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9. ABSTRACT
The papers in this report were presented at an International Board for Plant Genetic Resources (IBPGR) working group on Southeast Asian genetic resources in December 1976. They provide a current statement of the genetic resources work in the five countries of the region which participated (Indonesia, Malaysia, Papua New Guinea, Philippines and Thailand). There are also accounts of the work of regional and international organizations represented at the meeting. Some of the important points under consideration were: since southeast Asia is faced with a large number of species of crop plants, it is necessary to determine priorities for action as international funding may only be expected for major crop plants; there is a need to establish and increase existing living plant collections; what should be done with plants not native to southeast Asia; and organization of plant scientists. The IBPGR has tried to establish a pattern for a worldwide network of genetic resources centers based on regional and national centers in areas of genetic diversity and crop specific centers. During inter-country discussions, points of agreement were reached that laid the foundation for a regional cooperative program.

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PLANT GENETIC RESOURCES IN SOUTHEAST ASIA:

CURRENT ACTIVITIES IN THE REGION

INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES
PHILIPPINE COUNCIL FOR AGRICULTURE AND RESOURCES RESEARCH

1977

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EDITOR'S NOTE

The International Board for Plant Genetic Resources was established in 1974 to promote a global network of genetic resources activities. The Board is concerned with the collection, conservation, evaluation and documentation of germplasm as well as its fuller use. Much of the work of the Board will be carried out through regional programmes, mostly in developing areas of the world and such programmes will provide a stimulus to local cooperative efforts both within and between countries.

The papers in this book were presented at an IBPGR Working Group on Southeast Asian Plant Genetic Resources, co-sponsored by the Philippine Council for Agriculture and Resources Research, which met in the Philippines 6-10 December 1976. These papers provide a current statement of the genetic resources work in the five countries of the region which participated (Indonesia , Malaysia, Papua New Guinea, Philippines and Thailand). During the discussions points of agreement were reached which laid the foundation for a regional cooperative programme.

Not all the papers presented at the meeting of the Working Group are included but for each participating country there is a country report. In addition, there are accounts fo of the work of regional and international organizations which were represented at the meeting, and which are involved with genetic resources of direct relevance to Southeast Asia.

Rome, Italy
February 1977

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ADDRESS OF WELCOME

by

DR. RAMON V. VALMAYOR
Deputy Director General, PCARR

Distinguished members of IBPGR,
participants in the Working Group,
Honourable Guests, Ladies and Gentlemen,

It is my genuine pleasure and great privilege to welcome, on behalf of the Filipino participants, all foreign delegates to this Working Group. The Philippine Council for Agriculture and Resources Research is deeply honoured to co-sponsor with IBPGR this meeting on Southeast Asian Plant Genetic Resources. This is a great event in the history of Philippine agriculture. PCARR is presently concerned by the rapid erosion of valuable plant genetic materials in the Philippines and appreciates those measures being undertaken by neighbouring countries in Southeast Asia to minimize the steady depletion of plant genetic diversity within their national boundaries. We all realize that modern plant breeders depend heavily on primitive indigenous material for sources of resistance to pests and diseases as well as adverse conditions of soil and climate such as drought, poor drainage, strong winds and toxic substances in the soil. Faced with the ever increasing cost of synthetic pesticides, agricultural chemicals, and capital for development, the production of improved cultivars through breeding offers the most practical solution to present low productivity in many crop plants. It is therefore imperative that we conserve the existing germplasm resources and offer our plant breeders a wealth of genetic diversity from which they can mould the 'super' and 'miracle' cultivars of the future.

Southeast Asia is known as one of the world's richest biological regions. It is the cradle of many important economic plants that provide man the basic necessities of food, fibre and shelter. Unfortunately, Southeast Asia is also a region where devastating destruction of irreplaceable germplasm resources is taking place. It is therefore very timely for IBPGR to schedule this important meeting in the Philippines. PCARR welcomes the opportunity of co-sponsoring a workshop which will lead to the conservation of our natural heritage. We look forward to the establishment of a viable and integrated regional network of germplasm centres, each complementing the specialization of the others for the economic and common wellbeing of all the countries of the region. I realize the complexities of the problems confronting us but I am confident that with the prevailing cooperative atmosphere emanating from ASEAN, we will evolve a common program for regional action. I welcome you all to the Philippines.

ADDRESS

by

DR. SETIJATI SASTRAPRADJA

On behalf of the International Board for Plant Genetic Resources I have great pleasure in welcoming all of you to this regional working group. I am sure you are all enthusiastic and eager to discuss the plant genetic resources of the region. Let me take a few minutes to review some of the principal events which have led up to this meeting and then outline a few of the major issues. We are here, not only to discuss, but also to reach agreement.

The need to collect and conserve the genetic variation of our cultivated plants has been recognized for many years. Since the early 1960's international scientists have been talking about such needs and there has been significant crystallization of scientific ideas through the partnership between the Food and Agricultural Organization of the United Nations and the late International Biological Programme with two Technical Conferences held in FAO Headquarters. We are indeed fortunate to have FAO here today in strength, not only representing FAO but also in their dual role of providing the Secretariat of IBPGR. Moreover even though the International Biological Programme is now finished the spirit is still carried on and its prime spokesman for genetic resources, Sir Otto Frankel, is here in one of his other capacities.

In 1972 the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research on the suggestion of FAO pressed for a truly international programme to strengthen the efforts already under way. This led to the foundation

of the International Board for Plant Genetic Resources in 1974. The 1972 meeting of TAC, held in Beltsville, USA, proposed regional programmes in those areas of the world where there was significant genetic diversity. Southeast Asia was one of those areas designated.

You will all have received a copy of the Brochure[1/] describing the IBPGR and its work. So far, the IBPGR has tried to establish a pattern for the worldwide network of genetic resources centres. This pattern is based on:

(1) regional and national centres in areas of genetic diversity, and

(2) crop specific centres, for instance some of the International Centres, like IRRI here at Los Baños.

In order to get things moving in a logical way the Board has defined priorities among crops and regions and this is published as a Brochure[1/]. On pages 18 and 19 you will see that Southeast Asia ranks as a second priority but you as a group might decide differently.

With regard to the Southeast Asian region, in 1975 a regional symposium was held in Bogor in Indonesia under the auspices of UNEP and FAO, the Southeast Asia Ministers of Education Organization (SEAMEO) and the Indonesian Institute of Sciences (LIPI).

1/ Available from the IBPGR Secretariat, Crop Ecology and Genetic Resources Unit, Plant Production and Protection Division, FAO, Rome.

SEAMEO, through its institutes, is represented at this meeting. The symposium was for scientists to pool their knowledge and to inform each other of efforts in other countries of the region. Several stalwarts of that symposium are here today and I wish to mention in particular Dr. Ramon Valmayor or PCARR our co-sponsor, Dr. Trevor Williams of the IBPGR Secretariat, Sir Otto Frankel, Mr. Arasu, Dr. T.T. Chang and Dr. de Guzman.

The symposium produced a series of recommendations. Please make sure you have read these carefully. You all have copies of them, but I wish you to note in particular that the scientists were unanimous in saying that "genetic exploration and conservation within the region can be carried out effectively and economically only through cooperation between countries and institutions". This working group has been convened by the IBPGR to work out a plan for such cooperation. The time for talking should not extend beyond this week. Thereafter there must be action since the erosion of genetic resources assessed in 1972 and 1973 has accelerated so rapidly that, like the frightening figures of the numbers of human births every hour, the hardly noticed variability of our crops is disappearing hour by hour.

I would like to bring to your attention some important points:

> Firstly, here in our region we are faced with an incredible number of species of crop plants. We must therefore decide our own priorities for action since international funding may only be expected for major crop plants;

Secondly, many of our species are vegetatively propagated or produced seeds which are recalcitrant in type and we face the need to establish and increase existing living plant collections. This takes land and labour;

Thirdly, we have important resources of plants that have been with us a long time but come from other parts of the world, e.g. cassava, maize. Are we going to consider these are well as our huge list of native species?

Lastly, how are we to organize ourselves to work together? We realize in the region that the number of plant scientists is still small. Moreover, of this number only a few realize the importance of plant genetic resources for our future crop improvement. Therefore, we have to pool our strength so that our voice can be heard and action can be taken. I am sure that enthusiasm and motivation we have will work no matter how slow.

Ladies and gentlement, I say to you all, whether representatives of countries or scientific observers – you have a hard task in the next few days, but the results could set a pattern for other regions of the world. In devising the pattern, we need to guarantee free

availability of plant material and information, to decide on who can do what, where money is required from IBPGR to start us off, and whether other sources need to be explored. Like our regional symposium in 1975, we have another 'first' to score and I look forward to our deliberations.

Thank you.

ADDRESS OF WELCOME

by

C.R. MacCulloch
Senior Agricultural Adviser/FAO
Country Representative

Mr. Chairman,
Distinguished delegates,
Ladies and Gentlemen,

I thank you for the opportunity given me to address a few words of welcome to this distinguished gathering which includes both scientists and government officials from a number of member countries of the Southeast Asian Region, as well as representatives from several international and regional agencies actively involved with plant genetic resources.

As you are aware, this Working Group is a follow-up to the very successful Symposium on South East Asian Plant Genetic Resources held at Bogor, Indonesia, in 1975, under the sponsorship of the Indonesian Institute of Sciences, the SEAMEO Centre for Tropical Biology and FAO. This was, I believe, the first-ever regional symposium on genetic resources. Since then the International Board for Plant Genetic Resources has considered the resultant recommendations and now wishes to promote a regional effort as part of its strategy in establishing a global network of genetic resource activities.

While admittedly a comparative layman on genetic resources, what nevertheless appeals to me is the tremendous potential which they have to offer us in the never-ending battle to increase food production. We are still far too vulnerable in this part of the world,

for example, to the vagaries of the weather. A strong typhoon striking the rice crop at its most critical stage still makes the difference between self-sufficiency and shortage. Among others, it is through plant breeding programmes that we discover and propagate varieties of rice which are more resistant to typhoon damage than their predecessors. Crop diversification is yet another factor of increasing importance as again we seek to be able to produce commercially those crop types and varieties which normally would not thrive under a particular kind of soil and climatic condition. These two examples are clearly a gross over-simplification in terms of the magnitude and scope of plant genetic resources per se. Nevertheless, they serve, I hope, to illustrate the fundamental nature of this meeting. To this end, therefore, any effective mechanisms which can be established in the course of this meeting to facilitate an exchange of information, material and training facilities, etc., to the benefit of the region, will, I trust, be fully supported.

Finally, may I extend our thanks and appreciation to the Government of the Philippines and specially to PCARR, for the cooperation which they have extended to us in hosting this Working Group, for providing a varied and interesting programme and for the splendid facilities within which to conduct our sessions.

THE INDONESIAN GENETIC RESOURCES PROGRAMME

by

F. Rumawas and B.H. Siwi

INTEGRATION OF THE PROGRAMME

Substantial progress has been made in the efforts to establish a national genetic resources programme following the Symposium on South East Asian Plant Genetic Resources held at Bogor, 20-22 March 1975. Several meetings, convened by Dr. Setijati Sastrapradja as Director of the National Biological Institute, have been held in order to bring interested scientists and institutions together to create an awareness of the magnitude and importance of the national programme.

During these consultative meetings the following became apparent:

1. There is a need for a national organization to integrate and coordinate genetic resource work;
2. Many experimental stations are engaged in genetic resources activities;
3. Collections of germplasm of economically important plants have been made in the past but due to problems of maintenance and the lack of long-term programmes, some of these have been lost;
4. There is a poorly defined legal basis enabling free exchange of genetic material; and
5. Many persons and institutions are already aware of the urgency of genetic resources collection, conservation and documentation as outlined in IBPGR publications (IBPGR; 1975, 1976).

Following these consultations, Prof. Dr. Tojib Hadiwidjaja, Minister of Agriculture of Indonesia, established a National Council of Genetic Resources (NCGR). Institutions involved in genetic resources are under the auspices of the Ministry of Agriculture (Research Institutes for Industrial Crops, Estate Crops, Food Crops, Horticultural Crops, Forestry, etc.); the Indonesian Institute of Science (the National Biological Institute) and the Ministry of Education and Culture (several universities and BIOTROP). Other administrations e.g. the Ministry of the Interior, the Ministry of Research, several Governors, and the private sector have also indicated interest.

The following sections outline the steps to be taken to create a viable national network.

INVENTORY AND COLLECTION WORK

A major task of the CGR is to prepare inventories of collections already existing in the country, before new collections are made. Also the national priorities have to be decided or refined.

Existing Collections

Collection and inventory of estate crops (rubber, tea, oil palm, Cinchona, coffee and sugarcane) are in general well taken care of except for coconut. Coconut is therefore a high priority especially in view of hybridization possibilities between early dwarf and late maturing normal types. There exists a well established collection of mango in Pasuruan but other fruits (rambutan, durian, Lansium spp. and avocado) have to be moved

from their site at Pasar Minggu because of urban encroachment. The Pasar Minggu collections are well-known and assistance has been indicated. At the same time grafted and certified stock have been distributed for safe-keeping. Rice germplasm continues to be collected by the CRIA and duplicates are sent to IRRI.

Collections needed

A staggering amount of work must be done to preserve germplasm of most crops whether vegetables, roots, tubers or leguminous and medicinal species as well as coconut mentioned above. Valuable forest tree species must be collected urgently. Although the authors are aware that the provinces of South and East Kalimantan are already establishing genepools of forest species, collections at Sentani and Manokwari in Irian Jaya are now neglected.

Loss following improper long-term maintenance has occurred for cassava, banana and plantain sweet potato, and taro collections and these will have to be started again. Plants which have to be propagated vegetatively, those processing recalcitrant seeds or annual plants have all too easily been lost.

UTILIZATION OF GERMPLASM

A collection is useful only if its germplasm is used. Prior to that the collection has to be adequately evaluated and specific characteristics described. Records of these data must be kept up-to-date and be available to the users.

The most extensively utilized native crops is probably sugarcane. An expedition in 1976 to collect new germplasm was primarily motivated by the need to increase yields. Fortunately, the history of sugarcane breeding has from the early stages included other considerations besides high sucrose yields/unit area. This contrasts to the breeding of high yielding Heavea lines in Malaysia and Indonesia which was based on a narrow genetic variability and selected primarily for high rubber yields (Subramaniam and bin Abdul Ghani, 1975; Majid and Hondranata, 1975). Breeders neglected and lost specific characteristics, such as possible resistance to SALB. Similar problems have cropped up in the oil-palm industry (Arasu and Rajanadu, 1975; Lubis and Kiswito, 1975). In rice, the massive introductions of early high yielding varieties from IRRI could have been disastrous due to plant hopper and viral attacks, but such disasters were averted because of the availability of an adequate and well managed germplasm collection.

Although Frankel (1973) nominated Indonesia as the Garden of Eden for tropical fruit tree species, the Indonesian descendents of Adam and Eve are not yet aware of this fame. Vast unexplored possibilities await the breeders. Even the existing tropical fruit tree collections are mostly made up of selections of cultivated forms, and hardly any breeding has been attempted. The same is done for native legumes and yams. The logical reason for this seemingly lack of interest is the fact that these crops are not grown extensively in commercial orchards or farms. The authors firmly believe that the establishment of commercial fruit production is a prerequisite for the full use of our national germplasm. Moreover interest in tropical grain legumes and yams could be created through integration with the National Nutrition Programme.

Not much breeding has been done with native forest trees and simple selection of rapid growing species for plantations seems the major activity up to the present.

CONSERVATION

The problems of how to effectively conserve the germplasm varies according to the crop. Traditional estate crops have a well developed network of research stations and plantations maintaining living collections. This has resulted in the many tea, rubber and *Cinchona* clones selected in the plantations.

Fruit trees, ornamentals, medicinal plants, vegetables and secondary or minor food crop species need to be maintained in vegetative plantings involving a lot of work and care, and fresh methods of conservation should be looked at. Mr. Sadikin Sumintawikarta, Head of the Agricultural R & D Agency of the Ministry of Agriculture, has suggested that fruit tree graftings should be made available to plantations for maintenance in different areas. This will facilitate evaluation under different agroclimatic and soil conditions. There are also plans to establish genepools of vegetable and secondary food crops.

We predict increasing erosion of valuable native timber species due to population pressures in Java and the booming forest industry in other parts of the archipelago. It can be expected that, unless serious steps are undertaken now, Indonesia will face the same problems as the Philippines, so vividly described by Dr. de Guzman (1975).

Besides conservation in living collections, cold storage facilities should be established to conserve seeds which can be stored at low temperatures. Such facilities would be of national, regional and international benefit.

ORGANIZATION OF THE NETWORK

It has been mentioned that a NCGR has been established and institutes linked together in the national network will be responsible for collection, documentation, evaluation, conservation, utilization and training.

The Ministry of Agriculture has traditionally been involved in collection and maintenance of germplasm of economically important crops with an extensive network. The National Biological Institute includes the Herbarium Bogoriense, the several Botanic Gardens and a Genepool building (in 1977) and would be in a position to provide the necessary infrastructure to the NCGR's network. The Bibliotheca Bogoriense could assist in the dissemination of information. Currently on the National Biological Institute, in cooperation with the University of Birmingham, UK, is in charge of training manpower but these activities should expand to Indonesian universities.

The NCGR should provide a way in which a concerted effort can be made to collect, conserve, improve and exploit the plant riches of Indonesia despite the recent surveys pointing to their rapid loss.

ACKNOWLEDGMENTS

The authors wish to express gratitude to the IBPGR for enabling them to present this paper and to Dr. Setijati Sastrapradja and Mr. Sadikin Sumintawikarta for their invaluable suggestions.

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PLANT GENETIC RESOURCES CONSERVATION IN MALAYSIA, 1976

by

N.T. ARASU

Agriculture and forestry are of great economic importance in Malaysia and both are supported by a range of technical services which include regulation, advice and research. Part of the research is concerned with the evaluation and utilization of genetic resources as well as its collection and conservation. Activities in the conservation of forestry genetic resources are undertaken exclusively by the Department of Forestry. The Malaysian Agricultural Research and Development Institute (MARDI) is involved in the collection and maintenance of germplasm for a range of crops and the Rubber Research Institute concentrates on rubber. In addition, the University of Agriculture (Universiti Pertanina Malaysia) maintains crop museums comprising collections of a range of varieties in each crop.

Among crops, activities on genetic resources are concentrated on:

1. Indigenous crops for which extensive genetic resources are in existence within the country but have not been readily assembled for use; and

2. Plantation crops of economic importance which have been based on the introduction of a small range of material.

No attempt has been made in Malaysia to duplicate the effort of existing world collections. On the other hand, every effort will be made to utilize material from such collections for local evaluation. The position regarding individual crops is discussed below.

INDIGENOUS CROPS

Rice (*Oryza sativa*): Rice is an ancient crop in Malaysia and the wide range of traditional varieties constitutes a wealth of genetic variability. With the advent of high-yielding varieties and their adoption for large scale cultivation, the range of traditional varieties in regular cultivation began to fall. Recognizing this erosion, efforts have been made to collect and maintain local cultivars. The rice germplasm collection in MARDI contains over 2000 lines of largely Malaysia origin. This material has been regularly planted out on an annual basis and data collection for over 40 characters (covering plant form, maturity, various morphological traits, physiological responses and response to some pests and diseases: Kitsutaka and Chew, 1974). The annual regeneration of such a large collection has necessitated the use of small plots which is unsatisfactory. Long-term seed storage techniques are being adopted so that only a part of the collection will be planted out annually.

The world collection of rice varieties at the International Rice Research Institute (IRRI) contains more than 35,000 accessions. As material in this world collection will be made to build up a replicate collection. However, it would be of value to arrange for evaluation of parts of the world collection in Malaysia.

In spite of the number of accessions in the local collection, there is reason to believe that a wide range of material remains to be collected, especially in the less important rice areas in West Malaysia such as Johore and Pahang as well as the whole of East Malaysia.

Coconut (Cocos nucifera): Coconuts are an ancient crop in Malaysia and exhibit great variability. In 1922, seedling progenies of "selections" from various parts of Peninsular Malaysia, Sri Lanka, India, Philippines and Tanzania were planted near Port Swettenham. Selfed and open-pollinated progenies of individuals selected from this planting were planted at Teluk Bahru between 1955 and 1960. To these were added some new selections from India and Sri Lanka in 1962/63. In 1964, open-pollinated progenies of selected individuals from commercial plantations in Malaysia as well as mass-selected material from Sri Lanka were planted at Parit Botak. Currently, there is considerable interest in importing material from a range of distinct, more or less homogeneous, populations (e.g., the West African Talls, Rennels, Markham, etc.), due to their value as parents in inter-population hybridization programmes.

The high yield levels demonstrated for certain hybrids such as Malayan Dwarf x West African Tall (Fremond & De Nuce de Lamothe, 1972) have given the coconut industry a tremendous boost. However, the large-scale adoption of hybrid material also poses a serious threat to the survival of traditional types, and an urgent need has arisen for the systematic collection and conservation of coconut germplasm (Arasu, Vanialingam & Chan, 1976).

Fruit: Southeast Asia is the centre of diversity of a very wide range of fruit species, some of which, e.g., bananas, have become important internationally. However, the only fruit to have attained commercial importance in Malaysia is an introduced species, Ananas comosus (pineapple). Until recently, selection has been limited to the identification and propagation of favourable mutants of the 3 or 4 clones available in the country. Currently,

there is a programme of intercrossing amongst these highly heterozygous clones to release genetic variability. The need for further introduction of genetic material needs no emphasis (Arasu, 1976a; Lee, 1976).

Bananas (Musa sp.) are native to Malaysia and there is a wide range of material in the country and many varieties are cultivated for dessert and cooking purposes. A germplasm collection of over 124 accessions (including cultivars and wild types) has been assembled largely by the efforts of itinerant collectors.

Mango, Mangifera indica, is probably an introduced crop and a large proportion of introductions are ill adapted to local conditions. However, several species of Mangifera are native to Malaysia and many have attractive fruits (Burkill, 1966). It is imperative that a sufficient range of material of these species should be collected and evaluated for direct exploitation and for use in breeding programmes (Arasu, 1976 a.b.). Over 70 varieties of mango and a few and a few accessions of Mangifera species are included in the present collection in Malaysia.

Two popular local fruits are the durian (Durio zibethinus) and rambutan (Nephelium lappaceum) Both are tree species which are now clonally propagated. The increasing popularity of selected clonal material poses some threat to the established, more variable, seedling populations. The existing germplasm collection (ca. clones of each) is inadequate and simply represents selections by different workers at different times. There is a need for the systematic collection of these species. A tentative sampling distribution based on the Census of Agriculture (Selvadurai, 1962) has been proposed for durian (Arasu, 1976a) A similar approach could be adopted for other fruits.

Apart from the cultivated fruits, several forest trees produce edible fruits whose potential in agriculture has not yet been assessed. Further, numerous wild relatives of local fruits form part of the jungle flora. They are all threatened by the rapid clearing of forests for development. Some information on the distribution of wild tree species in the forests can be obtained from Forest Records and the Forest Resources Reconnaissance Survey of Malaya and any systematic collections should be based on this information. In this context, forest reserves and national parks (Ho, 1971) as well as Virgin Jungle Reserves provide excellent opportunities for in situ conservation. But they may be inadequate to conserve a sufficient range of genotypes to meet the long-term breeding requirements of economically important species (Arasu, 1976a).

Orchids: Over 700 species of orchids in more than a hundred genera have been recorded in the Malaysian flora. A large number of the Malaysian species, as well as a wide range of introduced varieties, has been brought into cultivation as ornamentals and to these have been added a vast array of interspecific and intergenenic hybrids. The genetic collections in the hands of orchid enthusiasts are jealously guarded and it is therefore difficult to assess the total range of the material available. There is some evidence that many areas are becoming denuded of valuable species due to indiscriminate collecting activities of orchid enthusiasts as well as those with more commercial objectives (Yap and Lee, 1972). Furthermore, a wide range of orchid types with a lowland forest distribution are threatened with genetic erosion due to large-scale clearing of jungle for agricultural development. Several orchid species that have been grown as ornamentals, have been replaced by more modern hybrids.

A modest start has been made to put together a representative collection of cultivated orchids. There are now more than 1000 accessions of 118 varieties in 20 genera. Only 23 of the 118 varieties are botanical species; the remaining 85 are hybrids. Efforts will be made to expand the collection and to attempt to salvage wild material from lowland forest areas earmarked for clearing.

PLANTATION CROPS

Rubber (*Hevea brasiliensis*): Rubber, the top foreign exchange earner of our country, is an exotic crop introduced from South America. *Hevea brasiliensis* appears to have a fairly wide distribution throughout Amazonia but other species of *Hevea* occupy smaller distribution areas in the same region. Only 22 seedlings of the original Wickham collection (Wycherley, 1968; Subramaniam & Ong, 1973) reached Southeast Asia where they provided the basis of a thriving industry. Intensive selection from this sample with its narrow genetic base has led to some inbreeding depression (Subramaniam & Mohd. Noor b. Abd. Ghani, 1975). The large seedling populations derived from this early introduction are being rapidly replaced by a few selected clones, thus threatening further the already limited genetic variability.

Realising the danger inherent in this situation, the Rubber Research Institute, Malaysia, has set up two gene pool gardens (Subramaniam & Ong, 1973). The "oriental" genepool seed garden consists of clones derived from the Wickham introductions and includes selections from Sri Lanka, Indonesia and Malaysia. The "occidental" genepool seed garden consists of new clones from South America and wild accessions of *H. brasiliensis* and of *H. benthamiana*.

Urgent action is needed to expand the genetic base of material now held in Southeast Asia. When collection is attempted random sampling throughout the geographic range of the species is recommended.

Oil Palm (*Elasis guineensis*): The oil palm was introduced from Africa and the local industry was based on only four seedlings introduced to Bogor, Indonesia, in 1848. The residual variability in the (Deli) population deirved from these palms was further narrowed by intensive selection (Jagoe, 1952; Hardon & Thomas, 1968). This in turn led to various levels of inbreeding and made selection progress more difficult and slow (Hardon, 1970; Ooi, Hardon & Phang, 1973). The breeding populations at research centres in West Africa, the home of the oil palm, were also narrow. Thus, the post-war exchange of breeding material between Southeast Asia and West Africa was of limited help in broadening the genetic base.

The seriousness of the problem has been realised for some time (Arasu and Rajanaidu, 1976) and various efforts made to remedy the situation. Perhaps two efforts in this area should be mentioned: those by IRHO in the Ivory Coast (Meunier, 1969) and by NIFOR and MARDI in Nigeria (Obasola, Arasu & Rajanaidu, in press). In the first case, detailed studies were made on samples of about 100 palms at each of ten locations and ultimately 19 Teneras were selected at one location (Yokoboue) for introgression into the breeding material (Gascon, pers. comm.). In the Nigerian prospection, open-pollinated seed bunches from over 900 palms were collected at random, from 45 sites throughout the oil palm areas. This material has been planted out in Malaysia and Nigeria for study and selections will be used for introgression into the

breeding material. It is also intended that the material should serve long-term conservation requirements. There is a need to carry out prospection in other areas with natural or semi-wild populations of oil palm, especially Cameroons, Zaire and Angola (Arasu and Rajanaidu, 1976).

In recent years, there has been considerable interest in E. oleifera. Although accessions of the species that have been studied appear to be poor yielders, the species hybridises with E. guineensis and the hybrids have several attractive features. Some collections of E. oleifera have been made in South and Central America but there is still considerable scope for collection especially in Brazil (Arasu, 1976a).

Cocoa (Theobroma cacao): Cocoa originated in South America, has been introduced into Malaysia and has become successfully established in recent times, as an important crop. Breeding programmes of this crop, too, have been based on a limited range of genetic material. The limitations in this case were, in part, self-imposed. The interest in cocoa as a plantation crop stemmed largely from the threat of serious disease to the established industries elsewhere. For this reason, Malaysia was reluctant to import cocoa budwood (Rosenquist, 1950). To earlier unspecified introductions of Trinitario and Criolo trees were added importations of Trinitario seeds from Sri Lanka, Indonesia, West Africa and Sulawesi (Thompson, 1950; Haddon, 1961). Open-pollinated F_2 seeds of Upper Amazon lines were imported in 1951.

A limited range of cocoa clonal material was imported in 1953 (ICS clones) and 1955-56 (Upper Amazon clones). A much wider range of Upper Amazon lines were imported in the late sixties and some two hundred clones, including most of the original Pound selections, are being currently introduced. Seedling progenies from a range of new

selections were imported from Brazil in 1973/1974 and clonal budwood of twenty new selections are to be imported from there in 1977. Thus, the range of of material that is now becoming available to cocoa breeders is quite considerable but there is still scope for systematic collection aimed at gathering representative samples of cocoa populations from across the geographic range of the species.

Other Crops

Crops such as maize and sorghum, pasture and fodder species, grain legumes and root crops are receiving increasing research attention in Malaysia. For most of these crops, material is available from world collections and local germplasm collections have not been established. Threat of disease prevents the free flow of cassava clones, and in this specific case, a germplasm collection is being assembled (Arasu, 1976a). Over 40 clones found in cultivation have been gathered and a considerably variable open-pollinated seedling population is under study.

FORESTRY

Conservation forms an integral part of the activities of the Department of Forestry. Over 8 million acres, on steep land, has been earmarked for protective conservation. In the lowlands some 8.5 million acres is being earmarked as a permanent forest estate in which logging will proceed in an organized manner to maintain productivity. In this area some 96 virgin jungle reserves, varying in size from 6 to over 4,000 acres (totalling some 47,000 acres), have been set aside (Tang, pers. comm.). In these reserves there will be no

logging and the species composition will be preserved. In addition to these are the national parks (game reserves) totalling over a million acres which will play a marginal role in conservation. The Forestry Department is also setting up an arboretum in which the whole range species of the Malaysian forests will be represented by at least one specimen each.

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MAJOR ACTIVITIES IN EXPLORATION, CONSERVATION, DOCUMENTATION AND EVALUATION OF PLANT GENETIC RESOURCES IN THE PHILIPPINES

by

R.V. Valmayor

PLANT INTRODUCTION AND EXPLORATION IN THE RECENT PAST

In late 1970, a team composed of four specialists working for the Bureau of Plant Industry (BPI)[1/] and the University of the Philippines at Los Baños (UPLB) and representing the fields of cereal grains, field legumes, fruit crops and vegetables, visited the leading research institutions of Indonesia, Malaysia, Thailand, India and Sri Lanka. The main emphasis of that mission was to establish a working relationship with the plant introduction agencies of these countries and gather improved cultivars of crop plants rather than collect botanical specimen merely to broaden the genetic base of our country's breeding stock. The team introduced to the Philippines 211 new and outstanding species and cultivars from India, 99 from Indonesia, 76 from Thailand, 75 from Malaysia and 40 from Sri Lanka. This mission to South and Southeast Asia was preceded by a visit of a UPLB pomologist to Brazil and the Caribbean region particularly Trinidad, Puerto Rico, Florida, and Honduras resulting in the introduction and establishment in the Philippines of tropical American fruit species uncommon to other countries in Southeast Asia. An ornamental horticulturist obtained plant materials from Hawaii, California and Florida while an orchid specialist visited Singapore, Malaysia and Thailand bringing back to the

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1/ Papers describing the work of the BPI, by R.L. Mondragon, on Seed and Plant Production and Distribution, and E. Pili-Sevilla, on Organization and Activities of the BPI, are available in mimeographed form from PCARR.

Philippines numerous popular ornamental species as well as stud plants for orchid breeding.

The International Rice Research Institute (IRRI) has also sponsored plant explorations to regions known for their wealth in genetic diversity of the rice plant. In addition to the official and organized plant explorations in the recent past, are numerous introductions made by amateur plant collectors, garden enthusiasts and plant lovers contributing to the enrichment of Philippine germplasm.

PRESENT ACTIVITIES IN THE CONSERVATION, DOCUMENTATION AND EVALUATION OF PLANT GENETIC RESOURCES

Rice -- the strategic location of the Philippine Islands forms a natural link among the Malay Archipelago, the Southeast Asian mainland, and the series of islands extending from Taiwan to Japan. Therefore, the Philippines was richly endowed with rice cultivars, of the two major geographic races *indica* and *javanica*. From the mountains of northern Luzon, varieties of the bulu type (*javanica*) found their way into Taiwan and Japan.

Although the exact number of rice varieties grown by Filipino farmers in the past has not been fully determined, records of the Bureau of Plant Industry (BPI) show that 1,282 varieties were reported to exist before 1920. However, research at the BPI later proved that only 991 were distinct varieties, the rest being duplicates. Apostol Elon-elon, Wag-wag, Raminad 3, Guinangang and Milagrosa were among the principal varieties prior to the 1950's. Quality rices such as Milagrosa are still being craved by discriminating consumers up to the present. Philippine upland varieties such as Roxoro were intensively used by rice breeders in the southern United States in developing improved varieties in that country.

Filipino farmers are also among those who readily recognize the virtues of foreign introductions and quickly adopt them for cultivation. A dramatic change took place during a period from the late 1950's to the early 1960's when many Filipino farmers shifted to Indonesian and Burmese varieties such as Peta, Tjere Mas, Intan and Bengawan. Peta later became the principal parent of the College and BPI series such as C4-63 and BPI-76 as well as many semi-dwarf varieties of IRRI and other national breeding programmes. Since 1968, the Philippines has been a forerunner among Asian nations in the proportion of rice acreage planted to the nitrogen-responsive high yielding varieties.

Fortunately, extensive efforts were made by the staff of BPI and the Bureau of Agricultural Extension during the mid-1950's in assembling the indigenous varieties. About 245 varieties were collected and these were later turned over to the UPLB College of Agriculture for maintenance. During 1962, the national rice collection of 607 accessions was donated to the germplasm bank of the International Rice Research Institute for conservation.

Because the efforts made in 1950's have adequately covered the principal rice growing regions of the country, no further efforts were made to systematically cover again the major production areas. However, field collections made by anthropologists, agricultural extension agents, and IRRI staff members continue to add to the IRRI world collection many minor varieties from remote areas. About 580 accessions were collected during 1962-1976. Such efforts will be continued in the future so that all minor varieties can be preserved.

Annual Crops other than Rice - The biggest inventory of annual crops including vegetables is found in the UPLB Institute of Plant Breeding. The accessions held in June 1976 may be summarized as follows:

	Number of types	Number of accessions
Vegetable crops	13	7,973
Legumes (field and vegetable)	7	4,263
Cereals (excluding rice)	3	3,899
Root crops	3	897
Fibre crops	4	522
Forage and pasture crops	3	147
Total	33	17,701

On 10 November 1976, the Institute of Plant Breeding was designated as the National Plant Genetic Resources Laboratory by Presidential decree. This underscores the concern and appreciation of the highest agricultural officials of the Philippines for the conservation of our endemic and introduced germplasm resources. IPB will now serve as the national repository for valuable plant materials and seedstocks. When the cold storage facilities (which has an appropriation of 5 million) become operational, the national network of research stations being serviced by PCARR will be able to send seed samples of their holdings for safe storage.

Field evaluation of collected materials will be conducted for general adaptability, yield potential, reaction to pests and diseases and resistance to adverse conditions. Greenhouse and laboratory tests will be carried out by plant breeders in close cooperation with crop protection scientists.

A computer programme will be prepared for proper storage and retrieval of valuable information derived from the evaluations.

Perennial Fruit and Plantation Crops - The Department of Horticulture at UPLB maintains the riches collection of fruit and plantation crops in the country. Outstanding in this collection are the 226 accessions of coffee, 57 clones of cacao, 50 varieties of coconut, 65 clones of abaca, 68 cultivars of bananas and plantains and 52 varieties of mango. The fruit variety collection includes the choice cultivars of Thailand, Malaysia and Indonesia of durian (*Durio zibethinus*) and rambutan (*Nethelium lappaceum*). It also includes the exotic fruit species of tropical America such as the jaboticaba (*Myrciaria cauliflora*), grumichama (*Eugenia dombeyi*) and pejibays (*Guilelma gasipaes*). In summary, the accessions of fruit and plantation crops are presented as follows:

	Fruit crops	Plantation crops
Families	35	9
Genera	68	11
Species	122	15
Cultivars/strains	404	395

BPI also maintains modest collections of tropical fruits at the Experiment Stations in Lipa, Novaliches, Davao and others, and a few subtropical fruits are grown at the Baguio Experiment Station.

Forest Plants - The forests of the Philippines have been acclaimed as one of the most valuable tropical forests in the world because of their diversity and economic importance.

Unfortunately, destruction of these important natural resources has been going on at a very fast rate and it has reached a point where many important forest plants are believed depleted, endangered or extinct.

Measures to conserve endangered or depleted species and to restore extinct ones are currently being undertaken by the government. These include:

Selective logging - the government requires concessionaires to cut mature and over mature trees 70 cm. d.b.h. and up, to ensure a continuous regeneration of the area and to prevent heavy damage on residual stands.

Establishment of reforestation projects - denuded lands are being reforested at the planting of vanishing commercial tree species e.g. *Pterocarpus indicus*, *Samanea saman*, *Vitex parviflora*, *Intsia bijuga*.

Declaration of forest reserves - a total of 160 forest reserves with a total area of 6,194,337 hectares have been established all over the Philippines. The smallest reserve, the Brook's Point Forest Station Site Reservation located in Brook's Point, Palawan, has a total land area of 0.25 hectare while the largest reserve, the Central Cordillera Forest Reserve has a total land area of 680,641 hectares and covers Abra, Ilocos Norte, Nueva Viscaya, Pangasinan and the Mountain Provinces.

Forest Conservation Education Programme - in cooperation with the Bureau of Forest Development, UPLB College of Forestry, Department of Education and Culture, the government is currently undertaking a massive forest conservation education programme with the aim in view of teaching the citizens the value of forests and the need to conserve them. The mass media, seminars, leadership training, community assemblies and other form of person-to-person contacts are being used.

Establishment of Botanic Gardens - two botanic gardens, the National Botanic Gardens in Sinoloan, Laguna, and the Makiling Botanic Gardens in Los Baños, Laguna, are currently involved in the conservation of forest trees, shrubs and orchids.

Conservation through research - the Forest Research Institute (FORI) is conducting research projects on the production of mangrove species, medicinal plants, rattans, high premium species for furniture making and Dipterocarps. Emphasis is on seed production, germination, seedling maintenance and plantation establishment.

PCARR is deeply concerned with the loss of several valuable introductions of fruit cultivars earlier established in Los Baños and other experiment stations in Luzon and Visayas through destructive typhoons. These two regions of the country lie within the

the typhoon belt. Strong winds also hamper the progress of performance trials involving introduced cultivars. For these reasons, BPI and PCARR are preparing a programme to establish at the Davao Experiment Station a duplicate collection of all fruit and plantation crops now growing in the various experiment stations in Central and Northern Philippines. Davao is located in the typhoon-free area of Southern Mindanao. In the southern Mindanao region is situated the modern and highly successful banana export industry, and a major pineapple plantation and cannery. Commercial production of citrus fruits (pumelo, mandarin and sweet orange), mango, mangosteen, durian, lanzones, rambutan, papaya and many others make Davao an ideal site for the National Fruit Research Centre. It is hoped that the Davao Experiment Station can also serve as the site for a banana germplasm bank for Southeast Asia.

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PLANT GENETIC RESOURCES OF PAPUA NEW GUINEA

by

A.E. Charles and V. Kesavan

INTRODUCTION

Papua New Guinea is a thinly populated country (6 people/km2) possessing a wide geographical and ecological diversity, ranging from coastal plains and swamps to the inter-montane valleys and forests of the central Highlands. Subsistence agriculture is the predominant feature of rural life (Barrau, 1958). The mountainous terrain and the mode of agriculture have preserved and enriched the wealth of genetic material available within the country. Nevertheless, population growth rate at 2.8 percent per annum is high and land pressure is becoming acute in some areas due to agriculture developments. Plant breeding is still in its infancy and selection work is likely to narrow the genetic base as more adapted and high yielding varieties are needed to increase food production in the immediate future. There is, thus, a growing need for conserving and broadening the genetic base for future use.

Before formulating steps towards preservation, detailed studies on the existing flora and fauna are urgently needed. Previous studies in the field of genetic resources in Papua New Guinea are scattered in various disciplines such as ethnobotany, anthropology, taxonomy and geography The results of such studies need to be collated to form the basis for future exploration, conservation and use. The risk of loss of wildlife, some of which is unique to Papua New Guinea, has been realised and a policy to reserve selected

areas as National Parks is underway. The rate of progress in implementation of the policy is relatively slow due to limited financial resources and problems in land alienation. Only 5 areas, totalling 5000 ha, have yet been gazetted as National Parks. The Wau Ecology Institute and the Department of Forests are both conscious of the need to conserve Papua New Guinea forest resources. However, limited work on documentation of forest flora has been carried out over the past 30 years (Lamb and Gressit, 1976). The Botanic Gardens at Lae are preserving a collection of Pandanus species and of wild relatives of Citrus.

It is with the domesticated and semi-domesticated plants that positive programmes of conservation must be developed. Cultivated plants in Papua New Guinea can be broadly grouped into major and minor crops. The major subsistence food crops –sweet potato, taros (Colocasia spp. and Xanthosoma spp.), yams (Dioscorea esculenta and D alata), bananas (Musa spp.), sago (Metroxylon spp) – are represented by very diverse genetic material Genetic diversity in these crops, which are all propagated vegetatively, has arisen through natural cross pollination and through somatic mutation (Shaw, 1975; Yen, 1974) Success in preserving this diversity lies in developing alternative storage methods.

Papua New Guinea also has an array of minor, semi-domesticated species, e.g. aibika (Abelmoschus esculenta), rungia (Rungia klossii), amaranths, pitpit (Saccharum edule and Setaria palmifolia), kun (Oenanthe javanica), Pandanus spp., valangur (Polyscias grandifolia), kagua (Ficus sp.) and tulip (Gnetum gnemon). Only limited and usually disconnected, survey of these minor food plants have been made (Powell et al, 1975).

Increasing attention is being given to these by the University and government researchers. But the resources available are limited and external assistance will be valuable in preparing a full catalogue of the minor food plants and in assessing their nutritional value and importance. The minor crops are being increasingly replaced by introduced leafy vegetables like cabbage and lettuce, which are nutritionally much inferior.

CROP PRIORITIES FOR PAPUA NEW GUINEA

The food crops that deserve special attention are sweet potato, yams, sugarcane, bananas, taros and winged bean. Coconut, both a food and industrial crop, also rates high priority. Papua New Guinea is considered as a centre of genetic diversity for sugarcane (Stevension, 2965), yams (Coursey and Martin, 1970), diploid Australimusa bananas (Simonds, 1966) and winged beans (Khan, 1976). Saccharum species collected from Papua New Guinea have contributed disease resistance to many of the cultivated varieties throughout the sugarcane growing areas of the world. Many plant explorers have made use of the Papua New Guinea banana varieties A start has been made on evaluation of sweet potato varieties and it is probable that Papua New Guinea germplasm can contribute to breeding programmes in other countries; some seed has already been sent to IITA, Nigeria. Very little detailed work has been done on taros and yams which occupy a prime agricultural and traditional value in areas such as New Britain, Sepik, Trobriand Islands and the Papuan Coast. An indication of the value of the yam germplasm is that, from a few varieties collected mainly in market places during a brief visit to Papua New Guinea, Martin

(personal communication) obtained at least one variety ranking with the best in his 'world' collection. At the University of Papua New Guinea, a team of researchers are working on winged bean (Psophocarpus tetragonolobus), a traditional crop of the New Guinea Highlands. The importance of this legume stems from its high protein content (c 34 percent in seeds, c.14 percent in tubers) and its nodulation capacity. The University collection has over 140 lines of this bean showing a wide genetic variation, assembled from Papua New Guinea and other neighbouring countries. Its value was amply demonstrated by the interest shown by the National Academy of Sciences, U.S.A. (1975) and the Asia Foundation Even with the limited facilities, germplasm material in winged bean has been supplied to more than 100 individual scientists and institutions The International Atomic Energy Agency, Vienna, has funded a mutation breeding project in winged bean with the main objective of developing a dwarf, determinate type If such a bush type mutant is located, winged bean is likely to reach the status of a field crop along with other legumes Ongoing activities in this crop need encouragement and support, particularly in the area of exploration (Khan and Erskine, 1976)

GERMPLASM COLLECTIONS IN PAPUA NEW GUINEA

The following is a brief summary of existing crop collections in the major food crops with notes on crops of minor value. These collections include mainly cultivars, many of which can be regarded as land races adapted to particular environments in Papua New Guinea. There are a few wild relatives included in these collections, notably in Musa spp. Cultivars introduced from other countries are also included in the collections.

(i) Traditional food crops

A very diverse collection of genotypes, numbering over 300 (Kimber, 1972), exists in sweet potato at Aiyura in the highlands. In addition, about 70 lines from the lowlands are assembled at Keravat, New Britain. At the lowlands Agricultural Experiment Station, Keravat, an excellent collection of 220 genotypes of taros (Colocasia esculenta and Xanthosoma spp.) has been assembled. Some resistance to taro leaf blight (Phytophthora colacasiae) has been located in this collection. Susceptibility to the lethal virue 'Alomae' was found to be variable in this taro material (R.M. Bourke - personal communication).

Two other notable collections are in, 1) bananas, where initial exploration and collection of the germplasm was supported by the New Guinea Biological Foundation), maintained in Lae, and 2) in winged beans maintained by the University of Papua New Guinea. The banana collection includes edible and non-edible types. A few clones of diploid species such as Musa banksii, M. ingenus and M. maclayi are also maintained. The winged bean collection has a limited number of related species such as Psophocarpus palustris. Genetic material from both these collections is available for international distribution.

Three important food crops which have received scant attention so far are sugarcane, yams and sago palm. A wide range of genetic variation is available in yams (Massal and Barrau, 1956). Work on exploration and preservation has not been carried out with the starchy sago palms (Metroxylon spp.).

Another palm which dominates the Pacific cultures is coconut (Cocos nucifera). Limited studies indicate that the majority of plantings are of a single 'variety' but there are localised populations whose characteristics differ substantially from the common 'variety' (Charles, 1973). An evaluation trial, comparing local and introduced varieties, is in progress.

Present collections in all these food crops need to be expanded and evaluated (and documented) in detail. Exploration and evaluation is also needed in crops such as yams and sago palms, which have been largely neglected so far.

(ii) Introduced Crops

These are mainly plantation crops such as cocoa, coffee, tea, rubber, oil palm and, of recent origin, cereal grains and grain legumes. High yielding clones, varieties and hybrids are being introduced. The small germplasm collections maintained in Papua New Guinea mainly comprise varieties selected overseas, so that they would have little international interest. However, there has been selection for adaptation to local conditions within segregating material of cocoa, pyrethrum and oil palm, and other countries could be interested in cocoa clones carrying resistance to Vascular Streak Dieback (Oncobasidium theobromae), and high yielding tenera oil palm seed which is commercially available.

POINTS OF SPECIAL CONCERN TO PAPUA NEW GUINEA

Papua New Guinea is a newly independent country with pressing demands on its limited economic resources from various sectors. Though we realise the importance of

conservation and use of 'genetic treasures' our ability to cooperate on a regional basis is limited due to lack of funds and trained personnel.

Similar problems exist throughout the South Pacific Islands – none being large enough to support active, national programmes in genetic resource work but all in need of the benefits of such work. Papua New Guinea depends and will continue to depend on her neighbouring Southeast Asian countries, Australia and other developed nations for enlarging its genetic base in the form of new varieties, new characters and new species. This is particularly relevant in crops such as coffeee, rubber and oil palm. But in exchange Papua New Guinea can offer 'raw materials' – plants of genetic value, but usually unevaluated, as in the case of sugarcane, bananas and yams.

It is in such crops that the need for cooperation, both material and technical, is of utmost importance. These areas of cooperation and specific goals are elaborated below.

PRESERVATION OF VEGETATIVELY PROPAGATED MATERIALS

Most of the major food crops of Papua New Guinea are vegetatively propagated. The difficulty in preserving such material was felt strongly by the Bogor Symposium in 1975 (Williams and Sastrapradja, 1975). The preservation of gene pools in such crops requires alternative methods. We also express our concern for thorough investigation of storage methods for such plants. Studies on mode of pollination, natural seed set and tissue culture, using local material, should be conducted before embarking on preservation work.

EXPORT OF SEED AND PROPAGATION MATERIAL

The Bogor meeting also emphasized the need to ease export restrictions on material needed for scientific research. We would strongly endorse the need to relax any restrictions which represent only a reluctance to share genetic resources, and we would also ask that the easing go somewhat beyond "material needed for scientific research". As has been explained earlier, our economy cannot support selection and breeding programmes for crops such as rubber, which nevertheless provides the only cash income for some of our people, so we need to be able to obtain budwood of superior clones from countries which have well supported breeding and research facilities. We recognise that those who develop high yielding material cannot be expected to give it away freely but we see an urgent need for easing restrictions and providing guidelines for the sale or exchange of such improved clones as well as for free exchange of basic genetic stocks

At the same time we would note that we adhere to the International Convention on Trade in Endangered Fauna and Flora, which places certain restrictions on exports with the specific aim of preventing loss of germplasm of particular species

Perhaps the initial aim of discussions under this heading should be to assist each country to clarify which classes of plants need to be subject to export restrictions, so that other plants may be exempted from restriction. One suspects that many of the problems obtaining plant material from another country arise because the exporter finds it easier to refuse or ignore the request than to make or obtain a decision as to whether the export is against national interests.

QUARANTINE

The Bogor meeting sought provision for intermediate quarantine facilities. Papua New Guinea is very conscious of the need for an exacting quarantine control in plant exchange, as our country's isolation has secured freedom from many of the worst plant pests and diseases. We certainly endorse the need for intermediate quarantine facilities outside the tropics but would also press for the inclusion of facilities for electron microscope screening and meristem culture to be included. Recently, virus or mycoplasma-like particles were detected in a large proportion of apparently healthy sweet potato cuttings introduced from Africa through a screening arranged privately in Britain (Shaw - personal communication). We would like to see all vegetative material of important crop plants screened in this way as a routine part of international exchange.

We would also emphasize that intermediate quarantine is not a substitute for other quarantine precautions. Without adequate care, intermediate quarantine could simply exchange diseases of the country of origin for diseases of the country of quarantine.

TRAINING IN PLANT GENETIC RESOURCES

This is one area where cooperation can be effective. To increase an awareness of valuable genetic resources, training of some of our graduates in agriculture and forestry will give added impetus to exploration, conservation and use.

POSTCRIPT

To summarise, Papua New Guinea is in need of genetic resource conservation. This can only be achieved through basic surveys and exploration work. All the major food crops are vegetatively propagated and they require alternative methods of storage and preservation. Also, there is a need for intermediate quarantine and training in plant genetic resources.

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PLANT GENETIC RESOURCES IN THAILAND

by

Narong Chomchalow

In all studies on the delimitation of centres of diversity, some of the classical work of Vavilov, Thailand has been considered to be part of the Southeast Asian or Indochinese-Indonesian Centre. The area is important because it lies close to the cradle of agriculture in Eastern Asia i.e. Burma-China; and Thailand has provided interesting data from archaeological sites e.g. the Spirit Cave in the NW and Nan Nok Thu in the northeast. Northern Thailand lies in the broad belt where the Asian rice evolved from an annual progenitor.

Although the place of origin of many Southeast Asian cultigens can be pointed to with a fair degree of certainty, none have been stated as Thailand. However, there is so much diversity seen in many native crops that their origin in this part of the region cannot be ruled out.

Important diversity is seen in durian, banana, pomelo, longan, rambutan and rice and there is secondary diversity in many other crops which are known to have originated elsewhere but have been introduced into Thailand for a long time, and indeed there are other crops which are relatively recent introductions which exhibit a diversity of forms.

As is the case in many other countries, modern agriculture tends towards minimizing the crops to a few species and varieties in order to obtain maximum yields and quality of the produce per unit area within a short time. More and more forest lands have been

cleared for agricultural activities and due to the bulldozer and fire many of our native crop species like teak, spices, medicinal plants, fruit trees and ornamentals which have once flourished in the forests have gone. Ten years ago Thailand had 50 percent of its land as forest areas. Now only 38 percent supports forest. Several ill-effects of this deforestation have been recognized, viz. erratic onset of rain, severe drought, and extremely high temperatures.

Most agricultural research agencies tend to work with a few species of economic crops. This is understandable since the national economy relies mainly on the export of agricultural products. Surprisingly enough, apart from rice, most of these crops are introduced. The governmental agencies have done a creditable job of introduction and the production of several improved varieties which are high yielding and adaptive in our agricultural systems. Thailand is a major exporter of many of the following crops or crop products: corn, kenaf, sugar, tapioca, para rubber, pineapple and grape. Other crops have great potential: soybean, groundnut, mung bean and Japanese mint.

But what about our native plants? Just like our beloeved traditions and culture which are now largely replaced by western influence, most of our native plants which nourished our ancestors for thousands of years have to make way for newly introduced species. Although it is a pity to lose this valuable material, it is also understandable that a poor country like Thailand (which faces not only economic problems but also political crises and foreign intervention) must put emphasis on those crops which have direct economic potential. The new economic crops are highly productive but are sometimes susceptible to diseases. Downy

mildew disease of corn, curly top disease of cotton, Phytophthora root rot disease of durian and para rubber are a few of the recent examples in Thailand.

Some people have tried to conserve our native crops but their efforts have been limited. Table 1 lists existing collections and the institutes involved in genetic resources. Collection of native cultivated crops, together with their wild relatives, is being attempted at several places, but with the limitations of budgets, personnel, facilities, and training, such efforts cannot keep pace with the needs for action. The author is happy to have the opportunity to discuss these problems at this important working group and is willing to cooperate or coordinate any activities to save the native plants of Thailand which may have future economic potentials.

TABLE 1: EXISTING COLLECTIONS AND INSTITUTES INVOLVED IN GENETIC RESOURCES

I LIVING COLLECTIONS

(i) Fruits: primitive cultivars, introduced varieties and related wild species of banana, mango, durian, longsat, jackfruit, tangerine, pomelo, coconut.

(ii) Root crops: cassava, sweet potato, potato, yam, taro.

(iii) Essential oil and spice crops

(iv) Vegetables: tomato, kale, Brassica and other crudifers, string bean, Chinese radish, lettuce, sweet pea.

(v) Miscellaneous: para rubber, coffee, tea

II SEED COLLECTIONS

- Grains: primitive cultivars of upland and lowland rice, corn, sorghum, millet.
- Fibre crops: kenaf, jute
- Oil seeds and grain legumes: soybean, mung bean, castor bean, groundnut, wing bean.

III ORGANIZATION

The following organizations are at present engaged in collection and conservation of plant genetic resources in Thailand:

(i) Department of Agriculture:

- Horticulture Division
- Field Crops Division
- Rice Division
- Seed Technology Laboratory

(ii) Office of the Under-Secretary, Ministry of Agriculture:

- Northern Region Agricultural Centre
- Central Region Agricultural Centre
- Northeast Region Agricultural Centre

(iii) Universities:

- Kasetsart University;

  Pak Chong Farm
  Suwan Farm-National Corn and Sorghum Research Centre
  KampaengSaen Farm
  Bangkhen Farm

- Khou Kaen University
- Chiang Mai University
- Prince of Songkhla University

(iv) Applied Scientific Research Corporation of Thailand:

- Essential Oil and Spice Research Station
- Sakaerat Ecological and Environmental Research Stations
- Ministry of Industry; Sugar and Sugarcane Office
- Ministry of Finance; Thai Tobacco Monopoly Experiment Stations
- Department of Forestry
- Department of Medical Science
- National Research Council

ACTIVITIES OF BIOTROP IN PLANT GENETIC RESOURCES

BIOTROP, the Regional Center for Tropical Biology, located at Bogor, Indonesia, is one of the institutes established by SEAMEO (South East Asian Ministers of Education Organization). The objective of BIOTROP is to contribute to regional economic need of the region by identifying and solving critical biological problems, the solution of which will enhance regional development.

BIOTROP entered its First Five-Year Development Plan in July 1973. One of the programmes existing at BIOTROP is on tropical forest biology. It is realized that the vast forests in Southeast Asia play a significant role in the economic development of the region and they contribute to the important natural resources. However, during the last few years, large-scale utilization of the forests has begun to endanger the genetic resources. Relizing the importance of conservation and utilization of plant genetic resources, the Tropical Forest Biology Programme has included studies of plant genetic resources.

The activities being undertaken in relation to the study of plant genetic resources are research projects, training courses and symposia.

Research projects

1. In 1973-1974 Dr. J. Dransfield, who worked part time at BIOTROP, completed his 4-year study on the biology of rattan species, including the morphological variation, and some ecological aspects of commercial species.

2. In 1973-1974, BIOTROP supported a study of important wild tropical fruit trees by Dr. Setijati Sastrapradja, Director of the National Biological Institute, Indonesia. An inventory of the common fruits was made in Malaysia, Thailand, the Philippines, Indonesia and South Vietnam. The inventory provided data on the species in the different countries, their economic importance and the degree of genetic erosion. This inventory has formed the basis for future programmes on utilization and conservation.

Another project by Mr. Pairoj Polprasid, Department of Agriculture, Thailand, on collection of tropical fruit germplasm was also supported by BIOTROP. This has included the:

(a) collection of as many as possible species of tropical fruit trees in Southeast Asian countries,

(b) the study of the economic value of the germplasm collected,

(c) the utilization of the germplasm beneficial to the development of fruit industry in the region.

3. A check-list of fruit-bearing plant families and species which have been recorded in museums and libraries has been compiled.

4. In August 1976, a plant nursery team went to the Tanowsee mountain range to collect wild species of fruit trees.

Since the start of the First Five-Year Development Plan, BIOTROP has had no permanent staff working on genetic resources. However, in 1976, Miss L.B. Ungson has been seconded to BIOTROP from the University of the East in the Philippines. She has started

work on Piper nigrum L. and its wild relatives in Java, in relation to utilization and conservation especially since there are serious disease problems in P. nigrum cultivars in some areas.

Training courses

Studies on plant genetic resources in Southeast Asia are primarily hampered by the inadequate number of suitably-trained scientists. In cooperation with the National Biological Institute of Indonesia and FAO, BIOTROP organized a short-term training course in conservation and utilization of Plant Genetic Resources from 10 February to 22 March 1975. The course was led by Dr. Setijati Sastrapradja and the objectives of the course were to provide training for young scientists from Southeast Asian countries to:

(a) make them aware of the problems relating to conservation and utilization of plant genetic resources;

(b) provide some theoretical background to these problems; and

(c) enable these young scientists to put some of this knowledge into practise.

The report on this training course is available from BIOTROP.

The tropical forest biology programme includes longer-term training courses of 6 months' duration. Besides attending lectures, each participant is assigned a research project. Studies on genetic resources may be selected as topics e.g.:

(a) "Gnetum gnemon L. and its relatives in Java" (Usep Sutisna, National Biological Institute, Bogor). Studies were conducted on the variation in morphological characters, protein contents, and phenolics in four species;

(b) "Variation in Smilax species of Java" (L.B. Ungson, University of the East, Manila, Philippines). Studies were conducted to determine morphological, phytochemical and cytological variation in the species. Smilax macrocarpa appears to be a potential species for cultivation.

(c) "Variation in Spathoglottis species of Java" (Sri Wismaniah Roedjito, National Biological Institute, Bogor). Studies were made on the patterns of morphological and ecological variation to provide information as a basis for utilization and conservation.

(d) "A systematic review of the Javan species of Baccaurea Lour. (Euphorbiaceae)" (E.S. Fernando, from the Department of Forest Biological Sciences, College of Forestry, UPLB, Philippines). This study was undertaken to provide characterization of the species for identification and to obtain information on their ecology and utilization.

BIOTROP has also studied factors affecting the viability of forest tree seeds. Studies have been designed to determine the methods of seed testing as well as the proper times for seed collection, and to provide information for the development of storage

methods primarily in connection with the production of nursery stocks needed in reforestation. However, the information will also be useful for developing long term storage of seeds for conservation. So far the following species have been investigated: Pinus merkusii, Agathis dammara, Lagerstroemia spp., Shorea spp., and Leucaena leucocephala.

Symposia

BIOTROP must take credit for being one of the three sponsors of the Symposium on Plant Genetic Resources held in 1975 at Bogor. The Symposium successfully collated information and made recommendations, one of which has led to the convening by IBPGR of this present Working Group.

Postscript

Due to limited availability of manpower and facilities, BIOTROP restricts its research activities to specific problems. It is hoped that the discussions of this Working Group will provide guidelines for selecting priority areas of studies in genetic resources

THE GENEBANK FOR ECONOMIC CROPS IN SOUTHEAST ASIA

The genebank project of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) was initiated in 1971 to help in country breeding programmes in Southeast Asia for a 5-year period, to identify genotypes that are adapted to the region. This was felt necessary since germplasm collections are usually too large for individual in-country programmes to evaluate. It was felt that one centre could screen the large collection from which smaller sets were then distributed to in-country programmes to serve as a major source of their breeding materials.

The objectives of the programme are:

1. to collect and maintain all available genotypes of crops of economic importance to Southeast Asia;

2. to serve as a centre from which member countries could obtain suitable genotypes;

3. to classify collected materials into categories that will be most useful to researchers in the region; and

4. to generate from the collection, breeding materials that are useful to member countries.

Much of the initial collection came from the breeding programme at the University of the Philippines at Los Baños (UPLB). In the succeeding years the project workers had a chance to visit International Centres in Asia and other parts of the world to develop

working relationships whereby accessions were sent to the project on a continuing basis.

All the accessions received by the project were tested for two planting seasons at the experiment station of UPLB and at least 5,000 seeds of each accessions were produced and stored at the existing UPLB seed storage.

Based on performance, adapted accessions were identified and listed in a plant introduction catalogue. This publication, covering to date corn, soybean, sorghum, mungo and groundnut, has been sent to all breeders in the region and to institutions who donated material. Any member country in the region could request seed materials which the project sends free of charge.

The project continuously examined the variability of all its accessions. Any sign of deterioration was immediately remedied by regeneration.

RESULTS AND ACCOMPLISHMENTS

Up to June 1976, a total of 2933 accessions of eleven species of annual crops had been amassed:

CROP	TOTAL ACCESSIONS
Corn	1254
Soybeans	320
Cowpea	420

CROP	TOTAL ACCESSIONS
Cotton	260
Sunflower	35
Potatoes	33
Pigeon pea	47
Cassava	50
Snap beans	114
Groundnut	20
Mungbean	380

In response to requests from breeders in the region and other parts of the world, a total of 1413 seed packets have been sent out to 103 institutions. The distribution of these seed packets by crop is shown below:

CROP DISTRIBUTED	NUMBER OF ACCESSIONS DISTRIBUTED	NUMBER OF INSTITUTIONS SERVED
Mungo	988	30
Corn	215	26
Sorghum	144	28
Cowpea	110	2
Soybean	123	10
Sunflower	12	1
Cotton	17	1
Snap beans	55	2
Groundnut	6	4

THE FUTURE OF THE PROJECT

Provisions have been made for the continuation of the project's activities even after the termination of SEARCA support. A new cold storage has been constructed to take care of long-term storage of seeds.

The service is now permanently housed and adequately supported at the Institute of Plant Breeding (IPB). Dr Noel G. Mamicpic, a co-worker of the project is now heading the Germplasm Section of IPB. Within the project life time, interest has been generated from other sources of funds to continue supporting the same service.

EXPANDED SOYBEAN PRODUCTION AND USE: THE INTERNATIONAL SOYBEAN PROGRAMME

by

C.N Hittle

The INTSOY Programme

The University of Illinois is committed to soybean research and education on an international scale, a commitment that has developed from the research on soybean production and soy food use beginning, in India, in 1965. Variety testing expanded to 11 countries from 1969 to 1972 under the Program for International Research, Improvement and Development of Soybeans (PIRIDS) that was supported by the Rockefeller Foundation and the U.S. Agency for International Development (USAID). The International Soybean Program (INTSOY), "a program of the University of Illinois at Urbana-Champaign and the University of Puerto Rico, Mayaguez Campus, cooperating with the international and national organizations to expand the use of soybeans for human food", was established in 1973.

In response to a request from the Technical Advisory Committee (TAC) of the Consultative Group for International Agricultural Research (CGIAR), the College of Agriculture, University of Illinois, studied "ways in which existing competence in soybean improvement, production, and utilisation could be organized to serve the needs of developing countries" and proposed the establishment of an "International Soybean

Resource Base (INTSOY)". This proposal was favourably reviewed by an ad hoc Steering Committee that met at the University of Illinois on 9-10 July 1973. While INTSOY has not been supported with amounts and flexibility of funds required to fully implement the plans that were laid, the programme has expanded in a manner consistent with the guidelines and priorities set forth.[1/]

The U.S. Agency for International Development has provided the primary support for INTSOY through companion 211(d) grants to the University of Illinois and the University of Puerto Rico and a research contract with the University of Illinois. The 211(d) grants, with objectives of "building institutional response capability" provide funds to each university for the five years, 1 October 1973 to 30 September 1978. The initial three-year research contract began on 1 April 1973. A new contract for the period 1 April 1976 to 31 March 1979 provides for research on development of soybeans for tropical and subtropical areas. A grant was made by the Rockefeller Foundation for the year that ended 31 July 1975.

USAID missions have supported country programmes under the AID Basic Ordering Agreement-Task Order format in Guyana, Uruguay, Peru, Bangladesh, Ecuador, Zaire, and Thailand. The United Nations Development Programme (UNDP), through the Food and Agriculture Organization of the United Nations (FAO), provides support for a major

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1/ "International Soybean Resource Base, A Proposal" prepared by the College of Agriculture, University of Illinois, for the consideration of the World Consultative Group on Agricultural Research and its Technical Advisory Committee, June 1973, 77pp.

soybean development programme in Sri Lanka. The Ivory Coast, Saudi Arabia, Brazil, and Korea have supported joint efforts.

Some 50 countries have had 393 representatives at three regional conferences for soybean workers held in Mayaguez, Puerto Rico; Addis Ababa, Ababa, Thiopia; and Chiang Mai, Thailand. The 1975 and 1976 training courses on soybean production and soybean processing have attracted 61 trainees from 33 countries. The quarterly INTSOY Newsletter was started in August 1974 and the mailing list has grown to about 1,200. Eleven publications have been issued in the INTSOY publication series since it was begun in early 1974.

The three years of INTSOY experience has shown that the basic concepts underlying the programme are sound. It has demonstrated that the Universities of Illinois and Puerto Rico, as developed country based institutions, have the capacity and flexibility to serve in a leadership role developing and sustaining the international soybean network of research, education, and development organizations and individuals. Both the results of research and growth of programme activities show that soybeans have an expanded role to play in the world food picture. The expansion of the variety testing programme from 33 countries in 1973 to 90 countries in 1976, upon request of scientists in those countries, is evidence of the worldwide interest in soybeans. Active cooperative programmes with the two international centres with soybean work await only the resources to implement projects.

Thus in recent years there has been an expansion of soybean research, extension and production in many of the tropical and subtropical countries. Accompanying this expansion are the initiation of new soybean breeding programmes and the introduction of new varieties, breeding lines and selections. All these factors lead to the disappearance of existing native and local strains (genotypes) unless appropriate and timely steps are taken for the collection, classification and preservation of this germplasm. INTSOY is willing and anxious to be of assistance wherever there is need for soybean germplasm collections.

Soybean Germplasm Collection

The following itemises important factors relating to the collection of soybean germplasm and lists countries in order of priority for collections:

1. Timing of Collection: Soybean seed must be collected just prior to harvest so the plants can be identified and seed harvested. This timing usually varies from area to area within a country. Therefore, repeated visits may be necessary, especially in the tropics.

2. Lead Time: Considerable 'lead time' is necessary. Most of the first year of a project should be spent in planning for the collections, including studying local customs,geography, language, travel schedule, clearances, etc. Four or five years of actual soybean germplasm collection might be required to cover the Far East (from India to Australia to China).

3. Country Collections: All local collections should be maintained in the country of origin as well as sending seed samples to regional and international collections.

4. The Regional Approach: The regional approach to collection, conservation, evaluation and disbursement, such as discussed at this IBPGR/PCARR Workshop on Southeast Asian Plant Genetic Resources, is strongly encouraged.

5. USDA Collection: The present USDA (U.S. Department of Agriculture) system (Soybean Germplasm Collection) works well and should be expanded and maintained as a complete collection. All organizations and persons collecting soybean germplasm are strongly urged to send appropriate seed samples to the USDA.

6. Dr. Theodore Hymowitz, University of Illinois, emphasizes that soybean collections should be made in the following countries, listed in order of priority:

Not Open	Open	For related species
South China	Ryukyu Islands	Australia
NE China	Taiwan	South Pacific Islands
USSR (Asia Area)	Indonesia	Papua New Guinea
North Korea	Thailand	Philippines
North Vietnam	Nepal?	
Burma	Bhutan ?	

7. Dr. Richard L. Bernard, USDA Regional Soybean Laboratory, Urbana, Illinois, believes that the USDA germplasm collection has everything it needs from South Korea and nearly everything from Japan. He places mainland China and North Korea in the highest priority for collection. The largest portion of entries in the collection resulting from the Morse-Dorsett collections in the 1920's and 1930's come from North Korea.

IRRI'S ROLE AS A GENETIC RESOURCES CENTRE, II

by

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The genetic conservation programme of the International Rice Research Institute (IRRI) from 1961 to 1972 was described in a series of three pages presented at the FAO/IBP Technical Conference on Crop Genetic Resources held in Rome in 1973 (Chang, 1975; Chang et al., 1975a; Chang et al., 1975b). This report updates the information in those papers by describing IRRI's progress from 1973 to 1976 in conserving the rice genepools and in related work.

PROGRESS IN FIELD COLLECTION

Field collection activities began in several Asian countries shortly after the 100 rice breeders present at the IRRI Rice Breeding Symposium in 1971 designated IRRI as the coordinating agency for the global conservation of rice germplasm (IRRI, 1972). Upon the invitation of the national centres, IRRI participated in the systematic canvassing and assemblage of germplasm in six Asian countries. Six additional countries

received technical help from IRRI in implementing their own collection operations (Chang and Perez, 1975). Moreover, extension workers in Bangladesh, Burma, Indonesia, Sri Lanka, and Vietnam (South) canvassed the countryside and sent in thousands of seed samples.

The progress in field collection in tropical Asia during 1971-76 is summarized in Table 1 (page 80). As of December 31, 1976 a total of 18,007 seed samples were collected, of which about 7,502 were collected with IRRI's direct participation. Moreover, 97 samples of wild taxa were collected. Field collection by extension workers was substantially helped by the distribution of a Manual for Field Collectors of Rice (Chang et al., 1972) to participating workers.

The collection of special types that have resistance to or tolerance for a biotic or environmental plant-stress factor was emphasized. During 1972-76, IRRI directly participated in assembling more than 4,845 samples with such special features (Table 2, page 81). However, the authenticity of such tolerance or resistance needs to be scientifically determined.

The pooling of financial resources from different funding agencies helped IRRI achieve success in coordinating and stimulating field collection activities. The Rockefeller Foundation, Ford Foundation, U.S. Agency for International Development (USAID), U.K. Overseas Development Ministry (ODM), U.S. Department of Agriculture (USDA), and more recently, the International Board for Plant Genetic Resources (IBPGR), contributed funds towards the collection operations.

An earlier report (Chang and Perez, 1975) describes the modus operandi in organizing and implementing collaborative programmes of field collection.

Officers of the Food and Agriculture Organization of the United Nations (FAO) and the Institut de Recherches d'Agronomiques Tropicales (IRAT) in West Africa made extensive collections of both the African and Asian rices in the Ivory Coast, Liberia, Mali, Niger, and Sierra Leone during 1972-74. They furnished about 2,940 seed samples to IRRI.

IRRI has established rapport with Japanese plant explorers who recently travelled extensively in India, Indochina, Nepal and Sri Lanka.

The Japanese workers provided IRRI with 1,135 cultivars and 57 populations of wild taxa.

Near the end of 1976, the IRRI Germplasm Bank had 34,200 distinct accessions of O. sativa, 3,800 newly received seed samples of the Asian rice, 1,372 strains of O. glaberrima, 866 wild taxa, and 637 genetic testers and mutants.

SYSTEMATIC CHARACTERIZATION AND CATALOGUING

Figure 1 (page 84) shows the sequence of the steps in processing newly arrived seed samples through the registration, seed increase, systematic characterization, multidisciplinary evaluation, utilization in breeding, and storage operations at IRRI.

Each viable accession is planted twice in three-row plots (more recently in two-row plots), once in the wet season and again in the dry season. Two seasons of planting are necessary to produce sufficient seed and to evenly distribute the systematic description work. During the mid-1960's, we grew, on the average, a total of 1,200 plots per season, which for 1972-76 increased to more than 4,000 plots per season.

Thirty-seven items are recorded for each accession: 1 seedling character, 11 leaf characters, 6 culm characters, 1 physiological character, 4 panicle features, and 14 grain characteristics according to the standards described by Chang and Bardenas (1965). We record quantitative traits, such as tiller number, plant height, and maturity in the wet season, and morphological features, such as pigmentation and pubescence, in the dry season. Records on about 28,547 accessions have been taken in the field; records on all 37 items are complete for 17,869 accessions.

The varietal catalogue published in 1970 (IRRI, 1970) contains, in addition to morpho-agronomic data, information on the reactions to blast, bacterial leaf blight, and stem borers of 8,628 accessions. The 47-item data were also recorded on magnetic tape. Nearly all the viable accessions have been tested for bacterial leaf blight reaction and analyzed for protein content. We are now putting the data on the second group of 9,192 accessions on punch cards and tape. Efforts are being made to collate the varietal designation, country of origin, and morpho-agronomic data with other outputs from various Genetic Evaluation and Utilization (GEU) tests of IRRI (Gomez and Chang, 1976).

GENETIC EVALUATION AND UTILIZATION

Conserved stocks in the germplasm bank are systematically channelled into the GEU programme of IRRI. Newly received samples known to have certain features are immediately distributed to the research department or departments concerned.

Each year IRRI researchers test tens of thousands of accessions for as many as 32 traits. The details of such systematic screening operatiions are described in a 1974 report on The Genetic Conservation Program of IRRI. Moreover, about 30,000 to 45,000 breeding lines are annually tested twice during the crop seasons under many facets of the GEU programme (IRRI, 1974, 1976).

Many outstanding sources of such desirable traits as short plant stature, early maturity, and photoperiod-insensitivity, resistance to diseases and pests, and tolerances for adverse environmental factors, have been identified from O. sativa cultivars, O. glaberrima cultivars, and O. nivara in the germplasm bank. IRRI's rewarding efforts in evaluating rice germplasm prompted several national research centres to evaluate their indigenous germplasm and eventually led to the establishment of the International Rice Testing Program (IRTP).

SEED STORAGE AND DISTRIBUTION

Seeds harvested from the field are heat-dried to about 12-13 percent moisture and stored in the air-conditioned seed laboratory (21-22°C, 50-60 percent RH). A portion of the seeds (up to 250 g/accession) is taken out and placed in a paper bag. A set of 12 bags are fumigated with 'Dowfume' and placed in an airtight, 7.57-liter (2-gallon) glass jar, containing ample silica gel. After a week, the seed moisture content is lowered to 8-9 percent. The silica gel is replaced with fresh indicator (blue) type, silica gel, the lid of each jar is sealed, and the jar is placed in the cold-storage room (2-3°C, 60-70 percent RH). Periodic checks are made on the colour of the silica gel to see if dry air around the seed is maintained. The silica gel is replaced if the jar has been repeatedly opened to fill seed requests.

Nearly 30,000 accessions are kept in cold storage in three places at the IRRI research centre. Every 6 months we test the viability of seed samples of three control varieties kept in the cold room. In July, 1976, 13-year-old seeds of two tropical varieties had 98 percent viability while those of the non-dormant Japonica variety had only 35 percent. Obviously, seeds for long-term storage need to be packed in vacuum cans and kept at sub-freezing temperature.

We send, for safekeeping, a 15-g duplicate sample of each completely recorded accession to the U.S. National Seed Laboratory, Fort Collins, Colorado, which now stores 18,780 accessions from IRRI.

Since 1962 we have distributed nearly 50,000 seed packages of *O. sativa* accessions to foreign researchers in more than 100 countries and territories in response to about 1,300 requests (Table 3, page 82). We have dispatched 4,456 packages of genetic testers, African rices, and wild taxa to foreign researchers in response to 156 requests. Moreover, we have supplied the research departments of IRRI with countless seed samples for genetic evaluation and utilization (Table 3).

Seeds drawn from the IRRI bank have restored thousands of varieties to the national collections of Indonesia, Malaysia, Sri Lanka, Vietnam (South) and Tanzania.

Accessions identified to have certain resistances or tolerances constituted a substantial segment of the entries in the nurseries of the International Rice Testing Program. During 1975, 286 such accessions amounted to 16 percent of the total number of entries. In 1976, 250 accessions in 14 nurseries made up 12 percent of the total.

TRAINING OF GENETIC STOCK OFFICERS

Only a few national agricultural research centres in the world have a full-time officer assigned to the maintenance of genetic stocks of rice. A few others have part-time personnel assigned to the rice crop. Because genetic conservation is a tedious and unglamorous job, very few workers have stayed on it long enough to provide continuity to the rather complex operations of the national programme.

IRRI's assistance is designed to improve the capability of the national research centres in continuing their genetic conservation efforts.

IRRI has trained genetic stock officers for Bangladesh, Malaysia, Pakistan, Thailand, and Vietnam (South) and will continue its resident training programme at Los Baños. Burma and Indonesia were assisted in acquiring refrigerated seed-storage facilities. IRRI has also advised several national centres on the procedures and physical facilities required for genetic conservation programmes.

A Manual on Genetic Conservation of Rice Germplasm for Evaluation and Utilization (Chang, 1976e), that contains the principles and methodology of genetic conservation as well as the techniques of systematic evaluation, has been published. It serves not only as a complement to the Manual for Field Collectors of Rice (Chang et al., 1972) but

also as a training manual for genetic stock officers of national centres. A similar paper for plant introduction officers of national centres. A similar paper for plant introduction officers has been prepared (Chang, 1974)

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Table 1. Indigenous rice varieties collected with IRRI's direct or indirect participation in 12 collaborating Asian countries. Sept. 1971 - Sept. 1976.

Country	Years	Indigenous varieties (no.)	
		Direct participation	Indirect participation
Bangladesh	1973-75	1203	2361
Burma	1973-74	225	37
Cambodia	1973	280	--
Indonesia	1972-76	4365	2680
Laos	1972-73	--	898
Malaysia, E.	1973-75	--	576
Nepal	1971	--	907
Pakistan	1972-73	--	750
Philippines	1972-75	18	311
Sri Lanka	1972, 1975-76	1080	355
Thailand	1973, 1975	--	289
Vietnam, S.	1972-75	108	649
Total		7279	9993

Table 2. Indigenous rice varieties with special traits collected and preserved in national programs and in the IRRI germ plasm bank, 1972 to 1976.

Reported features	Samples (no.)
Tolerance for salinity	280
Tolerance for acid soils (lowland)	209
Tolerance for alkaline soils	14
Tolerance for iron toxicity	4
Tolerance for iron deficiency	3
Tolerance for phosphorus deficiency	3
Upland types/drought-resistant types	2739
Floating/flood-tolerant types	651
High-elevation/ cool-tolerant types	645
Resistance to nematodes	5
Resistance to diseases	88
Resistance to insects	42
Non-preferred by rodents	9
Aromatic types	101
Multiple tolerances	38
Total	4831

Table 3. Number of seed packages of O. sativa accessions supplied by the IRRI germ plasm bank to foreign researchers and IRRI research departments, 1962-76.

Year	Foreign Researchers		IRRI Researchers	
	Packages	Requests	Packages	Requests
1962-63	400	17	.. a/	..
1964	2355	67	.. a/	..
1965	1608	56	.. a/	..
1966	1052	41	.. a/	..
1967	1764	121	.. a/	..
1968	5286	147	.. a/	..
1969	5800	101	2070	42
1970	5660	106	10317	32
1971	2300	28	8712	50
1972	2500	83	2738	54
1973	9776	96	8275	66
1974	2603	142	20498	108
1975	3347	150	22155	151
1976 (mid-Nov.)	4231	122	35708	173
Total	48,682	1,277	110,473	673

a/ Although no record of seed packages distributed from the bank was kept for the first 6 years, it is estimated that more than 37,740 accessions were screened during 1962-68 for their reactions to different diseases and insects and that about 11,000 accessions were analyzed for protein and lysine contents.

Table 4. Temperature and relative humidity levels in the proposed Rice Genetic Resources Laboratory of IRRI.

Type of storage/area	Temperature	R.H.(percent)
Seed processing	24°C(75°F) ± 2	60 - 70
Short-term storage	20°C (68°F) ± 2	45 - 60
Medium-term storage	4°C (40°F) ± 1	40 - 50
Long-term storage	–10°C (14°F) ± 2	30 - 40

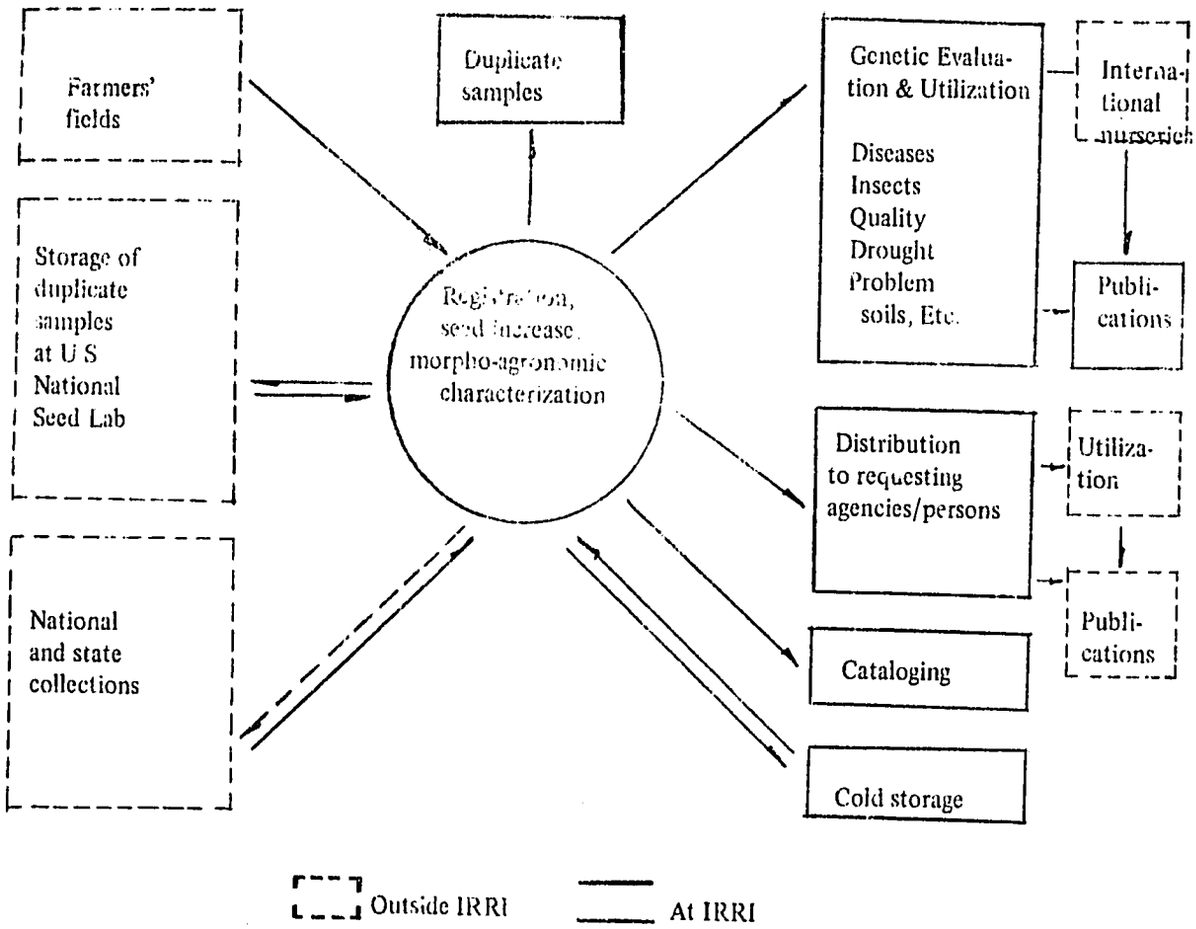

Fig. 1. Flow chart showing the different operations at IRRI in acquiring, increasing seed, cataloging, preserving, evaluating, and utilizing rice germplasm with the collaboration of other agricultural research centres.

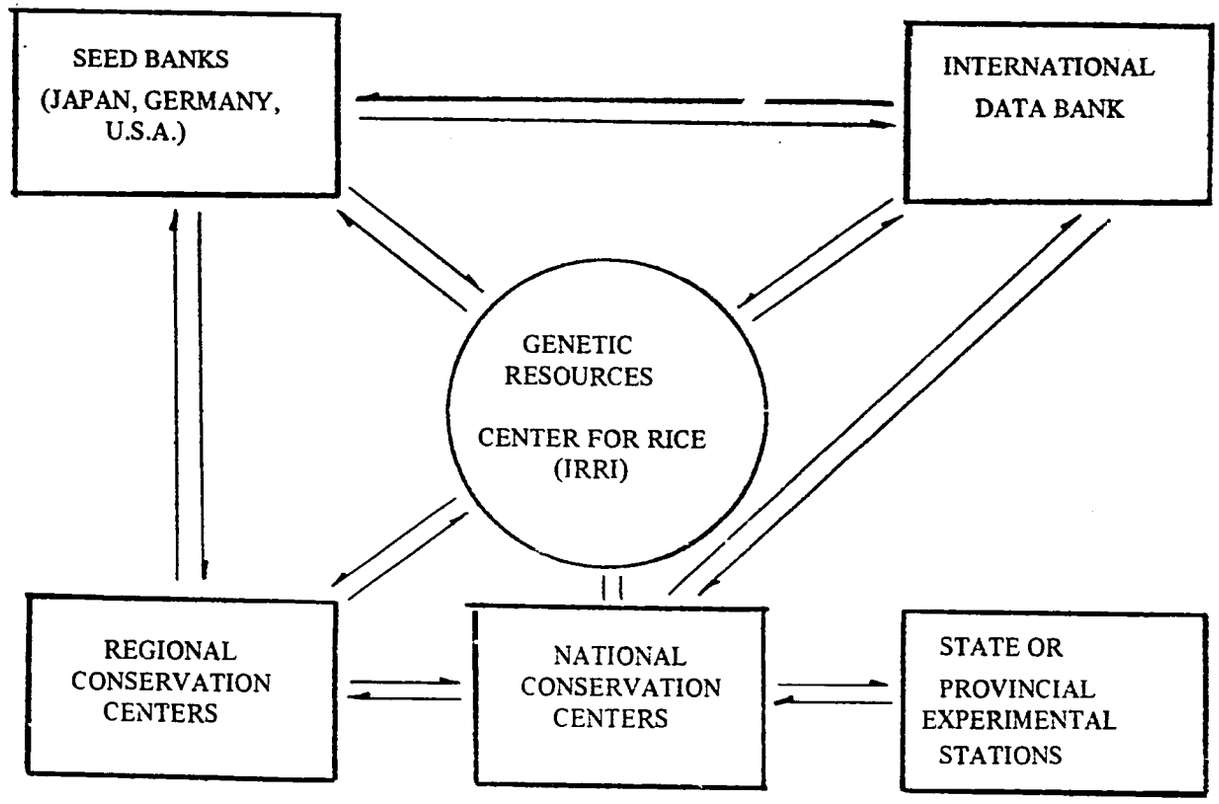

Fig. 2. Proposed network of international and inter-organizational collaboration for the seed increase, seed and data storage, distribution of seed and related information, and rejuvenation phases of genetic conservation of rice.

APPENDIX I

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