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Newsletter

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TARC Okinawa Branch Laboratories provide advanced facilities and experimental fields for subtropical agriculture research

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TARC
TROPICAL AGRICULTURE RESEARCH CENTER

Biotechnology as Diagnostic Tool for Tropical Agriculture Development

Nobuo Murata

"Knowing your enemy and knowing yourself you will never fail in hundreds wars. Not knowing your enemy but knowing yourself you may win a war but may lose another war. Not knowing your enemy nor yourself you will be endangered in every war you fight." So stated Sunwu, a famed philosopher and strategist of ancient China (380 to 320, BC). Knowing the subject to work with is of primary importance in the research for agricultural development as in the case of military strategy. Biotechnology offers very powerful tools for analysing, characterizing and identifying biological components. Tropical agriculture should benefit from this modern science.

The terms "modern" or "biotechnological indexing methods" usually refer to the nucleic acid hybridization-based assay or ELISA tests using monoclonal antibodies. Demands for such biotechnological assay methods can be illustrated in the following instances.

Necessity of improved crop propagation systems has been recognized in many tropical countries. In fact significant progress towards this objective has been achieved for specific crops in some countries, such as ornamental plants in Thailand and oil palm in Malaysia. In many instances of vegetative propagation, the elimination of viruses and other elusive pathogens from the stocks is important and often the indexing of these pathogens is a very crucial step where technical development is urgently needed.

The management of genetic resources is another topic which is currently attracting the attention of many tropical developing countries. One of the constraints is the lack of methods for indexing the genetic make-up as well as pathogens. In the management of germplasm of highly heterozygous vegetatively propagated crop plants, it is necessary to characterize the accessions in terms of phylogenetic relatedness to avoid duplication and to maintain the clones efficiently. Pathogen indexing is also required for the international exchange of germplasm.

In crop breeding for resistance to complex diseases due to the synergism of two or more pathogens, long latency or unstable symptoms, an assay of the disease using modern indexing tools can play a key role.

Sooner or later we will be faced with the necessity to use transgenic plants harboring useful exotic genes introduced by transformation as gene sources in the cross breeding of tropical crop plants. The identification of the genes of interest by biotechnological procedures will then be indispensable.

With the improvement of the infrastructure for agricultural research in the tropical countries as well as of the techniques themselves, the biotechnological assay methods are becoming accessible to many tropical developing countries. The International Institute of Tropical Agriculture (IITA) in Nigeria is shipping out ELISA plates coated with the antibodies for detecting viruses in cassava and other crops to African countries. Upon receiving the plates returned with the specimens to be tested, IITA carries out further procedures and provides the national institutions with the results of the tests. The International Potato Center (CIP) in Peru performs similar services by sending out test kits for the detection of potato spindle tuber viroid and some viruses using a nucleic acid hybridization-based assay. As a national research organization, the Malaysian Agricultural University has a group of researchers with a sound background of research in viruses infecting animals and plants. They are trying to adopt modern indexing methods. Restriction fragment length polymorphism (RFLP) and other methods of analysis of the genomic DNA structure of plants are becoming popular in national as well as international research centers.

As seen in these examples, we find that attempts have already been made in several tropical counties to utilize biotechnology with sound objectives, including indexing or diagnostic tools. To pursue this line of activities, however, many tropical countries require further international cooperation. Services being offered by IITA and CIP may pave the way for similar activities elsewhere. We should emphasize that these international centers rely on some other research institutions for the more fundamental part of technical development. Tri-, quadri- or multi-lateral research systems with one institution providing basic tools, the other transferring the techniques after standardization, the national centers, field stations, etc. as components may facilitate the task.

The Eco-Physiology Research Division is currently engaged in the development of a methodology to assay sweet potato viruses, rice yellow dwarf pathogen which is a kind of mycoplasma-like organism, and tropical rhizobia using biotechnological procedures. Analysis of potato mitochondrial genes and characterization of rumen microorganisms in the tropical ruminants are also underway. These studies may enable to develop the advanced indexing tools required for the development of tropical agriculture.

Through these cooperative research undertakings for the development of diagnostic or indexing tools, the up-grading of the infrastructure of the tropical countries for biotechnology in general may also be achieved in order to further promote international collaboration mutually beneficial.

Director, Ecophysiology Research Division TARC (since 1989)

Born in Osaka in 1933. Received Doctorate Degree from Kyoto University in plant breeding. Engaged in research in the Department of Genetics. National Institute of Agricultural Sciences (1957-1981), and in the Department of Molecular Biology, National Institute of Agrobiological Resources (1984-1986). Served as the First Officer, Plant Breeder and Geneticist, Plant Breeding and Genetics Section, Joint FAO/IAEA Division, Vienna (1986-1989). Major Research subjects: resistance to blast and bacterial leaf blight of rice, classification of bacterial plant pathogens in terms of DNA homology, conjugal gene transfer in Erwinia, Rhizobium and Agrobacterium species.

Dr. Hidaka of TARC Received Minister's Award

Dr. Terunobu Hidaka, Director of Research Division I, TARC was chosen as a recipient of Agriculture Minister's Merit Award of 1990. Dr. Hidaka joined TARC in 1970 as an inaugurating staff member and was dispatched to Thailand. His studies in collaboration with Dept. of Agriculture resulted in the extensive research findings on physiology and ecology of the rice gall midge, a major insect pest of tropical rice. The results obtained led to the integrated rice plant protection system against the damage caused by the rice gall midge in tropical Asia and greatly contributed to the stabilization of rice production. The introduction of resistant rice varieties and the action mechanism of natural enemies were also studied. Following his eight years of work in Thailand, he served as JICA Senior Expert of Food Crop Protection Project with Dept. of Agriculture of Indonesia and contributed to the establishment of nation-wide early warning systems for crop protection.

TARC's Collaboration with International Agriculture Research Institutions

Advisor to TARC, Ken-ichi Hayashi

1. Global future problems

Statistics and estimates, both national and global, clearly indicate that continuous efforts are further needed to meet the demand for food of the ever-increasing population, particularly in developing countries. Income growth will be the second factor affecting the food demand in developing countries, bringing an increase in food consumption and also a shift in diets from staple grains to a larger intake of livestock products and vegetables. Urbanization will be the third factor, causing a similar shift from coarse grains, root and tuber crops to high-value cereals such as rice and wheat, livestock products and vegetables. In addition, urbanization will also create problems such as shortage of labor in rural communities, reduction of land area for food production and worsening of pollution in agricultural lands by industrial and urban wastes.

Agricultural research priorities in the past have generally focused on the role of agriculture in food supply, which will certainly continue to be important for the foreseeable future. However, agriculture also makes many other contributions which must be stressed in connection to the above-mentioned future problems. These may include alleviation of malnutrition and poverty, sustainability and conservation of natural resources, etc. Furthermore, there is another category of factors also altering future research priorities, including changes in science such as development of biotechnology and involvement of private sector and evolution of scientific capacity in developing countries.

All of the foregoing introductory remarks intend to indicate fundamental and long-term problems which should be considered in promoting agricultural research activities at the international level.

2. International Agricultural Research Systems

Nowadays, international agricultural research systems involve various types of activities and institutions. International Agricultural Research Centers (IARCs) of the Consultative Group on International Agricultural Research (CGIAR) are certainly one of them. There is another group of institutions not associated directly with the CGIAR, such as International Irrigation Management Institute (IIMI), International Center of Insect Physiology and Ecology (ICIPE), Asian Vegetable Research and Development Center (AVRDC), etc. The third group which includes institutions funded mainly by the national budget, still conducts collaborative research at the international level, such as Australian Center for International Agricultural Research (ACIAR), Royal Tropical Research Institute (RTRI) in the Netherlands, etc. Tropical Agriculture Research Center (TARC) of Japan appears to belong to this third group.

All of these international or internationally-oriented institutions formulate basic principles determining their own objectives and features. An example for IARCs of CGIAR includes the following basic principles focusing on developing countries; research and research-related activities; production of food, feed, forestry and fisheries, commodities; international applicability and access; long-term sustainability; and finally improvement of nutrition and well-being of low-income people. These principles seem to be basically acceptable to TARC, although there have been and will be certain changes and expansion in TARC's mandate activities, It is in this context that collaborative research between TARC and the international agricultural research institutions was initiated, is being carried out and will further be strengthened.

3. Scientific basis for collaboration

In summing-up the foregoing discussions and in identifying further needs, there will be two important future directions - one is to deepen basic research on commodities and their use, and the other is to strengthen agro-ecological research on sustainability and resource preservation. These directions would also give a reasonably solid basis for evaluating scientific validity and operational relevance for any research initiatives on agriculture, forestry and fisheries of international nature. Recent information from TARC indicates the successful development of collaborative research with seven IARCs out of a total of 23 partners. In addition, there will be further opportunities to initiate collaborative research with international research institutions of the second and the third group, particularly since TARC plans to expand research areas such as ecophysiology, biotechnology and agro-environmental resources.

It is now commonly and strongly required not only for TARC but also for all international research institutions to improve their knowledge and techniques and to deepen their scientific capabilities for solving the problems from more basic and intrinsic angles. However, this does not imply that on-farm or field-level studies are not important. They are equally important and very often even more difficult to conduct and to analyse. TARC's collaboration with international research institutions could become very fruitful particularly when it contributes to solving the problems at the field-level, since TARC's main objective is to conduct research for the development of technologies pertaining to agriculture and forestry in the tropics and subtropics.

Thus, a judicious choice of the international partner for TARC should be made in taking into consideration of the interlinking and feedback between the research divisions pursuing different activities within TARC. Alternatively, some international institutions can be selected when target subjects are most efficiently pursued there rather than in any particular country.

It appears that what is more important for TARC is to define basic principles and to offer a flexible response on the basis of global agricultural problems and scientific research imperatives, rather than simply contemplating tentative partners. Above all, it should be emphasized that the future development of TARC depends, neither on statements on the desk nor on long comments from outsiders, but on the scientific initiative generated through the researchers and supporting staff members of TARC today.

Dr. Ken-ichi Hayashi, Advisor to TARC. Graduated from Dept. of Agriculture, Tokyo University (1953), joined MAFF at Hokuriku Agr. Exp. Sta. and at the National Inst. of Agr'l Sciences. Research on rice, wheat and barley breeding, plant genetic resources and crop physiology (1954-77). Visiting scientist for growth analysis at Rothamsted Exp. Sta. UK (1962-63). FAO Regional Rice Improvement Officer and Executive Secretary to International Rice Commission at Bangkok (1970-73). Research Coordinator on crop breeding and green energy programme at the Research Council, MAFF (1977-79). Joined TARC and became successively Director of two Divisions and DG (1976-86), then became DG of National Inst. of Agrobiological Resources (1986-89). CIAT Board Member (1985-88) and Member of Technical Advisory Committee (TAC) of CGIAR (since 1988).

Dr. Murata of TARC for IBPGR Board

International Board of Plant Genetic Resources (IBPGR, Hqs. in Rome) nominated Dr. Nobuo Murata, Director of Ecophysiology Research Division, TARC as a IBPGR Board Member, effective 28 February 1991, for a 3 year term. He will replace the outgoing Board Member from Japan, Prof. Fumio Kikuchi of Tsukuba University.

《Breeding》

Development of Wide-Compatibility Rice Line, Norin PL 9.

H. Araki, H. Ikehashi, K. Toya and S. Matsumoto

Indica varieties are now important genetic resources in the rice breeding program of Japan. Several Indica varieties are being extensively used for crossing with Japonica varieties at agricultural experiment stations. However, Indica-Japonica cross breeding is hampered in its efficiency due to several difficulties. One of the serious problems relates to hybrid sterility. It is well known that the F_1 plants between Indica and Japonica varieties show a low fertility and segregate a wide range of semi-sterile plants in their successive generations.

Past studies on cultivated rice showed that several specific varieties had provided a high F_1 fertility in their crosses to Indica as well as to Japonica. In this connection, Ikehashi emphasized the need for systematic screening and utilization of varieties which have a wide-compatibility(WC) to overcome the sterility problem observed in the remote crosses.

During the period 1981 to 1985, a genetic study on hybrid compatibility was conducted at the Okinawa Branch, with emphasis placed on the analysis of the genetic behavior of WC and hybrid sterility. In the course of implementation of that genetic study, Norin PL 9 was developed as one of the WC materials.

Norin PL 9 was selected from the cross, Akihikari/Nihonmasari/Ketan Nangka. The breeding objective was to develop early maturing Japonica lines with a WC and short stature. The source of WC is Ketan Nangka(KN), a tall and late maturing Indonesian variety. Akihikari and Nihonmasari are typical Japonica varieties with a short stature and early maturing.

Spikelet fertility of the F_1 hybrids between Norin PL 9 and several Indica varieties ranged from 80 to 90%, suggesting that these F_1 show obviously a higher spikelet fertility than in the case of standard Indica-Japonica crossing.

Norin PL 9 shows a Japonica-like plant type in terms of major agronomic characteristics. The agronomic characters such as heading time, stature and ear length of Norin PL 9 are similar to those of Toyonishiki, which was a leading variety in Okinawa Prefecture in 1986.

Results of yield trials indicate that Norin PL 9 has a high yielding ability close to that of Toyonishiki and Akihikari.

Norin PL 9 has a deep purple apiculus transferred from KN. Since this apiculus color is closely linked genetically with the WC gene, it is a useful trait for indirect selection of the WC in the breeding program.

It is anticipated that the WC varieties, including Norin PL 9, will contribute to the rice breeding program, especially Indica-Japonica cross-breeding, by means of their broad capability of overcoming sterility problems caused by remote crossing.

Fertility of F_2 Populations Drived from the Crosses between Norin PL 9 and Indica/Japonica Varieties

Cross Combination	Mean Fertility	Plants of More than 80% of Fertility	Experiment Station
Norin PL 9/IR 36	71.8%	32%	TARC Okinawa
IR 36/Akihikari	56.4	10	
Norin PL 9/IR 36	86.3	72	NARC* Tsukuba
IR 36/Akihikari	72.6	43	

IR 36: Indica Akihikari: Japonica *Nat'l Agr. Research Center

New winged bean cultivar 'Urizun' developed in Okinawa (Photo by Okinawa Branch)

《Breeding》

New Winged Bean Cultivar 'Urizun'

M. Noguchi, H. Nakamura and J. Abe

As a result of various studies on the adaptability and yield potential of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) carried out since the 1970's, this crop has been found to be a productive legume resistant to pests and diseases in the tropics. Therefore, if winged bean with low or without sensitivity to photoperiod could be obtained, it may become a promising summer season vegetable in the subtropics of Japan. In that region, green vegetables with good quality are hardly produced due to the severity of pest attacks, high temperature, strong solar radiation and frequent occurrence of typhoons.

At first we carried out a varietal evaluation using 44 accessions collected from eight countries at the Okinawa Branch of the Tropical Agriculture Research Center during a two year period since 1983. Four early flowering accessions, that is, Ishigaki-1, -2, -3 and -4 were selected. We then carried out field trials to determine the plant response to photoperiod and temperature together with productivity. In addition to such field performance we examined the trypsin inhibitor activity, nitrogen fixing ability and resistance to root knot nematodes of the selections. A new cultivar 'Urizun' (syn. Ishigaki-1) was eventually registered in 1986 as winged bean Norin No.1.

Since 'Urizun' originated from a day-length insensitive mutant of a Malaysian variety. 'M-13-1', it can flower whenever the air temperature is above 20°C, that is, any time except in January and February in the subtropics of Japan.

The characteristics of this cultivar are as follows:

The growth type is indeterminate, number of branches is large, plant height is medium and color of stem is green. The petiole is short, leaflet is small, leaflet shape is ovate and leaflet-margin is entire. The corolla color is light blue, pod length is short, color of young pod and wing is green, pod shape in cross-section is flat, texture of pod surface is smooth and number of seeds per pod is medium. The seed is small, seed shape is oval, seed color is light brown, hilum color is white and seed surface is smooth. Time of harvest is early, grain yield is high and number of flowers per cluster is medium. The growth under cold temperature is poor and resistance to virus diseases is low. Time of tuber harvest is early and size of tuber is large.

'Urizun' cultivar produces edible young pods of 10 to 13 cm in length and 7 to 10 g in weight. In the spring culture, young pod production in summer is stable and peak of harvest is observed from August to September. Total young pod yield ranges from 1.0 to 3.1 ton per 10a.

Optimum temperature for growth is above 20°C. At about 16°C, shoot growth is interrupted and the incidence of bud increases. Top of plant dies under the climatic conditions in winter in the subtropics, but in spring young shoots regenerate from the stem near the ground with the rise of the temperature.

For cultivation, chemical fertilizers are not generally applied but the soil acidity should be adjusted to a pH(H_2O) of about 6.5 and compost is supplied. The damage caused by insects and diseases is not severe.

The young pods contain nutritive components similar to those of the young pod of kidney bean (*Phaseolus vulgaris* L.). After harvest, the young pods can be preserved for a long period of time at room temperature by putting them in a black polyvinyl bag to prevent water loss. The taste of the young pods is nice after cooking.

≪Forestry≫

Estimation of Drought Resistance Relating to Survival of Tropical Trees

Nobuyuki Tanaka, Kiyoshi Nakashima and Roberto V. Dalmacio

Information on the ecophysiological characteristics of component tree species which is essential for the design of rational reforestation and agroforestry systems in the tropics is scarce. Among the environmental factors, water is most important as it affects the establishment and growth of tree species. Especially drought in the dry season is the main factor preventing the establishment of seedlings planted or germinated in an area with a tropical monsoon climate. Unless the seedlings are able to survive during the dry season, reforestation and agroforestry schemes will not succeed. In this study we analyzed the drought resistance of leaves and seedlings of 15 tropical trees and discussed the relationship among the drought resistance, leaf morphology and ecological characteristics of tree species.

Specific survival time is an index of drought resistance directly related to plant survival. Specific survival time which is computed from the values of cuticular transpiration (*Ec*) and available water (*Wav*) in the plant refers to the duration between the time of stomatal closure and the appearance of the first signs of desiccation injury.

$$\text{Specific survival time} = \frac{Wav}{Ec}$$

Persistence of leaves in drought-tolerant Acacia auriculiformis trees during the dry season. (Photo by N. Tanaka)

Specific survival time of leaves cut from various tree species.

Species	Specific survival time (h)
Shorea almon	0.43
Gliricidia sepium	0.88
Shorea polysperma	1.25
Anisoptera thurifera	2.15
Shorea contorta	2.27
Gmelina arborea	2.54
Tectona grandis	2.76
Eucalyptus deglupta	3.34
Dipterocarpus gracilis	3.37
Hopea foxworthyi	5.18
Swietenia macrophylla	5.20
Parashorea malaanonan	5.55
Acacia mangium	6.82
Acacia auriculiformis	7.57
Vatica Mangachapoi	11.06

Survival time is measured in hours and indicates how long after stomatal closure the leaves of a plant species can remain intact without supply of water, for a given evaporative value of the air. We determined the critical relative water content of leaves to estimate the content of available water by using leaves dried at different rates. We determined the transpiration rate and water deficit amount at stomatal closure by a gravimetric method. We conducted similar experiments for whole seedlings of *Acacia auriculiformis* to estimate the degree of the overall drought resistance. In addition, we observed the morphology of leaf sections, using a microscope and micrometer.

Among the 15 species exmined, the survival time was shorter than 3 hours in *Shorea almon, Gliricidia sepium, S. polysperma, Anisoptera thurifera, Shorea contorta, Gmelina arborea* and *Tectona grandis*. It was longer than 6 hours in *Acacia mangium, A. auriculiformis* and *Vatica mangachapoi*.

The group of species with a short survival time included deciduous reforestation species (*G. sepium, G. arborea and T. grandis*) and evergreen dipterocarp species. These deciduous species for reforestation shed leaves partially or completely during the dry season. The fall of leaves is an effective way of reducing the transpiring surface to avoid drought stress. It appears that the deciduous species for reforestation can survive in the dry season due to leaf fall. On the other hand, the evergreen dipterocarp species cannot be used as reforestation species for bare land. They may be damaged or killed by drought during the dry season.

The species with a long survival time consisted of evergreen trees. Since the leaves show a high drought resistance, these species can retain most of their leaves even during the dry season.

Since the measurements involved only leaves, this method does not measure the overall drought resistance of whole plants. It is known that the drought resistance of whole plants is affected by the water reserves in plant and drought tolerance of non-assimilating organs as well as drought resistance of leaves. The survival time calculated for whole seedlings of *A. auriculiformis* was 2.5 times longer than that of leaves. The longer survival time of whole seedlings is attributed to their larger water reserves.

Based on the morphology of the leaf sections, it appeared that there was a close relation between the leaf thickness and critical relative water content. Namely, thicker leaves tended to be more tolerant to the water deficit.

In conclusion, to evaluate the survival ability of tree species under dry conditions, information on drought resistance of leaves as well as leaf phenology, drought tolerance of non-assimilating organs, water reserves and water-absorbing ability from soil is essential.

TARC International Symposium 1990
Soil constraints on Sustainable Plant Production in the Tropics

Dr. Bartman of TARC summarizing Symposium debates on the sustainability issues for Proceedings

The 24th International Symposium on Tropical Agricultural Research sponsored and organized by TARC took place at Kyoto International Conference Hall under quasi-tropical conditions during the period August 14-16 1990, in conjunction with the 14th International Congress of Soil Science(ICSS).

Dr. S. Tsuru, the Director General of TARC gave the inaugural address while Mr. T. Sugimoto, Deputy Director General, Secretariat of the Agriculture, Forestry and Fisheries Research Council welcomed all the participants. During the Symposium, 7 country reports and 10 technical reports were presented followed by a general discussion. The closing remarks were delivered by Dr. S. Sekiya, Chairman of the Organizing Committee of the TARC Int'l Symposium. About 140 participants from 31 countries including 61 Japanese attended the Symposium.

In the country reports, the delegates from China, Malaysia, India, Indonesia, Sri Lanka, Thailand and Japan described the soil constraints on sustainable plant production and measures taken to alleviate the constraints in the respective countries.

In the technical reports, the delegates from ICARDA, IITA, ILCA and CIAT outlined major soil constraints and sustainable systems of land utilization implemented in West Asia and North Africa, West Africa, sub-Saharan Africa, and South America, respectively. The ICRAF delegate emphasized the beneficial role of agroforestry systems in the preservation of soil fertility in the tropics. The five technical reports presented by the Japanese delegates covered the following topics: 1) Development of an economical system of fertilizer application(macro-pellets) for the introduction of legumes on Oxisols in the pastures of the Llanos Orientales of Colombia; 2) Nutritional factors limiting crop growth in tropical peat soils; 3) Improvement of the productivity of Alfisols and Vertisols in the Indian Semi-Arid Tropics through cropping systems based on legumes (pigeon pea and chick pea); 4) Improvement of the productivity of Ultisols in Thailand by long-term application of organic matter and 5) Alleviation of soil salinity in sandy soils of Northeast Thailand through the planting of eucalyptus trees.

In the first part of the general discussion an animated debate took place on the definition of sustainability. It was eventually agreed that a balance should be struck between the need for promoting agricultural production while realizing the importance of preserving natural environmental resources such as soil, water and vegetation.

In the second part, the physical and biological constraints on sustainable plant production in the various agro-ecological zones of the tropics as well as the measures adopted to mitigate them were indicated. In the arid region, it was considered that erosion control and conservation of the natural vegetation in grazing lands were essential. Agroforestry and crop rotation were recommended for land use. In the humid and sub-humid regions, the main constraints included acid poor soils, high biotic stress, deforestation and soil erosion. It was suggested that minimum tillage systems or proper crop residue management, *ie.* conservation farming could help alleviate the constraints in addition to the promotion of plant adaptation through manipulation by biotechnological procedures. In the lowland and wetland areas, it was indicated that although rice-based cropping systems may afford sustainability, recently, a yield decline presumably associated with nutrient loss and depletion of organic matter has been recognized.

In the 14th ICSS, 45 symposia (298 presentations) involving current topics on "Global soil changes and their dynamics in a changing environment" and 44 poster sessions (675) were held during the period August 12-18. Four symposia and three poster sessions relevant to tropical soils were also organized. The titles of the former were "Soil management for sustainable agriculture in the tropics" (5); "Occurrence, structure and properties of soil minerals in the tropics" (7); "Soil biota in tropical soil ecosystems" (3); and "Salt-affected soils and effective methods of their utilization under different ecological/environmental conditions" (8). The titles of the latter were "Soil management for sustainable agriculture in the tropics" (26); "Methods of utilization of salt-affected soils" (8); and "Mineralogy and properties of soils in the tropics"(11).

(Hisao Watanbe)

(continued from p. 7)

those causing Fusarium wilt of cucumber which occur frequently in association with continuous cropping of vegetables, incidence and ecology of mulberry rust which causes serious damage in the Ryukyu Islands, distribution of the virus strain SCMV-H which causes sugarcane mosaic disease.

Insect pests: The development of mass-rearing methods for the melon fly(*Dacus cucurbitae*) as well as methods for estimating the density of the population of the insect are being improved in collaboration with the eradication operations conducted by the authorities of Okinawa Prefecture through the release of sterile insects. In addition, the ecology of strains of wireworms (*Melanotus tamsuyensis*) which impair the production of ratoons in sugarcane, and leaf-footed plant bug (*Leptoglossus australis*) which is widely distributed in the tropical and subtropical zone and is a pest of various economic crops, especially cucurbits, citrus and passion fruit have been defined. In addition the flight movement in the Okinawa region and the outbreaks of rice plant-hoppers and grass leafrollers are being investigated.

(6) *Preservation of soil fertility in the subtropics* – Experiments on continuous cropping with the inclusion of Napier grass which produces large amounts of dry matter are carried out in order to preserve soil fertility by the restoration of organic matter to the soil to enable the cultivation of sugarcane and pineapple which are the main crops of the region. The effect of the application of coral sand for the improvement of acid soils which are widely distributed in the tropics and subtropics has been evaluated. It could be demonstrated that since coral sand particles are coarse, a large amount of this material can be applied at a time and that the effect of soil acidity improvement can be maintained over a long period of time. On the other hand, with a view to making the best use of local resources, experiments on the preservation of soil fertility are being carried out through the utilization of legume crops as green manure and unexploited organic matters as compost. In addition, the natural abundance of micro-elements in the problem soils distributed in the subtropical zone is being determined to develop methods of soil fertilization and management suitable for the crops cultivated on these soils.

OKINAWA BRANCH
Laboratories

Profile of TARC Divisions

Masao Nara, Director

The OKINAWA Branch was established in Ishigaki Island (lies between Naha and Taiwan) at the same time as the TARC (1970). With a view to carrying out research on crop improvement, crop protection, maintenance of soil fertility, etc. in order to develop techniques which should contribute to the promotion of agriculture in the subtropical zone so as to stabilize production under a definite system. It is considered that the results of these studies could serve as a link to the research pursued overseas and could be a means of transferring technology to the subtropical areas, including the Nansei-Shoto (Ryukyu Islands) in Japan as well as in the tropical zone.

Organization and Personnel

Director of the Branch
- General Affairs Section (6)
- Crop Introduction and Cultivation Lab. (2)
- Crop Breeding Lab. (4)
- Tropical Fruit Tree Lab. (3)
- Rapid Generation Advance Lab. (2)
- Crop Protection Lab. (4)
- Soil Fertility Lab. (2)
- Farm Management Section (8)

Total No. of personnel: 32 (19 scientists).
(30 September, 1990)

Research activities of the Okinawa Branch Laboratories:

Crop Introduction and Cultivation Laboratory – Introduction and acclimatization of crops from the tropical, subtropical and temperate zones and improvement of cultivation methods.

Crop Breeding Laboratory – Research for breeding of crops in the subtropical zone.

Tropical Fruit Tree Laboratory – Introduction and improvement of cultivation methods of tropical/subtropical fruit trees.

Rapid Generation Advance Laboratory – Generation acceleration of crops under subtropical conditions.

Crop Protection Laboratory – Ecology and control of diseases and pests of crops and crop protection in general in the subtropical zone.

Soil Fertility Laboratory – Preservation and improvement of soil fertility under subtropical conditions.

Major Research Highlights:

(1) *Introduction and acclimatization of crops* – Useful plants are being introduced from the tropical and subtropical zone to utilize them as materials for improving the quality of food and feedstuffs, as sources of special constituents and for genetic engineering purposes. The tropical forage crops which have been introduced from Africa and deemed to have a potential based on the results of preliminary evaluation are as follows: 1) Gramineae: Guinea grass, Napier grass 2) Legumes: Siratro, Stylo, Glycine 3) Green manure crops: Dolichos lablab, *Mucuna capitata*. In addition legumes for human consumption and cassava varieties were introduced from Brazil and Colombia while several varieties of Euphorbiaceae and Eucalyptus were introduced to Okinawa as "energy crops".

(2) *Breeding of crops of economic importance* – Research on more than 200 varieties of sugarcane which have been collected covers the following aspects: methods for the control of flowering, analysis of varietal differences in typhoon tolerance as well as sugar yield in relation to dry matter production, etc. Presently the ecological and physiological characteristics of the varieties are being analysed along with the establishment of techniques for controlling heading and for hybrid seed production. On the other hand, research on breeding methods through tissue culture are being promoted and studies on tissue culture of young tassels and leaf buds as well as variability in culture have been completed. Presently attempts are being made to induce variations with a potential for breeding through the selection of cells in culture. Studies on the morphological characteristics of 113 varieties of pineapple have resulted in improvements in the identification and classification of the varieties. Essential aspects pertaining to crossing such as cross incompatibility and development of hybrid seeds have been analysed. In addition, efficient methods of propagation of pineapple through the use of chemicals (morphactin) have been developed. Presently research deals with the establishment of methods for the long-term preservation of pineapple varieties through the application of tissue culture.

(3) *Improvement of methods of cultivation of field crops* – With a view to stabilizing the production of vegetables, studies are carried out to increase the adaptation range of cultivation under a plastic net which has been found to be an effective method for the protection of summer vegetables against pests and strong wind. Investigations also deal with the identification of types of facilities and methods of cultivation for winter vegetables in order to develop planting systems adapted to the meteorological conditions of the subtropical zone. In the case of vegetables that require a high temperature such as green sweet pepper, the temperature can be raised by using greenhouses with two layers of materials, resulting in the acceleration of growth and improvement of quality.

(4) *Application of the rapid generation advance method for rice breeding* – When high-yielding varieties of rice developed overseas are used as materials for the breeding of ultra-high-yielding rice varieties, there are considerable variations in heading time and these materials can not be handled easily in the early generations in mainland Japan. Therefore the application of the advance generation method to breeding materials in making the best use of the climatic conditions prevailing in the subtropics offers great advantages. To fulfil this objective the method has been applied since 1982 with the collaboration of rice breeding laboratories located in various parts of the country. In addition experiments are carried out to analyse the frequent occurrence of sterility associated with wide crosses and to identify a suitable cropping schedule and method of selection in order to promote effectively the application of the method.

(5) *Ecology and control of diseases and pests in the subtropics – Diseases:* Strains of the pathogen of squash mosaic disease prevailing in the Ryukyu Islands, namely WMV-1, 2 and ZYNV have been identified and research involves the transmission, incidence and control of the disease. In addition studies cover the following aspects: control of soil-borne pathogens such as

(continues to p. 6)

Born in Ibaragi in 1933. Research field: crop physiology. B. Agr. from Utsunomiya Univ. (1957), M. Agr. from Tokyo Univ. (1959). After working at Paddy Rice Cultivation Lab., Crop Div., Central Agr. Exp. Station (Konosu, 1959-71), he joined TARC and was dispatched to Thailand (Technical Div., Rice Department, DOA. Bangkhen, 1971-75)and Sri Lanka (Central Agr. Res. Institute, Dept. Agr., Peradeniya, 1978-81). His main contributions include physiological and ecological studies on Japonica and Indica rice plant to achieve high yield. After served as Chief, Training Section, Div. of Planning, TARC. (1975-76), he was appointed Chief of the Upland Mechanization Agronomy La., Farm Technology Div., Tohoku Nat'l Agr. Exp. Station (Morioka, 1981-90). During the above period, he served as JICA Expert in the field of research on cold weather damage of crops (soy bean, maize and rice) at the Sanjianpingyuan Agr. Res. Center Project, (Harbin, the People's Republic of China, 1986-89). He rejoined TARC in March 1990 to assume the position of Director, Okinawa Branch.

Collaborative Research Programs of TARC with UPLB

TARC Activities in Agriculture

Collaborative research activities between the Tropical Agriculture Research Center (TARC) and the University of the Philippines at Los Baños (UPLB) were initiated in 1972.

The College of Agriculture was the first to be established within UPLB, one of the four autonomous campuses of the UP System, in 1909. After about 80 years, UPLB has developed into a multiuniversity composed of eight colleges including the Graduate School and 25 institutes, centers and other units.

UPLB is located at the foot of Mount Makiling, *(named after Maria Makiling, a goddess of the Tagalog legend, believed to live on the top of the mountain)* and in the southern shore of Laguna de Bay.

Today, the College of Agriculture, University of the Philippines at Los Baños (UPLB-CA) which is recognized as a national center for agriculture and rural development assumes an active leadership in agricultural education, research and extension.

Results of the major collaborative studies carried out mainly at the Institute of Plant Breeding (IPB) and the Department of Soil Science of the College of Agriculture are as follows:

Research at IPB: *1. Studies on Breeding of Maize Varieties for Resistance to Downy Mildew.* Using parent plants of one hundred one lines with high resistance to downy mildew selected in the Philippines, fourteen composite lines were bred and distributed to the organizations concerned in Indonesia, Thailand, Taiwan and The Philippines. 2. Studies on Method for Examination of Resistance to Insect Pests (in relation to breeding of maize varieties with high resistance to corn borer). Mass production system of egg batches of the corn borer and method for their inoculation in the field which were developed have contributed to the improvement of the efficiency of breeding of maize varieties highly resistant to the corn borer.

Research at the Department of Soil Science: *1. Studies on the characteristics and genesis of volcanic ash soils in the Philippines (1982-86).* Based on the relationship between the phosphate absorption coefficient and base saturation of the samples, volcanic ash soils in the Philippines were classified into two groups, namely the halloysite type and allophane type groups, depending on the variations and the combination of the values of these two parameters. It was assumed that the halloysite type group was influenced by the tropical monsoon climate characterized by a rainy and dry season, whereas the allophane type group may be affected by the tropical rainforest climate where a dry season is lacking. *2. Studies on the Genesis, Characteristics and Productivity of Red-Yellow Soils in the Philippines (1986-90).* The pedogenic process and physico-chemical and mineralogical properties of Red-Yellow and related soils in the Philippines and their patterns of distribution in relation to parent materials, topographic position and climate were revealed. These soils were classified according to some soil classification systems and their productivity potential is being evaluated to implement agricultural development programs in the Philippines.

(T. Hamazaki)

TARC Activities in Forestry

Established in 1910, the college of Forestry, UPLB is the oldest institution of its kind in the Philippines and second oldest college in UPLB. The College consists of five departments (forest biological sciences, silviculture and forest influences, forest resource management, social forestry, and wood science and technology). The Makiling Forest (4,200 ha) and 200-ha botanical garden are operated by the College. Presently, the College faculty is composed of 67 members, most of which hold graduate degrees.

The collaborative studies between the College and TARC were initiated in 1976. During the past 15 years, studies on (1) Regeneration technology of Dipterocarp species; (2) Multiplication and cultivation of tropical bamboo; (3) Biomass and production of man-made forests with fast-growing tree species; (4) Pests and diseases of tropical trees were carried out, and (5) Studies on the production technology of agroforestry systems have been continuing since 1986. Six researchers on long-term assignments were dispatched from TARC in collaboration with the Forestry, Forest Products Research Institute (FFPRI), in addition to two researchers on short-term assignments who are sent every year. Field studies have been carried out not only in the Makiling Forest and botanical garden but also in several forest areas throughout the country. Many reports based on these studies nave been published in various journals. In these programs the following themes were intensively studied: (a) Phenology of dipterocarp trees; (b) Response of Dipterocarp seedlings to various light conditions; (c) Seed dispersion of Dipterocarp trees; (d) Expansion and growth of bamboo by culm cutting; (e) Multiplication of bamboo using bamboo rhizomes with different growth types; (f) Aboveground biomass, litter fall and growth of *Leucaena leucocephala* plantations; (g) Stem growth of *Leucaena leucocephala* in relation to leaf life span; (h) Biomass and net production of man-made forests with fast-growing tree species; (i) Growth analysis of tropical fast-growing trees; (j) Soil and site classification in degraded forest lands; (k) Causal agent of *Pinus kesiya* deterioration; (l) Scolytid- and platypodid-fauna; (m) Microfungi of Ips-infested *Pinus kesiya*; (n) Needle blight of *Taxoduim mucronatum*; (o) Light climate under the canopy of a man-made forest; (p) Intercropping and illuminance in a tree farm. (Nobuyuki Tanaka)

The botanical garden adjacent to the College of Forestry (Photo by N. Tanaka)

Main entrance of the state institution of UPLB. Carabao, plow and man are the symbol of the College of Agriculture. (Photo by T. Hamazaki)

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