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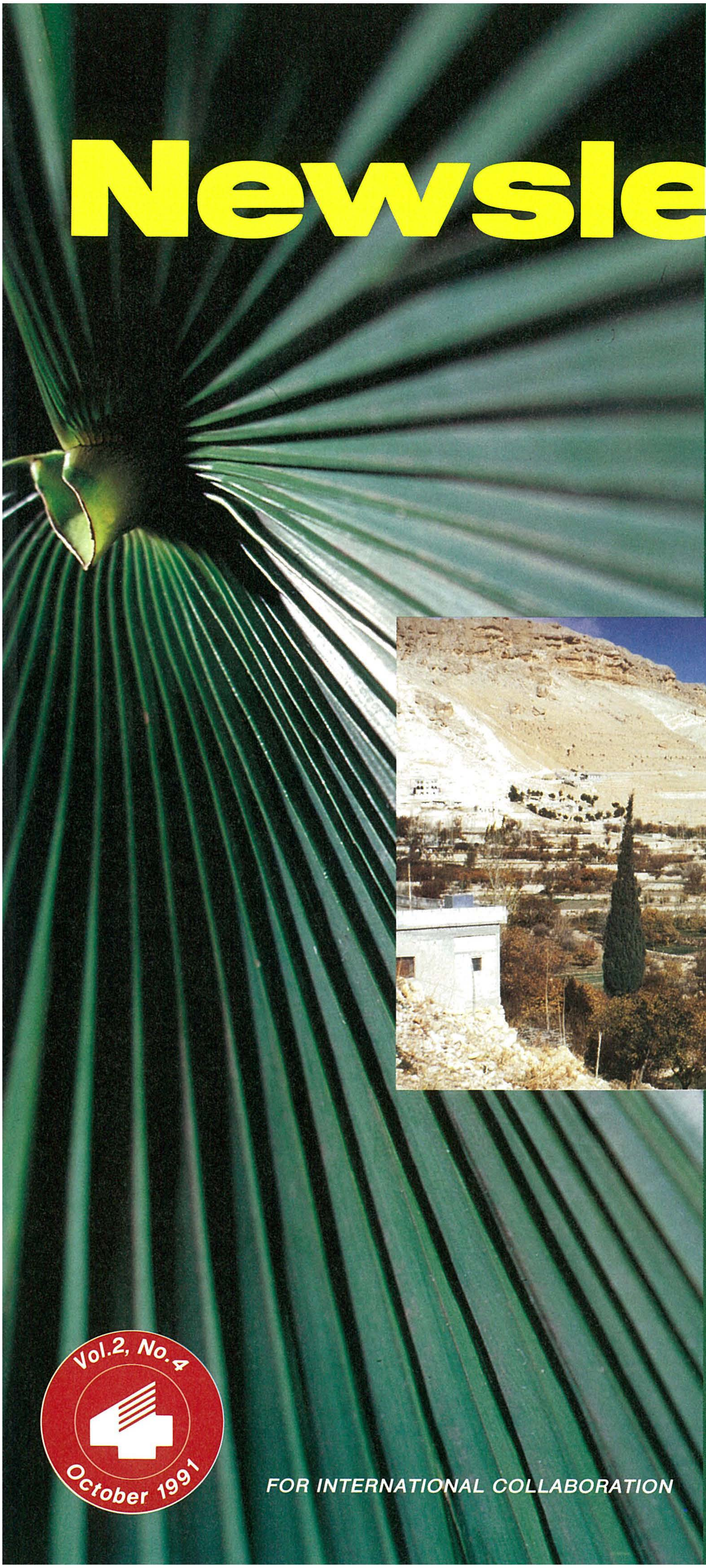
Newsletter



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Fruit cultivation in dry area of Syria
(Photo by H. Gocho)

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FOR INTERNATIONAL COLLABORATION

TARC

TROPICAL AGRICULTURE RESEARCH CENTER

Introduction, Re-introduction and Repatriation of Plant Germplasm

Nobuo Murata

Curiously, talks on the management of plant genetic resources, supposed to be based on an humanitarian motive, are sometimes tinted by epithets suggestive of short-sighted nationalism; "political", "strategical", "one-sided flow of germplasm", etc. There may be some aspects dominated by national interests. However, there is another facet, i.e. friendly mutual co-operation and international services. And we find that the latter activities are far broader than generally considered.

We may look into the record of the Central Gene Bank at the National Institute of Agrobiological Resources for the number of genetic stocks offered by the Bank to institutions located overseas. Although the concept of the Bank aiming at the promotion of international co-operation can be traced back to the late fifties when the late Dr. H. Ito installed a huge refrigerator in the Department of Genetics, National Institute of Agricultural Sciences, Hiratsuka, computerized record of import/export of germplasm became available only after 1985.

The table indicates the number of accessions of various crop plants that were distributed abroad from the Central Bank upon request during the period 1985-1991. Due to technical constraints, the transfer of vegetatively propagated plants is slow. In fact the fruit tree germplasm is preserved at the Fruit Tree Research Station and the genetic stocks are distributed from this Station upon requests that were first conveyed to the Central Gene Bank. There is a very strong demand for vegetables as well as cereals and legumes. Although detailed analysis of the germplasm distributed abroad is not yet available, some interesting trends are already recognizable. A sizeable portion of the genetic stocks offered by the Bank consists of improved varieties, to which specific genes were introduced from abroad. Some requests to the Bank refer to specific varieties listed in the catalogue while other refer to varieties with some specific traits or from a certain origin. In the latter case, varieties to be distributed are selected by the Bank based on the information supplied by the breeders. These operations indicate that the management and services relating to the plant germplasm can be effectively performed only with a strong domestic backup of breeding work.

Computerized records, however, do not tell all the stories. A considerable portion of plant genetic resources moving abroad are in fact those carried by Japanese scientists serving abroad in international co-operative research and development projects. These materials are recorded as utilized by Japanese scientists and are not recorded by computer as emigrants. It should be noted that this type of "unrecorded" immigrants has contributed significantly to the progress of agricultural research and development in various countries.

Many of the upland rice varieties in Japan are highly tolerant to blast disease. They are brought to IITA, Nigeria or EMBRAPA, Brazil by Japanese scientists to explore the possibility of using their tolerance genes in breeding schemes. Some of the tolerance genes can be traced back to the gene source introduced from Chinese varieties some decades ago. In such a case, the movement of the genes in fact corresponds to re-introduction.

In the co-operative research program with Yunnan Academy of Agricultural Sciences, TARC researchers introduced land races as well as improved varieties from Japan as a source of genes for the improve-

Plant Genetic Resources distributed to various countries/regions from the Gene Bank (1985 ~ 1990)

Countries/Regions	A	B	C	D	E	F	G	H	Total
Bulgaria	79	695			83			284	1141
India	383	21		4		5		81	494
U.S.A.	63		91		70	24		135	383
Korea	17	208	14			5	33	25	302
Canada					211			62	273
France		13	48		61	78		61	261
Philippines	21							178	199
Taiwan, China					103	7		8	118
China	11	11	5	37	15	4	21	12	116
Poland			1			69		31	101
U.S.S.R.	39	46		9	1	85		39	219
West Germany		32	5		43	2		27	109
South Africa						70			70
Greece								98	98
Nigeria			24			40			64
Czechoslovakia		13				6		48	67
U.K.	4	7	4		7			26	48
Turkey		4			19			21	44
Zimbabwe						12		30	42
Israel					12			39	51
Syria				38					38
Italy	20	10				19			49
Paraguay			30		3				33
Uruguay							32		32
Mexico								25	25
Australia		22							22
Brazil			10					12	22
Romania	20								20
Pakistan			20						20
Thailand		6	6						12
Bangladesh		10							10
Argentina			6			4			10
Peru			6	22					28
Indonesia			5						5
Colombia	5								5
East Germany		1	1			2			4
Netherlands						2			2
Switzerland		1							1
Sri Lanka	1								1
Hungary		11							11
Kenya						10			10
Total (41)	663	1111	314	72	628	444	86	1242	4561

A: Rice and relative species B: Wheat, barley, rye, oats C: Grain legumes
D: Root crops E: Maize, other cereals and industrial crops F: Forage crops
G: Fruit trees H: Vegetables
(Data provided by courtesy of Dr. K. Kawaguchi, Genetic Resources Co-ordinator, National Institute of Agrobiological Resources)

TARC Visiting Research Fellowship Program

The Tropical Agriculture Research Center (TARC), Ministry of Agriculture, Forestry and Fisheries, Japan, is planning to implement a Visiting Research Fellowship Program starting in October 1992. This Program emphasizes pioneer research on the conservation of the global environment and optimum utilization of bioresources in the tropics and subtropics.

For the past twenty years since its establishment, TARC has been engaged in research and development for the promotion of agriculture, animal husbandry and forestry in collaboration with various organizations and institutions located in the tropics and subtropics. At present, TARC implements cooperative projects with 23 institutions in 12 countries.

The successful candidates, the number of which will be about 10, will undertake relevant research pertaining to one of the four themes listed below for a period of six months or more after October 1, 1992. Research will be carried out at the Okinawa Branch of TARC in Ishigaki City, Okinawa Prefecture which is located in the subtropical zone of Japan and is equipped with advanced facilities for research.

Research Themes

(1) Development of techniques for environmental control by using plants and microorganisms specific to the tropics and subtropics.
(2) Studies on the mechanism of heat-tolerance of tropical and subtropical crops
(3) Identification and evaluation of salt-tolerant crops.
(4) Evaluation and development of long-term conservation techniques of genetic resources of vegetatively propagated crops in the tropics and subtropics.

Fellowship Qualifications

(1) Applicants should be nationals of developing countries, be currently employed in a research organization (institute or university, etc.) and be engaged in research relating to tropical or subtropical agriculture and forestry, in principle.
(2) Hold a Ph. D degree in a field relating to natural sciences and technology or equivalent research achievements in related fields.
(3) Be a researcher who will carry out research related to one of the four "Research Themes" previously listed.
(4) Be preferably less than 45 years of age
(5) Should enjoy a good health.
(6) Have an adequate command of English or Japanese language.
(7) Be committed to pursuing research in fields related to tropical agriculture and forestry after the termination of the fellowship.

Tenure

Six months to one year (extension is possible), starting after October 1992.

Fellowship Conditions

(1) A round-trip airline ticket (economy class) will be available (except for dependents).
(2) Living allowance: ¥260,000 per month (net amount after tax deduction, about US$2,100 at the exchange rate of ¥123 for one dollar)
(3) Housing: provided by TARC.
(4) Fixed-rate insurance package (for injury, sickness and damage, etc.) will be covered under the TARC Fellowship Program.

Application Procedure

Applicants are required to submit following documents to the Director General of TARC.

(1) Application form (Form I)
(2) Two recommendation letters (Form II) from the official representative or appropriate authority of the research organization in the fields related to agriculture and forestry
(3) Medical certificate (Form III)
(4) List of main publications

Deadline for Application

May 14, 1992

Notification

TARC will examine the application documents and notify the results of the selection to the successful applicants and their referees within three months after the deadline date for application.

Further information about the Visiting Research Fellowship Program can be obtained from the Chief of the International Relation Section, Tropical Agriculture Research Center, Ohwashi 1-2, Tsukuba, Ibaraki, 305 Japan.

Tel.: 81-298-38-6335
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TARC International Symposium 1991 Utilization of Feed Resources in Relation to Nutrition and Physiology of Ruminants in the Tropics

The Tropical Agriculture Research Center holds an international symposium on various topics related to tropical agriculture each year. The 25th International Symposium, this year, which was organized by TARC in cooperation with the National Institute of Animal Industry (NIAI) took place at the Tsukuba Center for Institutes, Tsukuba city, Ibaraki, on September 24 and 25. The subject covered the current situation and future prospects of utilization of feed resources for ruminant production in the tropics. More than 100 participants including delegates from overseas attended the Symposium.

The objective of the Symposium was to identify various kinds of nutritional constraints on ruminant production in the tropics and technical problems which limit the efficient use of available feed resources in taking account of the socio-economic conditions of the respective areas. Presently, in many areas of the tropics, the low

(continues to p.6)

(continued from p.2)

ment to eating quality and yield. The breeding scheme was successful and interestingly the rice varieties in the area which is considered to be a center of genetic diversity where the ancestor of japonica rice may have originated were improved by the incorporation of gene sources which were literally repatriated.

In the co-operation programs implemented by JICA (Japan International Co-operation Agency), vegetable seed stocks are also brought to Brazil, China, etc.

In another stream of gene flow, detailed information on specific genes obtained through extensive studies carried out on introduced germplasm circulates and contributes to research and development in other countries.

Cytoplasmic male-sterility system in rice was first discovered at Tohoku University, Japan in a hybrid with a wild species of tropical origin. In the mid-sixties, intensive indica-japonica hybridization studies led to the discovery of another cytoplasmic male-sterility system in the hybrid between a variety from India and Japanese varieties at the Ryukyu University. These studies stimulated the interest of rice researchers to explore the potential of "hybrid rice". Another system discovered later independently in China led to the wide application of cytoplasmic male sterility in rice breeding in China and some tropical countries.

Host-parasite relationships in blast and bacterial leaf blight in rice were extensively studied from the fifties through the sixties by using the collection of rice varieties preserved in the Gene Bank. Differential varieties developed through these studies to identify the pathogen races included varieties introduced from various countries. The standard seed stocks of differential varieties are now widely used in rice breeding schemes as well as epidemiological surveys. In some instances repatriation of varieties to the country of origin accompanied by information on their genetic traits actually takes place. Thereafter a set of isogenic rice lines each harboring a single gene for resistance to bacterial leaf blight was developed through an IRRI/ Government of Japan /TARC joint project to achieve a more efficient differentiation of the pathogen races in this disease.

It is interesting to note that very productive re-introduction and repatriation of plant genetic resources take place through international co-operative research or development activities as well as direct communication between gene banks or between a gene bank and an institution abroad. Strengthened international co-operation involving the participation of TARC may further expand the research-bound gene flow to promote agricultural development.

≪Agro-meteorology≫

Role of windbreaks in the alleviation of the effect of adverse climatic conditions and prevention of wind erosion

T. Maki, B. Pan and M. Nakai*

Meteorological observations relating to the alleviation of the effect of adverse climatic conditions in arid land were carried out at the Turfan Desert Research Station, Xinjiang Institute of Biology, Pedology and Desert Research, Chinese Academy of Sciences located in the northwestern part of China from 1990 to 1991. It was demonstrated that the use of windbreaks alleviated the adverse effects of wind speed and air temperature. It also improved the surface soil temperature and relative humidity, and prevented wind erosion.

Dry lands account for one third of the total surface area of the world. The process of desertification has been accelerated recently by excessive cultivation, deforestation, and over-grazing. In the marginal agricultural area of the dry lands, land erosion and sand accumulation due to dry wind are being promoted by the scarcity of water, and agrometeorological disasters are likely to occur frequently. We demonstrated that under very dry conditions wind erosion could be prevented and adverse meteorological conditions could be alleviated by the use of a tamarisk windbreak forest with a density of 85% and height of 4.7 m in July, 1990, and by the construction of windbreak nets with densities of 45% and 50% and height of 2.0 m in October, 1990.

1. Tamarisk windbreak forest

(1) The remarkable decrease of the wind speed associated with the wide effective area of the windbreak forest [30 H; the numerical of H indicates the distance represented by the multiple of the height (H) of the windbreak forest or net; the negative sign indicates the windward side and the positive sign the leeward side] at 6:00 was due to the fact that the direction of the wind formed a 90° angle with the windbreak forest. On the other hand , the effective area was not wide (15 H) at 12:00 when the direction of the wind formed a 45° angle with the windbreak forest.

(2) Although the air temperature increased inside the windbreak forest on the leeward side in the daytime, at night it decreased on both the windward and leeward sides, and increased in the early morning on the windward side due to sunshine.

(3) The relative humidity was high inside and near the windbreak forest due to the evapotranspiration from tree leaves of the windbreak forest.

(4) The changes in the soil surface temperature were similar to those of the air temperature. However the temperature inside the windbreak forest was 25° C lower compared with the temperature outside the forest due to the shadow of the trees.

(5) Wind erosion was negligible for values ranging from − 5 H on the windward side to 10 H on the leeward side, and sand accumulation was present at values from − to 5 H, in particular on the windward and leeward sides from − to 2 H.

It is necessary to plant a windbreak forest that is resistant to strong wind, as well as dry, high/low temperature and salinity conditions in the dry land of Northwest China. As the use of tamarisks can alleviate the adverse effect of the meteorological conditions and prevent wind erosion, due to their resistance to adverse conditions, such trees are suitable for a wind break forest.

2. Windbreak net

(1) Minimum relative wind speed was 25% and 35% due to the decrease of the wind speed by nets at densities of 50% and 45%, respectively.

(2) The air temperature increased in the range from − 5 to 10 H, the relative humidity decreased in the range from 5 to 7 H and the surface soil temperature decreased in the range from 1 to 2 H due to the shadow of the nets and increased to around 5 H due to sunshine for both windbreak nets.

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Tamarisk windbreak forest and windbreak net (Photo by T. Maki).

≪Plant Protection≫

Stored-product insects infesting rice grains stored in Thailand

H. Nakakita, P. Sittisuang, P. Visarathanonth* and P. Urairong**

Stored-product insects, which are responsible for major post-harvest losses in grains, pulses and other products, complete their life cycle rapidly and cause outbreaks in tropical countries. The collaborative research work on stored-product insects carried out with the Department of Agriculture, Ministry of Agriculture and Cooperatives Thailand, during the period 1988 – 1991, was focused on species occurrence, population dynamics, grain losses caused by the insects and presence of natural enemies to study the ecosystems in rice storage facilities in Thailand. Methodological and systematic surveys were conducted using food and pheromone traps. In addition, routine sample collection was performed at determined intervals in four rice storage facilities: farmers' warehouses, seed storage facilities belonging to rice experimental stations, rice mills and exporting companies' godowns -in 11 provinces throughout Thailand. Among 34 species detected, the largest number consisted of 27 Coleoptera including 2 unidentified beetles and 7 Lepidoptera were recorded in rice mills where both paddy and milled rice were preserved. In farmers' warehouses and seed storage facilities where only paddy was stored, 12 and 10 species were detected, respectively. Fourteen species were recognized in the godowns near Bangkok port where milled rice was stored. The species occurring most frequently in all the facilities where paddy and/or milled rice was stored included *Sitophilus* spp., *Tribolium castaneum*, *Cryptolestes* spp. and *Oryzaephilus surinamensis*. In contrast, 3 species, *Rhyzopertha dominica*, *Lophocateres pusillus* and *Sitotoroga cerealella* were very common in paddy storage facilities while *Corcyra cephalonica* and *Carphophilus dimidiatus* were confined to facilities where only milled rice was stored. Based on the food traps set up at 4-month intervals which contained 500 g of paddy, brown and milled rice separately, brown rice was most severely damaged with an average loss of 32.9 % in all the facilities. Paddy was most resistant to insect attacks since its average loss was only 4.1 %. Average loss of milled rice in all the facilities was 19.3 %. Explosive outbreak of *Sitophilus* spp. which caused serious damage to either brown or milled rice was sometimes observed. However, the insect infestations were very limited in many facilities even though the sanitary conditions were relatively poor. These observations indicate that special factors are involved in the regulation of insect pest populations. It was concluded that the presence of natural enemies especially from outside such as ants, spiders, lizards, etc. play an important role in regulating the insect pest population since common rice storage structures in Thailand are widely exposed to such predators from outside. Ants accounted for the largest number as natural enemies based on the food traps set up at either farmers' warehouses or seed storage facilities. In addition, lines of ants carrying live insect pests were sometimes observed (Fig). Moreover, webs spun by spiders which covered the structures and stacked bags were generally observed (Fig). Thus, the insect pests, the natural enemies especially predators from outside and the host grains form a very unique ecosystem, which is not present in the temperate zone, and contributes to the control of stored product insects in Thailand.

(* Dept. of Agriculture, MAC, Thailand)

Ants carrying a larva of an insect pest

Sitophilus zeamais, a most destructive insect pest

Rice bags covered by spider webs

The application of CFA as B source alleviated boron deficiency in garlic.

≪Soil and Fertilizer≫

Boron deficiency in garlic (*Allium sativum*) grown on Tropaqualfs in northern Thailand

H. Watanabe, C. Chermsiri[1], S. Attajarusit[1], S. Kaewroj[1], J. Tuntiwarawit[2] and W. Cholitkul[1]

Garlic has always been one of the staple crops in Thailand. According to the Agricultural Statistics of Thailand published in 1989, the farm value of garlic was 105 million dollars, ranking ninth next to soybean with a value of 129 million dollars. Garlic is mainly produced in the northern part of Thailand, such as Lampoon, Chiang Mai, Lampang Province, in rotation after rice, on Tropaqualfs (alluvial soils in tropics) which are widely distributed.

We detected latent boron deficiency in garlic (main current var. : Chiang Mai) grown at San Pa Tong Rice Experiment Station in Chiang Mai Province. Field experiments were conducted for a period of two years. Borax (3.75, 7.5, 15 kg/ha), CFA:coal fly ash, the power plant waste from Mae Moh in Lampang Province (1, 2, 4 t/ha) and FTE: Fritted Trace Elements, a micronutrient mixture of slow-release fertilizer (40 kg/ha) were applied to soil for studying the effect of boron application on garlic growth. Prior to the planting of cloves, hot water soluble boron (HWS-B) concentrations in the −B (control) ranged from 0.23 to 0.31 ppm. No signs of latent boron deficiency were detected in the garlic plants in the −B soils throughout the growing period. Garlic was cultivated during ca. 110 days. Differences in plant growth between the −B and + (boron application) plants were hardly observed up to 40 days after planting but became pronounced in the reproductive stage, two months after planting. It thus appeared that in all the + plants the fresh weight (FW) increased by 27 – 40% compared with the −B plants at harvest.

No critical values of boron in soil and plant have been reported for garlic growth. The critical level in soil for garlic productivity was ca. 0.30 ppm (HWS-B). For plant diagnosis, the critical level in the garlic top was 25-30 ppm at harvest. Garlic is classified as a plant sensitive to boron deficiency compared with the critical levels in soil for sunflower sensitive to boron deficiency and soybean resistant to it.

The boron content in the soils sampled from 58 sites in the garlic-producing areas of the seven northern provinces was 0.20 ppm on the average. The boron concentrations in only 8 sites were higher than the critical level in soil. Therefore, it is estimated that most of the garlic plants grown in the northern part of Thailand had experienced boron deficiency. It is thus suggested that 7-15 kg/ha borax, 2-4 t/ha CFA or ca. 40 kg/ha FTE should be applied to prevent the deficiency.

1) Dep. of Agriculture, Chatuchak, Bangkok, Thailand
2) San Pa Tong Rice Experiment Station, Chiang Mai, Thailand

Two IBPGR workshops in East Asia

The IBPGR office for East Asia in Beijing with Prof. Zhou Ming-De as the Coordinator has a unique feature among similar regional offices of IBPGR. Located in a country with an enormous size, rich in plant germplasm and historically the center of civilization of the Far Eastern region, its role in the mediation of the flow of information and genetic stocks among the East Asian countries should be invaluable. Under the auspices of the IBPGR supported by a special contribution from the Japanese government, the Office organized two international workshops on plant genetic resources in this area.

The first on "Less Utilized Crop Genetic Resources" was held with the co-sponsorship of the Chinese Agricultural Academy of Sciences on 24-27 April in Beijing. The meeting was attended by scientists from five East Asian countries, i.e. Mongolia, Democratic People's Republic of Korea, Republic of Korea and Japan as well as China, the host country. It was recognized during the meeting that vast areas in this region still remain to be surveyed for the genetic resources of less utilized crop plants such as millets, buckwheat, food legumes and wild forages. It was eventually agreed by all the participants that mutual co-operation among the countries in the region through the coordination by the IBPGR office in Beijing should facilitate the collection and utilization of otherwise endangered plant germplasm in this region.

Another workshop on "Buckwheat Genetic Resources in East Asia" was held with the co-sponsorship of the National Institute of Agrobiological Resources, Japan on 18 – 20 September in Tsukuba. The meeting was attended by delegates from India and Nepal as well as the five East Asian countries previously listed. Representing the IBPGR, Dr. D. H. van Sloten, Deputy Director, Dr. R. K. Arora, Associate Coordinator for South Asia and Dr. Zhou Ming-De, Coordinator for East Asia attended the workshop. In line with the conclusions of the Beijing workshop, the meeting discussed the buckwheat genetic resources in Asia in greater detail. Specifically during the meeting it was recommended that international support should be extended for the collection of buckwheat germplasm in the Eastern Himalayan region which is considered to be most seriously endangered.

Through various schemes for international co-operation, the Japanese agricultural organizations indicated their willingness to support activities for plant genetic resource management due to the interest in such undertakings worldwide. *(Nobuo Murata, Director, Eco-Physiology Research Division, TARC, and Board of Trustees, IBPGR)*

Soil Microbiology Research Group, Department of Agriculture, Thailand

As soon as I came to the institute just after my arrival from Japan, I was struck by the active atmosphere. Many young assistants and graduate students were walking around, talking and operating instruments. Many foreign scientists come here and hold discussions with the researchers.

The Soil Microbiology Research Group was established before 1960 as a unique laboratory compound in the Soil Science Division, Department of Agriculture (DOA). A total of 20 researchers and about 25 assistants is currently engaged in research activities covering a wide range of soil microorganisms, such as *Rhizobium*, including inoculant production (commercial delivery) and quality control, *Azolla*, cyanobacteria, free-living nitrogen-fixing bacteria, Frankia, mycorrhiza, compost and biogas production by bacteria. The Biological Nitrogen Fixation Resource Center (BNFRC) for South and Southeast Asia, which is the outreach effort of the NifTAL project (Hawaii) in collaboration with the DOA is also housed in the institute. The center supports international workshops, training courses (at least 2 times per year), transfer of technology and hosts visiting scientists from abroad.

The chief of the group and representative of BNFRC is Dr. Nantakorn Boonkerd, who is an energetic researcher, eager to introduce new research technologies, such as biotechnology, and is actively implementing several projects. He and his colleagues have published many papers in international journals or proceedings. Within this good environment, I have been engaged in studies on "Nitrogen Uptake in Legume-*Rhizobium* Symbiosis

TARC International Symposium
(continued from p. 3)
productivity of ruminants is associated with inadequate year-round feed supply and low quality of feeds. Therefore, in these areas, it is necessary to improve the quality of feeds and related resources as well as to secure their year-round availability.

Dr. S. Tsuru, Director General of TARC gave the inaugural address in the opening session while Mr. T. Sugimoto, Deputy Director General, Secretariat of the Agriculture, Forest and Fisheries Research Council, and Dr. H. Shishido, Director General of NIAI, welcomed all the partcipants.

In the session for the Country Reports, the delegates from six countries, i.e. Malaysia, Indonesia, Philippines, China, India and Brazil, discussed the current status of feed resources and ruminant production, and research needs for further development of the production in the respective countries.

In the following session for Organization Strategies, the delegates from five organizations, i.e. RAPA/FAO, ILCA (International Livestock Centre for Africa), ACIAR (Australian Centre for International Agricultural Research), UPM (Universiti Pertanian Malaysia) and TARC, presented their strategies for the enhancement of ruminant production in the regions concerned. TARC outlined some of the research achievements stemming from collaborative activities carried out in the past and research strategies for the future.

In the session for Technical Reports, there were 12 presentations, including research on the following subjects: (1) treatment of crop residues and agricultural by-products for improving the digestibility and nutritive value, (2) digestion of fiber components of roughages in the digestive tract, functions and genetic manipulation of rumen microorganisms, and use of chemical substances for improving fiber digestion in the rumen, (3) requirements of minerals and energy for dairy cows under high temperature conditions, (4) supplementation of protein sources to grazing cattle during the dry season, and (5) characteristic systems of ruminant production in Africa from the ecological and socio-economic viewpoints.

The main problems taken up in the general discussion were as follows: (1) how to enhance the utilization of crop residues and agricultural by-products, (2) how to overcome the low productivity of natural grasslands and related resources, (3) how to develop packages of technology applicable to farmers in integrated farming systems of rural areas and how to transfer new technology to the farmers, and (4) the role of international organizations in the promotion of sustainable livestock production.

Three approaches for increasing the utilization of residues and by-products were proposed: 1 increase of availability, 2 improvement of digestibility, and 3 enhancement of the efficiency of rumen digestion. Emphasis was also placed on the need to look into problems of collection, storage and processing of these materials. For improving the productivity of natural grasslands, three aspects were also emphasized: 1 accurate estimation of yearly variations of herbage production and control of the grazing rate, 2 introduction of legumes adapted to the local conditions, and 3 supplementation of herbage shortage with feed resources rich in minerals and nitrogen or energy. The application of genetic engineering to rumen microorganisms has a potential to increase the digestibility of fibrous materials and native grasses in the rumen, although many technical problems remain to be solved, In the discussions, it was also pointed out that although significant progress has been made toward the development of new technologies in animal production in the tropics, their transfer to the farmers has not always been successful or has been incomplete. In conclusion, due to the differences in the conditions of resource availability and climate, strategies specific to respective countries or areas should be adopted for the evaluation and utilization of feed resources and transfer of the technology to farmers through a multidisciplinary approach.

The proceedings of the Symposium will be published as Tropical Agriculture Research Series (TARS) No 25 in the near future by TARC. (Toshikazu Miyashige) in Thailand" under a TARC-DOA co-operative assignment from 1988. For the studies, I have analysed nitrogen fixation in mungbean by using the N-15 natural abundance method and clarified the seasonal changes in fixation, Although I am a plant physiologist and most of the researchers in the group are microbiologists, we have interacted with each other and collaborated well, in the same way as the *Rhizobium* symbiosis.

Visitors are welcome.

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(Toshifumi Murakami, Eco-Physiology Research Division)

Methane Emission from Paddy Fields in the Central Plain of Thailand

The concentration of atmospheric methane (CH_4) has been increasing at a rate of about 1% per year. Methane is one of the greenhouse gases; as well as CO_2, N_2O, and CFCs, which absorb the infrared radiation from the earth's surface, causing a possible elevation of the global temperature.

Although the leading cause of the rapid increase in atmospheric CH_4 has not yet been identified, it is generally considered that paddy fields may be an important source of atmospheric CH_4 among a wide variety of sources, taking into account the recent increase in the harvest area in the world. There is, however, a substantial lack of field data for CH_4 emission from paddy fields in tropical countries where about 70% of the world paddy area is located.

Against this background, we have conducted field measurements of CH_4 flux from paddy fields to the atmosphere in the central plain of Thailand. During the dry season in 1991, we performed the first series of measurements at the Rice Experiment Stations of Khlong Luang and Suphan Buri once a month at each site by using a closed chamber method. These two sites are located in the alluvial lowlands of the Chao Phraya river. The soil in Khlong Luang is an acid sulfate soil characterized by a low pH and high concentration of sulfate.

Methane flux from paddy fields in the central plain of Thailand showed marked seasonal variations. The flux increased with the growth of rice plants and the decrease in the redox potential of soil. The average and the maximum values of the flux at Khlong Luang were 3.8 and 9.4 mg CH_4/m^2 hr, respectively. These values were significantly lower than those at Suphan Buri, 19.5 and 46.6 mg CH_4/m^2hr. The CH_4 emission rates at these two sites were in the range of the values recorded in the temperate zone such as in California, southern Europe, and Japan, in spite of the relatively high soil temperature in the paddy fields of Thailand. It was assumed that the low contents of readily decomposable organic matter in the paddy soils were the major factor limiting the CH_4 flux from the Thai paddy fields. In addition, the low methanogenic activities in the acid sulfate soils led to a significant decrease of CH_4 flux from the paddy field in Khlong Luang. Total emission rates during one cultivation period were estimated to be 8 and 42 gCH_4/m^2 at Khlong Luang and Suphan Buri, respectively.

Field measurement of methane flux from paddy field by closed chamber method

Current estimates of CH_4 emission rates from paddy fieldds in the tropical region have been made by a simple correction of the soil temperature based on the field data of the temperate region, without considering the poor quality and quantity of organic matter in the tropical soils. Our results, therefore, strongly suggest that the emission rates of CH_4 from paddy fields in the tropics have been overestimated, and that we need more precise and extensive studies in various areas of the tropical countries.

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IRRI-Japan Seminar on Rice Grain Quality

The seminar on Rice Grain Quality was held on Oct. 8 at the Tsukuba Center for Institutes, Sci. Tech. Agency. The meeting was sponsored by IRRI and co-sponsored by NARC (National Agr. Res. Center), NFRI (Nat. Food Res. Inst.) and TARC (Trop. Agr. Res. Center) of Japan.

Approximately 200 people attended the seminar. JICA trainees in Tsukuba who participated actively in the discussions asked questions on testing methods and commented on the need to upgrade research on the improvement of rice grain quality.

Seven speakers presented papers on testing methods, breeding, variations of eating quality, as follows;

Otsubo, K. (Hokuriku NAES): Physico-chemical evaluation of rice quality in relation to eating quality.

Juliano, B. O.(IRRI): Rice starch properties and grain quality.

Shibuya, N. (Nat. Inst. Agrobiological Resources): Chemical structure of rice cell wall and genetic regulation.

Kawamura, Y. (NFRI): Physiologically active peptides derived from rice protein.

Horisue, N. (NARC): Recent research on breeding for rice quality in Japan.

Dela Cruz, N. M. (IRRI): Effect of temperature during grain development on stability of cooking quality components in rice.

Shigyo, M. (Kyushu NAES): Quantitative evaluation of environmental factors in relation to rice eating quality.

Dr. Bernard, F. A. (Dep. DG, IRRI) opened the meeting stating that, even though the enhancement of rice production to meet the demand of the ever-increasing world population was extremely important, the improvement of rice grain quality also became increasingly important to meet the diversifying needs in developing countries.

Dr. Chisaka, H. (DG, NARC) welcomed the participants, stating that, even though the Japanese scientists had been engaged in studies covering the rather narrow range of Japonica rice, their experience may contribute to the development of future research strategies.

Drs. Murata, N. (TARC) and Saio, K. (NFRI) mediated the discussion. They emphasized the importance of dialogues between IRRI and Japan and between rice breeders and food scientists.

Dr. Tsuru, S. (DG, TARC) closed the seminar, appealing for the continuous promotion of international collaborative research.

On Oct. 9th, the IRRI scientists visited NFRI, TARC and IRRI Japan Office which is located in the same building as TARC.

Drs. Koganezawa (virologist), Ikeda (plant breeder) and Yamauchi (plant physiologist) of TARC are currently engaged in research at IRRI under IRRI/Government of Japan projects.

For further information on the seminar, please contact Dr. Himeda, Director of IRRI Japan Office. *(I. Hamamura, Research Coordinator, Res. Information Div.)*

Cooperative Research with ICRISAT

Kensuke Okada

TARC has carried out collaborative research with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for about 14 years. ICRISAT, one of the CGIAR (Consultative Group on International Agricultural Research) Centers, is located on the outskirts of Hyderabad city in the Indian Deccan Plateau. ICRISAT which is in charge of the improvement of agricultural technologies in the semi-arid regions, has been assigned five major mandate crops, i.e. sorghum, pearl millet, chickpea, pigeonpea, and groundnut.

Collaborative research between ICRISAT and TARC covered four of the five mandate crops, within various disciplines.

First, studies on virus diseases of groundnut were carried out from 1977 to 1979. Survey and characterization of groundnut viruses in India were conducted to develop methods of control.

Second, basic research on the breeding of sorghum varieties resistant to sorghum shoot fly (*Atherigona soccata*) was conducted from 1980 to 1982. Sorghum shoot fly is a major pest problem for sorghum cultivation in the semi-arid tropics. This investigation revealed that both the reflectance of the leaves and the density of the leaf pubescence were suitable selection criteria. The mode of inheritance of the resistance and its characteristics were also clarified.

The contamination of groundnut by aflatoxin is a major problem for groundnut production in India. Two experts in post-harvest microbiology and mycotoxins were dispatched from TARC to address this problem. They developed a detection method characterized by a high sensitivity. They analyzed the frequence of contamination for grains on the market, and suggested that contamination occurred most probably during the post-harvest processing and marketing sequence and not the time of cultivation.

Chickpea (*Cicer arietinum* L.) and pigeonpea (*Cajanus cajan* (L.) Millsp.) are the main grain legumes in India and other semi-arid regions in the world. It had long been observed that the responses of these crops to the application of phosphorus fertilizer were less pronounced than expected even in soils with a low content of available phosphorus based on standard soil test (Olsen's method).

Studies on the phosphorus nutrition of chickpea and pigeonpea were initiated by an agronomist dispatched from TARC from 1983 to 1985 under the Pulse Agronomy Subprogram of ICRISAT. The response characteristics of the two legumes to phosphorus were compared with those of other crops along with studies on rooting habits.

This study was followed by the Special Project between ICRISAT and Government of Japan, entitled "Development of the Methods of Soil Management and Pulses Cultivation in the Semi-Arid Tropics" which was initiated by the same agronomist and two other scientists sent from Japan.

The major achievement was to clarify the unique mechanism of phosphorus uptake by pigeonpea and its role in the cropping systems of the Indian subcontinent.

It was revealed that pigeonpea was able to grow under conditions characterized by a low level of available phosphorus, especially on Alfisols. In Alfisols, most of the phosphorus is bound to iron and unavailable to usual crops. However, unlike other crops, pigeonpea is able to utilize iron-bound phosphorus and this ability was ascribed to the exudation of chelating chemicals, piscidic acid and its p-O-methyl derivative, from roots.

The implication of this finding was considerable as it enabled to justify the suitability of intercropping of sorghum and pigeonpea which had been practiced for a long time in the Deccan area. This sound practice is based on the lack of competition of the two crops for a phosphorus source, that is, sorghum depends on both soluble and Ca-bound phosphorus, while pigeonpea depends on Fe-bound phosphorus. In the rotation systems also, the inclusion of pigeonpea into the system was found to increase the pool of available phosphorus in Alfisols, resulting in the increase of the yield of the next crop, sorghum, in the absence of phosphorus application.

This Special Project covered other topics, such as, (1) mechanisms of adaptation of chickpea to Vertisols with a low level of available phosphorus through the exudation of citric acid, (2) critical evaluation of soil-tests for available phosphorus in the soils of the semi-arid tropics, in taking account of the role of the rhizosphere pH, (3) characterization of the rooting habits of these legumes, (4) ability of pigeonpea to improve soil physical properties, such as water infiltration, (5) mechanisms of suitability of sorghum-pigeonpea intercropping from the point of view of light-interception characteristics and soil physical properties, (6) light-absorption efficiency of chickpea and the process of yield determination.

To evaluate the achievements of this project and to exchange information on the topics concerned, the International Workshop on Phosphorus Nutrition of Grain Legumes in the Semi-Arid Tropics was held in January, 1990. The 57 participants from 10 countries actively contributed to the Workshop*.

The second phase of the project started from January in 1990. Phase II included various aspects of nitrogen dynamics, as well as in-depth analysis of topics being currently investigated.

Throughout the collaborative work, the TARC scientists have benefitted greatly from the co-operation with ICRISAT scientists, as well as the dedicated help of assistants and hospitality from the staff members. The assistance from the supporting sections, such as Farm Development and Operations, and Analytical Laboratory of Biochemistry was also outstanding and contributed significantly to the successful development of the research activities.

* The Proceedings of the Workshop were published under the title of "Phosphorus nutrition of grain legumes in the semi-arid tropics (Johansen, C., Lee, K. K., and Sahrawat, K. L., eds.) 1991. ICRISAT, Patancheru, A. P. 502324, India: ICRISAT."

Intercropping of pigeonpea and sorghum in a Vertisol field at ICRISAT

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