal products. When people overcome hunger, they become concerned about the quality and safety of what they eat. For example, they will avoid foods with contaminants such as pathogens, mycotoxins and pesticides, and prefer foods with physiological functions such as anti-carcinogenicity and anti-hypertension. It is important for rural farmers and enterprises to market products that meet the demands of urban consumers.

We dealt with postharvest losses of grains in the 5th JIRCAS Symposium in 1998, and then started a research project to reduce postharvest losses of grains in Southeast Asia. It is worthwhile to review the demands of urban consumers, the role of rural food industry and the related research activities in developing countries. For this purpose, we will invite distinguished experts from Japan and overseas, to discuss problems associated with ensuring high quality/safety of, and adding value to agricultural produce and products, and explore directions for research on these topics in developing countries.

For further information, please visit the website http://www.jircas.affrc.go.jp/sympo/, or contact:

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PEOPLE

Dr. Yutaka Fukuda, was appointed Director of the Fisheries Division on March 1, succeeding Dr. Masachika Maeda who has joined Miyazaki University as Professor in the Department of Environmental Sciences. Dr. Fukuda is a fisheries scientist and, prior to joining JIRCAS, was Director of Food Processing and Preservation Division at the National Research Institute of Fisheries Science (NRIFS). From 1996 to 2000, as senior scientist of JIRCAS, Dr. Fukuda conducted research on efficient utilization of freshwater resources at Shanghai Fisheries University, as part of a JIRCAS collaborative research project with China. (See page 2 for his Feature Article and photo)

Dr. Masa Iwanaga, Director of the Biological Resources Division at JIRCAS, has been appointed new Director General of the International Maize and Wheat Improvement Center (CIMMYT) and will join CIMMYT in July 2002. Dr. Iwanaga is the first Japanese scientist to become director of a CGIAR Center. He has said that he will "build on CIMMYT's strong mission to end hunger and poverty in the developing world through clearly focused research on maize and wheat." He added, "CIMMYT has an impressive record in improving the livelihoods of hundreds of millions of poor people, in rural as well as urban areas. My task is to ensure that CIMMYT continues to play a critical role in developing new knowledge and science-based technologies that will help farmers and consumers overcome malnutrition, improve their incomes, and move from subsistence into an economy marked by globalization and interdependence."

Dr. Iwanaga holds a MS degree from Kyoto University and Ph. D. in Plant Breeding and Plant Genetics from the University of Wisconsin, USA. He has more than two decades of research and management experience in international development. He had worked for IPGRI, CIAT, and CIP for about seven, three, and ten years, respectively, before he joined JIRCAS in April 2000.

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