منظمة الأغذية والزراعة للأمم المتحدة
联合国粮食及农业组织
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION

CPGR/89/7
February 1989

Item 8 of the Provisional Agenda

COMMISSION ON PLANT GENETIC RESOURCES

THIRD SESSION

Rome, 17-21 April 1989

# ASSESSMENT OF THE CURRENT COVERAGE OF BASE COLLECTIONS IN THE WORLD, WITH REGARD TO CROPS OF INTEREST TO DEVELOPING COUNTRIES

## Table of Contents

## KEY TO ACRONYMS

| | |
|---|---|
| AVRDC | Asian Vegetable Research and Development Centre |
| CGIAR | Consultative Group on International Agricultural Research |
| CIAT | Centro Internacional de Agriculture Tropical |
| CIP | Centro Internacional de la Papa |
| CPGR | Commission on Plant Genetic Resources |
| ECP/GR | European Cooperative Programme for Conservation and Exchange of Crop Genetic Resource |
| IARC | International Agricultural Research Centre |
| IBPGR | International Board for Plant Genetic Resources |
| ICARDA | International Centre for Agricultural Research in Dry Areas |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IITA | International Institute of Tropical Agriculture |
| ILCA | International Livestock Centre for Africa |
| IRRI | International Rice Research Institute |
| IUCN | International Union for the Conservation of nature and Natural Resources |
| PGRC/E | Plant Genetic Resources Centre, Ethiopia |

# ASSESSMENT OF THE CURRENT COVERAGE OF F BASE COLLECTIONS IN THE WORLD, WITH REGARD TO CROPS OF INTEREST TO DEVELOPING COUNTRIES

## I. INTRODUCTION

1. This paper summarizes details of the current coverage of base collections in the world, with reference to crops of interest to developing countries. It is based largely on information contained in FAO and IBPGR reports and publications, which document the germplasm holdings of collections throughout the world. Fairly comprehensive information is available for the major staple crops of developing countries, including, for instance, rice, maize, sorghum, millet, cassava, sweet potato, groundnut, and pigeonpea. However, for many crops of more local interest information is frequently unavailable.

2. Over the years, from the establishment of the FAO Panel of Experts on Plant Genetic Resources, through the early deliberations of the International Board for Plant Genetic Resources (IBPGR), to the discussions in the FAO Commission on Plant Genetic Resources, thoughts about the long-term conservation of plant genetic resources were largely directed towards the concept of a relatively small number of base collections, whether these were to be in their centres of origin or as part of a network of international and national institutes in both developed and developing countries.

3. The number of genebanks with cold stores operating at temperatures below $0^0$C has steadily increased since the sixties: there are now at least 100 institutions with appropriate technology for long-term storage in approximately 50 countries (some with large refrigerated facilities and others in ordinary domestic freezers).

4. Initially FAO and IBPGR developed both geographical (based on the areas of diversity) and crop priorities. For practical reasons the priority crops have since become the focal point for IBPGR's operation.

## II. DEFINITIONS

5. With the rapid development of new conservation techniques, the terminology used to describe the nature and role of germplasm collections has become rather confused. Collections can be classified in a number of complementary ways, for example according to:

- longevity: the expected interval between regenerations (long-, medium-, and short-term);
- purpose: to maintain material as little as possible changed from the original genotype in perpetuity (base collection); or to distribute material for breeding and research purposes (active collection);
- methodology: seed, in vitro, field, in situ, ex situ.

6. Base collections include substantial variability and are for long-term storage under adequate conditions; they are not to be used as a source for routine distribution. The major role of a base collection is to act as a custodian of the genetic resources in its care. Materials are only removed from base collections for infrequent regeneration when seed viability has started to decline below an acceptable standard, or when

stocks of an accession are no longer available from an active collection. Base collections thus form a security mechanism, both as an insurance and as an investment for sustaining and improving future food production.

7. Active collections are those from which seed samples are routinely withdrawn for distribution, multiplication and evaluation. There is no reason why active collections should not be maintained in long-term storage, if resources are available, but in practice conditions are usually less stringent.

8. There are many plants of economic importance which either do not produce seeds (cultivated banana), or which are not normally reproduced from seeds so as to maintain intact a highly heterozygous genotype (temperate fruits and some tuber crops), or which produce recalcitrant seeds that do not survive drying and freezing (rubber and cacao). Germplasm of such species is usually maintained ex situ in field or in in vitro genebanks. In addition, the use of liquid nitrogen (cryopreservation) is being investigated for preservation of germplasm of these species. This paper does not cover these crops.

## III. GLOBAL NETWORKS OF GENEBANKS 1/

### The IBPGR Designated Genebanks

9. Since 1976 the IBPGR has designated a number of genebanks around the world to maintain collections of specific crops on a regional or global basis. So far IBPGR has designated 39 genebanks for the long-term conservation of most of the major and a number of minor crops with orthodox seed. IBPGR has brought these institutions into a loose federation of designated base collections, based on a "bona fide" memorandum of understanding which includes the commitments described 'in Annex II. These memoranda of understanding are usually signed by the director of the genebank of the institute, they do not normally imply any formal commitment by a government, and they are not of the nature of a binding international agreement.

10. Of the 39 IBPGR designated genebanks, 31 are in the national institutes of the following countries: Africa: Ethiopia; Asia and the Pacific: Australia (2), Bangladesh, China P.R., India, Japan (3), the Philippines and Thailand; (2), Europe: Belgium, the German Democratic Republic, Federal Republic of Germany, Greece, Hungary, Italy, the Netherlands, Poland, Portugal, Spain (2), Sweden, the UK (2), and the USSR, Latin America and the Caribbean: Argentina, Brazil and Costa Rica; North America: Canada and the USA; seven are located in the CGIAR Centres (CIAT, CIP, ICARDA, ICRISAT, IITA, ILCA and IRRI); and one in the Asian Vegetable Research and Development Centre (AVRDC).

11. The base collections in genebanks designated by IBPGR cover mainly cereals (wheat, rice, maize, barley, sorghum and millets, oats, and rye); food legumes (chickpea, faba bean, groundnut, lentil, lupin, Phaseolus, pigeonpea, soyabean, mung bean, cowpea, and winged bean); root crops (cassava, potato, and sweet potato); vegetables (Allium, amaranth,

1/ A simplified presentation of some important features of existing arrangements is given in Annex I.

Capsicum, cruciferous crops, cucurbits, okra, tomato, and egg plant); industrial crops (cotton, sugarcane, and tobacco); and forages legumes and grasses (16 genera).

12. Designated genebanks hold either global or regional collections of specific crops under conditions which preserve their long-term viability. However, some of these base collections are held by centres with only medium-term storage conditions, which are accordingly being encouraged to upgrade their facilities to attain the standards necessary for long-term seed storage. IBPGR has recently evaluated the base collections in the designated genebanks against the IBPGR established technical standards for such facilities and their management. According to IBPGR's 1986 annual report "it has been found that some genebanks achieve all the standards, but a number are poorly managed or have unreliable or ineffective equipment. Several of the latter began immediately to upgrade their genebanks, whilst others are expected to do so in due course."

The FAO Network

13. The International Undertaking on Plant Genetic Resources envisaged in Article 7.1(a) that an internationally coordinated network of national, regional and international centres would be developed under the auspices or jurisdiction of FAO, in which base collections of plant species of economic and social importance, including wild relatives, would be held. Arrangements by which governments might make, varying degrees of commitment to the safe conservation and free exchange of germplasm stored in their collections were presented in CPGR/87/6 and discussed at the Second Session of the Commission. Subsequently, in October 1987, the Director-General of FAO addressed a Circular State Letter to Member Nations and some international institutions enquiring about their interest in participating in the FAO network. To date 27 replies have been received; 19 countries and two institutions stated that they were prepared to bring their collections within the FAO network. By placing the collections under the auspices or jurisdiction of FAO, a legal basis would be created for sustaining the collections in perpetuity. More detailed information of the replies of countries is provided in CPGR/89/4.

14. The CGIAR policy established in October 1988 states "that collections assembled as a result of international collaboration should not become the property of any single nation, but should be held in trust for the use of present and future generations of research workers of all countries throughout the world"1/. The proposed FAO network described 4 above provides a unique legal and institutional framework to meet such an objective. Documents CPGR/89/4, CPGR/89/5 and CPGR/89/6 also provide relevant information on the complementarity of the FAO network and IBPGR designated genebanks.

Other Arrangements

15. The International Union for Conservation of Nature and Natural Resources (IUCN) in 1987 established a Botanical Garden Conservation Secretariat to promote and coordinate a network of ex situ field genebanks in botanic gardens for the conservation of wild species and various other plants of economic and social importance.

---

1/ CGIAR policy on plant genetic resources, 1988 (AGR/TAC:IAR/88/4 Rev.2)

## IV. GEOGRAPHICAL AND SPECIES COVERAGE

16. Over the past decade, seed storage facilities for the conservation of endangered crop germplasm have increased. IBPGR estimates that there are more than 300 institutes which store seeds of various crops, and among these over 100 centres are involved in the maintenance of germplasm. Many of the recently established genebanks have begun to assemble germplasm from various sources but in many cases their facilities are still underutilized.

17. Good examples of the regional distribution of the genebanks with long-term storage facilities is as follows: Africa: Ethiopia, Kenya and Nigeria; Asia and the Pacific: Australia, Bangladesh, China, India, Indonesia, Japan, the Republic of Korea, Malaysia, New Zealand, Pakistan, the Philippines, Sri Lanka, and Thailand; Europe: Austria, Belgium, Bulgaria, Czechoslovakia, France, the German Democratic Republic, Federal Republic of Germany, Greece, Hungary, Israel, Italy, the Netherlands, Poland, Portugal, Spain, Sweden (Nordic genebank), Turkey, the UK, and Yugoslavia; Latin America and the Caribbean: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Mexico, and Peru; Near East: Egypt, Iran, and Libya; and North America: Canada and the USA.

18. Crops of major economic importance that are backed by strong agricultural research programmes are the most frequently represented in base collections. Numerous genebanks in developed countries, and those at the international centres of the CGIAR, hold large numbers of samples of major cereals and food legumes. Some of the national programmes in developing countries also hold significant amounts of cereal and pulse crop accessions. The majority of other crops (such as root crops, minor cereals and pulse crops, industrial crops, vegetables, forage grasses and legumes) are held in fewer, widely scattered locations in both developed and developing countries. Crops or species of particular interest to a locality or region are usually held in fewer and localized collections.

19. The international Centres of the CGIAR hold base collections of their mandated crops: for CIAT, Phaseolus and forages; for CIP, potato-seed; for ICARDA, chickpea, faba bean, lentil, wheat and barley; for ICRISAT, sorghum, millets, groundnut, chickpea and pigeonpea; for ILCA, forages; for IITA, African rice and cowpea, and for IRRI, rice.

20. The IBPGR Crop Directories list a total of some 2.25 million samples stored in genebanks around the world (Annex III). Of this figure about 30 percent are in IBPGR-designated base collections and 70 percent in other storage, of which about 20 percent under long-term conservation conditions. Many samples have been duplicated for safety reasons, but there are a number which have not. There are also several accessions which are in urgent need of rejuvenation or seed increase. These cases need urgent action.

21. A clear idea of the geographical and species coverage of collections can only be fully obtained when passport and characterization data have been analysed. For this to be done effectively, central crop databases are an important tool and a number of national and international programmes are currently working on this, notably those in the IARCs, and those within the framework of the European Cooperative Programme for the Conservation and Exchange of Crop Genetic Resources. Some general

information on geographical coverage is provided by curators, and some estimates have been produced by IBPGR on the progress made in capturing the genepool diversity of major crops (Annex IV).

22. It is estimated that collections of landraces of some crops, notably wheat and maize, represent a relatively large part of the available variability. For other major cereals, grain legumes and some vegetables, such coverage may be achieved within the next decade. However, the variability of crops of local interest to developing countries with low priority within the CGIAR system is poorly represented in existing collections.

23. A few national programmes in developing countries, including Brazil and India, are giving greater attention to indigenous crops and their improvement. Crop diversification programmes in some industrialized countries, including Australia, New Zealand and the USA, are experimenting with a variety of species that have hitherto been underexploited. Over the past ten years, attention has also been paid to multi-purpose woody species of value in forestry and rural development schemes. Despite such developments, crops of local importance for the most part continue to receive relatively low priority for action and need greater attention.

24. FAO is trying to fill gaps in the collection of crops of local importance, using the International Fund for Plant Genetic Resources. For example, a small grant was provided to PGRC in Ethiopia for the conservation and use of teff germplasm. Similar efforts are planned for Andean crops. These proposals include the collection, characterization, evaluation, and selection of material for further testing and improvement leading to the development of new varieties, including seed production and their release to farmers .

## V. CONSTRAINTS AND LIMITATIONS

25. The genebanks that accept responsibility to hold base collections in trust are expected to provide adequate storage facilities for long-term conservation, and to maintain the germplasm according to appropriate technical standards and management procedures. The centres and countries involved should also provide secure operating funds and manpower.
The lack of such resources is a major problem for most genebanks. There is a need to set high standards for collections so as to ensure that the germplasm samples are safeguarded, properly documented, characterized, evaluated and made available for use.

26. A number of existing base collections do not meet adequate standards and their management practices are less than satisfactory, with the result that there is a great risk of loss of part of their holdings. In some poorly managed genebanks greater loss of genetic materials may occur than in the field: this applies mainly to wild material.

27. IBPGR estimates that 30 to 40 percent of samples in genebanks may be redundant duplicates (within or between institutes). Little effort has yet been made in addressing this problem. However, some international centres, such as CIP, are applying combined taxonomic, agronomic and biochemical techniques to rationalize the situation and identify and reduce duplicates. The European Cooperative Programme has also gained valuable experience in this area, through its centralized crop data bases,

which has shown that it may take considerable time and. money to identify duplicates, even within a centralized crop data base.

28. In contrast to the large numbers of samples currently held in base collections, the documentation relating to those samples is deficient in both quality and quantity. This is true both for some of the major staple food crops and, even more so, for the crops that do not figure prominently in trade or international research programmes. These deficiencies may be the result of any of the following:

(i) a lack of detailed passport data;

(ii) a lack of computing facilities and trained manpower;

(iii) different centres using incompatible hardware and software for data storage and exchange;

(iv) a frequently limited distribution of catalogues, printouts, etc., with the result that information is not reaching breeders and other scientists; in certain cases interpretation of data is difficult;

(vi) a lack of feed-back to curators from breeders and other users;

(v) the limitation of central databasing to a few crops only; and

(vii) the need for the taxonomic verification of some samples, especially of wild species.

29. A basic principle in any sensible conservation policy is to ensure that duplicates of accessions in a given base collection are also held elsewhere under long-term storage: this duplication is an insurance against the 'loss or temporary unavailability of material. However, although duplicates exist, for some crops duplicate base collections still need to be systematically organized for many crops.

30. According to IBPGR, the minimum adequate accession size of seed-producing crops for base collections is 3,000 seeds, in the case of genetically homogeneous samples, and 4,000 in the case of heterogeneous samples. The preferred standards are 4,000 and 12,000 respectively 1/. seeds are sufficient; and for active collections the numbers advised are 3,000 and 5,000 seeds 2/. Nevertheless, it should be noted that these figures are practically chosen and lack scientific justification.

31. Collectors do not in practice always gather such a large number of seeds, and this often necessitates at least one cycle of multiplication to increase seed numbers. Many programmes are now starting to think in terms of the regeneration of samples - a necessary prerequisite for duplication. However, regeneration and multiplication are not only time-consuming and

---

1/ IBPGR, 1985. IBPGR Advisory Committee on seed storage. Report of 3rd Meeting.
2/ Hawkes, J.G., 1980. Crop Genetic Resources Field Collection Manual. IBPGR/EUCARPIA.

expensive, but may lead to the loss of genetic diversity through genetic drift, accidental hybridization and selection pressure. In addition, errors could occur due to human neglect and mechanical failure.

32. In order to minimize genetic erosion during multiplication, it may be advisable or desirable to multiply samples in their original habitat or country of collection. This is generally not done and most genebanks undertake seed increase and regeneration locally. In some cases the multiplication and regeneration of samples has not yet been started due to a lack of funds or facilities. For some crops there are no appropriate guidelines and standards for regeneration.

33. The ultimate goal of germplasm conservation' is utilization, and that it be made freely available to all interested workers. There are, however, in practice a number of different types of constraints to the exchange of germplasm samples:

(a) Legal: specific legislation restricting export of certain economically important genetic material; plant variety rights and plant breeder's rights;

(b) Political: a lack of diplomatic recognition between the countries involved;

(c) Commercial: similar to plant variety rights and plant breeder's rights;

(d) Economic: a lack of funds for multiplication and distribution is a major hurdle for many national institutions;

(e) Technical: the lack of proper and properly disseminated documentation, and a lack of appropriate procedures for handling the seeds of wild and other species;

(f) Quarantine: delays in treatment, and a lack of knowledge of quarantine requirements.

## VI. CONSIDERATIONS FOR FUTURE ACTION

34. Over the last three decades, much international effort has been directed towards building up storage capabilities for germplasm, and towards the generalized collecting of landraces, particularly those of major food crops. Much remains to be done for crops of local social and economic importance. In general, it can be said that recent efforts have been fairly successful but, perhaps because of this success, a number of problems which need to be addressed have arisen.

35. At present, there is still no adequate guarantee for the long-term security and availability of the germplasm, stored in base collections. This unfavourable judgement accords with current scientific opinion and the result of recent studies and developments. It reflects the following:

(i) the recognition that there is ,a need not only to guarantee the long-term security of plant genetic resources, but also to ensure their availability;

(ii) the rapid development of plant genetic resources activities worldwide, including the development of a large number of national genetic resources programmes;

(iii) the international recognition of the increased commercial value and potentiality of germplasm, due mainly to the new biotechnologies;

(iv) the tendency to extend proprietary rights to various kinds of genetic materials and their characteristics;

(v) new directions in plant genetic resources, including increased research on wild relatives, which potentially draws in a much larger group of institutions than hitherto, many of them outside the normal agricultural framework;

(vi) the need to include active and research collections in the crop networks, and also to establish links between these and the base collections; and

(vii) the recognition that viable crop genetic resources networks can only be established and maintained on the basis of full participation of all interested parties in the decision-making process, and on the goodwill of all parties concerned.

36. Little of the germplasm so far collected has yet been characterized and evaluated. For some crops, especially for local crops of importance to developing countries, the information on the kind and amount of material stored is often inadequate or missing. So as to alleviate some of the problems relating to the quality of data and the documentation of accessions, and to facilitate studies on the scope and coverage of collections, the following general recommendations are made:

(i) to channel greater assistance to centres to accelerate germplasm documentation through characterization and evaluation;

(ii) to provide support to centres to establish suitable documentation systems (including the provision of hardware and software);

(iii) to encourage the establishment of centralized crop databases, and for the dissemination of information on collections;

(iv) to expand the training of manpower in database management and handling for the general documentation of genetic resources;

(v) to promote the better publication and dissemination to breeders and other scientists of information on important characteristics, as an aid to the utilization of germplasm;

(vi) to encourage breeders and other scientists to supply information on their materials to curators; and

(vii) to encourage centres to exchange data on a regular basis between base and active collections, and between active collections.

37. In order to foster cooperative links, which may lead to the better utilization of available germplasm, efforts should be made to develop networks of institutions working on specific crops. IBPGR is currently studying this matter. In such an endeavour, it is necessary to bring together the relevant specialists to decide on the proper structure and function of the genetic resources network in question. For many minor crops, the development of such networks could prove a useful stimulus, and lead to greater attention being paid to them. This will have the following advantages:

(i) improved coordination for collecting, conservation and utilization, and less duplication of efforts;

(ii) the better identification of priorities for research, germplasm management and utilization

(iii) the more effective deployment of resources to meet needs within the networks;

(iv) a greater opportunity for all interested parties to participate, and to obtain access to germplasm and related information; and

(v) the provision of legal assistance to national programmes so that they may develop national legislation for the security and availability of germplasm.

38. The Commission may wish to indicate priorities among the action to be taken in order to improve matters and develop a sustainable and viable network of base collections for the conservation of plant genetic resources. There is an urgent need for greater financial assistance to some base collection centres, both to improve heir storage facilities and for operational expenses. In view of the reasons mentioned in paragraph 35 above, it is suggested that particular emphasis be placed on strengthening the existing base collections and bringing these under the auspices and/or jurisdiction of FAO. Such a development is in line with the International Undertaking, and provides a much needed legal and political umbrella for the existing base collections.

ANALYTICAL SUMMARY OF ARRANGEMENTS FOR EX SITU NETWORK OF BASE COLLECTIONS 1/

| | Genebank category 2/ | Description | Germplasm ownership | Legal framework for free availability | | |
|---|---|---|---|---|---|---|
| | | | | Type of commitment | Reversibility 3/ of commitment | |
| INT. JURISDICTION | FAO model A | Germplasm under international (FAO) ownership. Genebanks donated or leased to FAO | International | Physical transfer; donor government renounces ownership | irreversible | AGREEMENT TO VERIFICATION BY THE FAO |
| | FAO model B 4/ | Germplasm under international (FAO) ownership. Genebanks accept FAO verification | International | " | irreversible | |
| NATIONAL JURISDICTION | FAO model C 5/ | Germplasm under national ownership and FAO auspices with FAO verification | National | Governmental commitment to free availability | reversible | |
| | FAO model D | Germplasm under national ownership and FAO auspices | National | " | reversible | NO AGREEMENT TO VERIFICATION BY THE FAO |
| | IBPGR model | Germplasm under national ownership | National | Bona Fide non-governmental agreement to free availability | reversible | |
| | IUCN model | Mainly wild species in botanical gardens | National | - | - | |
| UNDEFINED | Crop-specific IARCs model | Genebank for each crop under the IARC's mandate | National or undefined | Various arrangements Bona fide | - | |

1/ Simplified presentation based on documents CPGR/89/5, CPGR/89/6 and CGIAR and IUCN information.

2/ The FAO models and other models are not all mutually exclusive. For example, geneplasms in IBPGR designated genebanks may also be placed under the auspices of FAO.

3/ Agreements to the free exchange of germplasm held under national jurisdiction are reversible. Changes of government policy or in national laws and regulations may result in legal or practical restrictions on their free availability. Firm legal (not necessarily financial) guarantees of the future availability of their germplasm can only be offered by collections under international jurisdiction.

4/ Germplasm under this agreement would be stored for the international community by a national body, but under FAO auspices. Several countries have offered to FAO to act as ad honorem depository of germplasm under international ownership; others have offered national germplasm for storage under international (FAO) ownership.

5/ The only difference between model C and D is accepting, or not accepting FAO verification. Many countries have already agreed to model C and several to model D.

Annex II

## Commitments of centres accepting the responsibility to hold base collections in the IBPGR designated genebanks

(i) the collection will continue to receive adequate operating funds and personnel and if, at some future time, this is not possible, FAO/IBPGR will be notified promptly;

(ii) if the material stored is not available from an active collection, it will be made freely available from the base collection to any professionally qualified institution or individual seriously interested in using it;

(iii) authorized representatives of the IBPGR will be given access to the collection and data at all reasonable times;

(iv) arrangements will be made to duplicate the material for safety;

(v) for base storage, seeds will be dried to 5% moisture content, packaged and stored at temperatures lower than -5oC (and preferably between -10 and -180C) with a viability monitoring regime as recommended by IBPGR; and

(vi) a suitable method of regeneration will be used to reconstitute the samples when seed viability begins to decline or quantitiy of seeds is reduced to a critical level.

Annex III

Worldwide holdings of crop germplasm in genebankcs (including wild relatives) 1/

(source: IBPGR Crop Directories)

| | | | |
|---|---|---|---|
| CEREALS | 1056400 | including: | Amaranthus 2000; Eragrostis 2300; Eleusine 3700; Fagopyrum 2300; Hordeum 191500; Oryza 234200; Pennisetum 35700; Sorghum 82400; Triticum 336200; Zea 101000. |
| FOOD LEGUMES | 464400 | including: | Arachis 24900; Cajanus 11200; Cicer 30700; Cyamopsis 2000; Glycine 119300; Lupinus 11900; Phaseolus 127000; Pisum 48000; Psophocarpus 3700; Vigna 66300. |
| ROOTS & TUBERS | 134300 | including: | Colocasia 5700; Dioscorea 8900; Ipomoea 21000; Manihot 25400. |
| VEGETABLES | 265700 | including: | Abelmoschus 3800; Allium 10500; Capsicum 24800; Cucumis 116700; Lycopersicon 40600; Raphanus 3400; Solanum 65600. |
| FRUITS | 49600 | including: | Anacardium 3700; Bactris 1500; Carica 1000; Citrus 15500; Durio 1200; Ficus 1800; Mangifera 4800; Musa 5500; Persea 3400. |
| FORAGES | 230400 | | |
| INDUSTRIAL | 47990 | | |
| OTHER | 2700 | | |
| TOTAL: | 2251400 | | |

1/ Includes samples in long-, medium-, and short-term storage.

Annex IV

Comprehensiveness of crop germplasm bease collections 1/

| Comprehensiveness 2/ | Cereals | Roots & tubers | Grain Legumes | Vegetables |
|---|---|---|---|---|
| Most Comprehensive | Maize<br>Wheat<br>Rice<br>Barley<br>Sorghum | Potato | Cowpea<br>Chikpea<br>Pigeonpea<br>Mung pea | Tomato<br>Amaranth<br>Capsicum |
| Moderately Comprehensive | Pearls millet<br>Minor millets | Cassava<br>Sweet Potato | Soyabean<br>Peanut<br>Lentil<br>Faba bean<br>Runner bean<br>Common bean<br>Winged bean | Okra<br>Crucifers<br>Allium<br>Cucurbits |
| Least Comprehensive | wild species (except wheat, maize) | Yam<br>Wild species (except potato) | Lima bean<br>Lupin<br>Bambara groundnut<br><br>Wild species (except soyabean and peanut) | |

1/ Based on Lyman, J.M., 1984. Progress and planning for germplasm conservation of major food crops. FAO/IBPGR Plant Genetic resources Newsletter 60: 3-21.

2/ Most comprehensive = more than 75% of germplasm collected,
Moderately comprehensive = 50-75% of germplasm collected,
Least comprehensive = less than 50% of germplasm collected.