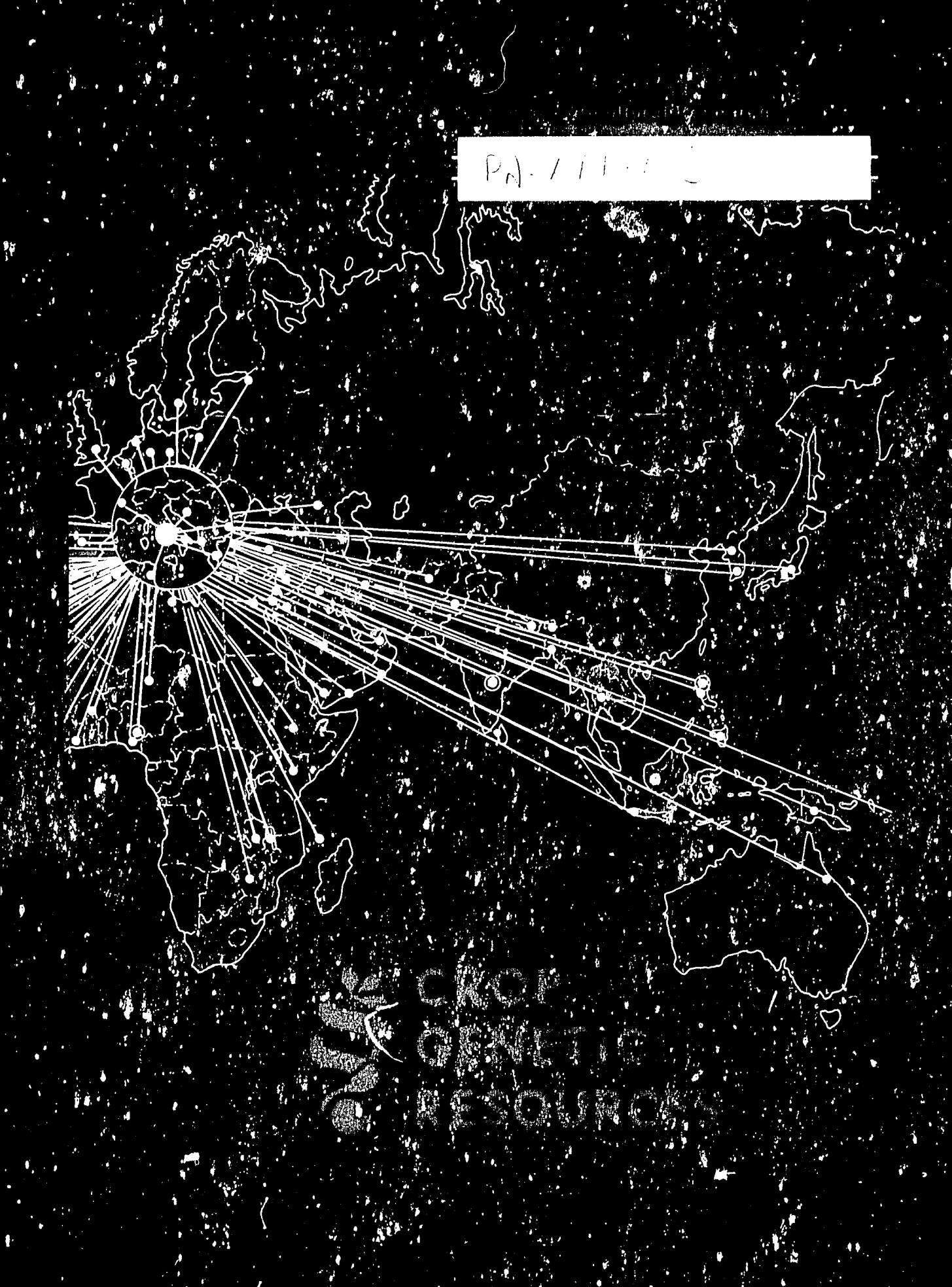
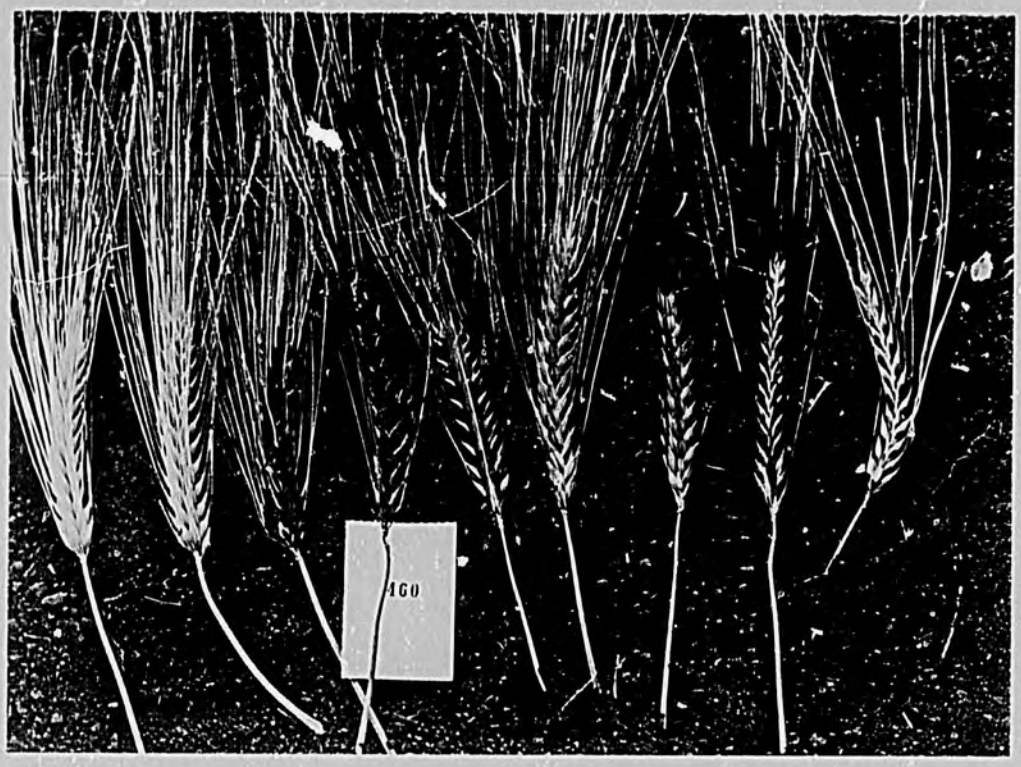

CROP
GENETIC
RESOURCES

PA-APB-652

AGP:IBPGR/81/67
September 1981

CROP GENETIC RESOURCES



The International Board for Plant Genetic Resources (IBPGR) is an international organization with global responsibility for resolving a problem threatening all humanity - the conservation of genetic diversity of economic plants which is being lost as a result of modern agricultural practices. Innovative crop varieties and the introduction of high-yielding varieties are rapidly transforming traditional and peasant farm lands into fields with uniform crops. These new varieties provide significantly higher yields or quality and have other beneficial characteristics bred into them. Unfortunately, however, they replace traditional cultivars and hence may be quickly responsible for the elimination of something like 10,000 years of evoluationary development. Once a local traditional cultivar is totally displaced its unique genetic characteristics are gone forever. Future generations are thus deprived of variation which is the raw material for breeding programmes and in particular for providing genetic combinations which can be used to combat actual or potential ravages by pests and diseases.

From the days when primitive hunters and gatherers first developed agriculture by cultivating wild plants for food more than 10,000 years ago, human society and the earth's abundant plant resources have been co-evolving, producing innumerable patterns of variation, especially locally adapted plant populations used for foods, textiles and fuels. These populations constitute an invaluable pool of variations from which material can be drawn for breeding. Primitive agriculture spread from the cradles of civilization in Southeast and East Asia and Central America during prehistoric times. Wild plants were domesticated

by early agriculturalists and these diverse species have developed into the crops which support the world's population today.

The spread of permanent agriculturally-based communities brought familiar crops into diverse, isolated regions as did the movement of plants around the world through conscious introductions. More primitive cultivation permitted genetic contact among already variable races of crops, and geneflow between these and their related wild species.

Modern agricultural development had dramatically altered this scenario by the introduction of new agricultural practices. Geneflow had been reduced and the continuing evolution which has gone on for millenia has been greatly diminished. The evolution of crops in many places had been drastically altered.

The first extensive studies of the variability in the world's cultivated plants were conducted under the leadership of the great Russian botanist N.I. Vavilov. In the 1920s and 1930s his efforts were responsible for ambitious exploration and collection expeditions throughout the world as well as the establishment of major repositories of genetic resources. His studies revealed that genetic variation in cultivated species is concentrated in certain regions, which he termed "centres of diversity". For example, although only a few distinct varieties of wheat were cultivated in Europe, there was tremendous diversity in the types and forms of wheat grown in West Asia, North Africa and Ethiopia. Vavilov identified a number of centres of diversity which are the principal areas from which breeders have collected raw material for their work. Although the boundaries and the actual number of centres identified by Vavilov have been modified, his concepts provided a basis for work in the past decades.

Today, however, areas which, until recently, seemed to be inexhaustable sources of breeding material have rapidly changed due to the introduction of new varieties possessing a narrow genetic base. Most of the centres of diversity are in the developing world where countries are undergoing profound alterations in their agricultural technology, economics, consumption patterns and traditions. New agricultural practices are having significant impact, changing the scale, composition and techniques of crop cultivation. Because of these changes - which may be aggravated by environmental factors such as desertification in some regions - the loss of variability ("genetic erosion") threatens every part of the globe. For example, in the last 40 years 95% of the once numerous native varieties of wheat in Greece have been lost forever, the victims of recently introduced commercial varieties. Landraces or local varieties in almost every part of the world are threatened; their extinction is a rapidly accelerating process. Time for action is limited and the potential for disaster is real.

Representative collections of germplasm, including primitive and wild species, are essential for breeding programmes. Even if collections seem adequate for present breeding objectives, the raw material or building blocks must be available in case the objectives change to meet different conditions and needs. The products of scientific breeding programmes are frequently vulnerable to changing conditions - an unexpected drought or a particularly virulent virus

can ravage uniform crops because of their narrow genetic base. When varieties lack sufficient genetic diversity to withstand stress imposed by pests and diseases they are vulnerable. The breeders are then challenged to maximize viable alternatives to avoid catastrophic losses. Apart from the Irish potato famine in the 1840s, the best example of vulnerability due to uniformity was the outbreak of southern corn leaf blight in North America in 1970-71, but there have been many others such as the famine in Bengal, India in 1965 due to rice brown spot.

Only in relatively recent years has the need for genetic diversity become obvious as scientists battle to overcome such disasters. When most major crops of the world - rice, wheat, sorghum, maize, beans and others - have been bred to produce varieties with high uniformity needed by cultivators, processors and consumers, it is clear that a large-scale international effort is necessary to collect, conserve, and evaluate the entire range of existing germplasm.

The IPPGR is charged with this daunting task. The answer cannot be to slow agricultural development but to implement a comprehensive strategy of genetic conservation at a global level.

OBJECTIVES OF THE IBPGR

The IBPGR was founded in 1974 by the Consultative Group on International Agricultural Research (CGIAR) to coordinate existing national, regional and crop specific international conservation efforts and to stimulate new efforts. It works in close association with the Food and Agriculture Organization of the United Nations (FAO). The development and administration of the international plant genetic resources conservation network is the Board's primary function. In the years since it was created a great deal of progress has been made toward the organization of a global network of genetic resources centres and a large number of collecting missions have been carried out. The IBPGR has had a dramatic catalytic effect upon conservation efforts of scientists and agricultural centres throughout the world.

In promoting a greater awareness throughout the world of the importance of genetic resources activities the Board's tasks include:

- the collection, conservation and evaluation of plant genetic resources with particular reference to species of major economic importance and their wild and cultivated relatives (hence the IBPGR is responsible for coordinating global efforts and for help in financing essential activities);
- the strengthening of programmes of existing institutions and the encouragement of new programmes to articulate activities particularly in the areas of major genetic diversity;
- stimulating the availability of material for plant breeding and other scientific activities;
- the establishment of standards, methods and procedures for exploration, evaluation and for conservation of stocks of both seeds and vegetative

material;

- the establishment of a network of replicated storage centres;
- the promotion of training;
- the promotion of the dissemination of information and material among centres;
- the promotion of awareness for effective information storage, retrieval systems and free exchange of information about the materials.

PRIORITY CROPS AND PRIORITY REGIONS

When the Board was established in 1974, the major collections of crop germplasm were poorly maintained and inadequately inventoried. There was virtually no complete collection of the entire range of cultivated and wild varieties of any major crop. Genetic erosion had reached crisis proportions for several of the major cereals, especially wheat, rice, maize and sorghum. The endemic genetic diversity of these essential crops was virtually extinct in some regions. Faced with tremendous gaps in the collections and imminent catastrophe, the Board, in accordance with its mandate, adopted global crop priorities and priorities between regions, stressing the major economic crops. Specific crops were allocated priority bearing in mind their value to development as sources of food, industrial materials or other economically useful products. In 1976 nine crops were assigned first priority status. In 1981 crop priorities were reviewed and many more crops taken into account. Over 50 crops are now assigned first priority status. Many of these crops have first priority status in only one, or in just a few, regions. Because of the unique and vast scope of conservation efforts, flexibility is vital. Priorities are only guidelines, and are under constant review.

The underlying concept for the delimitation of priority regions is based upon the geography of crop evolution (centres of diversity) outlined by De Candolle and Vavilov. Nevertheless the diverse origins of crops, the patterns of domestication and crop migrations by man have meant that, for genetic conservation purposes, the priority regions are much broader than those originally envisaged as centres of diversity. Regions have, therefore, been delimited if they contain irreplaceable genetic diversity in one or more of the priority crops threatened by changes in land use, the spread of new varieties or associated agricultural practices, or if climatic or other environmental hazards pose significant danger to indigenous varieties over substantial areas.

Crop Advisory Committees have provided invaluable expert advice and specific recommendations on crop and regional priorities. The Committees are composed of breeders and specialists from the scientific community who are the primary users of germplasm stocks. There are five Crop Advisory Committees which are co-sponsored by International Agricultural Research Centres: Rice (co-sponsored by IRRI); Maize (co-sponsored by CIMMYT); Sorghum and Millets (co-sponsored by ICRISAT); Phaseolus beans (co-sponsored by CIAT); and Wheat (co-sponsored by CIMMYT). In addition to these committees, in order to put the limited financial resources of the IBPGR to the most effective use, ad hoc working groups on other priority crops have been convened when expert advice is necessary.

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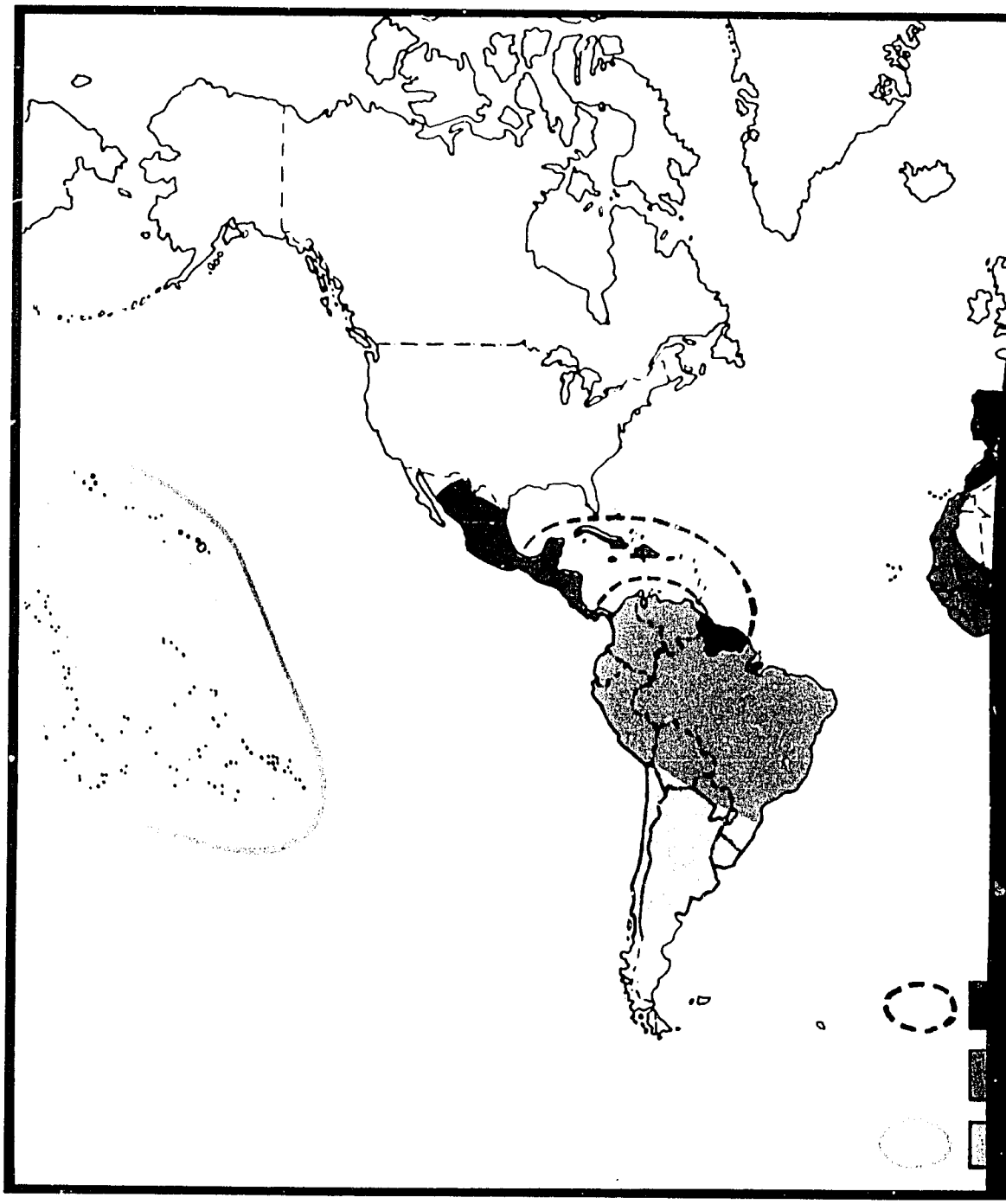

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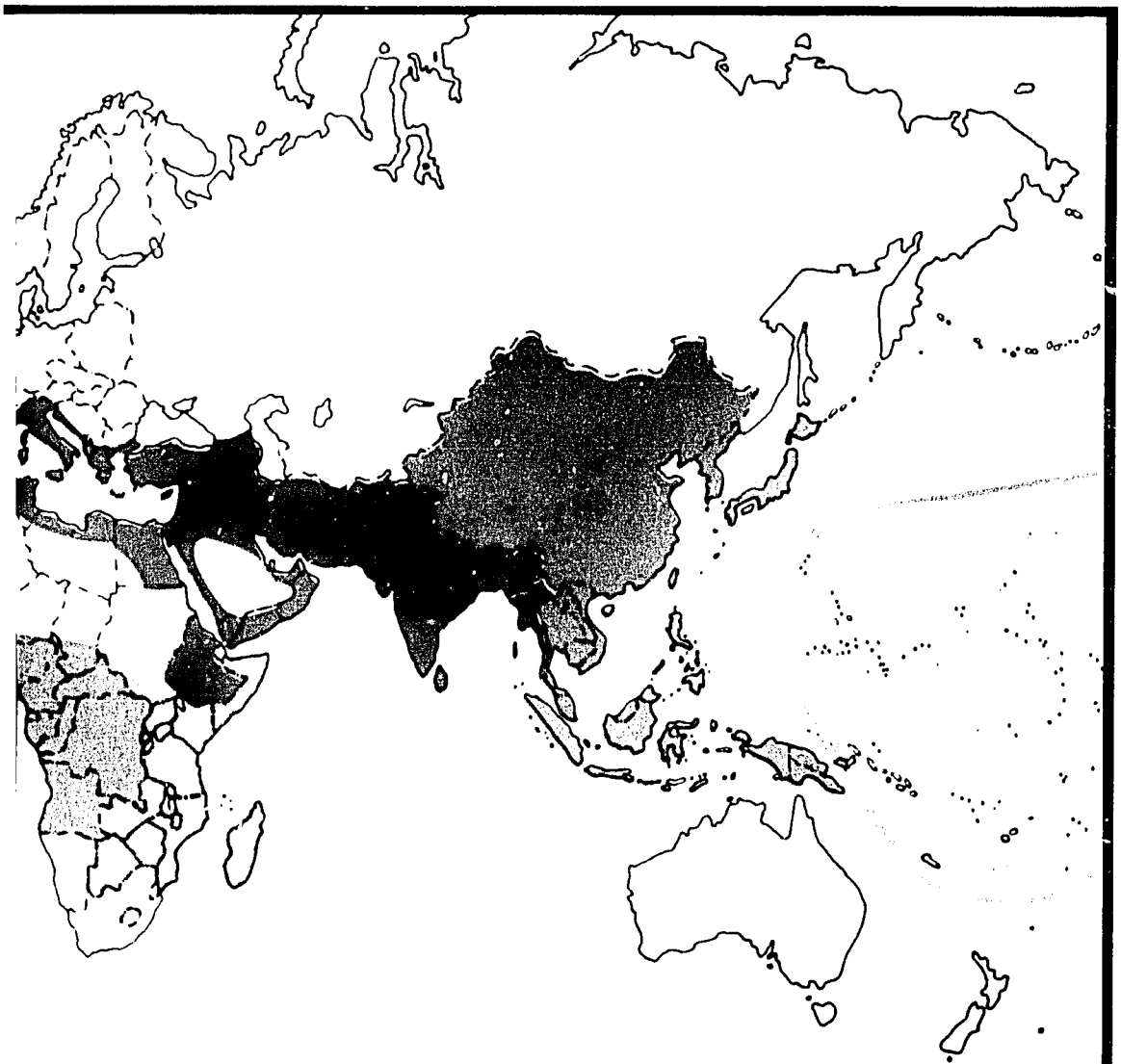

PRIORITY 1

PRIORITY 2

PRIORITY 3

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NATIONAL, REGIONAL AND INTERNATIONAL CENTRES

Every initiative which the IBPGR takes is implemented through or supported by the cooperative efforts of colleagues in the field, whether stationed at national, regional, or international facilities. The energies and skills of many hundreds of scientists and technicians, not only in Asia, Africa and Latin America, but in Europe, North America and Australia as well, have been enthusiastically enlisted, under IBPGR's leadership, in the common task of protecting the world's heritage of plant genetic variability and assuring its continued availability for use.

The Board's network includes national, regional and international institutions working to preserve the world's dwindling genetic resources. Among these institutions are International Agricultural Research Centres of the CGIAR and other designated institutions which have agreed to the IBPGR designating them to be responsible for maintaining major base (i.e. for long-term storage) seed collections of the principal food crops. Because of the extensive facilities and labour required, there are a limited number of designated base collections, and for this reason several are in the developed countries. Nonetheless the material is freely available and it is the Board's policy to encourage and assist the establishment of genebanks in the centres of diversity (which are almost exclusively developing countries) because of the advantages such locations provide in terms of multiplication, evaluation, regeneration and regional quarantine restrictions.

Apart from the International Centres, the national, and to a smaller extent regional, centres provide the expertise, facilities and manpower for most collection efforts. At the time the IBPGR was founded it was thought that the establishment of a number of regional plant genetic resources centres would be the best approach, but the unpopularity of such an approach with the nations concerned has ruled out this strategy. The current approach is to provide sufficient national strength in a number of countries in the priority regions; and the IBPGR adopts a regional perspective in the allocation of its funds and assistance. The support to the regions provided by the IBPGR is channelled through a diversity of organizational patterns depending on the participating countries. In the case of Southeast Asia there is a vigorous cooperative programme in five countries, guided by a regional committee and an IBPGR regional officer. In other regions such as South Asia efforts are being encouraged without an organizational structure but with vigorous leadership being provided by the IBPGR Secretariat and liaison officers designated by the countries. Regional officers have been or are in the process of being appointed to accelerate efforts in Latin America, Western and Eastern Africa and in Southwest Asia IBPGR technical advisers help the individual national efforts. The Bari Germplasm Institute in Italy has a small IBPGR secretariat to assist the Mediterranean Region. In some cases regional institutions help the work of the IBPGR; for instance the CATIE Genetic Resources Center in Turrialba, Costa Rica. Some countries have large national coordinated programmes such as Brazil and India which form focal points in the regions. This diversity of approach is adopted to satisfy the sensitivities of the countries concerned.

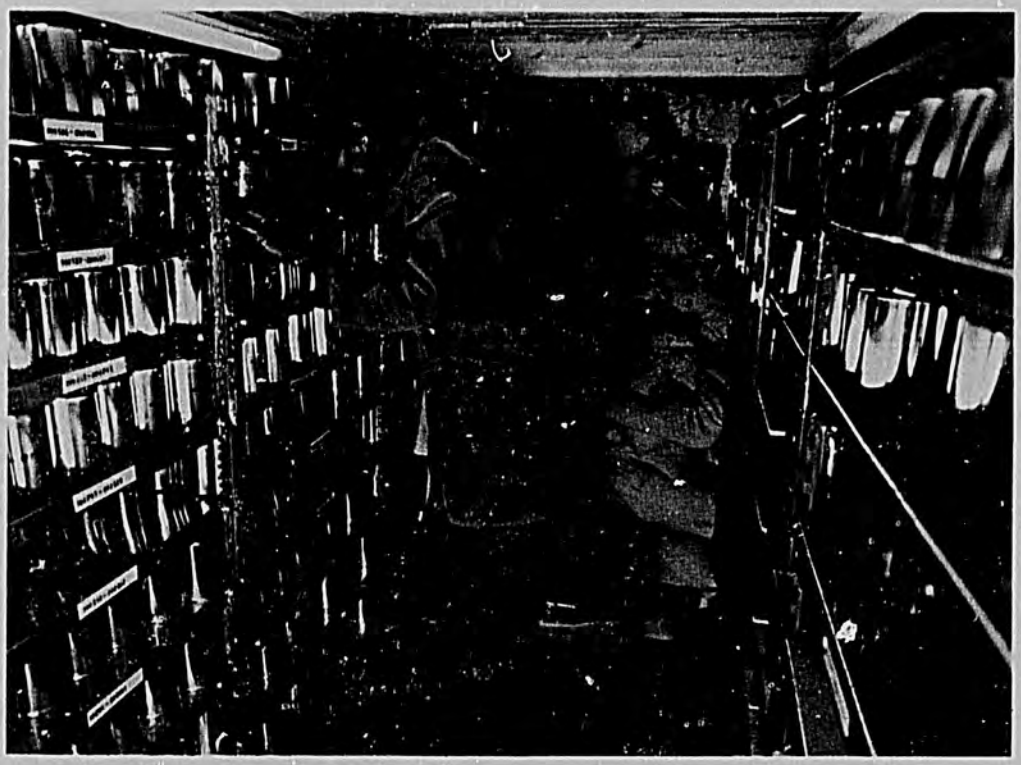
COLLECTION AND CONSERVATION PROCEDURES

In order to collect the representative diversity, teams of scientists from national, regional and international centres, or the IBPGR itself, launch expeditions to collect genetic resources samples. Samples are collected from a variety of environments; wild and primitive species may be gathered in remote uncultivated areas and on the fringes of cultivation, and diverse materials of local farmers are collected from areas of traditional agriculture.

The Board has developed criteria which national governments and institutions are asked to meet in order to receive IBPGR funds. A most important principle is full and free availability of materials and related information.

Seed samples collected are ultimately to be channelled to base collections (for long-term conservation), either directly from the field or after multiplication. A portion of each sample, as a matter of principle, is always left in the country where it is collected. Another portion may find its way into a working collection where the task of evaluation and description starts as a prerequisite for utilization. During multiplication, plants that are not self-pollinating are carefully isolated to ensure that their genetic composition is not altered by combination with different populations. As far as possible samples are collected as populations and maintained as populations. Upon reaching the conservation centre, seeds are cleaned, dried, weighed and sometimes separated according to rough phenotypic characterization and the sample is checked for viability.

Until 1980 most of the Board's efforts on conservation were directed towards seed crops. In that year it agreed to consider, in depth, the potentials of



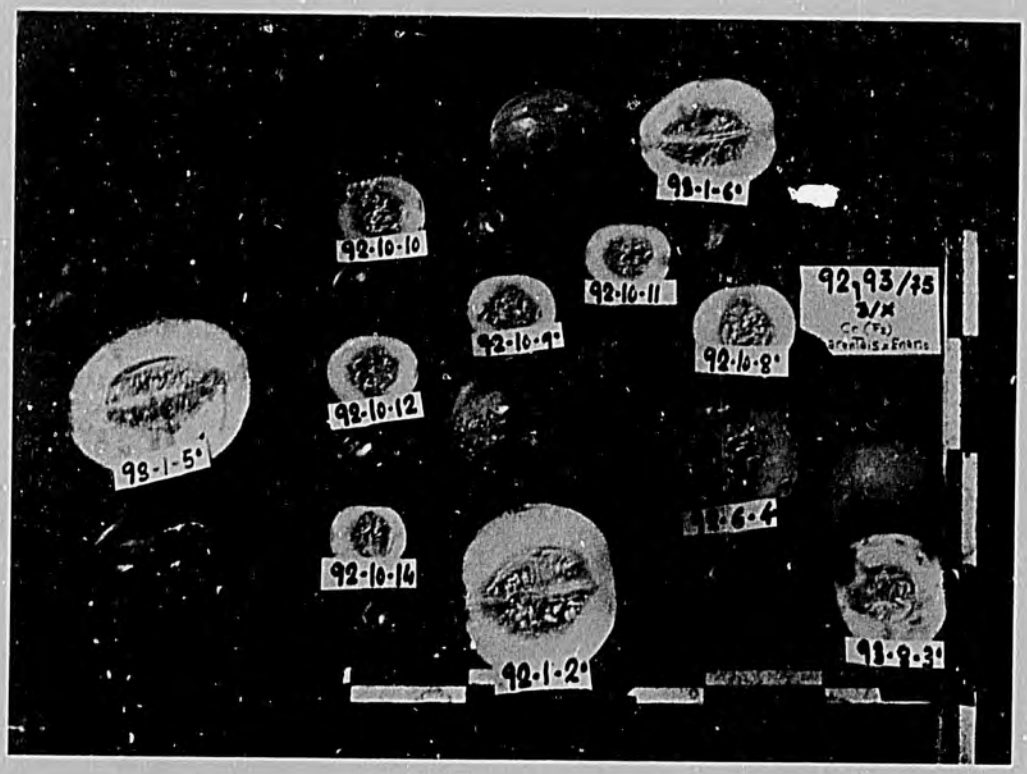
in vitro culture for long-term preservation of clonal crops and as a result of discussions it expects to make limited funds available for essential work on such material during 1981-86.

It is the task of the working collections to distribute materials to breeders and to document the samples. Seeds destined for long- and medium-term storage are generally dried and placed in sealed airtight containers (cans or laminated foil envelopes). These are stored in refrigerated rooms or cabinets which are maintained at about -15°C for long-term and about 0°C for medium-term storage. The samples are tested periodically for viability, and if it drops significantly the seeds are regenerated. Naturally it is preferable to regenerate samples as infrequently as possible in order to avoid altering their genetic composition through selection. Ideally, base collections of every sample are kept in at least two different genebanks to safeguard against accidental loss or damage.

INFORMATION, DOCUMENTATION AND PUBLICATIONS

The stimulation of data acquisition, storage, retrieval and exchange are among the Board's most important activities. Adequate information systems are essential for the smooth operation of the network; germplasm collections are more useful if reliable descriptions of their contents are easily accessible to breeders.

The Board's assistance to centres involves the development of information systems which are simple for users to operate and which do not necessarily require



installation of large, costly computers. The Board supports training programmes and provides on-the-spot assistance to help in the standardization of descriptions and to improve the information management capabilties of national and regional centres. The Secretariat helps centres, when necessary, to organize and assemble information in machine readable form appropriate to the facilities available. The Board also encourages the exchange and transfer of information in machine readable form, so that the processing facilities of the more adequately equipped centres benefit the entire network. An essential task of the Board in the future is to see that all collected material is documented and that evaluation data are entered into information systems.

The quality of documentation and the inclusion of preliminary evaluation data into the information held about collections directly determines their usefulness. The efforts of breeders and scientists will be hampered if there are inadequate descriptions of samples; lack of internationally agreed descriptive terminology has led to confusion and limits communications within the network. For these reasons, the Board has accepted responsibility for compiling internationally agreed lists of "descriptors" for the major crops and the publication of these is a continuing activity of the Secretariat.

The Secretariat also issues technical manuals, directories of information such as those of all known collections and a series of selected crop genetic resources studies. The joint FAO/IBPGR Plant Genetic Resources Newsletter appears quarterly and functions as a forum for information exchange among the centres.

TRAINING

Genetic resources conservation is a relatively new field. There is a critical lack of qualified personnel, particularly in the national centres in the priority regions which are the back-bone of global conservation efforts. Their efficient operation requires trained personnel for the entire range of activities.

In 1969 the University of Birmingham in the United Kingdom initiated the first International M.Sc. Training Course in Genetic Conservation. The course provides a broad theoretical and practical background to all the aspects of a genetic conservation programme. Graduates of the Birmingham course currently fill mid-level management positions throughout the network. The Board helps to support this course for the benefit of students from developing countries and also offers grants to individual students from developing countries enabling them to attend.

The Board also supports a number of short technical courses which cover many practical aspects of genetic resources work and are held in different locations for various lengths of time. Personal contact with colleagues working in different regions and familiarity with the different programmes encourages the flow of communication through the network and broadens the perspectives of trainees.

HEADQUARTERS AND SECRETARIAT

The Executive Secretariat acts as the international headquarters for the IBPGR and its network. It is responsible for the daily administration of the Board's programme, including the coordination of the various activities and the distribution of the funds. The Secretariat is provided by FAO in Rome which offers its offices and support services including those of FAO in the field. In addition to administrative work, the Secretariat also organizes many of the exploration and collecting expeditions, and its staff scientists provide technical advice. The headquarters operations are supported by IBPGR scientists and administrative staff situated in various parts of the world.

IBPGR FUNDS

The Board receives funds from the members of the CGIAR, which itself is sponsored by the World Bank, FAO and the United Nations Development Programme (UNDP). In 1981 the IBPGR is receiving funds from the United Nations Environment Programme (UNEP), the World Bank and the governments of Australia, Belgium, Canada, Denmark, France, F.R. Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the U.K., and the U.S.A.

Although the Board has its own funds, it does not pay for all the genetic resources conservation activities which it coordinates. Rather, it provides "pump-priming" funds for the initiation of important projects which are expected to support themeselves within three to five years. It also supports urgent collection missions, purchases necessary equipment for national centres and provides grants for individuals (through national centres) to attend training programmes. As in its other activities, flexibility is fundamental to the allocation of its funds. These funds frequently have considerably more impact than their actual quantities would suggest. The Board also acts as a catalyst for the mobilization of funds from other sources by identifying and publicizing important projects.

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The Board will receive proposals from Board members, any public international agency within the UN system including FAO, international and regional research centres in the international network, and from the Consultative Group and its Technical Advisory Committee.

Proposals to the Board from a private group or company must be made through and endorsed by FAO or the proposer's government. No such proposal will be accepted unless any benefits derived from it are freely available to all interested parties.

All proposals should be submitted to the Board through its Executive Secretariat, which will present them to the Board with its own analysis.

Acknowledgements

Photos: page 1, 9 and 13 IBPGR

page 3 IITA

page 10 J. Esquinas-Alcazar