

A photograph of three people standing in a lush green rice field. The person on the left is wearing sunglasses and a light-colored shirt, looking down at something in their hands. The person in the middle is wearing a striped shirt and light-colored pants, looking towards the person on the right. The person on the right is wearing a wide-brimmed hat and a brown jacket, holding a notebook. The rice plants are tall and green, with some golden-brown panicles visible. The background shows a line of trees under a clear sky.

PROCEEDINGS OF THE
WORKSHOP ON THE

**GENETIC
CONSERVATION
OF RICE**

THE INTERNATIONAL RICE RESEARCH INSTITUTE

PROCEEDINGS OF THE
WORKSHOP ON THE
**GENETIC
CONSERVATION
OF RICE**

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**INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES
and
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International Rice Research Institute
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FOREWORD

The founders of the International Rice Research Institute (IRRI) showed great foresight when in 1960–61 they planned the establishment of a rice germplasm bank. The varietal collections that numerous national rice research centers and agricultural experiment stations have donated to IRRI provide immeasurable impetus to the rice breeding programs of IRRI and of cooperating rice-growing countries around the world.

The 100 rice breeders who attended the 1971 Rice Breeding Symposium at IRRI adopted the resolution that IRRI initiate and coordinate world-wide field collection projects. As a result, almost 20,000 seed samples from remote areas of South and Southeast Asia were acquired between 1971 and 1977.

Recognizing the serious implications of the rapid disappearance of genetic resources in those areas rich in diverse rice germplasm, the International Board for Plant Genetic Resources and IRRI cosponsored the 1977 Rice Genetic Conservation Workshop, supported by a grant from the United Nations Development Programme, executed by the World Bank.

The three primary objectives of the workshop were: 1) to collect and share information on the status of genetic resources collection and conservation among the rice-growing countries of the world, 2) to develop a 5-year plan for an international program of accelerated rice germplasm collection and conservation, and 3) to organize an international network of rice genetic resources through which scientists can share and utilize the conserved germplasm.

The 44 scientists from 18 nations who participated in the workshop added momentum to field collection efforts and promoted international and interinstitutional collaboration on the collection, characterization, and conservation of rice genetic resources. They contributed invaluable insights and suggestions, now embodied in the workshop recommendations (pages 29 to 35). We are grateful for their support of this global project.

Dr. T. T. Chang (chairman), Dr. W. R. Coffman, Dr. H. Ikehashi, and Dr. D. V. Seshu organized the workshop. Dr. T. T. Chang and Ms. T. Altamarino prepared the proceedings with assistance from Dr. T. H. Johnston who chaired the drafting committee for the workshop and compiled the workshop recommendations.

These proceedings summarize the varietal diversity of rice in rice-producing nations, review the status of national and regional collections, and assess the extent of genetic erosion. Moreover the recommendations present long-range plans for a global program of rice genetic resources collection and conservation developed through the collective judgement of concerned and knowledgeable rice researchers from around the world.

N. C. BRADY
Director General, IRRI

OPENING SESSION

The Rice Genetic Conservation Workshop, jointly sponsored by the International Rice Research Institute (IRRI) and the International Board for Plant Genetic Resources (IBPGR), was held 12–15 December, 1977 at IRRI. Workshop participants were 44 scientists from 18 countries in Asia, Africa, and the Americas, and 13 IRRI staff members (see Appendix I).

N. C. Brady, IRRI director general, opened the workshop and pointed out three main objectives:

- Sharing of knowledge on the status of collection and preservation of the rice genetic resources in the nations represented.
- Development of a plan for the next 5 years through which rice workers can obtain samples yet to be collected.
- Organize an international network of genetic resources centers through which scientists in national programs can share and fully utilize the conserved germplasm.

John B. Melford, resident representative, United Nations Development Programme (UNDP) in the Philippines, commented on the UNDP-IRRI association and said he felt that UNDP can contribute to two important IRRI programs.

- Funding of a fellowship program through which young scientists from many Asian countries are trained at IRRI.
- Support of the International Rice Testing Program (IRTP) for 5 years.

M. S. Swaminathan, director general of the Indian Council for Agricultural Research, read the message of IBPGR expressing trust that the Workshop discussions and recommendations would provide concrete results — “that our endeavors will help toward the ultimate goal of providing food for all,” and “make life in the tropics a little easier — even if results are only seen by the next generation.” (see Appendix 2).

T. T. Chang, chairman of the workshop’s organizing committee, explained that country reports presented by their respective representatives would not be published in full, but would appear as abstracts in the proceedings of the workshop.



First row (left to right): M. Jaquot, S. V. S. Shastry, Ohn Kyaw, J. Pernes, R. Seetharaman, J. Kawakalmi, M. S. Chaudry, B. H. Siwi, I. N. Ivantshenko, B. Lusanandana, N. C. Brady, T. T. Chang, Khalid Zain, G. S. Chung, S. M. H. Zaman, S. Awakul, G. L. Shrestha.
Second row: H. M. Beachell, A. J. Oakes, T. H. Johnston, K. Suwantaradon, V. N. Soldatov, H. Ikehashi, K. Kumagai, D. N. Borthakur, J. K. Roy, R. C. Chaudhary, M. A. Choudhury, G. S. Khushi, J. S. Nanda, P. B. Escuro, Md. Nasiruddin, Erlinda Pilit-Sevilla, K. L. Mehra, Z. Harahap.
Third row: H. E. Kauffman, P. R. Jennings, J. R. Cowan, D. V. Seshu, W. R. Coffman, A. G. Lyachovkin, A. R. Hamdani, N. Mamicipic, T. Masajo, R. Mondragon, A. de Matos Lopes, A. Cruz, A. Bautista.

A SURVEY OF RICE GENETIC RESOURCES AND CONSERVATION IN ASIA

Abstracts of country reports

BANGLADESH

Md. Nasiruddin and S. M. H. Zaman

Seasonal variations in environmental conditions are quite marked in Bangladesh. Rainfall varies from 150 to 500 cm with the maximum rainfall from May to September. Day length is about 10 hours during December–January and 14 hours during July–August. The annual temperature ranges from 7°C to 37°C.

Seasonal and land variations contribute to varietal diversity. Four rice groups have been identified: *aus* rice, sensitive to cold and nonsensitive to photoperiod; *transplanted aman*, sensitive to photoperiod and planted in nonflooded low-lying areas; *broadcast aman*, photoperiod sensitive and planted in low-lying flooded areas; and *boro*, tolerant of cool temperature and insensitive to photoperiod.

Most Bangladesh varieties are nonglutinous indicas. Wild and weed races also grow there.

From 1918 to 1960, 1,442 purelines cultivars were collected and purified by selection in the BRRI germplasm bank. Since 1970, 2,739 rices have been collected in collaboration with IRRI, bringing the total to 4,181.

BRRI has limited cold storage facilities. Seed are placed in paper envelopes and kept in glass jars containing silica gel. Moisture content is maintained at 10% and temperature at 5°C. Seed are rejuvenated every 5 years.

There is little genetic erosion in the broadcast aman and boro varieties because no improved varieties are suited for the deepwater areas or for the cool season. The aus and transplanted aman varieties can be readily replaced.

Questionnaires are being sent to agricultural extension technicians in Bangladesh to gather information on existing varieties and to plan future collections. The areas scheduled for collection in the next 2 to 3 years are Chittagong hill tracts, Kushtia, Rangpur, Faridpur, Khulna, Barisal, Patuakhali, Dinajpur, Sunamganj, Dacca, Comilla, northeast Mymensingh, and Pabna.

BURMA

U Ohn Kyaw and P. B. Escuro

About 2,000 rice varieties grow in Burma. Distinct climatic and ecological variations led to the differentiation of irrigated-lowland, rainfed-lowland, upland, cool-tolerant, deepwater, and saline-tolerant varieties.

The replacement of indigenous by improved varieties motivated a field collection program in 1973. By 1974, 1,111 rices had been collected in collaboration with IRRI in Karen, Mon, Kachir, and Chin states, and in Mandalay, Sagaing, Pegu, Rangoon, and Irrawaddy divisions. Subsequent collections followed.

From 1973 to 1976, 1,543 accessions were collected. After a series of field tests for adaptability, the national collection was reduced to 1,398 accessions. All were entered in 1977 wet-season trials. The collection will be maintained in a new cold storage room and will be regrown only once every 3 to 5 years.

Although the improved varieties endanger the traditional rices, their rate of farm adoption is slow.

INDIA

J. K. Roy, K. L. Mehra, D. N. Borthakur, R. C. Chaudhury, and A. R. Hamdani

The genetic wealth of cultivated and wild rice germplasm in India is rich and diverse. An initial collection of 2,000 varieties was made in 1946–47 and maintained at the Central Rice Research Institute (CRRI), Cuttack. That collection has grown through collections from different states and countries. National holdings are now 48,738, of which 14,905 are stored at CRRI and the other 33,833 at 40 research stations in 16 states. Even if 50% of the entries were duplicates, the total collection would be about 24,000.

Breeders grow the materials every year because they lack cold-storage facilities. Not only is that laborious and expensive, but seed are

often lost or mechanically mixed. Medium-term storage facilities are being constructed at CRRI and short-term facilities at a few selected state centers.

The existing Indian germplasm has been evaluated against environmental stresses and pests. Suitable donors of resistance to those stresses, as well as high-protein and scented varieties, have been identified.

Despite past collections, the Indian breeders feel that numerous traditional varieties remain uncollected and have pinpointed areas for collection of specific types in 15 states.

International collaboration is essential to safeguard the efficient preservation of rice germplasm while seed storage facilities are being built at CRRI and duplicate storage sites are being constructed.

INDONESIA

B. H. Siwi and Z. Harahap

Although rice may be grown year round in Indonesia, most farmers grow it only in the wet season. Rice culture is classified as irrigated lowland, rainfed lowland, nonirrigated upland, tidal swamp, and continuous swamp (*lebak*). Specific varieties have been identified for each culture. The indigenous rice germplasm in Indonesia contains a wealth of varietal diversity. Both indica (*cere*) and javanica (*bulu* and *gundil*) types are cultivated. Little is known about wild relatives that grow in Kalimantan, Irian Jaya, and other islands.

Although collection of rice germplasm was initiated in the 1930's, no effort was made to preserve it. In 1970–71, a more systematic program to collect and conserve indigenous germplasm was resumed. In 1972–74, more than 6,000 samples were collected from Java, Kalimantan, Sulawesi, Sumatra, and Nusa Tenggara. Further collections were made in 1975–77. By 1977, the total collection was 8,277, consisting of 5,275 indicas and 3,002 javanicas. Those were stored at the Central Research Institute for Agriculture (CRIA), Bogor; a smaller collection was sent to IRRI for preservation.

About half of the stored accessions were lost because of improper storage lowering the total existing collection to 4,388 – 3,078 indicas and 1,260 javanicas — by November 1977.

Temporary storage facilities consist of an air conditioned room maintained at 22°C and 80% relative humidity (RH). For medium-term storage, the Ford Foundation donated a walk-in refrigerated cabinet

that operates at 4°C and is 2.8 × 4.1 × 2.4 m in size. It will be installed in a building scheduled for completion in January 1978.

Most of Indonesia's indigenous rice germplasm is maintained at IRRI. Four CRIA branch stations in Sumatra, Java, Kalimantan, and Sulawesi also maintain duplicate samples of cultivars indigenous to their respective regions.

Genetic erosion has reached a critical point in Indonesia's rice production centers due to the spread of improved varieties. Plans for intensive field collection within the next 5 years are being made for regions in West Java, Aceh, Bengkulu, Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Irian Jaya.

IRAN

M. Shafi Chaudry

Rice is believed to have been introduced into Iran from Pakistan in 354 B.C. All Iranian varieties are indicas. Because there is only one growing season and most of the crop is lowland, there is little ecogenetic diversification. The commercial varieties are classified according to grain characters as *sadi*, *binan*, *gharib*, and *champa* types.

Germplasm collection began in 1956 with 594 varieties obtained mainly from Gilan province. Seed are stored in paper bags under ordinary room conditions because there are no cold-storage facilities. The accessions are planted yearly. The germplasm collection has now dwindled to 495.

Little genetic erosion has taken place, but the introduction of improved varieties and land clearing for irrigation and drainage projects continually threaten to replace the traditional rices. The farmers are receptive to improved varieties with good grain quality.

Evaluation studies confirmed that some accessions are blast resistant. But almost all have the undesirable plant type of the traditional tropical varieties.

Further collection will be implemented in 1978 in at least six provinces: Mazandaran, Khorassan, Baluchistan, Kerman, Esfahan, and Fars.

JAPAN

Jun-Ichiro Kawakami

Japan has more than 2 million ha of lowland rice, all of which are planted to japonica varieties. Twenty leading varieties are grown on about 60% of the fields.

In 1962, 1,302 local varieties were collected directly from farmers' fields. Japanese scientists have actively collected cultivated rices and their wild relatives in South and Southeast Asia, West and East Africa, and Latin America. About 100 cold-resistant and early maturing varieties were recently introduced from Hungary and Italy.

Most of the national collection, which includes 18,000 cultivated rice varieties and almost 1,000 wild relatives, is kept at the Seed Storage Laboratory, Division of Genetics, National Institute of Agricultural Sciences (NIAS), and at Kyushu University. About 90% of the collection is japonica; the remaining 10% consists of indicas and javanicas. NIAS maintains 8,177 accessions in storage. Each sample is dried to 6 to 7% moisture content. For long-term preservation, seed are stocked in vacuum-sealed containers in rooms at -10°C and less than 40% RH. Seed for distribution are kept in moistureproof containers at -1°C and less than 30% RH. Seed for distribution are expected to maintain 90% germination for about 75 years; those in long-term storage should remain viable even longer. Seed are rejuvenated at 3- to 5-year intervals.

Analysis of certain physiological characteristics on the esterase isozyme pattern of leaves, endosperm characters, and phenol reaction of grains of varieties collected mainly from tropical Asia show that the centers of great genetic diversity are in Nepal; Bhutan; Assam province, India; Burma; Vietnam; and Yunnan province, China.

KOREA (REPUBLIC OF)

Gun Sik Chung

Before the 1971 release of Tong-il, only japonica varieties were grown in Korea. But by 1977, indica-japonica varieties had spread to about 50% of the total rice area.

Systematic field collection and introduction of rice varieties started in 1906 with the establishment of the Agriculture Experiment Station. By 1977 the Station had collected and preserved 4,227 indigenous rices and introductions from 33 countries. Rices are rejuvenated every 3 years.

For long-term storage, seed are maintained at -10°C and 50% RH, or -1°C and 60% RH. For medium-term storage, the temperature is kept at 14°C but RH is not controlled. All seed are stored in aluminum cans.

An evaluation of Korean native varieties revealed some with traits that could be useful in rice improvement, including blast resistance and cold tolerance.

MALAYSIA

Mohammed Khalid Bin Mohammed Zain

Malaysia's rice germplasm collection has almost 3,800 accessions, including 2,330 of indigenous origin. The local varieties were collected with the assistance of the Tropical Agriculture Council in Japan and, later, the Malaysian Agricultural Research and Development Institute (MARDI).

Most exotic varieties were obtained from IRRI or through seed exchange among rice breeders of MARDI and major rice-growing countries.

The collections are kept in sealed plastic bags in the Koitotron seed bank at the Rice Research branch, Bumbong Lima. Moisture content is 13%; temperature is -10°C and RH is 60%. Duplicate samples are placed in plastic bags inside tin cans containing silica gel and stored in a cold room.

These rices vary considerably in traits such as morphologic characters, grain pigmentation, grain characteristics, maturity, and disease reactions. Many are resistant to blast, bacterial blight, and sheath blight.

Further collection of indigenous varieties is planned; first priority is Sabah and Sarawak, East Malaysia.

NEPAL

G. L. Shrestha

Despite Nepal's small size, thousands of local rices, including wild types, grow at from a few hundred meters to 3,900 meters altitude and under agroclimatic conditions varying from tropical to temperate.

Collection and utilization efforts were launched in 57 of the 75 districts in 1971 and 780 rices were gathered. Those range from nonsensitive to strongly sensitive to photoperiod. Some are resistant to bacterial blight; most have more than 13% protein content.

Collections are generally stored in cloth bags at room temperature. They are rejuvenated yearly.

Genetic erosion is at a slow rate. Local varieties are grown on more than 80% of the rice area, but improved varieties now cover 75% of the rice lands in the Kathmandu and Chitawan valleys.

Another collection program should be launched within a few years.

PAKISTAN

Imtizaj Hussain and M. Akbar

In Pakistan, rice is grown on about 1.73 million ha, which are concentrated primarily in Punjab and Sind provinces. Although little rice is grown in North-West Frontier and Baluchistan provinces, the local varieties are important to genetic diversity.

Most rice varieties in Pakistan are indicas and are generally grown with irrigation.

Cultivars were collected in the early 1930's, early 1940's, and 1959. About 555 accessions were collected in Punjab province and were classified in 16 agricultural and commercial groups. Because no cold storage facilities are available, the accessions are replanted annually to maintain viability.

A project to systematically collect, catalog, screen, and maintain rice germplasm was implemented in 1971 with a PL-480 grant. The project was supervised by Pakistan's Agricultural Research Council in collaboration with the Rice Research Institutes at Kala Shah Kaku, Punjab province, and Dokri, Sind province. About 900 accessions were collected from Punjab, Sind, and North-West Frontier provinces.

The agronomic and botanical traits of accessions in the national collection of 1,404 entries have been systematically recorded. The accessions have been screened for cold, salinity, and heat tolerance; for resistance to blast, bunt, stem rot, and brown leaf spot disease; and for resistance to stem borers. They are also being screened for tolerance for zinc deficiency. Resistant varieties have been identified and used in breeding programs. A project report was published.

The introduction of high-yielding varieties brings a great danger of genetic erosion in Pakistan. The new rices already occupy 71% of the rice area in Sind, 40% in Baluchistan, 1970 in North-West Frontier, and 13% in Punjab.

The provinces of Baluchistan and Azad Kashmir and the districts of Chitral, Dir, Malakand, and Kurram Agency in North-West Frontier are still rich in unexploited genetic diversity. Renewed collection efforts are also needed to extensively cover central Punjab, Swat Valley, and both banks of the Indus River.

Ecological variation is considerable among the many islands and crop seasons of the Philippines. Although rice varieties have adapted to upland and lowland conditions in the Philippines, no clearcut morphological difference separates tropical rice into distinctly upland or lowland types. Thus we have upland-adapted, lowland-adapted and dual-purpose types. Variability is great within all those types but it appears greater among lowland than upland varieties.

As many as 1,500 local varieties are estimated to be grown by farmers in the Philippines. Past introductions have been partly responsible for this varietal diversity. Most are *indicas*; a few are *javanicas*. Wild species such as *O. meyeriana* and *O. minuta* are also abundant throughout the archipelago.

The Bureau of Agriculture made the first extensive effort to assemble local rice varieties in 1908; 828 varieties under 2,430 varietal names were collected from 27 provinces. The collection triggered rice improvement work, which World War II later interrupted.

In 1962, the Philippines donated its national rice collection of 607 accessions collected jointly by University of the Philippines at Los Baños (UPLB), Bureau of Plant Industry (BPI), and Bureau of Agricultural Extension (BAE) to IRRI. Another 580 accessions were added to the IRRI world collection through further collections from 1962 to 1976.

UPLB maintains a working collection of 240 accessions in short-term storage. At the BPI Maligaya Rice Research and Training Center, 735 lowland and 108 upland varieties are stored at ordinary room temperature in galvanized iron cans. UPLB rejuvenates seed every 2 years, and BPI, yearly.

Genetic erosion in the country began with the release of the first improved variety and was accelerated in the late 1950's by the establishment of the Philippine Seed Board. All types of germplasm are threatened but the few remaining local lowland varieties are in immediate danger.

Collection is proposed in those provinces believed still rich in indigenous varieties such as relatively remote areas with large hectares of upland rice. Varieties should also be collected in provinces where most rice is grown under rainfed-lowland conditions.

Collection will be undertaken jointly by BPI, BAE, and UPLB in collaboration with IRRI.

THAILAND

K. Suwantaradon and S. Awakul

Thailand is rich in rice genetic resources, with thousands of local varieties. Factors such as consumer preference, foreign market demands, and adaptation to edaphic and topographic conditions and water regimes contribute to the genetic diversification and ecological specialization.

All indigenous rice varieties in Thailand are indicas. Wild or weed races grow in swamps, canals, and around and inside rice fields throughout the country.

Before 1950, breeding was only to improve grain quality. Local rices were intensively collected from 1950 to 1967; 6,739 samples from 67 provinces were accumulated. The accessions have been evaluated continuously since then. Some selection was done and only those samples with potential were saved. Limited collections have subsequently been made.

The present national collection includes 3,050 accessions, of which 2,434 are cataloged. Those are kept in an air-conditioned room at the Bangkhen Rice Station. Small samples (10–15 g) are stored in tin cans and large samples (500 g) in glass jars. Room conditions are 23°C and 80% RH. Only about 2,000 of the accessions are now viable. Viability loss is due to age, unsuitable containers, and relatively high temperature and RH in the storage room.

Genetic erosion in upland rice is rather slow because the mountainous areas are remote and no recommended upland variety is yet being grown. But genetic diversity in lowland and floating rice faces serious deterioration as improved varieties released since 1966 are replacing local varieties. Another factor that destroys germplasm is improvements that allow farmers to adopt new varieties, such as the construction of dams, reservoirs, irrigation canals, and new highways (which also prevent floods, control water levels, and decrease water depths).

Rices should be extensively collected, especially in areas not previously collected, such as in the provinces bordering Burma, Indochina, and Malaysia. Although the urgency of collection has long been recognized, several problems must be resolved such as lack of travel funds and inadequate manpower for collection and evaluation.

A. G. Lyachovkin

Rice was introduced into the USSR more than 2,000 years ago. Most is grown in soils considered unsuited for other crops. Rice grows under varying climatic patterns.

Collection of rice varieties and their wild relatives began in 1923 when N.I. Vavilov started a private collection. Today the rice collection contains 3,200 accessions from rice-producing areas of the USSR and 44 foreign countries. Expansion of the collection is mainly through foreign expeditions and seed exchange.

Studies on the origin, morphological, and principal ecological traits of diverse collections led to eight eco-geographic groups: Far Eastern, South Asian, Philippines, Central Asian, Transcaucasian, European, African, and Latin American. Each group consists of one or more ecotypes. This classification facilitates the choice of initial germplasm for breeding programs in specific areas. Immunochemical analyses are being done to more precisely classify cultivated rice into botanical subspecies.

IRRI'S ROLE IN THE CONSERVATION OF RICE GENETIC RESOURCES

T. T. Chang

In 1961 IRRI decided to assemble rice accessions from national centers for its germplasm bank; in 1971, at the suggestion of 100 rice breeders, IRRI decided to launch and coordinate the field collection of unimproved rices in tropical Asia.

The two decisions were timely. From 1972 to 1977, numerous rice workers in national research programs, along with agricultural extension officers in remote areas, collaborated with IRRI to extensively canvass the country side and collect 8,018 seed samples in 7 Asian countries. Diverse funding agencies pooled their resources to help support the collection. From 1971 to 1977 another 16,083 samples of the two cultivated species were sent to IRRI by plant explorers, extension officers, staff of international service organizations, university faculty and staff, and researchers in other international agricultural institutions. Thirteen Asian and three African nations were involved in the massive collection activities.

Most of the collected samples were minor varieties or special types. In the last 6 years, IRRI's collection of *O. sativa* accessions has tripled

to about 44,600; the collection of *O. glaberrima* populations has increased seven-fold. About 100 wild taxa were also collected. Local workers claimed that almost 5,000 samples had resistance to pests or tolerance to ecoedaphic stresses. The combined field-collection efforts have undoubtedly counterbalanced the replacement of indigenous germplasm by the improved varieties and simultaneously enriched the IRRI collection with old land races and special types.

Expansion of systematic screening for desirable traits through IRRI's Genetic Evaluation and Utilization (GEU) program accompanied the growth of the germplasm bank. Many resistant or tolerant sources have been channeled into the International Rice Testing Program (IRTP) for use by rice researchers in 46 nations. Such activities will expand.

Every viable accessions is maintained in medium-term storage; the others in short-term storage. A duplicate set of 18,780 accessions is stored at the U.S. National Seed Laboratory, Ft. Collins, Colorado, U.S.A. Long-term seed storage will become operative in 1978. To safekeep the world's conserved seedstock, a collaborative scheme to share and divide responsibilities for preservation, rejuvenation, and distribution is proposed. The scheme will include international agricultural research centers, seed banks, and major national genetic resources centers.

A uniform system to record collected samples and characterize conserved stocks is essential to quickly and freely exchange information among research centers. At IRRI the adoption of a decimal coding scale in the early 1960's facilitated the computerized processing and retrieval of morpho-agronomic data. Further refinement of the recording scheme will assist national centers in genetic resources operations.

But many unimproved genotypes that tolerate ecoedaphic stresses remain to be collected. A combined analysis based on several fields of study suggests that northeast India, Sikkim, and Bhutan; upper Burma; northern Vietnam; and southwestern China are areas potentially rich in uncollected germplasm.

GENERAL DISCUSSION

Discussions after Asian country reports indicated that common problems that face many countries are lack of refrigerated seed storage facilities, limited staff to collect and maintain the germplasm, and lack of continuity in personnel. Furthermore, extension workers often do

not collect seed samples at the correct time, so the seed has low viability or no viability. On the other hand, Japan plans to build a seed storage laboratory large enough to hold all of the japonica varieties. India is also establishing a storage facility that can handle 100,000 samples in medium-term and 200,000 samples in short-term storage.

Another common problem facing Asian rice genetic stock officers is the abundance of duplicates in collections. Some duplicate accessions may be traced to the same place of origin but they might have obvious morpho-agronomic differences. The participants agreed that rice researchers must not hastily discard duplicates or mixtures of genotypes, other than obvious mechanical mixtures. It was suggested that seed of the variants be bulked and labeled as a composite genepool. Such a composite might contain important genes. Also, if promising traits are found in mixed samples from a region, researchers return there later to further collect the germplasm.

Several participants mentioned specific characteristics of collected samples. Some varieties have high protein content and good yield potential. Several Assam Rice Collection (ARC) accessions from India are resistant to both drought and blast. The conferees suggested that a complete list of such resistant sources not included in the country reports be provided to T. T. Chang, leader of IRRI's genetic resources program.

To facilitate international collaboration in evaluation and characterization, it is important to have common descriptors and descriptor states. Such uniformity would also help interlink data systems of different centers.

The usefulness of printed catalogs is being superseded by the computerized printouts of desired data according to a researcher's specific requirements. Therefore, IRRI does not plan to print additional varietal catalogs. Instead, rice researchers may request IRRI to provide the desired information according to specific characters.

Some experiment stations have given new names to foreign introductions with no reference to original name or source — a practice that leads to confusion and duplication. The conferees recognized that the varietal name is an important link in international seed exchange and urged retention of the original designations or sources.

Many national genetic resources centers lack trained personnel for collection and conservation. N. C. Brady, IRRI director general, indicated that if the group identified inadequate training as a limiting factor, IRRI could help in such training.

A SURVEY OF RICE GENETIC RESOURCES AND CONSERVATION IN AFRICA AND THE AMERICAS

Abstracts of reports

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (IITA)

S. V. S. Shastry

The major responsibility of the Genetic Resources Unit of the International Institute of Tropical Agriculture (IITA) is to conserve plant genetic resources in sub-Saharan Africa. Its duties are to collect, conserve, evaluate, and document the genetic resources of crops including rice.

The African germplasm includes two cultivated species, *O. sativa* and *O. glaberrima*, and eight wild species. Ecoedaphic conditions under which rice grows range from deepwater swamps to rainfed uplands. Thus, diversity is impressive.

Prior to 1976, collection in Africa was done mainly by the National Institute of Genetics, Japan; Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT), France; United Nations Development Programme (UNDP), Liberia; the University of Illinois, U.S.A., and IITA. Those institutions had gathered 5,042 accessions by the end of July 1976. Collections organized by IITA in 1976 yielded 428 samples. In early 1977, 100 new *O. glaberrima* and 450 *O. sativa* types were collected.

IITA has both medium- and short-term storage facilities. The medium-term storage has a capacity of 220 m³ maintained at 5°C and 60 to 65% RH. For short-term storage, seeds are kept in vaporproof packets in a 385 m³ storeroom at 18°C and 40 to 50% RH. In 1978, IITA plans to install a long-term (-20°C) storage facility with a capacity of 20,000 samples.

The IITA timetable for exploration is: 1978 – Guinea, Guinea-Bissau, and parts of Ivory Coast, Cameroon, Togo, Benin, southeast Upper Volta, Tanzania, Zanzibar, and Fernando Po; 1979 – southwest

Ethiopia, Central African Republic, southern Chad, Gambia, and Senegal; 1980 – Gabon, Congo Brazzaville, parts of Zaire, and southern Sudan. Collection in the remaining parts of the horn of Africa – north Sudan, Kenya, Uganda, Malawi, Zambia, Mozambique, Mauritius, Angola, South Africa, and Rhodesia – will begin in the early 1980's.

All aspects of genetic conservation in Africa will be carried out through close working relationships with other organizations, such as IRRI, IRAT, Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM), West Africa Rice Development Association (WARDA), and the national genetic resources centers.

INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES (IRAT)

M. Jacquot

IRAT is a French research institute established to ensure scientific and technical cooperation with francophone Africa.

Factors that contribute to the great varietal diversity in Africa include the wide range of ecological zones and ecosystems in which rice grows. In addition to *O. sativa* and *O. glaberrima*, two other species with the AA genome, *O. longistaminata* and *O. barthii*, are found in Africa. Wild species such as *O. brachyantha*, *O. eichingeri*, and *O. punctata* are also found.

From 1950 to 1976, 860 *O. sativa* ecotypes were collected in the Ivory Coast, Liberia, Guinea, Upper Volta, and Malagasy. Before 1974, 450 *O. glaberrima* ecotypes were gathered in Mali, Liberia, Ivory Coast, and Senegal. The collections are kept in air-conditioned rooms or stored at 4°C with uncontrolled RH.

IRAT formulated future collection in collaboration with ORSTOM. In 1978, Malagasy, Zambia, Guinea, and Guinea-Bissau will be explored for rice ecotypes and varieties.

Most African and Malagasy rice resources are envisioned to be collected before 1979. Rice researchers should recognize the urgency of saving the species, especially *O. glaberrima* and *O. barthii*.

The IRAT staff acknowledges the collaboration of ORSTOM, the governments of African countries and Malagasy, IRRI, IITA, WARDA, and IBPGR in its collection work.

M. J. Pernes

The interest of ORSTOM-IRAT in collecting *Oryza* species in Africa has four considerations.

1. *O. sativa* varieties are quickly replacing *O. glaberrima*, which may possess certain needed adaptation, resistance, palatability, and other characters.

2. Drought-resistant upland varieties suited to the randomly fluctuating environment have evolved within the *O. sativa* or *O. glaberrima* species. This trait could also be acquired from the weed species *O. breviligulata*, which has adapted to grow in the savanna.

3. Weed and wild *Oryza* races should be collected; they may have various gene structures for general homeostasis.

4. Analysis of crosses between Asiatic and African species would determine which species is the common ancestor of both Asiatic and African series.

Collection from 1974 to 1976 was mainly for a study of crop evolution. About 1,000 samples of *O. glaberrima* and *O. breviligulata* and a few *O. longistaminata* and traditional *sativa* varieties were collected in the central Niger Delta of Mali and in Senegambia.

Recommended collection strategies for Africa include:

1. to systematically sample the cultivated species, paying special attention to areas where *O. glaberrima* and traditional *O. sativa* are commonly grown;

2. to search for cultivars in marginal areas far from the main roads;

3. to search for truly wild *O. breviligulata*; and

4. to sample in depth the reduced number of *O. longistaminata* populations.

Two ORSTOM-IRAT teams are collecting plant samples in areas around Lake Tchad in Tchad, and in eastern Senegal, Ivory Coast, and Mali, Zambia, Tanzania, and Malagasy are scheduled for collection in 1978.

WEST AFRICA RICE DEVELOPMENT ASSOCIATION (WARDA)

M. A. Choudhury

The conservation of rice germplasm is a major activity of WARDA. It began its rice germplasm collection in West Africa in the main crop season of 1977.

There are four WARDA regional research projects.

1. *Mangrove Swamp Rice Research Project, Rokupr, Sierra Leone.*
Collection of rice germplasm from mangrove swamps of the region began in 1977. A program of intensive collection to begin in 1978 is being developed. Germplasm will be collected directly by the staff and through the cooperation of scientists in WARDA member countries. A cold-room facility for short-term storage is being developed at the Rokupr station.
2. *Deepwater and Flooded Rice Research Project, Mopti, Mali.*
Collection of deepwater and flooded rice germplasm began in 1977 and programs for intensive collection are being developed. ORSTOM has collected some deepwater rice and wild taxa. Cooperation with ORSTOM and IITA will be maintained.
3. *Irrigated Rice Research Project, Richard-Toll, Senegal.*
The scope is limited so there will be little effort for collection at the station.
4. *Upland Rice Research Project, Bouake, Ivory Coast.*
IRAT has initiated a good collection of the region's upland rice and expects to continue. Therefore, the WARDA team will not engage in detailed collection.

The WARDA region has been divided into five subregions with headquarters in Liberia, Ghana, Gambia, Niger, and Upper Volta. Subregional coordinators staff four of the subregions; the fifth is managed from WARDA headquarters in Monrovia. The subregional coordinators will routinely collect rice germplasm from their areas and forward it to the respective research projects. This activity will be initiated in 1978 and intensified in 1979, with research assistants posted at each subregion.

WARDA's cold-room facilities for medium-term storage at Fandell, Liberia, are being improved. WARDA will continue to share samples of all collected germplasm with IRRI, IITA, and IRAT.

UNITED STATES OF AMERICA (U.S.A.)

T. H. Johnston, A. J. Oakes, J. N. Rutger, W. F. Lehman, W. O. McIlrath, and C. N. Bollich

Rice was introduced to the United States less than 400 years ago. Germplasm diversity is primarily limited to foreign introductions or varieties and lines developed from them.

Rices presently grown in the U.S.A. contain germplasm from old and improved cultivars from Japan, Philippines, China, India, Indonesia, and other countries. But many of the cultivars presently grown in the U.S.A. have similar genetic backgrounds. Major efforts to broaden the genetic base of improved varieties being developed are being made in cooperative breeding programs.

The world collection of rice of the U.S. Department of Agriculture (USDA) contains about 15,000 entries, maintained in medium-term storage. The seed are rejuvenated at 8- to 10-year intervals. About 10,000 accessions are in the "active" collection, of which 5-g seed samples can usually be made available. Most of those accessions have already been included in the IRRI germplasm bank. Small samples of many of the rices are also stored at alternate sites.

All rice introduced into the U.S.A. from other countries must be initially grown for one generation in a plant quarantine greenhouse or nursery that is well isolated from commercial rice-growing areas.

The USDA accessions are characterized and evaluated as rapidly and completely as possible, contingent upon funding, personnel, and field and laboratory facilities. Additional agronomic and quality data are obtained as entries are rejuvenated. Much of the collection has been screened for resistance to major diseases, field and storage insects, and for other desirable traits such as cold tolerance. The data are entered in the USDA World Collection Rice Data Bank, which is patterned after the Rice Data Bank System of Louisiana State University.

Academic studies included the interrelationships among several agronomic traits and chemical characteristics of the endosperm, and research on the relationship of protein content, seed size, and tillering capacity to performance when drill-seeded.

In California, induced mutations have been used to obtain useful genes for short stature, early maturity, and the glutinous endosperm. Such genes have been incorporated into backgrounds adapted to California conditions. To better utilize existing germplasm, the establishment of instant germplasm reservoir packages that could quickly be put to use in areas with serious new pest problems should be seriously considered. IRRI could develop such gene pools in cooperation with researchers in national programs. Furthermore, IRRI could annually compile and list all new cultivars and elite germplasm in the world and distribute it to rice breeders. Seed of the new releases might also be made readily available for use in other breeding programs.

Latin America has extremely varied agroecological niches of rice cultivation. But, genetic variability is low because rice was recently introduced and few rice pests have entered the region or evolved. Population pressure on the demand for rice is low.

All Latin American rice is indica except in small areas of Chile and Uruguay.

There are practically no collections in Latin America and only Brazil, Colombia, Cuba, Peru, Mexico, and Surinam have breeding programs.

Genetic erosion has been fairly heavy – sometimes almost 100% in tropical and temperate irrigated areas and in mechanized upland areas. There has been almost no erosion in the unmechanized upland areas.

Only Brazil has plans for collection. Areas where collection could be valuable, and the means of collection available are:

1. upland rice areas in Brazil, particularly in southern Maranhao for resistance to aluminum toxicity, with coordination with EMBRAPA (Brazilian Agriculture Research Enterprise);
2. old and new SML varieties in Surinam and elsewhere that have horizontal resistance to blast, through correspondence with Surinam researchers; and
3. upland unmechanized areas in northern Colombia, southern Mexico, and Ecuador, through the IRRI representative at CIAT.

BRAZIL

Altevir de Matos Lopes

Before 1974, rice research in Brazil was carried out by the former National Agronomic Research Department. Because there was no specific institution to maintain genetic resources, each regional institute maintained its own collection. Plant breeders introduced most of the material.

With the founding of the EMBRAPA in 1974, the National Center for Genetic Resources (CENARGEN) was organized, and became the central long-term storage site of about 4,000 accessions, including duplicates from across Brazil. The National Research Center for Rice and Beans (CNPAF) is in charge of medium-term storage where seed are kept in paper bags or cotton sacks at 8 to 10°C and 30 to 40% RH. Seed are rejuvenated when germination drops to about 50%.

A 1976–77 preliminary survey by CNPAF in cooperation with the Brazilian Extension Service System (EMBRATER) showed that only 18% of the total cultivated rice area in Brazil grew improved varieties. The areas planted to unimproved varieties (82%) are valuable resources for breeding programs and are being collected.

All collected seed and data are sent to CENARGEN for long-term storage. Most collection in Brazil will be done cooperatively among CNPAF, CENARGEN, and EMBRATER. The group welcomes collaboration and advice from international institutes such as IRRI, CIAT, IRAT, and IITA.

GENERAL DISCUSSION

Cooperative effort for the conservation of rice germplasm in Africa have increased in recent years. IITA, IRAT, ORSTOM, WARDA and other institutions involved feel that the reports covered all vital issues discussed in previous meetings. Field collection should be implemented according to the plans as soon as possible.



Participants developing a preliminary plan for field collection in South Asia (front portion, L to R, D. N. Borthakur, Md. Nasiruddin, J. K. Roy, and G. L. Shrestha).



Participants studying an outline for field collection in Southeast Asia (L to R, J. Kawakami, B. H. Sivi, Z. Harahap, and K. Zain).

FIVE-YEAR FIELD COLLECTION PLANS

Each country was requested to formulate 5-year field collection plans based on guidelines distributed by T. T. Chang. Participants in the session on field collection formed four geographic groups, each with a leader: Africa – S. V. S. Shastry; South Asia – J. K. Roy; Southeast Asia – B. H. Siwi, and Latin America – P. R. Jennings.

The group leaders discussed the country programs with representatives of other countries in the same regions, consolidated the information, and presented a 5-year field collection plan for each region to Workshop participants, which was discussed and approved (see Recommendations of the Workshop, part II). Although the participants did not indicate financial resources required for the various field collection activities, it was obvious that outside funding would be needed in specific instances.

PRESERVATION, REJUVENATION AND DATA MANAGEMENT

DISCUSSION

T. H. Johnston presented a proposed collaborative plan for preservation and rejuvenation of conserved stocks initially prepared by T. T. Chang. The proposal was discussed and a number of additions and revisions suggested. The approved form of the collaborative plan is in part III of Recommendations.

The preservation of allopolyploid hybrids of wide crosses and anther cultures in addition to cultivars and breeding lines, was suggested. Physiological studies to detect genetic changes of seed under long-term storage must be conducted. Peripheral or terminal places of rice cultivation, as well as centers of diversity, must be explored. Archaeological findings of rice remains should be collected and preserved.

Seed science and seed production should be considered if the Workshop plans to discuss maintenance of a broad genetic base. Seed viability under long-term storage must be studied and monitored.

Abstracts of reports

THE ROLE OF SEED TECHNOLOGY IN GERMPLASM UTILIZATION

J. R. Cowan and T. T. Chang

Seed is the vehicle of superior germplasm. Seed technology, or seed science, provides inputs for the proper and efficient maintenance, multiplication, and distribution of seeds of improved cultivars. In many developing countries, several important steps in the process from varietal release to commercial production are often weak or neglected. In modern seed technology, a multidisciplinary approach to seed

maintenance and handling could ensure high-quality seed and efficient use of superior germplasm.

The careful choice of a clean nursery and accurate knowledge of the previous history of seed fields complements efforts on roguing and reduces errors in field certification. The true identity of a superior genotype should be fully described and maintained with due recognition to intravarietal variation.

To spread improved genotypes rapidly, certified seed of new releases should be made available to large numbers of farmers in small properly labeled, sealed packages rather than in large sacks.

While many international organizations recognize the importance of seed science, more efforts should be devoted to the training of personnel, further research on seed physiology, and improved storage in the tropics. A workshop on the seed science of rice should be held in the near future.

THE COMPUTERIZED MANAGEMENT SYSTEM FOR THE IRRI GERMPLASM BANK^a

K. A. Gomez, T. T. Chang, C. J. Francisco, and M. A. Chan

The IRRI germplasm bank currently maintains more than 44,000 distinct accessions and ecostrains of *O. sativa*. Information on 37 morpho-agronomic traits and 38 Genetic Evaluation and Utilization (GEU) traits are kept for each accession. Two computer-based systems have been developed to facilitate the management of such a large germplasm bank: one services the data management and another is for seed management. Data management involves the creation of a computer data bank containing all existing data on each accession with the ability to instantly retrieve desired accessions with specified combinations of traits. The seed management system monitors and records seed movement and instantly retrieves information on existing seed stocks and the history of seed movement for any desired accession. All germplasm bank data files are compatible with other GEU data files and allow easy linkage with and retrieval of all types of information for a given accession.

^aAfter this paper was presented, the IRRI Statistics Department gave the participants a demonstration on information retrieval.

CONCLUDING SESSION

The Workshop participants discussed, modified, and adopted the recommendations prepared by the drafting committee (T. H. Johnston, T. T. Chang, J. Kawakami, J. K. Roy, S. V. S. Shastry, and B. H. Siwi).

N. C. Brady congratulated and thanked the participants for their active role in the Workshop and their invaluable contributions to the future plan for genetic conservation. He also reminded the group that each participant, upon his return to his respective station, should familiarize his superiors with the decisions of the Workshop. Brady will follow up on the Workshop plan of action by writing to the top agricultural administrator in each country concerned.

RECOMMENDATIONS OF THE WORKSHOP ON RICE GENETIC CONSERVATION

The Workshop recognized the extreme urgency of collecting, preserving, and evaluating all of the older, unimproved cultivars and wild relatives of *Oryza sativa* and *O. glaberrima* wherever they exist.

I. GENERAL CONSIDERATIONS RELATED TO FIELD COLLECTION

A. All national and regional centers concerned with the genetic conservation of rice and IRRI should accelerate and intensify their collection rates in the next 5 years.

B. Definite guidelines are needed to determine which areas and countries should be assigned the highest priority for exploration and collection of traditional, unimproved varieties and wild relatives of both *O. sativa* and *O. glaberrima*. Criteria to be considered should include:

1. the rate at which improved cultivars are replacing local or traditional varieties;
2. the richness of genetic diversity and range of environments within the countries or areas;
3. the time and extent of past collection efforts;
4. the accessibility of potentially rich germplasm areas to field collectors; and
5. the extent of local (in-country) support for collecting.

C. The priority for collection (in order) should be primitive cultivars, wild species of the A-genome (which can contribute to the breeding programs), improved local varieties, mutants (including structural chromosome variants), and wild species distantly related to the cultivated species.

D. The Workshop recognized the relative priorities of geographical areas for collection of rice cultivars and their closely related wild and weed taxa. IBPGR, FAO, and national governments should consider

these proposals in the respective regional symposia before initiating field collection programs.

E. Not distracted by the size of existing collections, all collaborating scientists should continue to identify the gaps in worldwide collections and communicate with respective regional and national programs to ensure that missing cultivars and wild taxa are collected.

F. Field workers should collect enough seed of each sample so they can send a portion directly to IRRI or a regional center that participates in the coordinated collection activities, or to both. This will help ensure against loss of any accession.

G. Where possible, the germplasm collectors should be trained within the country of collection. International institutes should provide suitable literature and training opportunities to ensure uniformity of criteria for field collection, systematic evaluation, and data collection.

II. FIVE-YEAR PLAN FOR COLLECTION

The action plan for the next 5 years developed by the participants is summarized below. Where applicable, for each country, the agency responsible for coordination of collection activities is italicized.^a More details appear in Appendix 3.

A. *Africa:*

1. All of Africa, particularly Gambia, Mali, Ghana, Benin, Togo, and Nigeria – IITA.
2. Tanzania and Zambia, and all Francophone African countries, particularly Senegal, Mali, Upper Volta, Guinea, Guinea-Bissau, Niger, Cameroon, Chad, and Malagasy – IRAT and ORSTOM.
3. All West African countries, particularly Senegal, Gambia, Mali, and Upper Volta – WARDA.

B. *Southeast Asia:*

1. Burma* – *ARI*, Central Farm, and Extension Service
2. Thailand* – Rice Division
3. Philippines* – *UPLB*, BPI, BAEx
4. Indonesia* – CRIA
5. Malaysia* – MARDI

^a See Appendix 4 for full names of acronyms.

*Participation of IRRI staff members may be required in collection activities.

C. *South Asia:*

1. Bangladesh* – *BRRRI* and Department of Agriculture
2. India* – *NBPGR*, *CRRI*, *ICAR-Complex*, agricultural universities, and state departments of agriculture
3. Nepal* – *NRIP*, *ICP*
4. Pakistan* – *ARC*
5. Sri Lanka* – *CARI* (Sri Lanka-IRRI collaboration was agreed on early in 1977)

D. *West Asia:*

1. Iran* – *S & PII*, Rasht and Amol Rice Research Stations
2. U.S.S.R. – *VIR*, *AURRI*

E. *Central and South America:*

1. Brazil* – *EMBRAPA*, *EMBRATER*
2. Colombia, Ecuador, Guyana, Mexico, and Surinam – *CIAT-IRRI*

F. *Other countries:*

The workshop recommended that IRRI contact officials in other countries rich in germplasm such as China, Vietnam, Cambodia, and Laos, whose scientists were not present at the Workshop, and invite them to participate in the collaborative collection scheme.

G. The Workshop urged all collaborating national governments to endorse and implement their portions of the proposed action programs as completely as possible before their irreplaceable germplasm is lost.

H. The Workshop urged that IRRI coordinate and pool technical and financial support for these collection activities where needed.

*Participation of IRRI staff members may be required in collection activities.

III. COLLABORATIVE PLAN TO PRESERVE AND REJUVENATE CONSERVED RICE SEEDSTOCKS

The following comprehensive plan of action suggests a division of responsibilities among the participating countries and international institutes.

A. A complete set of conserved stocks (the base collection) should be preserved in long-term seed storage at IRRI. National and international centers should provide to IRRI fresh and healthy seed of those stocks not already conserved there and of stocks that IRRI cannot effectively rejuvenate (see points C, D, E, and H).

B. IRRI should preserve, rejuvenate, and distribute the indica and javanica cultivars and breeding lines of *O. sativa* and other *Oryza* species except for those from Africa.

C. Japan should preserve, rejuvenate, and distribute as many of the japonica varieties of East Asia as possible.

D. The United States should preserve, rejuvenate, and distribute varieties from the U.S., temperate South America, and the Mediterranean area; the U.S. also should continue to store duplicate samples of conserved IRRI stocks.

E. IITA should preserve, rejuvenate, and distribute cultivars of *O. glaberrima* and wild species of Africa. IRAT plans to collaborate with IITA on seed multiplication. IRAT, ORSTOM, and WARDA plan to collaborate with IITA on medium-term storage.

F. The above centers should exchange and carefully compare accession lists to minimize the maintenance of obviously duplicate accessions within single collections and to ensure that no distinct accession or ecostrain is overlooked in the inventorial process.

G. Major germplasm centers are urged to keep complete duplicate sets of accession records at separate locations to avoid loss through fire or other disasters. In the acquisition or exchange and use of accessions from major collections, original names and accession numbers should be included in the continuing records for cross reference purposes. Major germplasm centers are encouraged to standardize record systems. Where such standardization is impractical, compatibility of separate systems should be assured.

H. Each national and regional center should preserve and rejuvenate its complete collection or at least a working collection, and assist the major germplasm centers to increase and rejuvenate accessions that are poorly adapted to the growing conditions at the centers.

IV. SPECIFIC CONSIDERATIONS RELATED TO MANAGEMENT OF GENETIC RESOURCES

A. National collection should continuously replace the missing accessions with stock from the base collection at IRRI, and vice versa.

B. Procedures and guidelines should be developed for collecting and cataloging of minor variants such as ecostrains, induced mutants, and other genetic manipulations of varieties.

C. Participants recommend that germplasm conservationists at some locations try to “trap” genes from closely related wild species (for example, by growing domesticated and wild types in close proximity to take advantage of natural crossing).

D. Countries that plan to initiate rice breeding programs may need a minimum working collection. The International Rice Observational Yield Nursery of the International Rice Testing Program will provide widely divergent varieties and information to fulfill this need.

E. For the identification and avoidance of duplicates in germplasm collections, observations on biochemical characters and root characters may be included in addition to the conventional agromorphological characters currently taken on each accession.

F. Realizing that geographic environments differentially affect field performance and agronomic characters of varieties, stored data on such characters should include the date and location where such data were taken.

G. All countries that lack adequate facilities for medium-term seed storage are urged to send duplicate samples of all accessions in their collections to IRRI for safe storage if they have not previously done so. National programs should give high priority to the establishment of facilities for medium-term storage.

H. Variation may exist within a collected sample or population. In order to fully utilize such material, it is suggested that the original sample designation should be retained as part of the continuing identification in any division of the sample according to type.

I. Apparent off-types within named varieties should be retained in the collections – not discarded – unless they are obviously mechanical mixtures. Otherwise they should be designated as subsamples of the original accessions. When seedstocks are rejuvenated, the same care should be taken to not rogue out variants present in the original sample and thus lose potentially valuable genes forever.

J. Morphologic and other economic traits recorded in the data systems of the germplasm centers should be expanded periodically to include data collected at other locations. Also the inclusion of additional characteristics in the data system may be desirable.

K. There should be further standardization of terminology used in collection, preservation, and utilization of germplasm.

L. Recognizing the frequent changes in taxonomic nomenclature, the Workshop recommended that synonyms be identified in all rice collection catalogs.

M. The Workshop stressed the importance of having continuity in personnel experienced in germplasm conservation and in accurate record keeping for the proper maintenance, evaluation, and utilization of rice germplasm.

N. An urgent need to collect germplasm of wild and weed races of rice was recognized. To properly carry out such collection activities, specialized training conducted in the locality of the materials is highly desirable.

O. The Workshop expressed the desirability of adequate training of workers for field collection, maintenance, storage, and utilization of valuable germplasm.

V. FUTURE PLANS

A. It is strongly recommended to IBPGR and collaborating national governments that similar workshop be organized and held within 3 to 4 years. IBPGR and collaborating international agricultural research institutes might sponsor such a workshop to assess progress and to develop continuing action plans for conservation of rice genetic resources.

B. An organizing committee should be set up in the immediate future to develop plans for a comprehensive Seed Science Workshop to be held within the next 2 years.

C. Definite plans should be made to request nations that have areas of rich diversity of wild types to preserve such areas as natural reserves. Living collections, particularly of wild species, should also be maintain maintained at two or more locations.

APPENDICES

Appendix 1. Participants and observers.^a

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Appendix 2. Address by the IBPGR to the Workshop on Rice Genetic Conservation, IRRI, Los Baños, Philippines. 12–15 December 1977.

Life in the tropics is not easy, and the assurance of a good life for an ever-increasing population requires the agricultural experience from the past as well as the new technology of the present to be applied to food production to alleviate any struggle for food or even survival.

This workshop on genetic resources conservation is hosted by IRRI. This is an international institute aimed specifically at supplying the technology for immediate use in agriculture to increase the production and quality of rice – the staple crop for the many millions of people in the tropics. At the same time, this workshop is cosponsored by the International Board for Plant Genetic Resources (IBPGR) and we should like to take some time to explain the aims of this latter organization and to point out how, in its own way, it is working to safeguard the material required by the breeders to produce food for future generations.

The Board was established by the Consultative Group on International Agricultural Research – the parent body – and the International Centres, of which IRRI is one. The Board was established to ensure that the genetic variability in economic species of plants is collected and conserved so that it is available for use by the plant breeders and by research workers interested in other aspects of agriculture. The Board's objectives are therefore to develop international collaboration among the members of a global network of institutions active in the exploration, collection, conservation, documentation and use of plant genetic resources. The Board completed its first full year of work in 1975 and in order to develop its policies further, adopted an initial set of priorities both among crops and regions.

The need to collect and conserve the genetic availability of our cultivated plants has been recognized for many years. Since the early 1960's international scientists have been talking about those needs and there has been significant crystallization of scientific ideas through the activities of the Food and Agriculture Organization of the United Nations. The foundation of the IBPGR represented a further stimulus which, with some

funding, is now leading to the much needed action in those areas of the world where there is significant genetic diversity. In addition, the Board is acting as a catalyst for action and the cooperation and support which the Board has received clearly demonstrates the increasing concern by many institutions and national programmes.

Since the IBPGR is a member of the Consultative Group, it is to be expected that it works closely with its sister centers such as IRRI, IITA, CIAT, ICRISAT, CIMMYT, and CIP (which have a mandate from the Consultative Group for global responsibility for major crops) in a partnership in which the action required to further the Board's objectives is linked to the very real implementation of the findings of modern science continually coming out from the centers.

In organizing the network – in which centers such as IRRI will form an essential part as will some regional centers and all those national centers dealing with genetic resources – the Board requires a free exchange of genetic materials and of information related to them, the duplication of base collections (the collections held for long-term conservation) and the deposit of duplicates of all materials in the countries in which they are collected. Nevertheless, this somewhat administrative role of the Board is supplemented by its role in helping plant breeders make more effective use of the very substantial quantities of genetic materials which are collected or already held in collections but which are, in many cases, poorly and ineffectively documented.

In order for the Board's action to reflect the requirements and wishes of the world communities of plant breeders dealing with diverse crops, several Crop Advisory Committees have been established by the Board and co-sponsored where appropriate by an International Center. In the first instance, these deal with major staple food crops and to-date there are five committees dealing respectively with rice, wheat, maize, sorghum and millets and beans. These committees have provided a sharper focus on the Board's future collection programme and effective activities in the various geographic regions

Appendix 2. Address by the IBPGR (Continued)

covering all aspects of genetic resources work are now becoming a reality following the meetings and the recommendations of these committees. The work started recently forms a crucial dimension to the proposed international network.

The Board continues to support the computerized genetic resources, communication, information and documentation system developed at the University of Colorado at Boulder, through the use of which it should be possible eventually to maintain inventories of all major collections, in such a way that useful information can be easily retrieved. An important function of the Crop Advisory Committees in this respect is to agree upon the standard list of descriptors for each crop. This remains an important task for the Rice Committee and the list should be one that is generally agreed by all breeders.

The Rice Advisory Committee held its first meeting in 1976 and it recommended that the IBPGR should designate responsibility for the storage and conservation of seed stocks in several major institutes. IRRI will continue to play a central role and specialize in the preservation and regeneration of the indica and javanica varieties of *Oryza sativa*.

In addition, the Committee stressed the alarming lack of indigenous land races, wild species and weedy races in the existing collections. This recommendation was made despite the relatively large numbers of stocks held by IRRI. The Board has endorsed the collection plans of IRRI in which it cooperates with local farmers and national programs throughout the areas of indigenous variation. This workshop aims to discuss definitive plans for the future to enable the adequate capture of the genetic variability of this important crop and the IBPGR looks forward with great interest to the recommendations of this meeting.

This workshop coincides with the inauguration of the splendid new genetic resources facility at IRRI. This includes long and medium-term seed storage. Standards and recommendations for long-term seed storage conditions were developed by an expert panel convened by and approved by the Board in

1976. The IBPGR is pleased at the standards of the new IRRI facility and continues its policy of encouraging an upgrading of storage facilities to recommended standards in other genebanks. The Board commends IRRI on the excellence of its facility and acknowledges the technical expertise that IRRI has consulted in order to ensure such a first-class, modern and up-to-date installation.

It is fair to say that work on the genetic resources of rice is far advanced due to the excellent record of IRRI. From the outset, IRRI has laid great stress on the maintenance of a large collection of seed stocks and its programs rely heavily on the genetic resources evaluation work which is a day-to-day routine. There is no need to go into the success of this evaluation program but it is worth remembering that it can be necessary to screen many thousands of accessions in order to find a single trait to include in a breeding program.

The IBPGR therefore confidently looks to the future for the work on genetic resources of the rice crop and will continue to rely heavily on the deliberations of its Rice Committee which IRRI co-sponsors. This Committee will be holding its second meeting at the end of this workshop and will condense the ideas put forward during the workshop into recommendations for concrete action which the IBPGR will consider.

However, it should be pointed out that the IBPGR has a tremendous task in front of it, a task for which time is fast running out because of the disappearance of the genetic variation in the crop centers of diversity. The Board has to consider several score of different crop species and promote collaboration and liaison between institutions throughout the developing and developed world. The IBPGR considers itself fortunate that its Secretariat is provided by FAO and the strength of that organization can assist in the furtherance of the Board's objectives.

We have talked about rice in general but we should differentiate between the Asiatic rice and the African rice. When the Board drew up its priorities, it gave an overall priority No. 2 to rice in general because of the excellent work that has been done by IRRI. However, for African rice it gives priority

Appendix 2. Address by the IBPGR (Continued)

No. 1 for action and work has been initiated in West Africa through the Germplasm Collection Unit at IITA (which the IBPGR funded in the first instance), and through WARDA, ORSTOM, IRAT, and IRRI. Although priority No. 2 was given to rice in general, priority No. 1 was also given to indicas and javanicas in Southeast Asia and the tribal regions of India and this workshop will be discussing plans for these areas.

The IBPGR is also establishing regional programs in those regions where there is significant genetic diversity. A regional cooperative program for five countries of Southeast Asia, (Indonesia, Malaysia, Papua New Guinea, The Philippines, and Thailand) has already been approved by the respective Governments and in the immediate future, a Regional Committee will be meeting to discuss how best to allocate resources from the IBPGR and partition the work. One of the priority crops for this region is rice. We can therefore look forward to a concerted attack

through the excellent collaboration which is being developed by the IBPGR and IRRI with the national programs.

A second regional activity of interest to rice workers is likely to emerge from a workshop co-sponsored by IBPGR and the Indian Government which will be meeting in 1978 to discuss cooperation between the programs of Bangladesh, Bhutan, India, Nepal, and Sri Lanka. Undoubtedly, rice will be high on the list of priorities.

On behalf of the IBPGR, we welcome all participants to this workshop and feel sure that the action which will take place following your discussions and recommendations will provide concrete results. We trust too that our endeavors will help toward the ultimate goal of providing food for all and that in this instance the work being carried out will make food supplies and life in the tropics a little easier – even if results are only seen by the next generation. At least we shall provide that generation with every possibility of continuing the work we have started.

Appendix 3a. Plan for field collection. South Asia, 1978-82.

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Bangladesh ^{a,b}	<i>BRR</i> and Dept. of Agriculture (Extension)	Chittagang, Rangpur, Kustia, and Faridpur (Garo hills)	Aus (upland)	June-Aug.	200
India ^{a,b,d}	<i>CRRI</i> , <i>NBPGR</i> , ICAR Complex, Agricultural Universities and State Dept. of Agriculture	1978 North-East hills (Sikkim, Arunachal Pradesh, Mizoram, Nagaland, Meghalaya, Manipur), U.P. hills and Kashmir Assam, Orissa, and West Bengal	Upland (hills, early types), cold tolerant, high altitude and wild species — <i>O. rufipogon</i> & <i>O. nivara</i> Deep water	Sept.—Nov. Nov.—Dec.	500 100
Nepal ^{a,b}	<i>NRIP</i> , <i>JCP</i> , Stations & Farms of Tarai, ADO	Tarai belt	Upland and lowland	Aug. and Nov.—Dec.	500
Pakistan ^{a,b}	<i>ARC</i>	Swat valley, hilly & tribal areas of NWFP, Azad Kashmir	Lowland types	Aug.—Nov.	500
Sri Lanka ^a	<i>CARI</i>	Dry zone	Upland and lowland	Jan.—Feb.	300
Bangladesh ^a	<i>BRR</i> and Dept. of Agriculture	1979 Dinajpur, Sylhet, Coxbazar, and coastal areas	Transplanted aman	Oct.—Dec.	400
India ^{a,b}	<i>CRRI</i> , <i>NBPGR</i> , ICAR Complex, Agricultural Universities & State Dept. of Agriculture	North-East hill states, U.P. hills, Kashmir Bihar, Gujarat, Madhya Pradesh, and Andhra Pradesh	Upland (hilly) cold tolerant, high altitudes and wild types ^e Upland (early)	Sept.—Nov. Aug.—Sept.	700
Nepal ^{a,b}	<i>NRIP</i> , <i>JCP</i> , Stations & Farms of Tarai, ADO	Tarai belt	Upland and lowland	Aug.—Nov.	500
Pakistan ^a	<i>ARC</i>	NWFP and central Punjab	Lowland types	Aug.—Nov.	500
Sri Lanka ^a	<i>CARI</i>	Dry zone	Upland and lowland	Jan.—Feb.	300

Appendix 3a. Plan for field collection. South Asia (Continued)

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Bangladesh ^a	<i>BRR</i> , Dept. of Agriculture	Dacca, Pubna, Sylhet, and Mymensingh	Boro types	Apr.–May	100
India ^{a,b}	<i>CRRI</i> , <i>NBPGR</i> , Agri. Universities and State Dept. of Agriculture	Himachd Pradesh & Kashmir Tamil Nadu and Orissa West Bengal and Assam Madhya Pradesh and Andhra Pradesh U.P.	Hilly types Saline & alkaline types Boro Upland Scented & lowland types Hilly types	Sept.–Nov Oct.–Nov. Apr.–May Sept.–Oct. Sept.–Nov. Sept.–Oct.	500
Nepal ^a	<i>NRIP</i> , <i>ICP</i> , Stations & farms of hilly areas, ADO	Hilly areas	Hilly types	Sept.–Oct.	100
Pakistan ^a	<i>ARC</i>	Right bank of Sind River of Sind Prov.	Lowland types	Aug.–Nov.	300
Bangladesh ^a	<i>BRR</i>	Mymensingh, Pubna, Comilla, Faridpur and Dacca	Broadcast aman	Oct.–Dec.	200
India ^{a,b}	<i>CRRI</i> , <i>NBPGR</i> , ICAR Complex, Agric. Univ. & State Dept. of Agric.	Tripura Maharashtra and Karnataka	Boro & Aman Deep-water & wild types	Apr.–May Nov.–Dec.	400
Nepal ^a	<i>NRIP</i> , <i>ICP</i> , Stations & farms of hilly areas, ADO	Hilly areas	Hilly types	Sept.–Oct.	100
Pakistan ^a	<i>ARC</i>	Left bank of River Sind	Lowland types	Aug.–Nov.	200

Appendix 3a. Plan for field collection. South Asia (Continued)

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Bangladesh ^a	BRRRI	Left over areas			200
India ^{a,b}	CRRRI, NBPGR, ICAR Complex, Agricultural Universities and State Dept. of Agriculture	Assam West Bengal Orissa, Kerala, and West Bengal	Deep water types Upland Swampy and lowland types	Nov.–Dec. Apr.–June Oct.–Dec.	300
Nepal ^a	NRRP, ICP, ADO	Hilly areas	Hilly types	Sept.–Oct.	100
Pakistan ^a	ARC	Left over areas	Lowland	Aug.–Nov.	100

^a Indirect technical assistance from IRRI – training of personnel and preservation of materials at IRRI.

^b Direct technical assistance from IRRI – IRRI staff to collaborate with the local staff in the collection of germplasm.

^c Agency or agencies italicized will serve as the coordinator.

^d Japanese scientists wish to join the collection in Assam.

^e From all states where available.

Appendix 3b. Plan for field collection, Southeast Asia, 1978-82.

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Burma ^{a,d}	ARI, Central Farm, Extension Services	Kayah Magwe Tenasserim	Lowland, upland Lowland Lowland	Mar-May Mar-May Mar-May	
Thailand ^{a,b}	Rice Division	Suphanburi Chachoengsao Nakhon Pathom	Lowland and deep water Lowland and deep water Lowland and deep water, wild and weed races	1978-79 Oct-Feb Oct-Feb	
Philippines ^{a,b}	BPI, BAE, UPLB	Luzon, Visayas, Mindanao	Upland and lowland, wild species	1978-79, Sept-May	
Indonesia ^{a,b}	CRIA	W. Java Aceh (Sumatra) Bengkulu (Sumatra) Kalimantan	Lowland, upland Lowland, upland Lowland, upland Tidal swamp	Feb-Mar Feb-Mar Feb-Mar 1978-79, July-Aug	200 400 200 400
Malaysia (W) ^a	MARDI	Kedah, Kelantan, Trengganu	Lowland, upland	Mar-May	
Malaysia (E) ^{a,b}	State Depts. of Agriculture	Sarawak Sabah	Lowland and hill Lowland and hill	May-Dec May-Dec	

^aIndirect technical assistance from IRRI - training of personnel and preservation of materials at IRRI.

^bDirect technical assistance from IRRI - IRRI staff to collaborate with the local staff in the collection of germplasm.

^cAgency or agencies italicized will serve as the coordinator.

^dIBFGR assistance of \$1,000 for the 5-year period is needed.

Appendix 3b. Plan for field collection, Southeast Asia, 1978-82. (Continued)

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Burma ^{a,d}	ARI, Central Farm, Extension Services	Same as 1978	Same as 1978	Same as 1978	
Thailand ^{a,b}	Rice Division	Chainat, Sing Buri, Pathum Thani, Nonthaburi	Lowland and deep water, wild and weed races	1979-80 Oct-Feb	
Philippines ^{a,b}	BPI, BAE, UPLB	Luzon, Visayas, Mindanao	Lowland, upland, wild species	1979-80 Sept-May	
Indonesia ^{a,b}	CRIA	Sulawesi Kalimantan	Lowland, upland Tidal swamp, wild(?)	Apr-May 1978-79 July-Aug	600 400
Malaysia (W) ^a	MARDI	Perak, Negri Sembilan	Lowland, upland	Mar-May	
Malaysia (E) ^{a,b}	State Depts. of Agriculture	Sarawak Sabah	Lowland, hill Lowland, hill	May-Dec May-Dec	

^aIndirect technical assistance from IRRI - training of personnel and preservation of materials at IRRI.

^bDirect technical assistance from IRRI - IRRI staff to collaborate with the local staff in the collection of germplasm.

^cAgency or agencies italicized will serve as the coordinator.

^dIBPGR assistance of \$1,000 for the 5-year period is needed.

Appendix 3b. Plan for field collection, Southeast Asia, 1978-82. (Continued)

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Burma ^{a,d}	ARI, Central Farm, Extension Services	Rangoon, Pegu, Irrawaddy	Lowland	1980-81 Oct-May	
Thailand ^{a,b}	Rice Division	Angthong, Lop Buri	Lowland and deep water	1980-81 Oct-Feb	
Philippines ^{a,b}	BPI, BAE, UPLB	Saraburi	Lowland and upland, wild and weed races	Sept-Feb	
Indonesia ^{a,b}	CRIA	Luzon, Visayas, Mindanao	Upland and lowland, wild species	Sept-May	
Malaysia (W) ^a	MARDI	Nusa Tenggara Maluku	Lowland, upland	Mar-Apr	400
Malaysia (E) ^{a,b}	State Depts. of Agric.	Pahang Sabah, Sarawak	Lowland, upland	Mar-Apr Mar-May	100
Burma ^{a,b}	ARI, Central Farm, Extension Services	Rangoon, Pegu, Irrawaddy	Lowland	May-Dec	
Thailand ^{a,b}	Rice Division	Chiang Mai, Chiang Rai, Lamphun	Lowland, upland	Oct-May	
Indonesia ^{a,b}	CRIA	Irian Jaya	Upland, wild(?)	Sept-Dec	
Malaysia (W) ^a	MARDI	Johore	Lowland, upland	May-June	100
Malaysia (E) ^{a,b}	State Depts. of Agric.	Sabah, Sarawak	Lowland, hill	Mar-May May-Dec	

Appendix 3b. Plan for field collection, Southeast Asia, 1978-82. (Continued)

Country	Coordinating and executing agencies ^c	Province or district	Varietal types	Time	Estimated no. of samples
Burma ^{a,b}	ARI, Central Farm, Extension Services	1982 Sagaing, Mandalay Arakan, Chin, Kachin, Shan, Mon, Karen	Lowland Lowland, upland	1982-83 Oct-May	
Thailand ^{a,b}	Rice Division	Chaiyaphum, Nakhon, Ratchasima, Khon Kaen	Lowland, upland	Sept-Dec	
Malaysia (E) ^{a,b}	State Depts. of Agriculture	Sabah, Sarawak	Lowland, hill	May-Dec	
Indonesia	CRIA	Nias (Sumatra), Bangka (Sumatra)	Upland, lowland	Apr-May	100 50

^a Indirect technical assistance from IRRI - training of personnel and preservation of materials at IRRI.

^b Direct technical assistance from IRRI - IRRI staff to collaborate with the local staff in the collection of germplasm.

^c Agency or agencies italicized will serve as the coordinator.

^d IBPGR assistance of \$1,000 for the 5-year period is needed.

Appendix 3c. Plan for field collection, West Asia, 1978-81.

Country	Coordinating and executing agencies ^a	Province or district	Varietal types	Priority for collection ^b	Time	Estimated no. of samples
Iran ^c						
			1978 ^d			
	S & <i>PII</i> , Rasht and Amol Rice Research Stations	Gilan, Mazandaran, Khorassan, Baluchistan	Lowland types		Aug-Nov	500
	S & <i>PII</i> , Rasht Rice Research Station	Kerman, Fars, Esfahan, Khuzestan	Lowland, indica types		Aug-Sept	200
	S & <i>PII</i> , Rasht Rice Research Station	Bovir Ahmad, Bakhtiari, and Western provinces	Lowland indica types		Aug-Sept	200
	S & <i>PII</i> , Rasht & Amol Rice Res. Stations	Left-over areas	1981 Low lying, indica types		Aug-Sept	100
U.S.S.R.	<i>IIR</i>	Far East Ukrainia Uzbekistan	Modern varieties Elite breeding lines Special types	3	Yearly Yearly Yearly	50 100 100
	AUHRI	Krasnodar province	Same as above		Yearly	250

^a Agency italicized will serve as the coordinator.

^b 1 = first priority (within the next 1-2 years), 2 = second priority (within the next 3-5 years), and 3 = third priority (within 10 years).

^c Indirect technical assistance from IRRI — training of personnel and preservation of materials at IRRI.

^d Direct technical assistance from IRRI — IRRI staff to collaborate with the local staff in the collection of germplasm.

Appendix 3d. Plan for field collection, Africa, 1978-80.

Country	Coordinating and executing agencies	Province or district	Varietal types	Time	Funding assistance	
					National	Local
			1978			
Senegal	IRAT	Casamance	<i>sativa</i> or <i>glaberrima</i>	Oct-Dec		
Senegal & parts of Mauritania	WARDA ^{a,b}	Richard-Toll	<i>sativa</i> or <i>glaberrima</i>	Nov-Dec		Local
Mali	WARDA ^{a,b}	Mopti, Segou, Tombouctou, Gao	<i>glaberrima</i> and <i>sativa</i>	1978-80 Dec-Feb		Local (external funding for water transportation, speed boat)
Guinea-Bissau and Guinea-Conakry	ORSTOM, IRAT		<i>glaberrima</i> and <i>sativa</i>	Oct-Dec	IBPGR (being arranged)	
Ghana	IITA					
Benin, Togo	IITA		wild spp. (<i>longistaminata</i>)	Nov-Dec		Local
Zambia	ORSTOM, IRAT		wild spp., weed spp., <i>sativa</i> , <i>glaberrima</i>	Apr-June	IBPGR (being requested)	
Malagasy	ORSTOM, IRAT		wild spp., weed spp., <i>sativa</i>	Apr-May	IBPGR (being requested)	

^aIndirect technical assistance from IRR1 - training of personnel and preservation of materials at IRR1.

^bDirect technical assistance from IRR1 - IRR1 staff to collaborate with the local staff in the collection of germplasm.

Appendix 3d. Africa (Continued)

Country	Coordinating & executing agencies	Province or district	Varietal types	Time	Funding assistance	
					National	Local
Gambia	WARDA ^{a,b} IITA		1979 <i>sativa</i> or <i>glaberrima</i> (deep water), mangrove	Oct-Dec		Local
Mali	IITA	Bamako	<i>glaberrima</i> & <i>sativa</i>	Oct		Local
Mali & parts of Upper Volta	IITA	Sikasso	<i>glaberrima</i> & <i>sativa</i>	Nov		Local
Niger	ORSTOM, IRAT	Lake Chad	<i>glaberrima</i> & <i>sativa</i> , wild spp., weed spp.	Nov-Dec	IBPGR (to be arranged)	
Tanzania	ORSTOM, IRAT		wild spp., weed spp. <i>sativa</i> , <i>glaberrima</i>	Apr-Jan	IBPGR (to be arranged)	
Upper Volta	WARDA ^{a,b} IRAT (CERC)	Farakoba to Banfora	1980 <i>glaberrima</i> & <i>sativa</i>	Oct-Nov	External funds needed	
Niger	ORSTOM, IRAT	West & Southwest	<i>glaberrima</i> & <i>sativa</i> , wild spp.	Nov-Dec	(possibly by IBPGR)	
Central Africa		South Sudan, Zaire, Uganda, Congo	- explorations are difficult either due to logistic or political reasons -			

^aIndirect technical assistance from IRRRI - training of personnel and preservation of materials at IRRRI.

^bDirect technical assistance from IRRRI - IRRRI staff to collaborate with the local staff in the collection of germplasm.

Appendix 3c. Plan for field collection, Latin America.

Country	Agencies	Province or district	Varietal types	Priority ^a or time	Estimated no. of samples	Funding
Colombia	CIAT-IRRI	North coast Choco Llanos	Upland, indica Non-mechanized native Unimproved	2	100-200	CIAT/ IRRI
Ecuador	CIAT-IRRI	Guayas basin	- ditto -	3		INIAP
Guyana	CIAT-IRRI		- ditto -	4		Min. Agr.
Mexico	CIAT-IRRI	Yucatan, Chiapas, etc.	- ditto -	4	100-200	Nat. Program, INIA
Surinam	CIAT-IRRI		Old & improved, plus breeding lines from Surinam, Panama, Dom. Republic	1	50-100	Local
Bolivia, Peru & Venezuela	CIAT-IRRI by correspondence		Unmechanized, upland			Local resources
Brazil ^{b,c}	EMBRAPA & EMBRATER	Goiás Minas Gerais Mato Grosso Maranhao, Piaui Sao Paulo Paraña Rio Grande do Sul Santa Catarina	1978 Upland Upland, lowland Upland Upland, swamp Upland, lowland Upland Lowland Lowland	Mar/Apr Mar/Apr Mar/Apr Apr/May Mar/Apr Mar/Apr Mar/Apr Mar/Apr	61 98 30 63 73 35 48 14	Local Local Local Local Local Local Local Local

Appendix 3e. Latin America (Continued)

Country	Agencies	Province or district	Varietal types	Priority ^a or time	Estimated no. of samples	Funding
Brazil ^{b,c}	EMBRAPA & EMBRATER	Rio de Janeiro	Lowland	Mar/Apr	15	Local
		Espirito Santo	Lowland	Mar/Apr	15	Local
		Amazonas	Swamp, upland, floating, others	Feb/Mar	13	Local
		Pará	Swamp, upland	May/June	40	Local
		Bahia	Lowland	2	22	Local
		Paraíba	Lowland	2	15	Local
		Pernambuco	Lowland	2	4	Local
		Alagoas	Lowland	2	3	Local
		Sergipe	Lowland	2	6	Local
		Ceará	Lowland	2	66	Local
		Rio Grandc de Norte	Lowland	2	8	Local
		Acre	Upland	2	5	Local
		Rondonia	Upland	2	10	Local
		Roraima	Upland	2	15	Local
		Amapá	Upland	2	5	Local

^a 1 = priority (within the next 1–2 years), 2 = second priority (within 3–5 years), 3 = third priority (within 10 years), 4 = fourth priority (beyond 10 years).

^b Indirect technical assistance from IRRI – training of personnel and preservation of materials at IRRI.

^c Direct technical assistance from IRRI – IRRI staff to collaborate with the local staff in the collection of germplasm.

Appendix 4. Coordinating and executing agencies for field collection.

SOUTH ASIA

- *Bangladesh*
BRRI – Bangladesh Rice Research Institute
Department of Agriculture (Extension)
- *India*
CRRI – Central Rice Research Institute, Cuttack
ICAR-Complex – Indian Council for Agricultural Research Complex for North-Eastern Hilly regions, Shillong
NBPGR – National Bureau of Plant Genetic Resources, New Delhi
GBPUAT – G. B. Pant University of Agriculture and Technology, Pantnagar, U.P.
Kashmir – Department of Agriculture, Anantnag, Kashmir
- *Nepal*
ADO – Agricultural Development Office
NRIP – National Rice Improvement Program
ICP – Integrated Cereals Project Stations and Farms of Tarai
- *Pakistan*
ARC – Agricultural Research Council, Islamabad
- *Sri Lanka*
CARI – Central Agricultural Research Institute

SOUTHEAST ASIA

- *Burma*
ARI – Agricultural Research Institute Yezin
Central Farm, Hwambi
Extension Services
- *Indonesia*
CRIA – Central Research Institute for Agriculture
- *Malaysia (W)*
MARDI – Malaysian Agricultural Research and Development Institute
- *Malaysia (E)*
Sarawak and Sabah State Departments of Agriculture

SOUTHEAST ASIA (Continued)

- *Philippines*
UPLB – University of the Philippines at Los Baños
BAE – Bureau of Agricultural Extension
BPI – Bureau of Plant Industry
 - *Thailand*
Rice Division, Department of Agriculture and Cooperatives
- ##### WEST ASIA
- *Iran*
S & PII – Seed and Plant Improvement Institute
Rasht Rice Research Station
Amol Rice Research Station
 - *U. S. S. R.*
VIR – N.I. Vavilov Institute of Plant Industry, Leningrad
AURRI – All-Union Rice Research Institute, Krasnodar

AFRICA

- IITA – International Institute of Tropical Agriculture
- IRAT – Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières, Paris, France
- ORSTOM – Office de la Recherche Scientifique et Technique Outre-Mer, Paris, France
- WARDA – West Africa Rice Development Association, Monrovia, Liberia

LATIN AMERICA

- CIAT – Centro Internacional de Agricultura Tropical, Cali, Colombia
 - EMBRAPA – Empresa Brasileira de Pesquisa Agropecuaria, Brazil
 - EMBRATER – Empresa Brasileira de Assistência Técnica e Extensão Rural, Brazil
 - INIAP – Instituto Nacional de Investigaciones Agropecuarias, Ecuador
 - INIA – Instituto Nacional de Investigaciones Agrícolas, Mexico
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