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INTERNATIONAL COLLABORATION

JIRCAS 40th Anniversary

In This Issue

JIRCAS

Forty Years of Research Activities for Agricultural Development Aiming at the Eradication of Extreme Poverty and Hunger

Nature, which is one of the most definitive general scientific journals in the world, has carried many articles and reports on the present situation of hunger and malnutrition, food security, issues for the development of agricultural technology and effects of climate changes on agriculture in recent issues. These documents would be due to the "Annual Report for the United Nations Millennium Development Goals (MDGs)" published last June from the United Nations. Although the United Nations has fixed a goal to reduce by half the populations under extreme poverty and hunger by 2015, the populations in extreme poverty and hunger in many countries of Africa and South Asia are still increasing even now. The United Nations set up the accomplishment of the projects for the MDGs as the major subject of the Annual General Assembly (AGA) in 2010, and held the High Level Meeting just before the AGA.

The predecessor of the Japan International Research Center for Agricultural Sciences (JIRCAS), the Tropical Agricultural Research Center (TARC) was established in 1970 to develop agricultural technologies. Although most of the developing regions in Southeast Asia are blessed with good climate and soil conditions, agricultural productivity was considerably low. The collaborations to develop technologies adapted for developing regions in Southeast Asia between TARC staff and scientists, engineers, government officers and farmers in developing countries were performed in inadequate research facilities, inferior living conditions and also political instability. It should be noted that many excellent scientists and engineers who have contributed to taking huge steps toward achieving high agricultural productivities were encouraged through the collaborations.

Based on those activities, "Eradication of Extreme Poverty and Hunger", which is the first goal of the MDGs, has been cleared or nearly cleared in developing countries of Southeast Asia, as reported in the Annual Report of MDGs. We are proud that the activities of TARC and JIRCAS contributed to these accomplishments.

The prices of major crops have jumped up globally from 2007 to 2008 because of climate functions and also speculation in crops. Riots over shares of food have coursed in several countries in developing regions of

Africa and other areas. Under these scenarios, the Fourth Tokyo International Conference on African Development (TICAD IV) in Yokohama in May, the High Level Meeting of the United Nations Food and Agriculture Organization (FAO) in Rome in June, and the G8 Summit at Lake Toya in Hokkaido in July, 2008, were held, and expectation was expressed to promote agricultural technologies adaptable for the African Continent to advance agricultural productivity for agricultural scientists and engineers in developed countries.

The Coalition for African Rice Development (CARD) initiative, which is the international framework to double rice production in Sub-Saharan Africa, has been established in the TICAD IV. JIRCAS has joined as a member of CARD Steering Committee, and re-arranged a part of its ongoing research projects to contribute to the development of agricultural technologies adaptable to regional needs, climate, soil condition and rural communities in Africa based on the successful experiences in Southeast Asia.

We are now fixing the new mid-term plan for our activities, which will start from April 2011 for five years. Mitigation and adaptation of agricultural systems to global warming and activation of rural communities will be the focus as the central subjects. We are determined to promote sustainable and overall development of agriculture, forestry and fisheries in harmony with the ecological system from the upper reaches (forests) to the seacoasts.

Kenji Iiyama
President, JIRCAS

Unchanged Principle and Evolving Research Activities

Forty years have passed since the establishment of the Tropical Agriculture Research Center (TARC), which has since been reorganized into the Japan International Research Center for Agricultural Sciences (JIRCAS). The agricultural, forestry and fisheries industries both in and outside Japan have undergone major changes during this period. Let me review the principle of the center's activities at the time of its establishment, outline the changes made to the research system, and present an overview of the future prospects of JIRCAS' activities.

Problems solved by dispatching individual researchers

Increased and expanded overseas agricultural technical cooperation, which was propelled by the foundation of the Overseas Technical Cooperation Agency in 1962, formed the background to the establishment of TARC in 1970. It became clear that it was essential to conduct full-scale studies and collect knowledge about agriculture in target tropical and subtropical countries to which aid would be provided. After five years of discussions and preparation, TARC was founded. There were questions at that time as to whether Japan, which faced domestic farming issues, really needed to conduct research on agricultural technologies for overseas countries. Understanding was obtained on the importance of its missions, which included providing technical cooperation to developing regions and contributing to a secure food supply from those countries to Japan in the future; and the center was launched.

The center opened with 43 researchers. Each researcher investigated and solved one problem at a time in his or her field while staying at the research site in the tropical or subtropical region. Most researchers stayed on site for two to three years and sometimes longer. Several years after its establishment, the center began to employ a research system whereby a number of researchers with different specialties jointly sought solutions related to expanding agricultural development cooperation programs. In 1975, a division equipped with expertise in farm management was also created to undertake studies on the assembly of production technology systems.

In the 1980s, when the Cold War ended and food prices declined, the demand for agricultural development cooperation changed. The gap between beneficiaries, i.e. emergent industrialized regions and the least developed countries, expanded, leading to the diversification of the technological developments required in each region. To deal with the changes, the system for collecting information on the agricultural situation and research system in each region was enhanced, and a project study team system was established to achieve cooperation between on-site TARC researchers and those engaging in basic and supportive studies in Japan. The number of members gradually increased, and there were 106 researchers in 1993, which was twice the number at the time of foundation.

Establishment of JIRCAS and comprehensive projects

In the 1990s, the importance of dealing with environmental issues and realizing sustainable development was increasingly advocated by such bodies as the United Nations Conference on Environment and Development,etc. As a result, the need arose for the incorporation of interdisciplinary, broader-based and long-term viewpoints in agricultural, forestry and fisheries studies. Against this background, JIRCAS was established in 1993 to respond to requests for research cooperation by developing countries in areas other than the tropics and subtropics (such as the northeastern part of China, high-latitude areas in South America, and Central Asia), and to incorporate the fisheries field, which plays important roles in relation to food supply and maintaining ecosystems. Its organization was designed to cover all the special fields needed for enhancing cooperation with outside institutes; and a comprehensive project study system was introduced, which emphasized the creation of new technology by fusing individual study fields and socioeconomic points of view. Basic studies have also been conducted mainly in Japan, including biotechnology studies, to improve the technological standards of developing nations.

Comprehensive study projects were funded separately, and they gradually became the main activities of JIRCAS. Each project had distinctive characteristics, and new types of activity were undertaken. These activities included a brackish water project designed to understand the relationships between mangrove forests and aquatic ecosystems, which involved cooperation between forestry and fisheries, food resources projects in China, and aimed at organic cooperation on research activities in multiple fields in China and a soybean project in South America, which was conducted in three South American countries with the

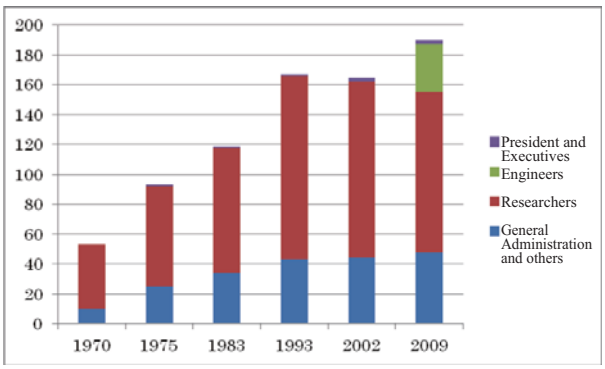

Fig. 1. Changes in the number of permanent employees at TARC-JIRCAS

goal of multi-country research cooperation.

JIRCAS has attached importance to deepening its relationship with international research centers of the Consultative Group on International Agricultural Research, Japan International Cooperation Agency and other organizations, and has dispatched its researchers to those organizations and promoted the use of research facilities of those organizations. These activities brought JIRCAS to the attention of the international community.

Autonomous mid-term research projects

In 2001, the government of Japan engaged in administrative reforms and reorganized many national research institutes, including JIRCAS, into incorporated administrative agencies. The reform allowed JIRCAS independence and autonomy as regards its project implementation. The First Mid-term Goals and Plans (FY 2001 - 2005) stressed the continuity of studies and followed the basic research plan of the center before the reorganization. In addition to the comprehensive projects, new individual projects were introduced, which are based on the long-term dispatch of researchers and aim to achieve results within a predetermined period.

At around the same time, the new Food, Agriculture and Rural Areas Basic Act (1999) was enacted, which clarified the status of agricultural technology cooperation in developing regions within the agricultural policies of Japan. The UN Millennium Development Goals (2000) advocated common goals for mankind, such as halving poverty and starvation. In 2003, the Agriculture, Forestry and Fisheries Research Council determined policies for promoting international agricultural studies as challenges for Japan aimed at solving food and environmental issues, and set forth a new concept of contributing to solving global issues by providing research results as global public goods. On the other hand, discussions were held on the relationship between international cooperation in the fields of agriculture, forestry and fisheries and competing domestic industries in Japan. Internal investigations (research strategies) were also performed on appropriate research activities that consider international situations and systems for making the best use of the advantages of being an independent institution; and the results suggested the need to promote studies by using project systems.

The Second Mid-term Goals and Plans (FY 2006 to 2010) were decided against this backdrop, and a system was set up in which almost all research activities are performed under the responsibility of project leaders. The introduced system involved defining goals for a given period, strictly controlling the schedule and accounts in each fiscal year, and assessing the study results. In 2008, JIRCAS took over the overseas agricultural operation of the former Japan Green Resources Agency, which enabled it to conduct in-situ verification surveys of study results and strengthened its capacity to deal with and solve problems encountered at the sites.

Directions of future activities

The agriculture, forestry and fisheries industries throughout the world have recently undergone further globalization and destabilization as manifested by the steep rise in food prices and the subsequent financial crisis between 2008 and 2009. New research topics include those related to measures to be taken by the agriculture, forestry and fisheries industries to cope with climate change and to protect biodiversity. Old problems, such as alleviating hunger and poverty and restoring water resources and degraded soil, have not yet been solved. In Japan, centers have been requested to operate more transparently and efficiently than before to showcase administrative innovation and to cope with deteriorated financial conditions. Centers engaged in research and development also have the duty to explain their activities to taxpayers and must aim at activities that are easy for people to understand.

The Third Mid-term Goals and Plans (FY 2011 to 2015) are being drafted so that they will clearly state the issues in developing regions to be handled by each project and the target contributions by establishing the following three programs to integrate research activities. The programs are based on the Basic Research Plan for Agriculture, Forestry and Fisheries decided by the Agriculture, Forestry and Fisheries Research Council in March 2010. These and the fourth program for collecting and providing information on the agricultural, forestry and fisheries industries, which is another operation undertaken by JIRCAS, will form a program-project system and enable more transparent and efficient research activities.

- Develop sustainable technologies for controlling soil, water and biological resources in developing regions
- Develop technologies for improving and stabilizing agricultural production and productivity in unstable tropical and other environments
- Develop technologies for increasing the income and improving the livelihood of people engaged in agriculture, forestry or fisheries and for revitalizing the economy of rural areas

JIRCAS experienced periods during which it dispatched individual researchers and introduced project studies, and it is now constructing a system connecting all its activities related to global agriculture, forestry and fisheries issues that can manifest the roles of JIRCAS in the most effective way. However, the principle that JIRCAS conducts joint studies in collaborations of equality and trust fostered by face-to-face human relations over a long period of time has not changed. We will continue our constant effort to find effective research methods.

Osamu Koyama
Director, Research Strategy Office
JIRCAS

Reorganizational Changes and Expansion of the Target Areas

Organization at the founding of the Tropical Agriculture Research Center (TARC)

In June 1970, the Tropical Agriculture Research Center (TARC) was established with its headquarters located at Nishigahara, Kita-ku, Tokyo. The principal objectives were 1) to develop necessary technologies for promoting agriculture and forestry in developing countries (the majority of which are located in the tropics and subtropics) for example, to increase food production, and 2) to contribute to the expansion of research areas of Japanese researchers (by conducting studies in the tropics to develop farming technologies for Japan). At the time of the establishment, the Center consisted of the Director, the Planning and Coordination Office, the General Affairs Section, the Accounting Section, the Research Division, and the Okinawa Branch (1 office, 2 sections, 1 division and 1 branch). Studies in TARC were conducted mainly in foreign countries by researchers who resided there over long periods.

The Okinawa Branch was first established within the campus of the Yaeyama Branch of the Ryuku Agricultural Experiment Station, Ishigaki Island. At that time, Okinawa had not yet been returned to Japan, and there were many difficulties encountered while trying to establish the Okinawa Branch. The principal aim of this branch was to promote the technologies of agriculture and forestry in the tropical and subtropical developing areas. This branch was also expected to contribute to the promotion of farming in Okinawa. After Okinawa had been returned to Japan, the branch moved to its present location in June 1975, where new facilities were built.

Start of comprehensive researches and transfer to Tsukuba

After its establishment, TARC conducted its studies by dispatching researchers to foreign countries. Recognizing the importance of conducting joint studies involving researchers with different specialties, we established the Research Coordinator positions in 1974 to coordinate interdisciplinary studies. From 1975, we started a research project named “Production Technology System Assembly Studies”, and the Research Division II was established to engage this project in Southeast Asia and Latin America.

The construction of Tsukuba Science City began in the early 1970s. TARC was the first research institute of the Ministry of Agriculture, Forestry and Fisheries (MAFF) to move to Tsukuba. The move started in 1975 and was completed in 1977. In 1983, the research institutes of MAFF were reorganized, and TARC moved within Tsukuba City to its present location.

Enhanced information analysis

When TARC moved to Tsukuba, there was no big change in its organization. In the late 1970s, the situations around developing countries changed significantly, such as the growth of ODA. To cope with these changes and enhance information collection and analysis, TARC established the Research Information Division in 1985. To enhance the basic studies needed to solve specific problems of developing countries, the Eco-physiology Research Division and the Marginal Land Research Division were established in 1987 and 1988, respectively. The former engaged in basic biological studies including those related

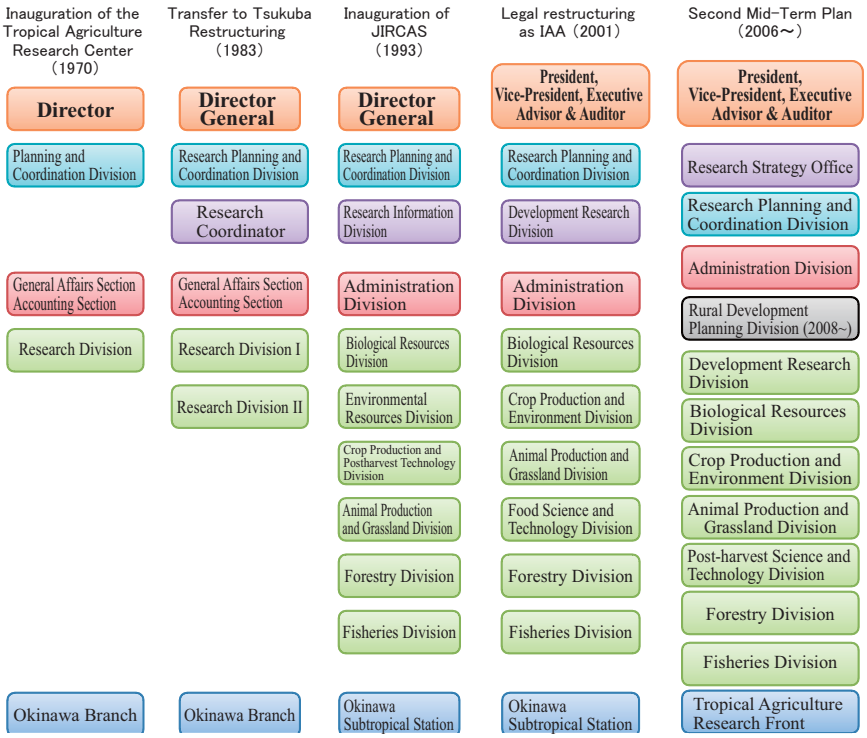

Fig. 1. Changes in the organization of TARC and JIRCAS

to animal diseases and mechanisms involved in drought tolerance of crop plants. The latter conducted studies related to soil preservation and agroforestry. Up to this period, most TARC researchers had resided abroad, but some basic studies were initiated mainly based in Japan to support the overseas research.

Reorganization into Japan International Research Center for Agricultural Sciences (JIRCAS)

In the 20 years that have passed since the establishment of TARC, circumstances surrounding global agriculture have changed drastically, including advanced globalization and the growing concern about environmental issues. Developing countries outside the tropics, such as those in Central Asia, emerged due to the dissolution of the Soviet Union. TARC had engaged in agricultural and forestry studies for developing countries in the tropics and subtropics. To respond to these new circumstances, the target areas of research were expanded to developing areas in and outside the tropics and subtropics, and TARC was reorganized into the Japan International Research Center for Agricultural Sciences (JIRCAS) in October 1993.

JIRCAS was composed of a President, a Research Planning and Coordination Division, an Administration Division, a Research Information Division, a Biological Resources Division, an Environmental Resources Division, a Crop Production and Postharvest Technology Division, an Animal Production and Grassland Division, a Forestry Division, a Fisheries Division, and the Okinawa Branch (9 divisions and 1 branch). The system was organized with a view to covering all fields of agriculture, forestry and fisheries in cooperative research, deepen specialist studies on issues characteristic of developing countries, promote joint studies and introduce social scientific approaches.

Reorganization into an independent administrative institution and today's JIRCAS

In 2001, almost all research institutes under the Ministry of Agriculture, Forestry and Fisheries, including JIRCAS, were reorganized into independent administrative agencies. The purpose of these agencies is to improve the efficiency in their works which do not need to be directly conducted by the national government but must be performed for the benefit of the public and cannot be directed to the private sector since it is not profitable. The institutions are given five-year mid-term goals by the ministers in charge, and undertake work following mid-term plans to achieve the goals. When JIRCAS became an independent administrative agency, it added some directors and auditors under the President, and reorganized the Research Information Division into the Development Research Division and the Environment Resources Division and the Crop Production and Postharvest Technology Division into the Crop Production and Environment Division and the Food Science and Technology Division, respectively, to enhance studies on post-harvest crops (9 divisions and 1 branch in total).

During the second mid-term period, which started in 2006, importance has been placed on interdisciplinary studies designed to solve problems in the developing countries. The research management system changed from the former discipline-oriented one to the project-oriented system. The Okinawa Branch was reorganized into the Tropical Agricultural Research Front to build an organization that focuses on project studies. To enhance the abilities to draw up project plans and on social science studies, the Research Strategy Office was established. Since 2006, the employees are not classified as government officials. In 2008, JIRCAS took over the overseas research work of the former Japan Green Resources Agency and established the Rural Development Planning Division.

In the forty years since the foundation of TARC, the importance of studies on agriculture, forestry and fisheries in developing regions has increased as an increasing number of serious issues have surfaced related to the global environment, starvation and poverty in developing areas, and food security in many countries, including Japan. The increasing importance has been reflected in the changes in organization, areas in which studies are conducted, and study fields. During its history, JIRCAS (formerly TARC) has always and characteristically employed a flexible system rather than a laboratory system. On the basis of this history, JIRCAS will continue fulfilling its missions by taking the importance of its role seriously, and also by giving full consideration to effective ways to respond to the expectations of Japanese citizens.

Makoto Nakatani
Director, Research Planning and Coordination Division
JIRCAS

Utilization and Dissemination of JIRCAS' Research Achievements

Every year in JIRCAS, the major research achievements are published as "Research Highlights" in its homepage (http://www.jircas.affrc.go.jp/index.html).

JIRCAS selected 18 subjects as "research subjects whose results are expected to be highly adaptable and can be disseminated to the research regions" from the Research Highlights (reported from Fiscal Year 2003 to 2007). Follow-up surveys were conducted on those 18 subjects. They were evaluated into rank A, B, and C according to the degree of practical uses.

The results of the evaluation were A: seven (7) subjects, B: eight (8) subjects and C: three (3) subjects.

As an example of a subject with an A rank, results of the "Improvement of feeding management and meat quality of pigs by using locally-available under-utilized feed resources in the Mekong Delta region of Vietnam" were utilized at 88% of the farmhouses guided by us in the Mekong Delta region.

On the subjects with B and C ranks, a factor such as the bottleneck of dissemination activities was analyzed.

Five outputs selected from the past research results will be described in the following pages of this newsletter. Some other new results will be explained in this article.

Fuel block technology in Mongolia

Mongolian nomads traditionally use the droppings of large livestock, aside from wood, as fuel materials. Likewise, the fuel block which is used by nomads was improved by mixing cattle dung and waste coal powder in the JIRCAS project. For the dissemination of this block, we have developed an extension system in which the government participates and has proven its effectiveness.

After the practical use of local resources in this system was evaluated, the system was introduced into the "FY 2009 Socio-Economic and Community Development Basic Plan" of Uvurkhangai Province. In the current fiscal year, the spread of fuel blocks has been advanced in 12 out of 18 soums (districts) of the province.

In the future, when the fuel block will be established as the alternative fuel of nomads, it will also become an effective measure for forest conservation (cf. JIRCAS Newsletter No.59, P.11).

Photo. 1. A letter of appreciation was bestowed by Thailand's Khon Kaen University

Feeding standard of beef cattle for the Indochinese peninsula

In the project, "Establishment of Feeding Standard of Beef Cattle and a Feed Database for the Indochinese Peninsula," the Thai version of the Feeding Standard for Beef Cattle was published in 2008 and the Thai version of Nutritional Examination Method Manual was also published in 2009. The English version of the Feeding Standard of Beef Cattle and a feed database for the Indochinese peninsula will be released in 2010. Dissemination of the beef cattle breeding technique is expected.

A letter of appreciation was bestowed by Thailand's Khon Kaen University to this collaborative research in 2010.

Pond water use planning tool for integrated farming

It is necessary for the carrying on of integrated farming that farmers should plan water use for several months in advance. This study has developed a water use planning tool for farmers in rainfed agricultural areas of Northeast Thailand who have no prior experience of integrated farming. The tool is a disk which is made of paper and written in Thai. Through this, the farmers can instantly get information about their pond capacity, water loss during the dry season due to evaporation, water consumption of each agricultural product, such as vegetables, cattle, etc.

A positive feedback of the tool has been obtained in monitoring evaluation of farmers, and the tool has just been started to be disseminated.

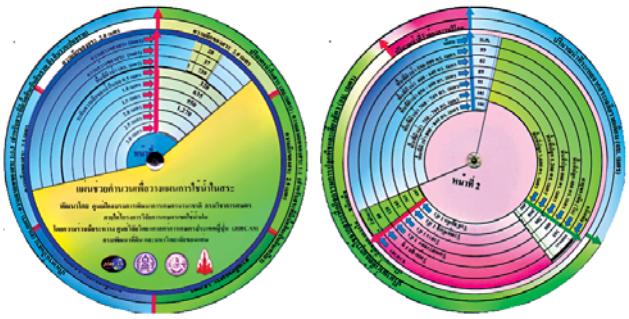

Fig. 1. Pond water use planning tool

Takeshi Kano
Research Planning and Coordination Division, JIRCAS

Breeding of Rice Varieties with Cold Tolerance, Blast Resistance and High-Yield Potential Using a Wide Diversity of Genetic Resources in Yunnan, China

The importance of crop genetic resources and diversity is increasingly gaining interest in the world. The 10th Conference of the Parties to the Convention on Biological Diversity, also known as COP 10, was held in Nagoya, Japan in October 2010. There is an increasing awareness of the importance of crop genetic resources to human well-being and of reaching broad agreement on the need to conserve these resources for use now and in the future.

New rice varieties

China's Yunnan province is a center for genetic diversity in Asian cultivated rice, *Oryza sativa* L. We conducted a collaborative research project for rice breeding using a wide diversity of genetic resources from Yunnan and Japan within 1982-1996. We released 15 varieties with cold tolerance, blast resistance and high quality in Yunnan. These varieties were named "Hexi", which means "a line developed by a joint project" in Chinese characters. The Hexi varieties showed much progress in high-yielding potential and yield stability in diverse environments in Yunnan and other provinces. In 2000, the total acreage of the Hexi varieties covered more than 200,000 ha, accounting for more than 20% of the total rice growing area in Yunnan.

Landraces with high tolerance to cool weather

The growing stage which is the most susceptible to cool temperature in rice is the booting stage (especially the young microspore stage), followed by the flowering stage. We found landraces with high tolerance to low temperature at both booting and flowering stages when rice plants were most sensitive. These landraces have been used for developing high yielding varieties with high tolerance to cool weather in China and Japan.

Diversity of biochemical properties of rice grains

We studied the biochemical properties of rice grains by using a wide diversity of genetic resources. The amylose content in endosperm starch is a major determinant of eating, cooking and processing qualities of rice grains. Yunnan upland rice exhibited the largest variation in amylose content among the varietal groups from Japan and China. Upland rice varieties with low amylose content are expected to be useful for the breeding of new varieties with improved eating quality.

Rice grain deterioration and the development of staleness during storage are serious problems that reduce quality. It is difficult for developing countries to construct temperature-controlled warehouses that would help ensure proper treatment of harvested rice. The lack of lipoxygenase enzyme in rice grains may reduce oxidative deterioration during storage. We screened Yunnan rice for lipoxigenase-3 content in embryos, and detected 22 varieties without lipoxigenase-3. These varieties have been used for breeding and biochemical studies.

Based on our experiences of the joint project in Yunnan, crop landraces will become breeding materials of the high-yielding, pest-resistant and well-adapted varieties which resulted in much increases in crop yields and quality. The genetic resources of crop landraces should be well utilized in efforts to solve today's food supply problems.

Kazuo Ise
Research Planning and Coordination Division, JIRCAS

Photo. 1. Rice cultivation in a basin near Kunming City, Yunnan. Rice plants belong to a new cultivar 'Hexi 35'. Hexi means "a line developed by a joint project." (Photo by Kazuo Ise)

Photo. 2. Yunnan landrace 'Lijiangxintuanheigu' showing high tolerance to cool weather conditions at flowering stage. (Photo by Kazuo Ise)

Technology Development for Double Cropping of Rice in the Muda Irrigation Scheme in Malaysia

JIRCAS' predecessor, the Tropical Agriculture Research Center (TARC) and JIRCAS have more than 30 years together of collaboration with Muda Agricultural Development Authority (MADA) in Malaysia since 1970 when TARC was founded as a research center for improving agriculture in developing countries in tropical regions.

The Muda Irrigation Scheme was the first full-scale rice double cropping system in Malaysia. It is located in the west coast of peninsular Malaysia with 96,000 ha of coverage area, and is the largest rice granary area in Malaysia. Pedu and Muda dams with 900 and 100 million m^3 of storage capacity and canal and drainage canal systems were constructed in the late 1960s with a loan from World Bank and it has been managed by MADA since 1970.

Many researchers from TARC have tackled the problems encountered in the sites and fields to stabilize double cropping of rice in the tropical monsoon areas where they only had previous experiences on rainfed rice before 1970. The number of researchers dispatched from TARC to MADA, who stayed for more than 2-3 years, reached almost 40 persons. Through the project-type research and owing to the effort and cooperation with TARC and MADA which was carried out for 30 years, the double cropping of rice was expanded successively throughout the Muda Irrigation Scheme. Some examples of their challenges are shown below.

Shortage of irrigation water in the 1st cropping season, from March to August, and outbreak and spread of the Rice Tungro Disease in the Muda area became very serious problems with the dissemination of the double cropping technique of rice. To solve the problems above, TARC researchers proposed the construction of a tertiary canal to store irrigation water which was low because of the long-distance involved in plot-to-plot irrigation and also advised the introduction of a fallow period for the month of February to stop the Tungro disease caused by year-round cultivation. MADA approved the proposal and implemented the construction of pilot tertiary canals in an irrigation block with an area of 800 ha. Furthermore, MADA compelled all farmers in the Muda area to stop cultivation for one month to serve as a fallow period. The social experiments carried out in the project have remedied the water shortage dramatically and also caused the disappearance of Tungro disease after the experiment.

With respect to their research contribution in the Muda scheme, two TARC researchers were awarded a decoration from the Sultan of Kedah State and the project was awarded the MAFF Minister's Award and the Ueno Award of the Japanese Society of Irrigation, Drainage and Rural Engineering (JSIDRE).

The direct seeding cultivation of rice has rapidly spread, replacing transplanting cultivation in the Muda area since the latter half of the 1980s due to labor shortages and rise in labor costs. The project on the production system under direct seeding has been carried out due to yield reduction under direct seeding caused mainly by the weed infestation and poor crop establishment. Five researchers with different disciplines in agronomy, weed science, water management, farm economy and farm machinery dispatched to MADA solved the issues under direct seeding and recommended a suitable standard of land leveling and field drainage to attain the target yield of 5 t/ha after finding proof through field experiments.

Photo. 1. Experiment on improvement of crop establishment by using a field ditch

Photo. 2. Land leveling experiment using tractors with rear buckets

Hideto Fujii

Crop Production and Environment Division, JIRCAS

Development of Prawn Culture Technology and Its Use On-site in Southeast Asia

In the Fisheries Division at JIRCAS, we are implementing basic physiological research on the mechanisms of molting and reproduction in commercially important species of prawns and shrimp. One of these species is the giant freshwater prawn, *Macrobrachium rosenbergii* (Photo 1). The giant freshwater prawn is cultured extensively throughout Southeast Asia, and particularly in Vietnam, the culture of this species is considered to bring about significant economic benefit to impoverished farmers who have traditionally grown this prawn in combination with rice culture. However, until the beginning of 2000, the supply of hatchery-reared *M. rosenbergii* depended on a few previously established national hatcheries, and was still far from being sufficient to meet the growing needs of commercial prawn culture.

Recognizing this problem as a major factor limiting the development of *M. rosenbergii* culture in the Mekong Delta, JIRCAS and Vietnam's Cantho University initiated collaborative research in 1995 in order to develop a more productive and sustainable seed production technology. Initial studies were conducted to determine whether the "green water" model, developed in Malaysia, could be suitable for use in the Mekong Delta, and whether the technology could be successfully transferred to local users. We firstly compared the "green water" model to another system of seed production, the "re-circulating water" model, and found that densities of 60 to 120 larvae per liter could be utilized in both models, but the "green water" model yielded more post-larvae (PL) per liter, varying from 27.8-41.7 PL/liter compared with 18.6-32.9 PL/liter for the "re-circulating water" model. Moreover, the "green water" model requires less labor, and is easier to implement in "back-yard" hatching facilities that are likely to be adopted by farmers engaging in prawn-rice culture.

Based on these results, we developed a modified static "green water system" suitable for the conditions of seed production in the Mekong Delta. In this system, super-saturated seawater from salt fields in the southernmost coastal parts of the Mekong Delta and freshwater are mixed in appropriate quantities to obtain the desired salinity concentration, and the water is treated for several days with chlorine. Next, in order to create "green water", tilapia are stocked for a week in a separate tank to create an environment where planktonic algae bloom and the water turns green; algal blooms serve as bio-agents that stabilize the environment within the culture tanks. *Chlorella* is obtained selectively by filtration, and the water is then transferred to tanks to be used for prawn seed production. After larval prawn hatch, they are reared for nearly 30 days without the exchange of water until they metamorphose into post-larvae.

Furthermore, in order to bolster prawn larvae survival rates, we also designed and evaluated different feeding diets. We found that larvae fed a custard diet formulated from chicken egg yolk, milk powder and squid oil provided the most satisfactory results in terms of survival rate and number of post-larvae produced per liter and could be further improved by the supplementation of vitamin C and lecithin. These results are now used in our standard methods of seed production.

Since the beginning of 2000, the "green water" model has been introduced to various users (including provincial authorities and the private sector), and the number of hatcheries and quantity of post-larvae produced rapidly increased. In fact, the production of post-larvae reached over eighty million by the end of 2001 or about 80-fold compared to the 1990s. As of mid-2002, the "green water" model has been transferred to a total of 90 hatcheries, both state-run and private, in different provinces of the Mekong Delta. Typical hatcheries utilize 10-40 cubic meters of rearing water based on the "green water" model (an example located in Cantho Province is shown in Photo 2).

The giant freshwater prawn is cultured in a variety of ways, but prawn-rice combined farming systems are considered especially important in raising impoverished farmers' standards of living. We believe that these newly-established hatcheries have contributed to meeting prawn seed demands for use in prawn-rice farming and other aquaculture systems in Vietnam, and have helped to promote the further development of this industry in Vietnam.

In addition to the above work in Vietnam, JIRCAS has engaged in cooperative research with International Mariculture Development Co. Ltd., the National Research Institute of Aquaculture of Japan's Fisheries Research Agency, and Higashimaru Co. Ltd., in the development of land-based re-circulating production systems for the whiteleg shrimp, *Litopenaeus vannamei*, a marine species. At present, the culture of *L. vannamei* is increasing at a rapid rate, and replacing that of the black tiger prawn, *Penaeus monodon*. The developed technology, the "Indoor Shrimp Production System" currently operates on a commercial basis in Myoko City, Niigata Prefecture. Because this technology minimizes the effects of culture on the environment and can be operated in any geographical location, it is considered to have much potential to contribute to the sustainability of the shrimp culture industry in Southeast Asia. We wish to give consideration to the issue of technology transfer in this regard in future endeavors.

Marcy Wilder
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Photo 1. The giant freshwater prawn, *Macrobrachium rosenbergii* (Photo by Marcy Wilder, at JIRCAS).

Photo 2. Dong Phat Hatchery in Cantho Province. This hatchery has a capacity of 40 m^3 and produces 3-4.5 million post-larvae per year (Photo by Marcy Wilder, in Catho Province, Vietnam).

Development of a Medium-Term Forecasting Model for the World Food Supply and Demand

It was another hot summer this year in Japan with the number of tropical days, those days where the air temperature is more than 30 degrees Celsius, reaching a record in Tokyo. It is believed that La Niña caused such an extreme weather pattern. La Niña is a decrease in sea-surface temperature in the eastern equatorial Pacific Ocean. There have been periods of La Niña since the olden days; however, global warming may affect changes in sea-surface temperature and is thought to lead to extreme weather conditions around the world. Analyses of the impacts of global warming on agriculture in developing countries where the farmers' infrastructure is vulnerable to extreme weather are of an urgent matter.

Impacts of changes in climatic variables on agricultural markets are analyzed using a modified version of the world food model named IFPSIM housed at JIRCAS. In this model, yields of crops, i.e., production per harvested area are affected by changes in temperature, rainfall, and technology (Fig. 1). Analyses of changes in productions of crops according to the socio-economic scenarios of IPCC are being conducted.

There are four main socio-economic scenarios, i.e., A1, B1, A2, and B2, established by IPCC. The A1 (A1B) scenario assumes that trade liberalization progresses and the economic growth rate is high while the population growth rate is low. The B1 scenario assumes that low CO2 emission energy technologies are developed, while the high economic growth rate and low population growth rate are same as those in A1 scenario. The A2 scenario assumes that trade, labor immigration, and technological transfer are restricted in each country. The B2 scenario assumes that clean energy technologies progresses; however, trade, labor immigration, and technological transfer are restricted and the economic and population growth rates are intermediate between B1 and A2 scenarios.

Let's see an example of the results of the analyses which use the world food model. Fig. 2 shows the production path of rice in China for each scenario. Production of rice in China will increase twenty million metric tons (mMT) in the next twenty years under the A2 scenario, while the production will remain unchanged for the next twenty years under the B2 scenario. Alternatively, production of rice in China will decrease 20 mMT and 10 mMT under A1B and B1 scenarios, respectively. The predicted values of temperature and rainfall are the outputs of Hadley Center (HadCM3) in this simulation; however, the production of rice in China is affected by the predicted values of GDP and population than the climate variables.

In addition to the baseline analyses of the results of the world food model, the variability analyses of productions and prices of agricultural products are conducted using a stochastic version of the world food model putting into consideration the geological correlations of temperature and rainfall. Furthermore, a world food model used for long-running analyses which can make outlooks of supply and demand of agricultural products within over a hundred years is being developed.

Jun Furuya

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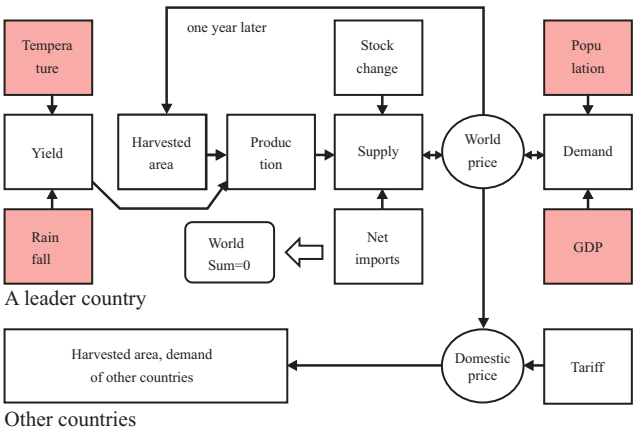

Fig. 1. Flowchart of crop sectors in the world food model

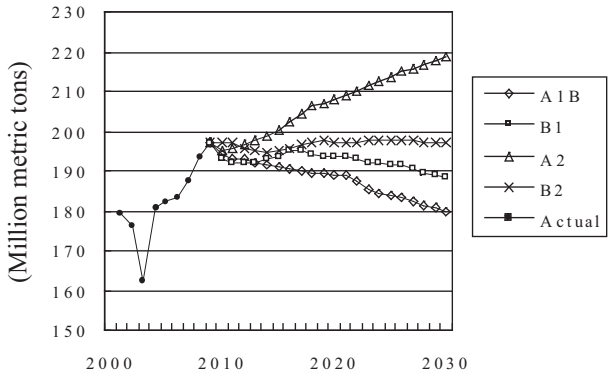

Fig. 2. Path of rice production in China according to the IPCC scenarios

Development of High-Yield, High-Starch Content Cassava Varieties in Thailand

Cassava is a root crop which accumulates starch in the tubers and grows up to about 2 m aboveground. It is widely cultivated in the tropics to produce starch because of its high productivity and stable growth even in arid and barren conditions where other crops cannot survive. Cassava is the fifth-largest source of starch in the world, following rice, wheat etc. The root and its starch are utilized in many different ways, including as food, feed and materials for industrial products.

In Thailand, cassava cultivation started in the 1970s. In the 1980s, the area under cultivation reached 1 million ha, and the annual production rose to 15 million tons. Along with the increase in production, JIRCAS has helped to develop new varieties that are better adapted to the growth environment in Thailand.

From 1980 to 1987, three researchers from TARC (now JIRCAS) worked at the Field Crops Research Institute of the Thai Ministry of Agriculture and Cooperatives to jointly breed new cassava varieties, assess their characteristics and improve cultivation methods. JIRCAS also cooperated with the cassava breeding program of the Centro Internacional de Agricultura Tropical (CIAT), particularly on the development of methods for selecting varieties, assessing cultivation methods and understanding physiological characteristics. JIRCAS determined the growth and physiological characteristics of early bulking of roots and branching type which are known to be related to the high yield and high starch content of superior varieties such as Rayong 60 and that are essential for breeding new varieties.

Superior varieties produced in Thailand, which contain a large amount of starch and provide high yields, include Rayong 3, Rayong 5, Rayong 60 and Rayong 90. Before the Rayong series was introduced, the mean yield of cassava in Thailand was only 13 to 15 t/ha, and the mean starch content was less than 20%. In and after 2000, when the cultivation of the Rayong series exceeded 50% of all cassava plants grown in Thailand and Rayong 60 and Rayong 90 were being actively spread, the mean yield increased to 23 t/ha and the starch content reached 23%. Today, the gross cassava production in Thailand is 30 million tons, which is the second largest in the world. The yield has increased substantially compared with the early 1980s, when the old varieties were grown. The development of new high-yielding, high-starch varieties and cultivation technologies has contributed to the improvement of the regional economy through a yield increase of at least 50%.

The results obtained in Thailand have been applied to breeding programs and cultivation technologies in Vietnam and China, where they have resulted in substantial increases in cultivation area and yield. The increased production of cassava in Asia is also attracting attention in relation to the production of bioethanol.

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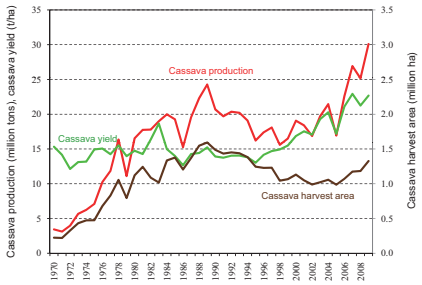

Fig. 1. Increase of cassava production in Thailand

Photo. 1. Cassava harvest in Thailand
(Photo by Naruo Matsumoto)

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