International Plant Genetic Resources Institute

IPGRI

8 January 1996

Dear Dr. Scobie, Grant

I am pleased to send you, attached herewith, the Report for CIAT of the External Review Panel of the CGIAR Genebank Operations.

I am also enclosing a copy of the synthesis report of the review exercise which has been distributed to ICWG-GR members and will be discussed at the Sixth Session of the Inter-Center Working Group on Genetic Resources to be held at CIP in Lima, Peru from 23-29 January 1996.

I would like to take this opportunity to thank you and your staff for your contribution to this important exercise.

Sincerely,

Geoffrey Hawtin
Director General

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REPORT OF EXTERNAL REVIEW PANEL OF THE CGIAR GENEBANKS OPERATIONS

INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE (CIAT), CALI, COLOMBIA

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REPORT OF EXTERNAL REVIEW PANEL OF THE CGIAR GENEBANKS OPERATIONS - INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE (CIAT), CALI, COLOMBIA

COMMENTS/RECOMMENDATIONS

The Panel noted that CIAT was reviewing the future of the GRU and that a new Director-General and Deputy-Director General (Research) would ultimately influence the form, status and program of the Unit.

The Panel recognized that financial constraints are limiting CIAT's operations, but thought that the GRU is underfunded in relation to the Centre's total budget.

The Panel thought that there are dangers in making use of special Project funding for key areas of conservation and research.

The Panel was impressed with the successful way in which CIAT and NARS had involved farmers in the utilization of the Centre's germplasm (beans) and also noted that studies were currently underway at CIAT to assess, in a quantitative fashion, impact made by CIAT's genetic resources in partner countries.

The Panel was informed by CIAT's staff that the data bases used by CIAT for its mandate crops were likely to be compatible with the System-wide Information Network on Genetic Resources (SINGER) when it became operational.

The Panel was satisfied that for *Phaseolus*, forage and grass species CIAT's goal is to adhere to International Genebank Standards, as endorsed by FAO and published jointly by FAO and IPGRI in 1994. Inadequate staff and funds have precluded complete achievement of these standards. Recommendations are made to address specific deficiencies.

The Panel thought that exchanges involving staff of the GRU and NARS partners could have a beneficial and stimulating effect.

For the *Manihot* collection, CIAT and IPGRI's research on *in vitro* storage had reached the stage of drawing up International Standards for this vegetatively produced crop and wild relatives. The Panel noted the intention of CIAT and IPGRI, in conjunction with FAO, to draw up a set of International Standards in the very near future.

Recommendations:

1. CIAT's Senior Management should address the heavy demands made on the GRU by the Commodity Programs.

2. CIAT should continue to review carefully the large number of grass and legume species in the Tropical Forage collection with a view to concentrating on those species most relevant to its research needs or that

are in danger of genetic erosion. For some accessions, recollection may be more efficient than regeneration.

3. CIAT should review the position of its bacterial and fungal collections with a view to declaring these collections to be held in trust in the public domain.

4. For accessions with limited longevity, samples for both base and active collections should be stored in the long-term seed store.

5. CIAT should negotiate with ICA to permit first increase of forages in mesh-houses to increase effective population size and reduce genetic drift.

6. CIAT should assess the need to increase staff for SHL (considering charging other units for service provided by SHL). CIAT should consider establishing the same seed health routine procedures, as done for seeds to be sent abroad, for materials distributed within Colombia.

7. Dehumidifiers need to be up-graded in the medium-term storage unit to maintain 25 to 28% r.h. Dehumidified seed drying capacity should be expanded to replace the high temperature drier.

8. CIAT should establish additional field genebanks, under suitable agro-ecological conditions, for cassava and other *Manihot* species which are not adapted to headquarters conditions.

9. CIAT should intensify its efforts to promptly arrange for formal safety backup duplication of the cassava collection off-site and to request relevant information from national and international institutes holding "non-formal duplications". Formal agreements should be signed by both parties.

10. CIAT should seek to develop formal agreements for security backup off-site seed storage of tropical. forages.

11. CIAT should expand viability testing to obtain an initial viability test for all seed accessions and to permit monitoring as needed.

12. Because most accessions have sub-standard numbers of seeds, regeneration of these accessions and those with sub-standard viability should be done promptly.

13. Place seed of tropical forage in local and off-site long-term storage as soon as possible irrespective of seed numbers.

14. Initiate a pilot cryopreservation project for *Manihot* as soon as possible, based on CIAT research and on research on other crops at other institutions.

15. Initiate applied research to reduce costs for routine activities.

16. Make a classification of the training-user countries, based on the stage of development of GRU in each NARS. The information will make it possible to develop a strategy for coordinated research between NARS and CIAT, and/or service training of national researchers at CIAT headquarters, as well as the development of research projects by NARS researchers at CIAT.

17. CIAT should develop and distribute information in a data base on genetic distances between accessions, which will improve the efficiency of the use of germplasm in breeding programs. The CIMMYT IWIS software might be useful.

18. Tape backups of the GRU database should be made weekly and securely stored in a different building.

19. CIAT should continue refining GRU core collections and designating cores in additional forage species as feasible. The Panel commends the GRU for the early development and use of core collection methodologies. The methodologies used for the initial core were excellent, and the refinements in progress (GIS and molecular markers) are cutting edge technology.

PREAMBLE

As part of the External Review of the CGIAR Genebank Operations a team comprised of:

Dr. N.L. Innes: Consultant, c/o Scottish Crop Research Institute, Dundee, UK
Mr. Enrique Arias, FAO Representative, Agricultural Office, AGPC, FAO, Rome, Italy
Dr. Steve Eberhart, Director, National Seed Storage Laboratory, USDA-ARS, Fort Collins, USA
Dr. Mario Lobo, NARS Member, CORPOICA-GRU, Medellin, Antioquia, Colombia.

visited CIAT, Cali, Colombia, from 3-6 August, 1995

The purpose of the External Review is to make a critical assessment of the constraints and opportunities for the CGIAR genebank operations in technical, scientific and financial terms. It is expected to produce an opportunity to sustain and improve the quality of services offered by the CGIAR Gene Banks, and enhance partner confidence and improve funding opportunities. Detailed Terms of Reference are included in Appendix I.

To ensure fairness, clarity and transparency across CGIAR Centers, a checklist prepared by IPGRI, FAO and the Chairman of the Review Panel was made available to and approved by all Centers involved in the Review. Senior Management at CIAT responded to this checklist of the Review Panel in advance of the Panel's visit to Cali, so that the Panel had access to a document that adhered closely to providing the sort of information it required.

The report that follows is based on the information and documents provided by CIAT, on the interaction between the Review Panel and CIAT staff and on a tour of the Genebank and other facilities at the Center. Much of the information contained in this report was obtained from CIAT's response to the checklist. A list of CIAT and IPGRI staff who interacted with the Panel is given in Appendix II and a timetable is included in Appendix III.

Because of the integrated nature of the programs involving genetic resources at CIAT, the Review Panel includes in this report information and comments that extend beyond those normally associated with a Genebank per se. By its integrated approach CIAT optimizes the use of its resources, provides valuable research on genetic conservation and helps to ensure that the Centre's genetic resources are used to best advantage.

A. POLICY ITEMS

1. Institutional Objective in Germplasm Conservation

The Genetic Resources Unit (GRU) is the basic unit of CIAT genetic resources activities. Its role (CIAT Medium Term Plan, 1992) is to assemble, conserve, characterize and make freely available all critical germplasm resources of *Phaseolus* beans, cassava and selected groups of tropical forages; and to research these collections so that they can be conserved more effectively and used more fully by national programs (NARS) and the user community worldwide.

2. Status of the GRU and associated institutional structures

Assembling of germplasm collections at CIAT began in the seventies, and the GRU was created in 1976. The GRU was the first of the so-called support Units, with a center-wide mandate to support the commodity research of the programs. The BRU and the Virology Research Unit (VRU) were only organized in 1985.

With a re-organization of CIAT in 1994, the GRU was linked to the Genetic Diversity Scientific Resource Group (GD-SRG); as such, the interests of the GRU staff are now represented by the Leader of the GD-SRG. The purpose of the GD-SRG is to stimulate scientific discussions and develop research initiatives across the center that lead to strategies for the conservation and sustainable use of genetic diversity. The scientific resource groups, with their associated units, are placed in parallel to the programs (Fig. A-1). The GD-SRG Leader is a member of the CIAT Scientific Resource Committee.

Although the more essential conservation activities in CIAT are in the GRU, genetic resources work is spread throughout the center. As shown in Figure A-1 a commodity program shares the conservation work and all commodity programs carry out the agronomic evaluation of germplasm. The Biotechnology Research Unit (BRU) and some of the commodity programs carry out a sizeable part of the research effort on genetic resources and agrobiodiversity in cooperation with the GRU.

The GD-SRG has initiated consultations on the possibilities of merging the BRU with the GRU into a single Unit or Program. This initiative will be further discussed by CIAT management before it is submitted to the Board of Trustees (BOT).

The GRU is also represented in the CIAT standing committee on genetic resources. This committee advises the CIAT Director-General (DG) on matters concerning policy issues on GR.

3. Linkages with other Germplasm Conservation Centres, including Regional, and Networking arrangements

CIAT's collaborative links in genetic resource conservation are summarized in Table A-2.

The GRU collaborates with the Programa Cooperativo Regional de Frijol para Centro América, México y el Caribe (PROFRIJOL) and Programa Cooperativo Regional Para la Zona Andina (PROFRIZA); bean networks

for Central America and the Andean region, respectively. Both the GRU and BRU are also members of the Cassava (Biotechnology) Network, where a subnetwork deals specifically with cassava genetic resources. The BRU has also been instrumental in the creation and development of the Bean Advanced Research Network (BARN) with important participation of the GRU. The GRU has been collaborating in the Red Internacional de Evaluación de Pastos Tropicales (RIEPT), an evaluation network developed for tropical forages.

The GRU has on-going linkages with partners of the regional plant genetic resources networks sponsored by IPGRI: REDARFIT for the Andean Region, and REMERFI for Central America, as well as with the Amazonian network TROPIGEN.

TABLE A-1. GRU in the context of GR activities across CIAT (1995)

Germplasm Activity	GRU	BRU	VRU	Commodity Programs	NRMR Programs	Inst. Develop. Program
COLLECTION/ACQUISITION	BCF	--	--	BCF	--	--
CONSERVATION	BCF	--	--	C	--	--
CHARACTERIZATION	BCF	--	--	BCF	--	--
DISTRIBUTION	BCF	--	--	--	--	--
HEALTH TESTING	BCF	--	CF	--	--	--
GERMPLASM ENHANCEMENT	--	B	--	BC	--	--
AGRONOMIC EVALUATION	--	--	--	BCF	BCF	--
RESEARCH ON:						BCF
• CONSERVATION METHODS	CF	C	--	--	--	BCF
• EVALUATION METHODS	BC	BC	--	BC	--	BCF
• CHARACTERIZATION TOOLS	--	BCF	--	BC	--	BCF
• SAFE MOVEMENT	--	--	CF	--	--	BCF
• GENETIC DIVERSITY STRUCTURE/DISTRIBUTION	BC	BCF	--	BCF	BC	BCF
TRAINING	BCF	BC	BCF	BCF	--	BCF

GRU: Genetic Resources Unit

BRU: Biotechnology Research Unit

VRU: Virology Research Unit

NRMR: Natural Resources Management Research

B: Beans; C: Cassava ; F: Tropical Forages

TABLE A-2 CIAT Collaborative Links in GR Conservation (1992-95)

	BEANS	CASSAVA	TROPICAL FORAGES
ACQUISITION	NARS: **Mexico, Guatemala, Perú, Ecuador, Colombia**	NARS: **Argentina, Guatemala, Brazil, Salvador, Bolivia**	NARS: S.E. **Asia, Colombia, Brazil**
CHARACTERIZATION/DIVERSITY			
• BOTANICAL	**Belgium** (Gembloux), **USA** (Fort Collins), **Colombian** Univ.	**Colombian** Univ., **Brazil** (CENARGEN)	**Colombian** Univ., **Brazil** (CENARGEN), **U.K.** (Kew Gardens)
• BIOCH./MOLECULAR	**USA** (Univ. California, Davis; Univ. Wisconsin), **Italy** (Bari)	**Brazil** (CENARGEN), **USA**: (Wash. Univ.; Univ. Georgia); **U.K.** (Univ. of Bath)	**U.K.** (Bristol),**Brazil** (Univ. of Sao Paulo)
SAFETY DUPLICATION	**Brazil** (CENARGEN), **Costa Rica** (CATIE)		
• SHARED COLLECTIONS	**USA** (USDA, Pullman and Fort Collins)	NARS	**Brazil** (CENARGEN), **Ethiopia** (ILCA), **Australia** (CSIRO), **USA** (Univ. Florida)
RESTORATION	Initiating: NARS (**Guatemala, Peru, Ecuador**)	--	--
CAPACITY BUILDING	Redafit, Remerfit, OEA, IICA, COLCIENCIAS, LAC, IARCs	Redafit, Remerfit, OEA, IICA, COLCIENCIAS, LAC, IARCs, CBN, MGRN	Redafit, Remerfit, OEA, IICA, COLCIENCIAS, LAC, IARCs, TF-GRN, **Australia, Brazil**, ILCA

The GRU, as part of the GD-SRG, is involved in the organization of a Latin American and Caribbean (LAC) Alliance in Agrobiodiversity Conservation. This is a CIAT initiative, in partnership with IPGRI, Centro Internacional de la Papa (CIP) and Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), and responds to the CGIAR System-wide Genetic Resources Program (SGRP). The participation of LAC countries in a first scoping workshop with regional organizations such as FAO, Instituto Interamericano de Cooperación para la Agricultura (IICA), Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), will be convened by the LA UNEP Office in Mexico.

CIAT has formal agreements with CENARGEN, Brazil, and CATIE, Costa Rica, for the duplication of *Phaseolus vulgaris* collections (see Table D-2). Although duplicate sets of CIAT's *Phaseolus* are stored in USDA's active and base collections, there is no formal agreement.

4. Agreement with Host Country on the Ownership and Movement of Material.

The Government of Colombia recognized by law (Law 29 of March 18, 1988) the international status of CIAT, and the article 5c of law 29 specifically recognized the right of CIAT to import and export genetic material for research purposes and to move such materials within the Colombian territory with the only requisite of complying with the national phytosanitary regulations.

5. Institutional Policy on Material that is Designated under the IARC's Agreement with FAO.

All germplasm accessions of mandate species acquired by CIAT prior to the entering into force of the CBD, and which have been completely processed for conservation and assigned a number, are included in the designated list.

After the CBD, and following the approach of the Inter Center Working Group on Genetic Resources (ICWG-GR) and the CGIAR Genetic Resources Policy Committee, only those germplasm accessions acquired without strings attached and provided by the donor as "common good" are accepted for conservation in the CIAT genebank and become designated.

The Panel was informed that CIAT hoped to have a Material Transfer Agreement (MTA) in place before end of the year. The IPGRI MTA document was being reviewed by CIAT's Standing Committee on Genetic Resources with a view to making modifications to meet CIAT's specific requirements. CIAT Board approval would be sought in November 1995.

The following germplasm has been designated in 1995 under the CIAT-CG agreement with FAO (Total accessions at CIAT are given in parentheses). *Phaseolus* beans: 26,395 accessions (41,061). Cassava: 5,595 accessions (5,985). Tropical Forages: 15,448 accessions (20,689). Germplasm that is in the process of virus clean up, is being multiplied, and which qualifies as designated will be added in due course to that already under the aegis of FAO.

6. Restoration of germplasm

Although CIAT does not have a formal restoration policy, germplasm collections made since 1977 have involved leaving a duplicate sample of collected germplasm in the country of collection. Sets of germplasm, as detailed below, have already been shipped to countries of origin, through nurseries or specific shipments, at the request of country programs:

a. *Phaseolus* beans

Mexico: Set of 349 accessions of wild *Phaseolus vulgaris* sent in August, 1983. Most of this material was collected in Mexico, but was not represented in the national gene bank.
Iran: Set of 493 accessions of cultivated *Phaseolus vulgaris* sent in June, 1986.
Honduras: Set of 434 accessions of cultivated *Phaseolus vulgaris* sent in June, 1989. This germplasm corresponded mostly to part of the original national collection which was lost due to poor seed viability.
Peru: Set of 159 accessions of landraces of *Phaseolus vulgaris* sent in October, 1990.
Rwanda: This restoration is in progress as part of an international effort (Seeds of Hope Project) for recovering the agricultural research capacity of Rwanda. It embraces about 311 accessions

b. *Manihot*

Cassava germplasm has been restored to Argentina, Paraguay and Peru. Plans are under way to progressively restore the whole collection of beans and cassava through specific projects that include research and training components in addition to the physical shipment of the germplasm. In these plans, staff from national programmes will be trained in germplasm handling and characterization through classical or molecular methods, and participate in the development of specific areas of knowledge about their plant genetic diversity. Such plans have been initiated with Guatemala, Ecuador and Peru.

c. Forages

The Genebank of Kenya at Maguga has made a request for restoration of the *Brachiaria* germplasm that had been donated to CIAT.

7. Future Outlook

As stated previously, CIAT's focus has shifted from solely a crop production approach to a more demanding one that adds conservation of the natural resource base. The very nature of the commodities for which CIAT holds germplasm collections in trust, leads the center to develop a strong research component, targeted on the utilization side, at the generation of information on useful sets of diversity and genepools and useful genes; on the conservation side, at a better definition of the genetic diversity to be conserved and of methods for improved conservation. The attainment of these objectives will involve the development of genetic maps and molecular markers technology, the integration of assessment of genetic diversity with geographic information systems, the documentation of useful genes into modern databases are examples of initial research that will augment genetic enhancement, and genetic methodologies for efficient conservation *ex situ* and *in situ*.

B. PLANT SPECIES/TYPES CONSERVED IN THE GENEBANK

1. List of species and categories and estimate of coverage

Species and categories are listed in Table B1-1. A summary of CIAT's collecting activities is included in Table B1-2.

Table B1-1 List of species and categories

	Number of accessions (as per June 1995)		
Category	**Phaseolus Beans**	**Manihot Cassava**	**Tropical Forages**
Cultivated materials	39,903 (97.2%)	5,632 (94.1%)	----
Wild materials	1,158 (2.8%)	353 (5.9%)	23,894
Total Accessions received	41,061 (100%)	5,985 (100%)	23,894 (100%)

Table B1-2. CIAT germplasm collecting activities (1981-1995).

Year	Phaseolus Beans*		Cassava		Tropical Forages	
	No. countries	No. accessions	No. countries	No. accessions	No. countries	No. accessions
1981	-	-	3	148	5	1,119
1982	1	215	2	309	11	496
1983	-	-	5	397	8	652
1984	-	-	3	221	11	2,938
1985	3	212	3	128	12	1,940
1986	3	1,058	9	464	7	1,503
1987	4	381	5	215	7	705
1988	2	168	4	79	6	679
1989	3	202	1	2	5	774
1990	2	109	3	13	3	193
1991	-	-	3	362	3	249
1992	-	-	1	80	6	480
1993	-	-	2	87	5	118
1994	1	41	2	57	-	-
1995	1	40	-	-	-	-
Total	8**	2,426	18**	2,562	28**	11,846

* 85% of the Phaseolus bean collection at CIAT comes from donations by existing genebanks and not from collecting activities; ** No. of different countries.

a. ***Phaseolus*** **beans Collection**

1. List of species and categories

The composition of the *Phaseolus* germplasm collections includes a total of 41,061 accessions received of which 27,813 are already increased. Of these, 90% correspond to *P. vulgaris*, 5% to *P. lunatus*, 2% to *P. coccineus*, 1% to *P. polyanthus*, close to 1% to *P. acutifolius*, and the wild non-cultivated species about 0.6%. Most accessions of the cultivated species correspond to landraces. There is a low percentage (less than 2%) of bred materials, mostly in the *P. vulgaris* collections. In addition, there is a backlog of material which includes: duplicate material, material without passport data (needs evaluation in case-by-case basis), material received with poor viability (probably to be re-asked to country of origin, or re-collected) and material with full passport data (worth introducing).

2 Estimate of coverage

It is estimated that about 50% of the variability of the genus, including all species, is represented in the CIAT genebank. Table B1-3 summarizes the estimated coverage of *Phaseolus* collections in the CIAT gene bank, for the American centers of diversification. There are 55 *Phaseolus* beans collections in 39 countries which contain about 106,000 accessions. Of this total, 86% correspond to *P. vulgaris*, 13.1% to the other cultivated species, 0.3% to the wild non-cultivated species and, 0,6% of doubtful identification. The CIAT *Phaseolus* collection has a good representation of the major collections of *P. vulgaris, P. lunatus, P. coccineus, P. polyanhus*, and *P. acutifolius* germplasm stored in those banks.

Table B1-3. Estimate of coverage of Phaseolus collections in American centers of diversification (geographic estimate)

CIAT GRU Mandate Species	**%**
Common bean, *Phaseolus vulgaris*	65
Lima bean, *Phaseolus lunatus*	55
Scarlet runner, *Phaseolus coccineus*	35
Year-bean, *Phaseolus polyanthus*	40
Tepary bean, *Phaseolus acutifolius*	90
All *Phaseolus* wild forms and species	40 to 0

The land race representation in the five domesticated species from the primary centers of diversity is the most complete, but, the coverage of the wild non cultivated species is low.

b. Cassava germplasm

1 List of species and categories

The cassava collection comprises about 87% of landraces and the remainder are advanced cultivars (277) and hybrids (293). The *in vitro* collection holds 5,632 clones of *Manihot esculenta*, an additional 353 accessions of 29 *Manihot* species and 3 undefined species, and a set of genetic stocks developed for molecular mapping.

2 Estimate of coverage

The estimated coverage of *Manihot esculenta* is 70%, and it ranges from 0 to 5% for the wild *Manihot* forms and species. The highest representation of cassava accessions is from Brazil, Paraguay, Colombia and Venezuela; and the lowest from the Amazon basin, Mexico and the Caribbean.

c. Tropical Forages Germplasm

1. List of species and categories

This collection comprises 150 genera with more than 730 wild undomesticated species of possible forage potential. Around 90% of the collections are legumes, 10% are grasses. Over 50% of the collection comprises the legume genera *Stylosanthes, Desmodium, Centrosema, Zornia and Aeschynomene.* (Table B1-4).

2 Estimate of coverage

The diversity represented in the tropical forage germplasm, is limited to species of forage potential from tropical, acid soils regions. Around 70% of the collection was acquired through collecting expeditions: of these, about 70% are South and Central America and the Caribbean; 15% from Asia and Oceanía, 10% from Africa. Five percent remain without information. Out of 20 of the most important legume species, 10 are represented in the CIAT genebank at medium to high level in terms of accessions; and only 2 out of 8 grass species have medium level of representation. In geographical terms, Colombia, Brazil and Venezuela have a good representation. Overall the collection represents around 50% of the variability in forages legumes for tropical acid soils, and only 25% for the grasses.

The Panel recognized the difficulties faced in making estimates of coverage and noted that CIAT's current research program is aimed at identifying gaps in collections. Wild species of *Phaseolus*, Tropical forages are all deserving of increased attention. However, the Panel queried the need for CIAT to focus on such a large number of Tropical Forages.

The Panel was impressed with CIAT's herbarium collection of grass and legumes pasture species.

* **Recommendation**: CIAT should continue to review carefully the large number of grass and legume species in its Tropical Forage collection with a view to concentrating on those species most relevant to its research needs or in danger of genetic erosion. For some accessions, re-collection may be more efficient than generation.

Table B1-4. Status of the tropical forages germplasm held in trust at CIAT (July, 1995).

Genus*	Accessions registered (no.)	Accessions conserved (no.)	Accessions multiplied (no.)	Backlog accessions (no.)	Accessions in base collection (no.)
Legumes					
Aeschynomene[3]	1,036	998	657	341	293
Arachis[1]	173	59	50	9	29
Calopogonium[3]	581	536	410	126	121
Centrosema[1]	2,596	2,451	2,231	220	1,050
Desmodium[2]	3,245	2,904	1,917	987	737
Galactia[3]	668	570	557	13	378
Leucaena[2]	216	199	177	22	150
Macroptilium[3]	659	615	608	7	466
Pueraria[2]	288	258	234	24	116
Rhynchosia[4]	510	445	228	217	33
Stylosanthes[1]	4,034	3,607	2,871	736	1,101
Vigna[3]	838	741	654	87	337
Zornia[4]	1,091	1,028	896	132	77
Other	4,894	4,203	2,853	1,279	1,463
Total legumes	20,829	18,614	14,343	4,200	6,351
Grasses					
Andropogon[2]	149	91	89	2	-
Brachiaria[1]	1,121	654	563	91	124
Hyparrhenia[3]	117	53	40	13	4
Panicum[2]	848	598	512	86	35
Paspalum[2]	154	105	71	34	24
Other	691	494	242	323	1
Total grasses	3,080	1,995	1,517	549	188
Other families	3	2	-	2	-
Grand total	23,912	20,611	15,860	4,751	6,539
Percent of total (%)		100%	76.9%	23.0%	31.7%

* Relative importance: 1 very important; 2 important; 3 intermediate; 4 not important.

Numbers of accessions for crops stored in active and base collections in the CIAT genebank and the number of accessions stored in off-site collections are summarized in Table B1-5.

Table B1-5. Number of accessions in active, base, and off-site collections

Crop	Collection		
	Active	Base	Off-site
Bean	28,271	6,500	21,428
Forage			
Legume	18,614	6,351	0
Grasses	1,995	188	0
Cassava			
Tissue	5,085		2,784
Seed	(190)		(150)
Field	(4,306)		(2,613)
Total	53,965	13,039	24,262

( ) Duplications not included in totals.

d. Bacterial and Fungal Collections

In addition to its plant genetic resources, CIAT has a collection of about 4,000 strains of *Bradyrhizobium*. There are about 100 requests per annum for forage legume inoculants and ampoules are provided by CIAT. There is also a collection at CIAT of *Rhizobium* and *Mycorrhizae* from a range of Tropical soils.

* **Recommendation**: CIAT should review the position of its bacterial and fungal collections with a view to declaring these collections to be held in trust in the public domain.

C. GENEBANK MANAGEMENT, OPERATIONS AND RESOURCES

1. Organizational set up within CIAT

With the organization of CIAT activities into projects in early 1994, a new organizational structure was implemented. As shown in Fig. A-1, the CIAT matrix structure comprises the Commodity with the Natural Resource Management Programs along one of the axes and the Scientific Resource Groups along the other. The GRU is associated to the Genetic Diversity Scientific Resource Group (GD-SRG) which directly responds to the Office of the Deputy Director General Research.

2. Administration and management

Currently, the Leader of the GD-SRG has been assigned as interim Head of the GRU (Fig. C-1). The Unit's Senior Scientist (formerly with IPGRI) has a coordinating function in the GRU. The three germplasm Curators are directly responsible for the day-to-day work within their respective collections. With the pending decision

before the end of 1995, by CIAT management and BOT, about the merging with the BRU, the status and leadership of the unit will be formally defined.

a. Human resources

Number of personnel currently assigned to the GRU is 42; their distribution per crop and services is shown in Table C-1.

Table C-1. CIAT GRU Staff (June 1995)

GRU Staff	Service	Beans	Cassava	Forages	Total
Professional					
Ph.D.	1	--	1	--	**2**
MSc.	1	1	--	1	**3**
B.Sc.	1	1	1	1	**4**
Technical	3	6	3	5	**17**
Labor	1	6	2	6	**15**
Secretarial	1	--	--	--	**1**
Total	**8**	**14**	**7**	**13**	**42**

Since activities in genetic resources at CIAT are distributed among the GRU and the various programs and units of the Center, the overall additional contribution to genetic resources at CIAT would be equivalent to 6.25 scientist-years at senior staff level plus one at Post Doc level (Table C-2).

Table C-2. Principal Staff dedicated to Genetic Resources at CIAT (1995)

	S Y in CIAT Programs and Units							
Staff	**GRU**	**BRU**	**VRU**	**BP**	**CP**	**TFP**	**NRMPs**	**TOTAL**
SS	1.00	1.50	0.50	0.75	0.75	0.75	1.0	**6.25**
AS	4.00	--	0.50	--	--	--	--	**4.50**
PDF	--	1.00	--	--	--	--	--	**1.00**
	5.00	**2.50**	**1.0**	**0.75**	**0.75**	**0.75**	**1.00**	**11.75**

SS: Senior Scientists; AS: Associate Scientists; PDF:Post Doct Fellow

b. Financial resources

The current (1995) core direct operating budget of the GRU is U.S.$ 791,000 (Table C-3). This budget includes the personnel of Table C-1, including one senior scientist who occupies the budgeted position of the Unit's Head. The total cost of the GRU including indirect costs (e.g. electricity, security, station operations, administration, etc.) is calculated at U.S.$1,028,000. The total costs of the GRU operating budget represents about 3.4% of CIAT's core operating budget. The additional core budget assigned to genetic resources activities across CIAT programs and units (Table C-2) covers 6.75 principal staff-years, representing approximately U.S.$1,350,000 in 1995. Taking the latter amount into account, the overall total share of CIAT genetic resources activities would be around U.S.$2,378,000 or about 7.9% of CIAT 1995 core budget.

Table C-3. GRU operational resources (U.S.$) per major activities for 1993-1995

Activity	1993	1994	1995
Phaseolus collection	185,000	220,000	240,000
Manihot collection	60,000	175,000	195,000
Tropical Forages collection	186,000	173,000	193,000
Coordination and services	347,000	95,000	162,000
Total	**778,000**	**663,000**	**791,000**

* Does not include the cost of maintaining the Cassava field gene bank ($150,000)

'em Includes one Senior Scientist, Secretarial help, Seed Health and Electrophoresis Lab.

CIAT is considering transferring responsibility for the Cassava field genebank and associated funding ($150,000) to the GRU.

c. Physical Plant

The GRU is housed in a separate set of buildings that were remodeled at the time of establishment of the GRU. Facilities sizes and capacities are summarized in Table D-1. The medium term and long-term seed stores are insulated (4") environmental chambers with duplicate sets of cooling equipment installed in 1990. Mobile shelves maximize storage capacity. Current seed accessions in the active and base collections (Table B1-5) occupy much of the 90,000 estimated capacity of the medium-term vault. With the slighter smaller sample sizes for the base collection, the long-term vault has room for expansion, although there is a large backlog of accessions not yet in long-term storage.

* **Recommendation**: For accessions with limited longevity, samples for both base and active collections should be stored in the long-term seed store.

d. Plant Quarantine and Seed Health Facilities

1. Seed health testing facilities

CIAT's Seed Health Laboratory for seed health testing includes nine sections. They are designed to test seeds for fungi, bacteria, viruses, and occasionally nematodes. Seed health testing activities include: 1) reception, registration, sampling and storage of samples; 2) preparation of working samples for testing, and 3) analysis.

2. Post quarantine facilities

Facilities for post-quarantine include one greenhouse and three screenhouses specially equipped for grow-out tests. These facilities are used to examine plants from particularly valuable seed material to eliminate pathogens. Additionally there is an incinerator located near these facilities to destroy material infested with micro organisms of quarantine importance. Because of limited size of the greenhouse, only 4 forage plants per accession can be grown.

* **Recommendation**: CIAT should negotiate with ICA to permit first increase of forages in mesh-houses to increase effective population size and reduce genetic drift.

3. Seed health testing of outgoing material

Seed health testing of out-going germplasm (bean, tropical pastures and partially cassava), is designed to detect pathogens of quarantine significance. The SHL applies the methodologies recommended by CIAT's pathologists and virologists to comply with the specific quarantine regulations of the recipient country.

The ICA plant quarantine Officer, stationed at CIAT, carries out field and green house inspections and issues "ICA's Phytosanitary Certificate" which accompanies all out-going germplasm from Colombia. The SHL also collaborates to improve the phytosanitary standards of the genebank material. In the last five years the SHL analyzed 11,466 samples from different sections of CIAT; but only 1,973 (17%) and 617 (39%) were for GRU samples. In 1993 and 1994, 876 (31%) were for GRU.

In the case of cassava, plant quarantine activities are supervised by the ICA Officer and coordinated by the GRU and the VRU. For germplasm export *in vitro*, indexation of material is conducted by the VRU, while the seed health laboratory performs indexation of seeds.

* **Recommendation**: CIAT should assess the need to increase staff for SHL (consider charging other units for service provided by SHL). CIAT should consider establishing the same seed health routine procedures, as done for seeds to be sent abroad, for materials distributed within Colombia.

D. DESCRIPTION OF AVAILABLE FACILITIES, TYPES AND METHODS OF CONSERVATION

1. *Phaseolus* germplasm

a. Facilities

A new seed storage facility, built with a donation from the Italian Government, began operations in early 1990. The facility includes a long-term storage room, a medium term storage room, and a seed drying room. Currently the medium-term storage room is occupied at about 65% of its maximum capacity with GRU germplasm, including a disease free core subset. Initial seed drying is at 30 °C.

* **Recommendation**: Dehumidifiers need to be upgraded in the medium-term storage unit to maintain 25 to 28% r.h. Dehumidified seed drying capacity should be expanded to replace the high temperature drier.

The GRU facilities are shown in Table D-1

Table D-1. GRU facilities for *Phaseolus* beans and tropical forages in the GRU

Purpose	Type	Features	Volume or area	Capacity (accessions)
Seed storage	Medium-term[a] (5-20 years)	5 to 8 °C, 35% r.h. 10% seed moisture	360 m^3	90,000
Seed storage	Long-term[b] (30 to 50 years)	-15 to -20 °C, 6% - 8% seed moisture	260 m^3	100,000
Seed drying	Heated air	30°C, Low r.h	34 m^3	715
Seed drying	(long-term)	20°C	68 m^3	1,485
Thresh & clean	Processing	35% r.h.	260 m^3	-
Seed laboratory	Seed preparation		101 m^2	-
In vitro				
Laboratory		Air conditioned	44 m^2	3,600/yr
Growth room		5 tubes/clone [c]	11 m^2	3,600/yr
Slow growth	23-24°C	5 tubes/clone [d]	32 m^2	6,720
Cryopreservation				
Laboratory	Preparation	Growth chambers		
Cryo-storage	Long-term	Cryo-tanks		
Seed Health	Laboratory	9 sections	125 m^2	8,000
Greenhouse		5 plants/clone	45 m^2	356
Electrophoresis	Laboratory		44 m^2	1,000/yr
Herbarium				
Lab.and office	Sample prep.	Air conditioned	8.8 m^2	-
Sample storage	Cabinets		20.6 m^2	15,000
High land fields	Regeneration		2 ha	1,500/yr
Equipment storage	Covered		24 m^2	-

a. Plastic jars; b. Aluminum foil bags; c. 18 mm tube size; d. 25 mm tube size

b. Areas for seed increase and multiplication

At present, seed increase, multiplication, and cleaning of the *Phaseolus* germplasm is carried out in three locations of different altitudes: (i) Increase and cleaning in Palmira (1,000 m.a.s.l.) under closed greenhouse followed by three mesh-houses; this location is intended mostly for *P. vulgaris* and *P. lunatus;* (ii) Multiplication phase is carried out mostly in an isolated highland location (Tenerife, at 2,000 m.a.s.l.), suitable for adaptation of a large percentage of common bean germplasm; (iii) Popayan (1,800 m.a.s.l.), used mostly for multiplication of the complex *P. coccineus-P. polyanthus*, some germplasm of *P. lunatus*, and wild forms of the cultivated species. Mesh-houses are used for controlling outcrossing.

c. Duplicate conservation for safety

Two agreements have been signed for holding a duplicate of the *Phaseolus* collection as black box. One, with EMBRAPA, CENARGEN in Brazil, and the other with CATIE, Costa Rica. To the present, about 13% of the increased common bean collection is already duplicated in CENARGEN, and nearly 90% of the total increased collection is duplicated in CATIE (55% of total collection) (Table D-2).

2. *Manihot* germplasm

a. *In vitro* genebank

A tissue culture facility exists for *in vitro* conservation of cassava germplasm under slow growth conditions. This facility was built following a collaborative CIAT-IBPGR project on a "pilot" *in vitro* gene bank (1987-89). Table D-1 presents information on the cassava *in vitro* gene bank and Table D-3 on the associated field gene bank. The *in vitro* gene bank has reached about its maximum capacity for conservation. A rough estimate of the available diversity, the representation of priority areas and traits for specific ecozones can help to illustrate the need of additional space for *Manihot* germplasm. Steps are being taken for increasing the *in vitro* storage capacity. Cassava clones in the *in vitro* gene bank are conserved under controlled temperature of 23-24°C, with alternating dark and light for 12 hours of 1,000 lux. Nodal cuttings of the clones are planted in a slightly modified MS culture media and depending on the genotype, subcultured every 8 to 17 months.

Cryopreservation, an alternative for long term, low cost conservation is under study in the BRU. It is expected to have soon an improved protocol applicable to all genotypes. It is, however, necessary to assign a fully equipped area for the gene bank of cassava clones in liquid nitrogen.

b. Field gene bank

The field collection has historically been managed by the Cassava Program, but will probably be transferred to the GRU in 1996. The field area assigned to the cassava collection is about 6 ha, with an additional 6 ha required for overlapping of field plots during 4 months. Six plants per genotype are maintained in plots organized by the vigor of the respective material, and the plots are renovated every 12 months. As the bank is located in CIAT headquarters, under conditions where about 35% of the accessions are not adapted, the cost of management (pest control) is high and longer rotations are needed to avoid disease problems. Introduction from the *in vitro* collection, and the identification of duplicates, as well as characterization are additional activities related to field maintenance.

An additional 0.3 ha is dedicated to the 29 wild *Manihot* species which present more serious problems of adaptation. A large investment is made in greenhouse labor associated with the vegetative propagation of *Manihot* species.

Table D-2. Safety Duplication of IARCs *Phaseolus* Beans and *Manihot*

CENTRE	Duplicated Material	Total No. of increased Accessions	No. Acce. Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with institute
CIAT	**Phaseolus Beans**						
	Phaseolus vulgaris	24,563	21,448	87.3	Black-box	CATIE, Costa Rica	Yes
			3,124	12.7	Black-box	CENARGEN, Brazil	Yes
			7,859	32.0	Active; base	USDA,Pullman,WA, USA, NSSL	No
	Phaseolus lunatus	1,548	744	48.0	Active; base	USDA,Pullman,WA, USA, NSSL	No
	Phaseolus coccineus	597	172	28.8	Active; base	USDA,Pullman,WA, USA; NSSL	No
	Phaseolus polyanthus	292	96	32.9	Active; base	USDA,Pullman,WA, USA; NSSL	No
	Phaseolus acutifolius	271	118	43.5	Active; base	USDA,Pullman,WA, USA; NSSL	No
	***Phaseolus* Total**	28,271	21,478				
	M. esculenta	5,632	4,567	89.8	Active	NARS each country	No formal
	M. spp	353				CENARGEN	No
	Cassava Total	5,985					

Table D-3. **Field gene bank facilities-areas for the cassava collection - CIAT (June 1995).**

Purpose	Area (ha)	Capacity (No. clones)	Observation
Main gene bank (include core)	4.5	4,695	Six plants per clone. Plots are renovated every 12 months. Plots overlap (old bank vs. new bank) during 4 months.
Auxiliary plots for morphological characterization	0.5	500	
Sanitation plots	0.3	200	
Additional plots/ Other locations	0.5	350	
Wild spp bank	0.3	268	Plots are renovated every 24 months. Plots overlap (old bank vs. new bank) during 6 months
Greenhouse (borrowed)	50 m^2	350	Required for enhancing vegetative propagation of *Manihot* spp.
Growth room (borrowed)	24 m^2	200	Controlled conditions for seedling production *Manihot* spp.

* **Recommendation**: CIAT should establish additional field genebanks, under suitable agro-ecological conditions, for cassava and other *manihot* species which are not adapted to headquarters conditions.

c. Seed conservation

To Nov 1994, seed of 12 wild *Manihot* species from collecting missions by CENARGEN/EMBRAPA, targeting the primary gene pool of wild *Manihot*, has been shared with CIAT. Seed is conserved under low relative humidity conditions, before seed health testing/cleaning are performed and placed in the field. There is need for developing appropriate methods for conservation of wild *Manihot* species.

d. Duplicate conservation for safety

There is not a formal duplication of the cassava collection in another institute. Using the available information it is estimated that 89% of "non formal" duplication of cassava germplasm in different NARS and one CGIAR center (IITA). There is no formal information for duplication of wild *Manihot* spp, but CENARGEN holds a large representation. (Table D-2).

* **Recommendation**: CIAT should intensify its efforts to promptly arrange for formal safety backup duplication of the cassava collection off-site and to request relevant information from national and international institutes holding 'non-formal' duplications. Formal agreement should be signed by both parties.

3. Tropical Forages Germplasm

a. Facilities, types and methods of conservation

The tropical forages collection utilizes the same facilities for storage as the *Phaseolus* collection (see Table D-1). Field space for initial increase and multiplication, and facilities for field conservation of some species are located near Palmira (11,752 m^2), Quilichao (18,994 m^2) and post quarantine green house space (100 m^2) are available near Palmira.

b. Duplicate Conservation for Safety

The establishment of a duplicate security backup base collection in another institution is regarded as high priority. This issue is being discussed with ILCA, the Svalbard International Seedbank (SIS) in Norway, and the national seed storage laboratory (NSSL), USDA in USA. Nevertheless, a large proportion of the tropical forage collection is held as "common accessions" (in active duplication) in ILCA, CENARGEN - Brazil, Commonwealth Scientific and Industrial Research Organization (CSIRO) -Australia, and the University of Florida, USA. About 41% of legumes and 57% of grasses are jointly listed with these institutions, which may serve as a back up to the CIAT collection. Also, 50% the accessions from the "key species" is shared with these institutions (Table D-4).

* **Recommendation**: CIAT should seek to develop formal agreements for security backup off-site seed storage of tropical forages.

E. GENEBANK STANDARDS

1. *Phaseolus* beans germplasm

a. Procedures and methods for germplasm conservation

1. Types of containers used for conservation

Two types of containers are used for storing the bean seeds. (a) Plastic jars made of high density plastic for medium term storage (5 to 10 years); (b) Aluminum foil bags made with a fine inner plastic covering for long-term storage. The capacity of plastic jars is 700 to 800 grams of bean seeds. Capacity in number of seeds varies according to seed size: for cultivated species it ranges between 1,200 to 4,000; for seeds of wild species, it varies from 1,200 for large seeds to 15,000 for small seeded wild species. Aluminum foil bags have a capacity which ranges from about 500 seeds for large seeded materials, up to 2,500 seeds for small seeded materials. The physical properties of the bags are satisfactory.

Table D-4. Tropical forage germplasm conserved at CIAT and shared with other important institutions [a] (number of accessions), 1995.

Genus	CIAT	ILCA		CENARGEN		CSIRO		Univ. Fl.		PI	
Legumes											
Aeschynomene	998	70	(7.0)*	228	(22.8)	140	(14.0)	44	(24.4)	88	(8.8)
Calopogonium	536	23	(4.3)	260	(48.5)	54	(10.1)	5	(1)	-	-
Centrosema	2451	215	(8.8)	1218	(49.7)	633	(25.8)	146	(6.0)	16	(1)
Desmodium	2904	82	(2.8)	375	(12.9)	378	(13)	282	(9.7)	35	(1.2)
Galactia	570	1		56	(9.8)	38	(6.7)	10	(1.8)	3	(1)
Macroptilium	615	12	(2)	57	(9.3)	98	(15.9)	155	(25.2)	12	(2)
Pueraria	258	1	(5.6)	7	(2.7)	48	(18.6)	1	(-)	-	-
Rhynchosia	445	25	(16.2)	42	(9.4)	43	(9.6)	7	(1.5)	1	
Stylosanthes	3607	584	(2)	1617	(44.8)	870	(24.1)	63	(1.7)	6	
Vigna	741	15	(19.2)	40	(5.4)	125	(16.9)	29	(3.9)	5	
Zornia	1028	197	(7.3)	411	(40.0)	45	(4.4)	33	(3.2)	10	(1)
Other	4461	326		427	(9.6)	587	(13.2)	110	(2.5)	20	
Total legumes	18614	1551		4738		3059		1085		196	
Grasses											
Andropogon	91	4	(4.4)	7	(7.7)	35	(38.5)	-		0	
Brachiaria	654	375	(57.3)	412	(6.3)	34	(5.2)	-		26	(4)
Hyparrhenia	53	15	(28.3)	12	(22.6)	12	(22.6)	-		0	
Panicum	598	39 227	(6.5)	340	(56.9)	30	(5)	-		0	
Other	599	-	(37.9)	33	(5.5)	76	(12.7)	-		0	
Total grasses	1995	660		804		187		0		26	
Other families	2										
Grand total	20611	1443		5542		3246		1085		222	

[a] ILCA = International Livestock Centre for Africa, Ethiopia

CENARGEN = Centro Nacional de Recursos Genéticos, Brazil

CSIRO = Commonwealth Scientific and Industrial Research Organization, Australia

Univ. Fl. = University of Florida-AREC Fort Pierce, USA

PI = Plant Introduction Number

* In parenthesis is presented the percentage represented in each institution

2. Seed viability monitoring

There is no routine checking of the initial viability. However, viability monitoring is done by batches based on seed age to plan multiplication and regeneration; this monitoring is carried out after five to six years of storage. A viability monitoring test using 6,000 accessions of *P. vulgaris* was carried out four years ago. Using rolled paper towels in incubators, it was found that 90% of the accessions had germination above 60% and, that 75% of the accessions had germination greater than 80%. A project is underway to establish emergence monitoring in sand, because of its high correlation with emergence under field conditions. A batch of 600 accessions of *P. lunatus*, having more than six years of storage, is planned to be checked this year.

*** Recommendation**: CIAT should expand viability testing to obtain an initial viability test for all seed accessions and to permit monitoring as needed.

3. Quantity of material conserved.

Because seed capacity of the plastic jars varies with seed size, a modification of the seed inventory control is underway by which the total number of seeds per jar are estimated. This change will be fully implemented by mid 1996. Table E-1 and E-2 show data on seed inventory of *P. vulgaris* and other cultivated *Phaseolus* species, respectively.

Table E-1. Seed inventory for *P. vulgaris*

Jar volume fraction	Number of accessions	%
5/5	1,039	4.2
4/5	3,704	14.9
3/5	4,145	16.6
2/5	5,698	22.9
1/5	7,883	31.6
<1/5	2,454	9.8
Total	24,923	100.0

Table E-2. Seed inventory for the other cultivated *Phaseolus* species

No. Seeds	*P. lunatus*		*P. coccineus*		*P. polyanthus*		*P. acutifolius*	
	No.acc.	%	No.acc.	%	No.acc.	%	No.acc.	%
>1,000	615	33.4	161	27.5	103	35.2	255	83.1
600-1,000	182	9.7	61	10.4	31	10.6	35	11.4
200-600	434	23.5	135	23.0	80	27.3	16	5.2
<200	613	33.2	229	39.1	79	26.9	1	0.3
Total	1,844	100.0	586	100.0	293	100.0	307	100.0

The current inventories of the cultivated species suggest that, in order to meet the IPGRI/FAO standards for seed quantity, the following percentages of the present collections need to be regenerated (i.e.) in the short-medium term: 64% of *P. vulgaris*, 66% of *P. lunatus*, 73% of *P. coccineus*, 65% of *P. polyanthus* and, 17% of *P. acutifolius*. These figures are given for the material already increased. Only 6,500 of the 28,271 accessions have been placed under long-term storage; 77% of those are *P. vulgaris*, and the remainder are other cultivated species. Some 6,400 accessions are in the backlog waiting for quarantine processing; 63% are *P. vulgaris*.

* **Recommendation**: Place seed of all bean and tropical forage accessions in local and off-site long-term storage as soon as possible irrespective of seed numbers.

4. Health of material

Bean germplasm is multiplied in isolated fields (in Vijes, Tenerife and Popayán) and in Palmira under greenhouse conditions, with supervision from ICA Quarantine Officers. During multiplication, plants showing any symptoms of fungi, bacteria, or viruses are destroyed. The SHL occasionally analyzes the bean seed from Palmira, Popayán, Vijes and Tenerife to establish its health status before storage. The SHL has been working on practical procedures, under green house conditions for clean bean germplasm production, especially with material from the core collection. ELISA checks are used to detect the presence of BCMV.

5. Monitoring and maintenance of conserved material - regeneration.

Routine monitoring of viability of stored materials will be implemented. The maintenance of the collection is checked with respect to the amount of seed stock in the jar, as well as the age of the seed. When the seed stock is below 1/5 of the jar's capacity, multiplication is planned. If the accession has more than six years in storage, but, if the seed stock is higher than 1/5, the material is scheduled for a germination test, prior to a decision about regeneration.

*** Recommendation**: Because most accessions have sub-standard numbers of seeds, regeneration of these accessions and those with sub-standard viability should be done promptly.

6. Maintenance of adequate documentation system

Major emphasis has been placed on documentation of the bean germplasm from the primary centers of domestication and/or diversification, i.e. Mesoamerica and Andean South America. In addition, catalogs with relevant data for *P. lunatus, P. vulgaris,* wild forms of *P. vulgaris* and the complex *P. coccineus-P. polyanthus* were published and distributed to national programs and bean researchers. Basic morphological characterization, seed descriptors, growth habit, and flowering features are registered as well as evaluation for key traits and limited biotic and abiotic factors for crop production in a worldwide context. Lists of "minimum" descriptors were developed, taking as a basis the descriptors published by

IPGRI. All the documentation has been implemented in database under ORACLE software. CIAT's institutional network system, which in the case of beans includes also the databases of all the sections of the Bean Commodity Program, runs under a central server (Sun Spark 2000) with terminals in all the sections of the GRU and the Bean Program.

2. *Manihot* germplasm

a. Procedures and methods for germplasm conservation

Procedures for *in vitro* conservation of cassava via limiting growth involve: entry of stem cuttings, establishment of cultures; entry of cultures into conservation and maintenance routine; monitoring culture viability and stability. Germplasm enters into the bank either, as stalks from the field gene bank or *in vitro* (international exchange) and hence two types of protocols have been established. Five test tubes per clone enter conservation. Monitoring viability and stability under slow growth include: contamination, leaf senescence (ratio between green and dead leaves), number of viable tips for future micropropagation, number of viable nodes related to the stem's length, presence or absence of roots, occurrence of callus, phenolization of roots and culture medium.

* **Recommendation**: Initiate a pilot cryopreservation project for *Manihot* as soon as possible, based on CIAT research and an research on other crops at other institutions.

b. Maintenance of adequate documentation system

The cassava data is implemented in ORACLE through the UNIX operational system. Passport data includes collecting institution, names and codes for the accession as well as information related to the place of collection. The only 2 countries with >90% basic information (origin, date of collection) are Colombia and Guatemala, followed by Ecuador, Peru, Malaysia, Puerto Rico, Indonesia, United States and Fiji with fairly comprehensive origin information. Germplasm from the remaining 14 countries is poorly documented, making this a topic where action should be taken for data exchange with NARS through the *Manihot* Genetic Resources Network. Morphological characterization consists of the application of 21 minimum morphological descriptors recorded in the field by the Cassava Program. Morphological characterization is 90% complete for most of the 21 characters for the germplasm of 15 out of the 23 countries. Work at this level is also demanded to complete characterization in at least one major ecosystem. Biochemical characterization is based on the determination of α - ß esterase patterns, which reveals 22 distinct alleles (bands) in cassava. To the present, 4,300 accessions have been fingerprinted with α - ß esterase isozymes. DNA fingerprinting is carried out on groups having similar morphological isozyme patterns.

3. Tropical Forage Germplasm

a. Procedures and methods for germplasm conservation

The storage facilities described for the *Phaseolus* collection are shared by the tropical forages collection

1. Types of containers used for conservation

For medium-term storage, plastic jars, of one liter capacity, with double lid. For long-term storage, aluminum foil bags.

2. Initial viability and quality of materials

Initial germination and moisture tests are carried out on a representative number of accessions per species. Tests are carried out by species, not by accession. Physical quality is high since samples are cleaned manually using screens and blowers. Genetic quality. Contaminations are avoided by locating the accessions randomly in the greenhouse and field, so that no species blocks are formed. To prevent contamination when breeding systems are unknown, every species is treated as outcrossing.

3. Quantity of material conserved

The goal for seed produced per accession is 10,000 seeds; for the base collection (3,000); monitoring (1,000); duplication (3,000); and active collection (3,000). Some accessions are stored with less seed, because of low requests for distribution or because they are poor seed producers.

4. Health of materials

The initial seed increase is carried out in mesh-houses or in the field with control of diseases and pests. However, there is not a routine procedure to monitor the health status of the materials before storage.

5. Monitoring and maintenance of conserved material

There is limited information available on the physiological quality of most of the accessions. Germination of 178 legume accessions, representing 10% of seed samples stored from 1985 to 1987, was assessed; under medium-term storage conditions, germination ranged 71 to 89%; and 82 to 97% under long-term storage conditions. This information indicates that legume seed with initial high quality can be stored over a long period with no significant loss of viability.

6. Regeneration

Regeneration has seldomly been carried out with selected legume species when seed quantity in the active collection was substandard. Re-collection may be required when regeneration is not possible.

7. Maintenance of adequate documentation system

Documentation of the tropical forages collection is carried out with Sunpark station 2000 with total disk space of 126 Gigabytes and total memory of 128 Megabites, using a database implemented on a data management software system ORACLE. Recently, an inventory of species held in the collection has been published, as well as catalogs of collections from Colombia; Mexico, Central America, and the Caribbean; Venezuela; South East Asia; and a world catalog for *Centrosema*. The basic passport data are available and have been revised for about 85% of the accessions. Besides the basic passport data, information on number of seeds collected and number of plants sampled (40% of accessions) is also included. Many important tropical genera lack a modern taxonomical treatment (e.g., the monograph of *Arachis* was published only in 1994). Proper identification thus requires the collaboration of a large number of specialists worldwide. This effort has led to a steady decrease in un- or ill-identified accessions in the collection. Nevertheless, 2,624 accessions (12.7%) are still not identified at the species level, particularly in the genera *Crotalaria, Desmodium, Indigofera, Phyllodium, Tephrosia*, and *Zornia*. The reference herbarium now keeps 16,091 specimens of about 70% of genera and species. Morphological characterization has been carried out on 18% of the conserved accessions, and 7% have been biochemically characterized by isozymes and native seed proteins. The Tropical Forages (formerly Pastures) Program characterized acid soil adaptation of about 7,500 accessions (36%).

4. Security of facilities and databases

Internal emergency power plants. For a long time CIAT had an internal power plant which supplied about 40% of the Center energy requirements; it was used when the public energy was off due to a variety of reasons. Because of its limited capacity, only key areas, including GRU as first priority, had priority for connection to this plant. Because of a critical drought (1991-92) and of increased demand for energy, costs have increased substantially. Hence, CIAT invested in a new system, which includes two power plants with a total capacity of 2,500 Kw. These two plants work during the peak hours (9:00 to 12:00, and 18:00 to 21:00). Also, when the regional energy system fails, these plants connect immediately to all sections of CIAT including the GRU (seed bank, in vitro bank, electrophoresis lab, herbarium, seed health testing lab., offices). In addition, the old system is still operational as back up to the new system.

Duplicated cooling and drying systems-equipment. Each one of the three main rooms of the seed bank for beans and tropical forages has a duplicate set of cooling, dehumidifying and drying equipment, working independently, so that if one fails, it is immediately replaced by the other one.

Seed bank doors alarms. The seed bank has four metallic doors: main entrance, long-term storage, medium-term storage, and drying room. Each of these doors has an individual alarm, which starts ringing when the corresponding door has been forced open or left open for more than one minute. This system insures that all the doors must remain locked all the time.

Seed bank internal alarms. Although all doors can be opened from inside, each one of the four rooms of the seed bank has a big and visible push-button on the inside; this can be used if any person gets locked in any of those rooms. When the button is pushed, it triggers a noisy alarm outside in the seed preparation room.

Monitoring seed bank conditions and the respective equipment. A panel continuously monitors temperature and relative humidity of each room in the seed bank, as well as operation of the equipment. This panel is strategically located for a daily monitoring routine. There is also a routine checking coordinated with security CIAT guard personnel, in case that something goes wrong during this period.

Building fire protection. All sections of the GRU have at least one fire extinguisher. Carbon dioxide gas extinguishers have been placed in some laboratories where chemical powdered extinguishers are not suitable or recommended.

Additional fire alarm protection. There is a plan under study to install fire, smoke and gas detectors in the risky areas of the Genetic Resources Unit, such as all the sections of the *in vitro* bank (laboratory and storage rooms), where there are both a temperature component and numerous electrical connections, as well as in the computers working sections for protecting the databases. These detectors will send either a signal to a telephone station, and/or, ring an alarm in the central CIAT security office. The possibility of installing sprinklers of carbon dioxide gas in those risky sections is also under consideration.

Earthquakes. The new building, which houses the seed bank and the in vitro bank, was planned and designed with high standards against earthquakes. The foundations and the shell of the building surpasses the Colombian construction standards for earthquakes.

Back up for protection of the databases. Before the new CIAT internal communication network system was established last year, a routine back up of the databases on tapes was carried out twice a year on average. Under the new system, back ups of all the databases will be produced on a more frequent schedule and, if possible, on an automatic basis, as soon as the databases are updated. The original databases are on the central server of the network; this is located in the Information Management Network System (IMNS) building away from the GRU.

*** Recommendation:** Tape backups of the GRU database should be made weekly and securely stored in a different building.

F. DEVELOPMENT AND CHARACTERIZATION OF CORE COLLECTIONS

A core collection (core subset) can represent most of the genetic diversity of the crop collection with a minimum number of accessions (5 to 30%). Characterization and evaluation costs are greatly reduced and efficiencies when screening for desired traits can be increased.

1. *Phaseolus* Germplasm

A core collection was formed from among the 24,000 accessions which were available from the global *Phaseolus vulgaris* collection held in CIAT. A baseline of 10% of the crop collection was set for representation by countries in the primary centers, but this was adjusted up or down according to specific situations such as duplication of accessions. Subsequently, a three-step process was followed. First, regions were prioritized, giving greater weight to traditional bean growing areas. Second, germplasm was classified as to agroecological origin. Four environmental parameters were identified as critical: length of growing season, photoperiod, soil type and moisture regime, with 3,2,3, and 3 levels, respectively. All possible combinations of these parameters yielded 54 possible environments, of which 49 were actually represented in the crop collection. Another minor class was created to represent cold environments of very long season. By use of map coordinates of the germplasm collection sites, accessions were matched to their respective environmental class. The third criterion utilized was based on morphophysiological data of grain color and size, and growth habit. Primitive types were weighted more heavily than modern commercial types. Having weighted the representation as such, a random selection was practiced within the agroecological classes. A total of about 1,000 accessions were identified from primary centers, and an additional 300 were chosen from secondary centers, plus 40 key landraces, 40 standard bred lines, 40 genetic stocks, and 80 additional accessions for a total of 1,500. A core collection (111 accessions) has been designated for the wild species based on passport and agronomic information. Molecular markers (RAPD's, AFLP's) will be used to refine these core subsets.

Using a GIS database, representing a range of agroecologies in the major centers of *Phaseolus* diversity, the two core collections are being classified according to edaphoclimatic characteristics of their original sites, and thus provide a basis for identifying promising areas not yet represented. Combination of the two approaches will enable correlation of genetic diversity at the molecular level with diversity at agroecological level. The data obtained from the core collections will be also correlated with agronomic evaluation. This has begun with response to low P soils.

2. *Manihot* Germplasm

A core collection of 630 accessions has been defined at CIAT for improving the efficiency of germplasm evaluation. Together with elite clone accessions, the core collection represents the most completely characterized cassava germplasm and the material most frequently utilized in breeding programs. In the absence of direct measures of genetic variability among accessions in the global collection, parameters (weighted) expected to influence or reflect variability were used in selecting clones for the core collection:

(i) Geographic origin; (ii) Diversity of morphological characters; (iii) Diversity of a β esterase banding patterns; (iv) A priori decision based on criteria of special interest; (v) Within each country, the definition of the core germplasm, prioritized landraces, accessions from primary centers of diversity and variation among cassava growing ecosystems.

The core collection (about 10% of the crop collection) has been characterized for agronomic traits including root quality parameters (cyanogenesis, amylose-amyllopectin ratios, starch functional properties) and prevailing biotic and abiotic constraints at CIAT headquarters as well as in representative testing sites of Colombia (for sub-humid lowlands and acid soil lowland savanna production ecosystems). In addition, subsets are evaluated for promising characteristics such as high photosynthetic rates, nutrient use efficiency, C4 metabolism, and pest and disease resistance.

3. Tropical Forages Germplasm

GRU has given priority to forages of 9 genera and 18 species in two families, Leguminosae and Gramineae, for characterization and development of core collections. The genera *Stylosanthes, Centrosema* and *Desmodium* have received the most attention in assembling large genetic resources, and in morphological characterization. Recently, the genus *Arachis* was identified as promising for pasture improvement and soil cover. For some species, such as *S. scabra*, a core collection was formed on the basis of geographic representation and preliminary evaluation data and subjected to further agronomic evaluation. For the purpose of preliminary evaluation in different environments, small, geographically representative collections of individual species have been assembled. Intensive research using isozyme fingerprinting and morphological descriptors will be used to designate core collections of important key species, such as *S. guianensis* or *Brachiaria brizantha*.

* **Recommendation**: CIAT should continue refining GRU core collections and designating cores in additional forage species as feasible. The Panel commends the GRU for the early development and use of the core collection methodologies. The methodologies used for the initial core were excellent, and the refinements in progress (GIS and molecular markers) are cutting edge technologies.

G. RESEARCH AND PUBLICATIONS ON GERMPLASM CONSERVATION

1. Research

Research in plant genetic resources at CIAT has been targeted at answering some basic questions such as: what is the genetic diversity for conservation in order to ensure genetic progress in the commodities; which methods can make conservation of that genetic diversity safer and more efficient.

Research activities have been carried out collaboratively by GRU, BRU and genetic diversity specialists in the commodity programmes at CIAT. The following topics have been tackled using molecular markers and

other technologies to measure genetic diversity: species phylogenetic relationships and structure of crop gene pools using classical and molecular approaches; structure of genetic diversity according to spatial gradients and ecological gradients using GIS; analysis of founder effect under domestication; minimum genetic diversity to capture the variability existing in the commodity germplasms (definition of core collections by integrating molecular markers and GIS information); heritability of certain traits for molecular genetic mapping; protocols of seed drying for different germplasm of *Phaseolus* and tropical forage species; cryopreservation of *Manihot* meristems; tissue culture for *in vitro* conservation of wild *Manihot* germplasm.

* **Recommendation**: Initiate applied research to reduce costs for routine activities such as: drying in paper bags versus open drying boxes; counting smaller samples to estimate total seed number with computer connections to scales to enter seed number and seed weight per 100 seeds in the data base; mechanization in seed processing; estimation of seed longevity of various species at temperatures above freezing (accelerated aging, etc.) to identify species where the active collection should be stored at -18°C; use of bar codes; computer programs to enter germination results, compute means, and enter in data base; determine genetic purity with alternative pollen control systems for outcrossing species, especially forages.

2. Publications

The large number of publication (Table G-1) by CIAT staff working in Genetic Resources (GRU, BRU, GD-SRG) and the quality of the papers provides evidence of the excellent research work and the dedication of the scientists in publishing information for use by others. The numerous GRU germplasm catalogs provide valuable information to users.

* **Recommendation**: CIAT should develop and distribute information in a data base on genetic distances between accessions, which will improve the efficiency of the use of germplasm in breeding programs.

Table G-1. Publications by CIAT staff working in plant genetic resources (1990-1995)

Publications	GRU*	Total
In refereed journals	26	42
In non-refereed journals	18	18
In books	21	42
In proceedings	23	27
CIAT catalogs of germplasm	8	8
Total	**96**	**137**

* Directly related to GRU work

H. ACCESSIBILITY AND EXCHANGE OF GERMPLASM

1. *Phaseolus* beans germplasm

a. Distribution of material.

A total of 32,740 samples were distributed during the period 1992-1994. More than 26,700 (86%) were distributed to the CIAT commodity programs, while about 6,000 (14%) were distributed to NARS in developing and developed countries. The above samples comprise 16,523 different accessions, which embodies 62.2% of the designated *Phaseolus* germplasm. Very few materials were requested by NGO's and the private sector. It is worth mentioning that more than 370,000 samples have been distributed since the assembling of the collection began in the early 70's. (Table H-1).

Table H-1. Distribution of *Phaseolus* germplasm. (1992-1994)

	NUMBER OF ACCESSIONS* (AND SAMPLES)		
	1992	**1993**	**1994**
Centre Staff in Host Country	6697 (12,741)**	3957 (7,970)	2151 (6,007)
Other IARC's			
NARS in Developing Countries	283 (365)	1317 (1,478)	612 (1,359)
NARS in Developed Countries	585 (835)	73 (374)	806 (1,501)
Private Sector in Developing Countries			7 (10)
Private Sector in Developed Countries		16 (17)	
Others	19 (19)		
Total	7,584 (13,960)	5363 (9,839)	3,576 (8,887)

* Number of different accessions sent to each sector

** Numbers in parenthesis are the numbers of samples sent (may include repeated accessions)

b. Germplasm utilization and impact

Utilization

CIAT's Bean Program has been very active in evaluating and using the *Phaseolus* collection. More than 270,000 bean accessions have been provided to the Bean Program throughout the existence of the collection. Many new cultivars have been released by collaborating national programs.

*** Recommendation**: CIAT should develop and distribute information in a data base on genetic distances between bean accessions, which will improve the efficiency of the use of germplasm in breeding programs. The CIMMYT IWIS software might be useful.

Impact.

During the period 1979-1994, a total of 203 cultivars have been released in 37 countries in most continents, through the international nurseries established by the Bean Program. From the above, 201 (99%) were released in developing countries. Of those cultivars, 55 were selected directly from the germplasm collection without breeding. The other 148 were the result of the breeding strategies, using a wide range of progenitors selected from the germplasm collection.

2. *Manihot* Germplasm

a. Distribution of material

1540 *in vitro* materials have been distributed to research partners in the period 1992-1994. As shown in Table H-2 highest demand has been from developing country crop improvement programs, followed by advanced laboratories or developed country programs. During 1979-1994 the *in vitro Manihot* germplasm collection has distributed a total of 1531 different accessions, which embodies 27.4% of the designated cassava germplasm. In addition, the CIAT Cassava Program has been a major user of the collection.

Table H-2. Distribution of *Manihot* Germplasm (*in vitro*)

	Number of Accessions** (and samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	163 (163)**	29(29)	81(81)
Centre Staff in Other Countries	–	–	–
Other IARC's	-	-	-
NARS in Developing Countries	175 (182)	243(290)	185(279)
NARS in Developed Countries	21(47)	200 (262)	131 (191)
Private Sector in Developing Countries	7(7)	6(6)	–
Private Sector in Developed Countries	–	3(3)	–
Others	-	-	-
Total of material sent by year	(399)	(590)	(551)
Total of different Acc. sent by year	366	481	397

* Number of different accessions sent to each sector.

** Numbers in parenthesis are the numbers of samples sent (may include repeated accessions)

Note: During 1979-94 the *in vitro Manihot* germplasm collection has distributed a total of 3,891 accessions.

b. Germplasm utilization and impact

Useful variability for nearly all important agronomic traits has been identified in the cassava collection. In the last 14 years a total of 47 varieties have been released to national programs. Twenty one out of the 47 clones correspond to landraces released after adaptive evaluation without breeding, and the remaining as improved lines.

3. Forage Germplasm

a. Distribution of material

From 1980 to 1994, the tropical forages germplasm distributed 40,146 samples of around 100 genera inside CIAT and to 76 countries worldwide. The above include 10,834 different accessions which embodies 70.1% of the tropical forages designated germplasm (Details of the last three years are shown in Table H-3).

Table H-3. Distribution of Tropical Forages Germplasm

Location	Number of Accessions* (and samples)		
	1992	1993	1994
Centre Staff in Host Country	305 (369)**	1,005 (1,250)	1,042 (1,833)
Centre Staff in Other Countries	1,168 (1,495)	296 (310)	- (0)
Other IARC's	153 (155)	346 (603)	44 (58)
NARS in Developing Countries	578 (906)	404 (576)	846 (1,051)
NARS in Developed Countries	175 (186)	1,057 (1,071)	72 (72)
Private Sector in Developing Countries	82 (125)	75 (104)	38 (43)
Private Sector in Developed Countries	10 (10)	6 (6)	- 0
NGO	- -	3 (3)	- -
Others	1 (1)	46 (50)	12 (12)
Total of material sent per year	(3,247)	(3,973)	(3,069)
Total of different acc. sent per year***	2,472	3,238	2,054

* Number of different accessions sent to each sector.

** Numbers in parenthesis are the numbers of samples sent (may include repeated accessions)

*** Total of different accessions sent per year

NOTE: In total the tropical forages germplasm collection has distributed 40,146 samples which include 10,834 different accessions during 1980-1994; 3 acc. (have been sent more than 100 times), 18 acc. (>50-100), 153 acc. (>20-50), 589 acc. (>10-20), 985 acc. (>5-10), 5,068 acc. (>1-5) and 4,018 acc. sent only once.

b. Germplasm utilization and impact

Germplasm distributed through evaluation networks led to releases of cultivars such as *Andropogon gayanus* (CIAT 621) in 10 countries, *Brachiaria dictyoneura* (CIAT 6133) in 8 countries, and *Arachis pintoi* (CIAT 17434) in 3 countries. Since 1980, a total of 13 species were selected from germplasm maintained in the CIAT genebank and released as commercial cultivars in 12 tropical American countries and China. (Table H-4).

Table H-4. Material from the Tropical Forages Germplasm collection released as cultivars since 1980.

Genus	Species	No. CIAT	Country
Andropogon	*gayanus*	621	BRA, COL, CUB, CRI, MEX, PAN, VEN, PER, NIC, HND, GTM
Arachis	*pintoi*	17,434	HND, CRI, COL
Brachiaria	*brizantha*	6,780	BRA, MEX, VEN, CUB, CRI
Brachiaria	*decumbens*	606	COL, CRI, MEX, PAN, CUB
Brachiaria	*dictyoneura*	6,133	COL, PAN, VEN, CRI
Brachiaria	*humidicola*	679	COL, MEX, VEN, PAN
Centrosema	*acutifolium*	5,277	COL
Centrosema	*pubescens*	438	HND
Desmodium	*heterocarpon*	350	BRA
Leucaena	*leucocephala*	21,888	COL
Pueraria	*phaseoloides*	9,900	MEX
Stylosanthes	*capitata*	10,280	COL
Stylosanthes	*guianensis*	184	CHN, PHI, PER
Stylosanthes	*guianensis*	2,243	BRA
Stylosanthes	*guianensis*	2,950	BRA
Stylosanthes	*macrocephala*	1,281	BRA

I. TRAINING IN GENEBANK ACTIVITIES

The SHL has trained a total of ten seed health professionals from five countries. The overall training activity of the GRU, from 1983 to 1995 has involved personnel from 22 different countries. Sixty-three people have attended courses and fifty-five have been involved in work training at CIAT. In addition, 49 research Theses dealing with genetic resources were produced at CIAT from 1983 to 1995.

* **Recommendations**. Make a classification of the training-user countries, based on the stage of development of GRU in each NARS. The information will make it possible to develop a strategy for coordinated research between NARS and CIAT, and/or service training of national researchers at CIAT headquarters, as well as the development of research projects by NARS researchers at CIAT.

J. CONSTRAINTS AND OPPORTUNITIES

Major challenges must be overcome to ensure the conservation and utilization of plant genetic resources of beans, cassava and tropical forages held in trust by CIAT. These invaluable collections result from more than forty years of work by national programs, CIAT, IPGRI and others concerned with plant genetic resources. Guaranteeing the future availability of this genetic diversity requires joint actions by CIAT, the

genetic resources programs of Latin American countries, and other IARCs to confront a range of problems through common agendas and joint activities that improve quality and increase efficiency.

1. Safety Duplication

Background

Ensuring the safety and full security backup duplication of the collections of beans, cassava and forages with all pertinent information is the highest priority task. This requires improvements at CIAT as well as the genebanks that assume responsibility for maintaining duplicates. An interrelated set of activities is involved that includes the processing of materials according to the highest international standards for plant health and genetic integrity as well as research to develop specific protocols that are reliable, economical and rapid. Training of national personnel in these protocols is essential. For safe security backup duplication, preferably as black box entries, institutions such as other IARCs, regional organizations and NARS of developing countries, as well as public institutions in the region will be considered.

Objectives

- To develop reliable and massive plant health testing for the three collections;
- To expedite safe conservation and duplication by increasing the rate of multiplication and processing materials through quarantine under the highest standards in coordination with the ICA plant health office, particularly for *Phaseolus* beans and tropical forages. For cassava, increasing the rate of disease indexing of materials prior to dispatch will also be necessary.
- To ensure adequate processing for effective conservation and duplication it will be necessary to install a seed quality lab at CIAT, and provide needed training in recipient countries.

2. Improving conservation technologies.

Background

Because technologies for conserving genetic material in genebanks have been developed principally for temperate species, there is a lack of in depth knowledge of physiology and metabolism of conserved organs (seed, tissue) of important tropical species including *Manihot* and tropical forages. Consequently there is a lack of reliable, validated, low cost protocols appropriate to the particular requirements of these species.

Current *ex-situ* conservation of genetic resources is carried out both in the field and as *in vitro* cultures. Both methodologies are means to maintain germplasm for short term. Both interact but are unsuitable for long-term conservation of cassava genetic resources. CIAT in cooperation with IPGRI has made significant advances in developing cryopreservation of cassava shoot tips suitable for a base gene bank in liquid nitrogen. Cryopreservation of cassava shoot tips offers the opportunity to significantly reduce costs of long term maintenance as well as facilitating duplicate collections. Conversion to cryopreservation of

the collection of *Manihot* needs to be complemented with studies to monitor the safety and genetic stability of this technique.

Little is known about the seed physiology of tropical forage species, and proven protocols for conservation need to be developed. To a lesser extent similar studies are needed for wild species of *Manihot* and *Phaseolus* in order to even maintain working collections to collections evaluate their potential for further utilization.

Objectives

- To improve efficiency in the conservation of priority tropical forage germplasm to ensure long-term viability of forage germplasm. Research in collaboration with NSSL and other labs in the region and abroad is essential for the achievement of this objective. This would also be undertaken to a lesser extent for certain wild *Manihot* and *Phaseolus* species that are conserved as seed germplasm.

- High priority will be given to the development of the technical and logistical aspects involved in establishing and running a cassava collection under cryopreservation. This work can be carried out as a pilot project in cooperation with IPGRI, the NARS and IITA. Participation of advanced labs such as NSSL should also be considered.

3. Assuring adequate coverage of diversity in germplasm collections in both CIAT and in countries of origin

Background

Genetic conservation is effective only to the degree that the full range of diversity is conserved. The evaluation of extent and representativity of the biological and genetical diversity contained in the collections held in trust at CIAT is required to assure that a full range of diversity is adequately conserved. This involves understanding the patterns and distribution of natural diversity as well as susceptibility to genetic erosion. This assessment is particularly needed for cultivated and wild species of *Manihot* and *Phaseolus*. It would be conducted in collaboration with NARS and universities in Latin America in order to attain an in-depth and fast assessment.

Objectives

1. To appraise, in collaboration with NARS, *in situ* diversity in relation to present holdings to ensure that biological and genetic diversity is fully understood and properly documented, and to ensure through targeted collecting that essential diversity is adequately collected and conserved in *ex situ* collections, in both CIAT and in countries of origin.

2. When tropical forage species to be used in the future are better defined by CIAT and user partners, studies will be made to ensure that patterns of genetic diversity are properly documented and used for sampling and conservation strategies.

3. To facilitate the continuity of conservation and utilization of genetic diversity in the countries of origin by assisting NARS through joint research and training to effectively restore to their collections the full range of indigenous diversity. Subject to NARS priorities, focus would be placed on the countries of highest diversity. For *Phaseolus*, this would include Mexico, Guatemala, Peru, Bolivia, and Ecuador. For *Manihot* species, this would include Guatemala, Colombia and Brazil.

APPENDIX I

TERMS OF REFERENCE FOR THE INTERNALLY-COMMISSIONED EXTERNAL REVIEW OF THE CGIAR GENEBANK OPERATIONS

This review is commissioned by the CGIAR's System-wide Programme on Genetic Resources (SGRP) and will be led by an external team of experts, coordinated by IPGRI in consultation with the Inter-Centre Working Group on Genetic Resources (ICWG-GR).

The review will critically assess constraints and opportunities for the improvement of the CGIAR genebank operations in technical, scientific and financial aspects. It is expected to provide an opportunity to sustain and improve the quality of services offered by the genebanks, and thus enhance partner confidence and improve funding opportunities. The review and report should be completed before the end of 1995 and its report extensively discussed by the ICWG-GR before its formal submission.

The review will assess technical, scientific and financial aspects of each genebank according to the following:

1) general operations of genebanks (conservation facilities, regeneration/multiplication activities, characterization, germplasm viability testing, germplasm health aspects, germplasm distribution and documentation/ information). The International Genebank Standards, endorsed by the FAO Commission on Plant Genetic Resources, will be used as a key reference for technical assessment;

2) general status of germplasm collections (number of accessions, comprehensiveness of the collections, coverage of species, etc.);

3) germplasm conservation research;

4) linkage and collaboration with partners (e.g. participation in regional networks, black box storage etc.);

5) status of safety duplication; and

6) opportunity for the restoration of national collections by sending duplicate samples.

Additionally, the review will also assess, though with lower priority than the above, (a) germplasm collecting/acquisition policies and activities; (b) training activities; (c) legal status of the collection; (d) status and function of genebanks within respective Centres; (e) examples of utilization/impact of Centre's germplasm; and (f) additional items relevant to each Centre in line with overall objectives of the review.

Based on analysis of review findings, the team will further:

- identify areas of strength as well as constraints for each genebank;
- develop a synthesis report describing constraints and opportunities on a system-wide level;
- identify major deficiencies and make suggestions for immediate actions needed and identify areas where improvements could be made in the medium-term with suggestions and options for such improvements.

Review Process

Although some Centres will already have recently undergone a review process and will therefore have much of the key information needed by the Review team readily available, all Centres' genebanks including ICLARM should be visited. Information therefore should be made available prior to the visit for purposes of speed. Thus, the two major tasks of the team during each visit will be site verification of the information gathered, plus interacting with staff and obtaining preliminary feedback with regard to the results of the review. It is important that the review team work to an agreed protocol based on a checklist covering the elements of the Terms of Reference. It may well be beneficial to have a preliminary review at one of the genebanks in order to examine the review process and the effectiveness of the checklist.

The focal person for the SGRP (Coordinator or Interim-Coordinator) will be located at IPGRI, Rome, and will support the review team in respect of information gathering and logistic arrangements.

Review Team

The review team consists of one team leader and 2/3 team members who will have specific expertise with regard to the location and mandate of Centres in question. It is expected that the team leader will visit all the genebanks, although the team members will vary according to the regional/technical needs of each Centre. Amongst other qualities, the team will need to have expertise in the key elements of genebank operations and practical experience. For example, whilst reviewing CIP, CIAT, IITA and INIBAP, they will need experience in *in vitro* conservation, and in respect of ICRAF, ILCA (ILRI), IITA, CIAT and CIP, field genebank experience. Input to the review from key CGIAR partners, such as NARS should be reflected in the team composition.

As described in the recent Agreement between FAO and the CGIAR Centres, FAO will also be involved in helping to define further the terms of reference and strategy development of the review and will also be sending representatives as part of the review team to visit the various genebanks.

APPENDIX II

List of Staff of CIAT and IPGRI with interest in Plant Genetic Resources

Dr. **Robert D. Havener**
Director General - CIAT
Dr. **Gerard Habich**
Associate Director, Institutional Relations
Dr. **Douglas Pachico**
Associate Director Resource Management Research
Dr. **Katsuo A. Okada**
Regional Director IPGRI
Dr. **Mikkel Grum**
Regional Office, IPGRI
Dr **Stephen E. Beebe**
Bean germplasm specialist, Bean Programme
Dr **Merideth Bonierbale**
Cassava geneticist, Cassava Programme
Dr. **Brigitte L. Maass**
Tropical Forage Programme, germplasm specialist
Dr. **Joseph M. Tohme**
Geneticist, Biotechnology Research Unit
Dr. **William M. Roca**
Head, Biotechnology Research Unit (BRU). Leader Genetic Diversity Scientific Resource Group; Interim Head, GRU.
Dr. **Antony Bellotti**
Entomologist, Interim Leader, Cassava Program
Dr. **Carlos Lascano**
Interim Head, Tropical Forages Program
Dr. **Cesar Cardona**
Interim Head, Bean Program
MSc. **Ricardo Uribe**
Geographic Information System
Dr. **Daniel G. Debouck**
Senior Scientist, Genetic Resources Unit
Dr. **Claudia L. Guevara**
Curator, Genetic Resources Unit
MSc. **Rigoberto Hidalgo**
Curator, Genetic Resources Unit
MSc. **Amanda Ortiz**
Curator, Genetic Resources Unit
MSc. **Benjamín Pineda**
Seed Health Laboratory, Genetic Resources Unit
MSc. **Mercedes Andrade**
Statistics, Genetic Resources Unit
MSc. **Jaime Urdinola**
Plant Quarantine, ICA

APPENDIX III

PROGRAM FOR PANEL OF EXTERNAL REVIEW OF CIAT GENEBANK OPERATIONS

THURSDAY AUGUST 3

08:00 - 09:00	Panel Meeting	
09:00 - 09:15	Genetic Resources in CIAT	**R. Havener (RH)**
09:15 - 09:40	Conservation and utilization strategy	**W. Roca (WR)**
09:40 - 10:05	Operations and status of germplasm collections	**D. Debouck (DD)**
10:05 - 10:30	Discussion	
10:30 - 10:45	**Coffee break**	
10:45 - 11:10	Germplasm conservation research	**J. Tohme (JT)**
11:10 - 11:25	Discussion	
11:25 - 11:50	Challenges & Opportunities	**D.Debouck (DD)**
14:00 - 17:15	Visit to GRU	

FRIDAY AUGUST 4

08:00 - 09:30	Panel meeting with CIAT GRU Staff
09:30 - 09:45	Panel and WR (Leader, Genetic Diversity SRG)
09:45 - 10:00	NLI, ML, with DD (Genetic Diversity)
09:45 - 10:00	SE, EA with Brigitte Maass (BM) and Amanda Ortiz (AO) (*Forages* Germplasm)
10:00 - 10:15	NLI, ML with Steve Beebe (SB) and Rigoberto Hidalgo (RH) (*Phaseolus* Germplasm)
10:00 - 10:15	SE, EA, with Antony Belloti (AB) and Claudia Guevara (CG) (*Manihot* Germplasm)
10:45 - 11:30	**Coffee break**
11:30 - 12:30	GIS
12:30 - 14:00	**Lunch**
14:00 - 17:00	Panel meeting and Report writing
17:30	**Cocktail**

SATURDAY AUGUST 5

Morning open for Panel Business

13:00 - 14:30	Round Table Discussion (RH, DP, WR, DD, SB, JT, BM, AB, RH, CG, AO)
14:30 - 15:00	R. Havener, Director General
15:00 - 18:00	Panel meeting

SUNDAY AUGUST 6

08:00 - 10:30	Panel meeting
11:00 -	Departure for Cali Airport

APPENDIX IV

ACRONYMS

AFLP	Amplified Fragment Length Polymorphisms
B	Beans
BARN	Bean Advanced Research Network
BCMV	Bean Common Mosaic Virus
BOT	Board of Trustees
BP	Bean Program
BRA	Brazil
BRU	Biotechnology Research Unit
C	Cassava
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CBD	Convention on Biological Diversity
CBN	
CCMV	Cassava Common Mosaic Virus
CENARGEN	Centro Nacional de Recursos Geneticos
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research
CGIAR-GR	CGIAR-Genetic Resources
CHN	China
CIAT	Internacional Center for Tropical Agriculture
CIMMYT	Centro Internacional de Mejoramiento-Maíz y Trigo
CIP	Centro Internacional de la Papa
COL	Colombia
COLCIENSIS	
CP	Cassava Program
CRI	Costa Rica
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CsXV	Cassava X Virus
CUB	Cuba
DG	Director General
dsRNA	Double Strand RNA
ELISA	Enzyme Linked Immuno-Sorbent Assay
EMPRAPA	Empresa Brasileira de Pesquisa Agropecuaria
F	Tropical Forages
FAO	Food and Agriculture Organization of the United Nations
FSD	Frog Skin Disease
GD	Genetic Diversity
GIS	Geographical Information Systems

GR	Genetic Resources
GRU	Genetic Resources Unit
IARC	International Agricultural Research Center
IBPGR	International Board for Plant Genetic Resources
ICA	Colombian Agriculture and Livestock Institute
ICWG	Inter-Center Working Group
IICA	Instituto Interamericano de Cooperación para la Agricultura
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
IPGRI	International Plant Genetic Resources Institute
LAC	Latin American and Caribbean
MGRN	
MTA	Material Transfer Agreement
NARS	National Agricultural Research System
NSSL	National Seed Storage Laboratory
OEA	
PROFIZA	Programa Cooperativo Regional para la Zona Andina
PROFRIJOL	Programa Cooperativo Regional de Frijol para Centro América, Mexico y el Caribe
REDARFIT	Red Andina de Recursos Fitogenéticos (Andean Network on Plant Genetic Resources)
REMERFI	Red Mesoamericana de Recursos Fitogenéticos
RIEPT	Red Internacional de Evaluación de Pastos Tropicales
SGRP	System Wide Genetic Resources Program
SHL	Seed Health Laboratory
SIS	Svalbard International Seed Bank, Norway
SRG	Scientific Resources Group
TF-GRN	
TFP	Tropical Forages Program
TPP	Tropical Pastures Program
TROPIGEN	Red Tropical de Recursos Geneticos
UNEP	United Nations Environment Program
USDA-ARS	United States Department of Agriculture-Agricultural Research Service
VRU	Virology Research Unit

REPORT OF THE INTERNALLY-COMMISSIONED

EXTERNAL REVIEW OF THE CGIAR

GENEBANK OPERATIONS

5 January 1996

CONTENTS

d. Plant quarantine and seed health facilities

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1. Short-, medium- and long-term conservation
2. *In vitro* conservation
3. Field Genebanks
4. Duplicate conservation for safety

E. GENEBANK STANDARDS

1. Procedures and methods for Germplasm conservation:
2. Maintenance of adequate documentation system

F. DEVELOPMENT AND CHARACTERIZATION OF CORE COLLECTIONS

G. RESEARCH AND PUBLICATIONS ON GERMPLASM CONSERVATION

H. ACCESSIBILITY AND EXCHANGE OF GERMPLASM

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2. Germplasm utilization and impact

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J. CONSTRAINTS

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EXECUTIVE SUMMARY

The Panel reviewed the general operations of the CGIAR Centres' genebanks; the general status of germplasm collections; research related to germplasm conservation; linkages and collaboration with partners; the status of off-site safety duplications, and opportunities for the restoration of duplicate samples to countries of origin. Additionally, it reviewed germplasm collection; training; the legal status of collections; status and function of genebanks at each Centre, and examples of utilization of Centres' germplasm.

There was no clear uniform pattern across Centres for the status of genebanks. At some Centres the genebank is still a support unit, at others it has the status of a Division or Department. Whatever its status, at most Centres the genebank still plays an important supporting role for a Centre's other scientists and for the users of its germplasm outside the Centre. Changes are occurring, however, that are likely to improve each genebank's own scientific role and standing.

Most Centres have a formal agreement or MOU with the Government (or Government Institute) of a host country that enables freedom of movement of material into and out of a Centre's genebank, provided national and international standards of plant quarantine and health are observed. Where there is no specific agreement, or no agreement on genetic resources within a general agreement, there seems to be a common understanding in the host country that allows such freedom of movement. However, the Panel would have preferred to find formal agreements with host countries on genetic resources for each Centre, but recognized that the preparation and signing of such agreements could better be left until there is legal clarity at an international level on the movement of genetic resources.

The Panel was impressed by the contribution to NARS, especially in developing countries, made by the distribution of germplasm by the Centres, some directly from genebanks, the rest enhanced germplasm with its origins in material derived from genebanks. However, it was thought that NARS would benefit from more information on genetic distances between different accessions. Moreover, the Panel felt that Centres should take steps to quantify and publicize more effectively, the impact made by the genetic resources held by the Centres.

At the time of the Review, the twelve CGIAR Centres had 593,717 accessions in their collections, with 438,264 accessions, or 74% of total, designated to FAO. ICLARM does not as yet have an agreement with FAO for the designation of fish genetic resources. Most Centres found it difficult to estimate 'coverage' and there was variation among Centres with respect to policy on making further collections. The Panel thought that policy on collecting expeditions warranted discussion at a System-wide level.

Those collections, or parts of collections, which were designated to FAO by the Centres, continue to be freely available to all, but germplasm added to the Centres subsequent to the coming into force in December 1993 of the CBD, could be subject to conditions imposed by the country of source. Most Centres are making use of an Interim Material Transfer Agreement (MTA) or similar document for the release of germplasm and an Interim Germplasm Acquisition Agreement (GAA), for collecting missions and for receipt of germplasm.

Although the restoration of germplasm to countries of origin has been partially successful, and several NARS have benefitted from restoration after the loss of their own collections, other countries have experienced difficulty in accepting such restoration because of lack of adequate facilities or insufficient resources. The Panel thought that some Centres could be more pro-active in promoting the restoration of germplasm in their training programmes.

In general, the Panel was satisfied with the operations of most of the Centres' genebanks and thought that they were well managed though underfunded. Problems which were identified were highlighted by the Panel in individual Reports. The technical aspects of the International Genebank Standards, endorsed by the FAO Commission on Plant Genetic Resources, were mainly at the requisite levels and where they were not the Centre was informed. The current International Standards are applicable only to crops that produce seed, and there are as yet no such standards for clonally-propagated crops. The Panel therefore thought that Centres involved with clonally-propagated germplasm should interact as soon as possible with IPGRI and FAO to remedy this situation. It was pleased to note that a meeting that included this topic on its agenda, and which was being organized by IPGRI and CIAT, and sponsored by SGRI and FAO, would be held at CIAT in January 1995, and would involve the IARC's and NARS.

Where serious problems occur in genebank operations they are related more to activities than to technical failings. There are, for example, serious gaps in characterization and evaluation at several Centres. The Panel also identified a need for more timely and comprehensive viability tests, regeneration and production of disease-free material. Several Centres will require additional staff to catch up with a backlog of substandard accessions which currently have low viability and low seed numbers and which are not in local long-term storage or duplicated off-site for safety purposes. The importance of efficient, user-friendly databases at the Centres that can be integrated into a System-wide network that is easily accessible internationally has already been recognized by the Stripe Study. The Panel noted that the implementation of the System-wide Information Network on Genetic Resources (SINGER) will require a number of improvements at most Centres so as to simplify communications with users and that progress was being made.

Some Centres have been successful in identifying genotypes as opposed to phenotypes in their collections, thereby allowing the identification of duplicates, the quantified assessment of genetic diversity, more accurate estimates of the need for further collection, and in the designation of core collections. A range of molecular biological techniques is being used for such purposes and GIS is also proving to be a useful tool in the research of a few Centres. The Panel urged that all Centres should capitalize on the progress that has been made with molecular techniques and GIS. One of the main strengths of the CGIAR Centres is the multi-disciplinary nature of staff. However, when viewed at a System-wide level, research is patchy and the publication of scientific papers in international, refereed journals could be improved. The Inter-Centre Working Group in Genetic Resources (ICWR-GR) could play an important role in rationalizing programmes within the SGRP so that specialized areas of research would be concentrated at Centres with a critical mass of appropriate and proven expertise. Centres of excellence for particular areas of research would then be established at different Centres and better use made of limited resources. An alternative, or additional approach, would be for those Centres with specialized expertise to train their counterparts from other Centres. There is a need for a System-wide approach in the determination of research priorities among Centres.

The Panel found that considerable progress is being made in research on cryopreservation of certain crop species (and their wild relatives) that are clonally propagated, and which are currently maintained by other expensive, time-consuming and labour intensive in-vitro techniques. A breakthrough is likely that could allow cryopreservation to be used routinely for the conservation of some crops, and the Panel recommended that those Centres which are involved in cryopreservation research should share their results and experiences as soon as possible. Cryopreservation facilities will undoubtedly require extra financial resources.

One of the weaker and most variable of Centres' activities is that of off-site duplication of accessions for safety purposes, although collaboration between Centres has helped considerably and Centres have recently intensified their efforts to find appropriate sites for such duplication. The Panel encouraged Centres to arrange formal agreements when placing duplicates off-site and when accepting collections from other genebanks. Not surprisingly, considerable difficulties occur in finding suitable off-site locations for the duplication of *in-vitro* material. An integrated approach involving ICWG-GR, FAO and NARS is needed to attain the levels of duplication necessary for the full protection of the IARC/FAO germplasm. The value of off-site duplication is emphasized by WARDA's experience in losing its rice germplasm during civil strife in Liberia and its partial (80%) replacement from duplicates that were stored at IRRI and IITA. The Panel strongly recommended that off-site security backup duplication should be given very high priority.

The Panel was impressed with the efforts being made by Centres to set higher germplasm health standards and with the close and fruitful links that they had developed with National Quarantine Services.

The Panel was pleased with the extent and success of linkages and collaboration of the CGIAR Centres with different partners, including sister Centres, NARS, NGO's and regional/international networks, but thought that information on such linkages had been poorly publicized. The Panel also thought that a greater involvement by NARS in helping Centres to develop their policy and strategy on genetic resources would be beneficial. As the strategy for CGIAR Centres' genetic resources programs is to be an integrated component of a global framework for conserving and utilizing genetic resources and FAO also has considerable experience with crop networks, it therefore seems timely to assess more objectively the information on networks in terms of successes and failures in the conservation and utilization of genetic resources.

Most Centres have been actively involved in training courses for NARS personnel, both on- and off-site. Such courses were sometimes for groups but many scientists and technicians have benefitted from hands-on experience at Centre genebanks on an individual basis. However, the Panel detected that in a climate of financial constraints, training by Centres is usually one of the first activities to suffer from cuts. At a time when emerging technologies in subjects such as molecular biology and GIS are becoming of increasing importance in research on genetic resources, the Panel felt that Centre staff could also themselves benefit from special training at centres of excellence, including CGIAR Centres which have themselves already developed appropriate expertise. Higher priority should be given to training for NARS and Centre personnel; combined efforts by groups of Centres would be more efficient and cost-effective. Closer collaboration between Centres, FAO and NARS is essential in a fully integrated-training programme.

Where particular constraints were identified at individual Centres these were drawn to the attention of management at the Centres. Most of the constraints have a direct or indirect implication for increased financial and human resources. The Stripe Study of Genetic Resources in the CGIAR stressed, *inter-alia*, the need for a more coherent and unified CGIAR programme on genetic resources and the importance of greater visibility of the CGIAR programme. The Panel that carried out the present Review observed that although there has been a relatively short timespan since the Stripe Study Report , steps are being taken by Centres to address in a positive fashion the issues raised by the Stripe Review. However, as was pointed out by the Stripe Review, there is a need for adequate and sustained funding for genetic resource activities. Until extra funding becomes available, several key areas in genetic resources work at the Centres will remain below the necessary level of activity and quality to meet the important objectives within a reasonable timeframe. The present Review has identified in some detail specific problems and shortcomings at each Centre, whilst recognizing the important contributions that have already been made by Centres as a consequence of their efforts on genetic resources, and the way in which such resources have been made available to NARS. The Panel strongly recommended that each Centre should use the Report with which it has been provided to prepare a plan with priorities and costings that would allow it to make the necessary improvements in building new facilities or upgrading existing ones, in obtaining equipment, and in appointing new, suitably qualified staff. The ICWG-GR, in collaboration with FAO, would then be in a position to prepare a Strategic Plan and to quantify the funding necessary at a System-wide level to raise standards to meet fully the International Genebank Standards and to improve the management and utilization of genetic resources. Such a Plan should include estimates for both capital and recurring operating costs. There is a very strong case to seek increased and secure funding from the proposed International Fund for Genetic Resources. At the same time, it may be possible to attract additional funding. To do so it will be necessary to convince, through greater public awareness, the public, politicians and policy makers of the importance of genetic conservation, management and utilization of genetic resources and to make more widely known the IARC's key role in genetic conservation.

RECOMMENDATIONS

1. The SGRP should take steps to publicize widely and more effectively the successful and productive linkages on genetic resources that have been established among the CGIAR Centres, as well as with NARS and centres of excellence in developed countries.

2. Because of reorganization at several Centres which has caused uncertainties about shared responsibilities, the CGIAR Centres should review existing formal agreements or MOUs with each other and with other institutions and, where none exist, formal agreements should be made. Such agreements are particularly important in relation to duplicate storage of accessions.

3. Centres should encourage temporary exchanges of GRU staff both between Centres and with NARS, which could have a stimulating and beneficial effect.

4. ICRAF should discuss as soon as possible with FAO its proposals for the conservation and utilization of MPTS germplasm.

5. Through the SGRP, Centres should be encouraged to give high priority to publicizing to NARS the availability of germplasm for restoration, and to assisting NARS to develop expertise and facilities for such restoration.

6. Centres should give high priority to determining more accurately 'coverage' in the collections held by them and when they are confidently able to identify gaps in these collections, or where genetic biodiversity is under threat, they should seek funding and partners, including FAO, to mount collecting expeditions.

7. Those Centres that hold bacterial/fungal collections should declare that these collections are held 'in-trust' and arrange for their duplication off-site. Such collections should be catalogued and the data on them be added to SINGER.

8. There is a need to collect and conserve African maize germplasm as soon as possible. A modality should be reached between IITA and CIMMYT in the context of the SGRP so that appropriate steps are taken.

9. All Centres should consider establishing an Advisory Committee on Genetic Resources with specialists from different countries, preferably from NARS.

10. The SGRP should commission a desk study by a consultant who is expert in the financial management of scientific research to quantify objectively the cost of running genebanks at different Centres and provide a breakdown of the costs of maintaining accessions of different crops.

11. The preparation of germplasm health standards for genebank material should be prepared by each Centre as soon as possible.

12. Those Centres experiencing difficulty in their clean-up of infected material should seek extra resources and try to involve NARS in such clean-up.

13. Centres should give high priority to the regeneration and multiplication of accessions that have not yet been duplicated off-site and all germplasm designated under the FAO/CGIAR Agreements should be placed for safety duplication in off-site genebanks as soon as possible.

14. Centres should seek to establish formal agreements with NARS and other Institutes that hold, or are about to hold, duplicated material.

15. Each Centre should produce a manual of operations and procedures for its genebank(s).

16. WARDA should place, as soon as possible, its FAO-designated rice germplasm in an active collection that meets International Genebank Standards.

17. Several Centres (identified in individual Reports) should establish, as soon as possible, a full base collection of their mandate crops in long-term storage so as to meet International Genebank Standards.

18. All Centres should give high priority to the speedy regeneration of material that fails to reach International Standards and all 'designated' material should be placed in long-term storage.

19. Steps should be taken, as soon as possible, to produce a set of International Genebank Standards for the production and maintenance of vegetatively propagated crops.

20. Centres should take steps to further refine their designation of core collections but they should also continue to maintain in their genebanks accessions not in the core collections.

21. Core collections should be preserved in base, active and off-site duplicate collections.

22. Centres should place greater emphasis on the publication of results, whether of basic, strategic or applied research, in high quality, refereed, international journals. Simultaneously, Centres should continue to publish catalogues to make known to potential users the useful genetic variation available in their genebanks.

23. There is a need for a System-wide approach in the determination of research priorities among Centres.

24. Centres should take steps to quantify, and publicize more effectively, the impact made as a consequence of the utilization of the genetic resources held by them.

25. When planning training the CGIAR Centres should aim for more joint courses so as to make greater use of the complementary strengths and experience of different Centres and hopefully reduce costs.

26. Centres should review carefully and positively the training needs of both NARS personnel and their own genebank staff.

27. Centres should be asked to plan and cost, on a priority basis, the extra resources needed to overcome, within an agreed timeframe, the problems and bottlenecks identified by the Panel. This would make possible the preparation of a System-wide Strategic Plan to quantify the resources needed to raise standards to meet fully International Genebank Standards and to improve the management and utilization of genetic resources at the Centres.

PREAMBLE

A review of the CGIAR's Genebank operations was commissioned by the CGIAR's System-wide Programme on Genetic Resources (SGRP) and was coordinated by IPGRI in consultation with the Inter-Centre Working Group on Genetic Resources (ICWG-GR), as convening Centre, and FAO.

The purpose of the External Review was to make a critical assessment of the constraints and opportunities for the CGIAR genebank operations in technical, scientific and financial terms. In doing so, the Review Panel was expected to check that each Centre was adhering to International Genebank Standards and meeting the criteria of their Agreement with FAO. The Review is expected to produce an opportunity to sustain and improve the quality of services offered by the CGIAR Genebanks, and enhance partner confidence and improve funding opportunities. Detailed Terms of Reference are included in Appendix 1.

The Review was undertaken by a Panel with a Panel chairperson (Dr N L Innes) who visited all the genebanks. Panel members varied according to the regional/technical needs of each Centre with a representative (who varied) from FAO as a member of the Panel, in addition to a regional representative. For several of the Centres the Panel was also strengthened by the presence of a NARS person from the region. The Composition of Panels for the different Centres is given in Appendix 2.

Throughout the review process the Panel was supported by the Interim-Coordinator or Coordinator of the SGRP who is based at IPGRI, Rome. Prior to the Review, the Chairman of the Review Panel met with IPGRI staff in Rome; four further such meetings were held during the course of the Review.

To ensure fairness, clarity and transparency across CGIAR Centres, a checklist (Appendix 3) prepared by IPGRI, FAO and the Chairman of the Review Panel was made available to and approved by all Centres involved in the Review. Senior Management at the Centres responded to this checklist of the Review Panel so that the Panel had access to a document that provided some of the information required. Panels interacted with Centre staff, toured each genebank and its associated facilities and subsequently prepared a detailed report for each Centre that will hopefully serve to help strengthen genebank operations at that Centre. The Summary Comments and Recommendations from each individual Report are included in Appendix 4.

This Report was prepared by the Chairman of the Review Panel and is based on information contained in individual Centre reports, as well as on information provided to the Chairman by Centre staff subsequent to Panel visits. Acronyms and Abbreviations used in the Report are listed in Appendix 5.

Several CGIAR Centres are in a transitional phase, with changes in policy, facilities and human resources that are affecting, or will affect their genebank operations. For example, ILRI's genetic conservation facilities are being strengthened at Addis Ababa whilst it is the Centre's intention to make greater use of the comparative advantage of its Nairobi laboratories and expertise on molecular biology and GIS to strengthen its genetic resources research programme. CIMMYT has successfully planned and obtained funding to build a new genebank that will provide it with extra space to increase its landrace collections of maize and bread wheat held in other genebanks. ICRAF has new conservation facilities under construction in Nairobi; previously it has relied

heavily on other genebanks for safe storage of its collections of multipurpose trees and shrubs and it is currently reviewing its policy on genetic resources. WARDA's present policy is not to have a genebank which meets International Standards but to utilize the rice genebanks at IRRI and IITA, with whom WARDA has a formal agreement whereby IITA stores material from WARDA in a base collection and duplicate samples are deposited at IRRI. However, WARDA makes full and profitable use of its rice working collection in its breeding work and the Panel which visited the Centre noted that with very little capital investment WARDA could attain the International Standards necessary for an active collection.

With the exception of ICLARM, the other eleven Centres visited by the Review Panel have plant or tree genetic resources for crop improvement in agriculture or agro-forestry. As most of this Report covers plant genetic resources (PGR) and eleven of the Centres under review are involved with crops, the reader should assume that remarks pertain to PGR and crops or trees unless it is made quite clear that the subject matter is aquatic and covers Fish Genetic Resources (FiGR).

As a Centre responsible for living aquatic resources, ICLARM's genetic resources are somewhat different to those of other Centres. 'Fish Genetic Resources' (FiGR), as interpreted by ICLARM include fin fish, crustaceans, molluscs and other aquatic animals exploited by humans, but not aquatic plants. There are two main approaches to the *ex situ* genebanking of FiGR, namely by keeping broodstocks of different species and strains in ponds, tanks or aquaria and by the cryopreservation of gametes or embryos. Obviously, centralization of aquatic germplasm accessions is more likely when based on cryopreservation than on live broodstock collections, because of the scale and cost of required facilities.

As recommended by the Stripe Review on Genetic Resources in the CGIAR, ICLARM will not develop *ex situ* genebanking on a scale comparable to that of most of the Crop Centres. Rather it intends to concentrate on strategic research, training, information and methods for natural resources management. ICLARM is currently considering the establishment of a Biodiversity and Genetic Resources Program (BGRP) for which support will be sought from the System-wide Genetic Resources Initiative (SGRI) of the CGIAR.

For brevity purposes, germplasm collections are sometimes referred to in the Report as 'Centres' collections', ' its(their)collection(s)' or 'collections designated to FAO'. Such terms should not be interpreted as implying ownership. The genetic resources at the Centres are designated as coming under an agreement by which an intergovernmental body, i.e. FAO, formally recognizes that the Centres are trustees on behalf of the world community.

The Panel was impressed with the dedicated commitment of both internationally and nationally recruited staff working on genetic resources at the CGIAR Centres and grateful for the open and frank discussions that were held with genebank staff and senior management.

A. POLICY ITEMS

1. Institutional objectives in germplasm conservation

Each Centre with plant and tree genetic resources is committed to the collection, characterization, evaluation, documentation, preservation, multiplication, free distribution of healthy seed (propagules) and information (particularly to the national agricultural systems (NARS) of developing countries), and utilization of genetic resources of its mandated crops and related species, either globally or regionally. To support these activities, Centres have developed, or are developing, user friendly computerized databases for information related to accessions in the Centres' collections of genetic resources. Increasingly, research is being done to determine objectively the true biological genetic diversity of Centres' mandate crops and their wild and weedy relatives.

All Centres adhere to a policy on genetic resources which complies with the policies of the CGIAR, FAO and the Convention on Biological Diversity (GBD) and "in trust" germplasm has been designated as part of the International Network of *Ex situ* Collections under the auspices of FAO. Centres collaborate with other Centres within the CGIAR, with NARS, NGOs and other organizations within the framework of the CBD.

Through the training of NARS staff on genebank activities, joint research and the restoration of germplasm the CGIAR Centres aim to assist NARS to build up successfully and maintain and utilize their full range of indigenous diversity.

At the CGIAR Mid-Term Meeting in New Delhi, India, in 1994 it was stated that "The Genetic Resources Units (GRU's) at the Centres will be elevated to Program status or equivalent and will take on a wider mandate than the servicing of the Centre breeding programs at the Centres" The objectives outlined here, and the perceptions of the Panel, show that the responsibilities of the GRU's go well beyond servicing their own plant breeding programmes and serve to emphasize the increasingly important role of the Centres in a global system for plant genetic resources. Comments on the status of genebanks within the Centres are made in Section A.2.

Allied to ICLARM's activities in the conservation of FiGR are training, the development of information technology and assistance to NARS networks. ICLARM holds its FiGR "in-trust" and is currently preparing a policy statement on FiGR and Intellectual Property Rights that will be released in 1996.

2. Status of the Genebanks within the Centres

There is no clear, uniform status of Genebanks across Centres. At some the Genebank is still seen as a support unit, originally formed to support the commodity research of a Centre's programs; e.g. the Maize Germplasm Bank at CIMMYT, which functions as a support unit within the Maize Program and ILRI's project on genetic resources which is part of a larger research Program on Conservation of Biodiversity. Reorganization at some Centres has led, or could lead to changes in the status of Genebanks. At IRRI the International Genebank is managed as a project in the Genetic Resources Centre (GRC); the other project in the GRC is the International Network for the Genetic Evaluation of Rice (INGER). The GRC has the same status as the other research Divisions and Centres within IRRI. At ICRISAT all the genetic resources activities of the

Institute are under one administrative unit called the Genetic Resources Division (GRD), headed by a Research Division Director. Reorganization at CIP in 1992 led to genetic resources activities being concentrated in one of CIP's new Programs: 'Germplasm Management and Enhancement'. In other Centres, although the essential conservation activities are concentrated in a Genetic (Germplasm) Resources Unit (GRU), genetic resources research work is spread throughout the Centre, as at CIAT, where consideration is being given to merging the Biotechnology Research Unit (BRU) and GRU into a single Unit or Program. IPGRI/INIBAP's genebank is unusual in that it is sited at the Catholic University of Leuven, Belgium, to whom IPGRI/INIBAP has successfully contracted out the maintenance and operation of its *in-vitro* banana and plantain collections.

These comments are not intended to favour any particular organizational system but to show the variation that occurs across Centres. What is evident is that there is a general trend for greater collaboration between Genebank staff and scientists from a range of disciplines within a Centre.

As a generalization, it is probably fair to say that at most Centres whilst a genebank or GRU still plays an important supporting role for a Centre's other scientists and for its clients outside the Centre, a number of changes are occurring that are likely to enhance each genebank's own scientific standing and role.

3. Linkages with other germplasm conservation centres, including regional and networking arrangements

The Panel recognized the importance of strong linkages, especially in a System-wide Genetic Resources Program that is itself an integral part of a much larger global effort. The comments made on the wide extent of linkages of individual Centres are therefore presented in full in Appendix 6.

The Panel was impressed with the widespread, strong and productive linkages among CGIAR Centres on genetic resources and between them and other non-CG Centres, NARS and Networks, and thought that the System should publicize more effectively these successful linkages on genetic resources and allied research and development. The experiences of existing networks, particularly in terms of successes and failures, could provide valuable information, especially in relation to the effective utilization of genetic resources. The strong linkages that have been described serve to achieve a coordinated effort of IARCs, NARS and NGOs but the Panel thought that NARS representatives could be more actively involved in the planning of policy and strategy on genetic resources at the Centres.

RECOMMENDATION. The SGRP should take steps to publicize widely and more effectively the successful and productive linkages on genetic resources that have been established among the CGIAR Centres, as well as with NARS and centres of excellence in developed countries.

RECOMMENDATION. Because of reorganization at several Centres which has caused uncertainties about shared responsibilities, the CGIAR Centres should review existing formal agreements or MOUs with each other and with other institutions and, where none exist, formal agreements should be made. Such agreements are particularly important in relation to duplicate storage of accessions.

RECOMMENDATION. Centres should encourage temporary exchanges of GRU staff both between Centres and with NARS, which could have a stimulating and beneficial effect.

4. Agreement with the host country(ies) on the ownership and movement of material

Although most Centres have formal agreements of a general nature with the Government (or with a Government Institute) of the host Country(ies), such agreements do not always explicitly cover genetic resources. However, although genetic resources are sometimes not covered specifically, there appears to be a common understanding in the host country whereby a Centre's plant genetic resources can be made freely available to any users for agricultural research purposes, provided phytosanitary regulations are observed. Some Centres, such as ICRAF and ILRI, are currently negotiating new agreements with their host country.

Where there are agreements on ownership and movement of material, there is, as might be expected, considerable variation in detail. The Government of Colombia recognizes the right of CIAT to import and export genetic material for research purposes and to move such material within Colombia provided national phytosanitary regulations are adhered to. The use and exploitation of CIMMYT germplasm within Mexico falls under Mexican legislation in force at the time and Mexico has first right to the use of the germplasm. CIP's Agreement with the Government of Peru includes activity by CIP in collecting, maintaining and distributing germplasm so that it can be utilized nationally and internationally for purposes of genetic research. IITA has the power, subject to any trust, to hold or dispose of any property (including germplasm) it acquires, provided the objectives of the Centre are met. Under IRRI's new International Status Agreement with the Government of the Philippines, it is clearly stated that the genebank and its genetic resources would not become the property of the University of the Philippines upon the dissolution of IRRI. Under an Agreement between the Government of Cote d'Ivoire and WARDA, member states of WARDA are the legal owners of all germplasm for which WARDA is custodian. In the event that 'force majeur' conditions made relocation of WARDA necessary, it is agreed that WARDA "shall deposit its germplasm samples with the most appropriate international germplasm bank".

ICLARM does not as yet have an overall host agreement for all of its activities in the Philippines, though such an agreement is expected very soon. Meanwhile, ICLARM has Memoranda of Agreements (MOAs) with those institutions that participate in the project "Genetic Improvement of Farmed Tilapia (GIFT)", under which "fish germplasm is held by ICLARM as an international resource for research to further the improvement of fish farming in the Philippines and other countries." ICLARM is also developing an agreement for distribution of germplasm to the private sector and, as it is already involved in germplasm acquisition, genebanking and germplasm

dissemination to a limited extent, it proposes to release in 1996 a policy statement on fish genetic resources and intellectual property rights (IPR). There is a set of protocols for the transfer of fish within the International Network on Genetics in Aquaculture, which currently has 13 members, with ICLARM as Member-Coordinator. In the Solomon Islands, ICLARM's agreement specifically permits the export of germplasm to other countries, but ICLARM limits this to the re-establishment of certain species which have been extinguished by over-exploitation in the areas of the Indo-Pacific, such as giant clams in the Philippines and Western Samoa.

5. Institutional policy on material that is designated under the IARC's Agreement with FAO

Most of the Centres signed Agreements with Host Countries prior to 1983 when FAO member countries adopted the International Undertaking on Plant Genetic Resources and established the Commission on Plant Genetic Resources (CPGR). Under the legal framework of the International Undertaking the "Global System for Plant Genetic Resources" was developed. As part of this system the FAO International Network of *ex-situ* Collections aims to ensure safe conservation and to provide an equitable means whereby all countries have access to plant genetic resources (PGR), so as to enhance their agricultural sustainability, productivity and well-being, while they share equally and fairly in the benefits accruing from the utilization of such resources. At present the FAO Network encompasses the PGR Collections of the CGIAR Centres, which hold their collections in trust for the benefit of humankind. Those collections held by CGIAR Centres which have been designated under FAO/CGIAR Centre Agreements will continue to be readily available to all. Germplasm added to the Centres/ PGR subsequent to the coming into force in December 1993 of the Convention on Biological Diversity (CBD), which affirmed the sovereign rights of States over their national resources, could be subject to conditions imposed by the country of source. Nevertheless, breeders, scientists and farmers will continue to have unrestricted (with the limitation that no IPR can be applied to the material) and free access to the enormous source of diversity stored in the CGIAR Centres' Genebanks prior to December 1993.

This item is as yet not applicable to ICLARM.

The numbers of accessions designated to FAO by the IARCs are summarized in the Table B.1.1. (Appendix 7): "*Ex situ* Collections of Plant Germplasm at CGIAR Centres". Where material has not been designated to FAO because it fails to meet the International Standards agreed by FAO and published by FAO/IPGRI, steps are being taken to bring such material up to the necessary standards, when it will be designated to FAO.

Most Centres are making use of an Interim Material Transfer Agreement (MTA) or a similar document for the release of germplasm and an Interim Germplasm Acquisition Agreement (GAA) as prepared by the Inter-Centre Working Group on Plant Genetic Resources for collecting missions and for receipt of germplasm. Boards at some Centres are reviewing these Interim Agreements with a view to meeting a Centre's specific requirements. The CIMMYT Board has approved Agreements that deviate to some extent from the Interim Agreements currently under review by FAO's legal experts and its Commission on Plant Genetic Resources.

After the CBD and following the approach of the Inter-Centre Working Group on Genetic Resources (ICWG-GR) and the CGIAR Genetic Resources Policy Committee, some Centres now accept only those germplasm accessions acquired without strings attached and which are provided by the donor as 'common good'.

ICRAF is experiencing some difficulty with multiple purpose trees and shrubs (MPTS) in being able to satisfy all the obligations of its Agreement with FAO, and indicated a desire to discuss with FAO the possibility of using different categories of germplasm for MPTS. ICRAF does not want to leave germplasm stored in its GRU as undesignated, and the Panel thought that ICRAF and IPGRI should hold discussions with FAO as soon as possible.

RECOMMENDATION. ICRAF should discuss as soon as possible with FAO its proposals for the conservation and utilization of MPTS germplasm.

6. *Restoration of germplasm*

All Centres are committed to the restoration of material to countries of collection in line with the spirit of the CBD and respond positively to requests for such restoration when sufficient seed or propagules are available. If seed or propagules are not available at the time of a request, steps are taken to regenerate for restoration purposes. Additionally, Centres are responsive to NARS which want to establish, or add to genebanks of their own, and wish to build up their collections with material from other countries. Centres are careful to ensure that permission is obtained when necessary from a country of origin before they make such transfers. Moreover, when Centres engage in collecting expeditions, duplicate material is deposited in the country of origin.

In several instances Centres have restored to NARS duplicate samples of accessions that have been lost or damaged by the NARS concerned. Sadly, there are examples where material has been restored by Centres and subsequently lost because of inadequate facilities or resources by a country of origin. Table A.6.1 provides a summary of germplasm restored by the Centres over the period 1981 to 1995, when a total of 37 countries received part of the germplasm of the 18 different crops or species listed. The Seeds of Hope Project to help recover the agricultural research capacity and production of Rwanda also serves to emphasize the important role of the Centres in restoration of germplasm.

At WARDA restoration of germplasm has been 'inward' as well as 'outward'. After the loss of rice material in Monrovia, Liberia, as a consequence of civil disorder, duplicate samples were obtained from IRRI and IITA and over 80% of WARDA's accessions were replaced. Subsequent to this replacement WARDA has itself restored 1075 accessions of rice to six West African countries.

Whilst most Centres have restored material to NARS, some Centres appear to be more pro-active than others in encouraging NARS to participate as recipients of such material and have plans in place to restore such material through specific projects that include research and training components in addition to the physical shipment of germplasm.

This item is as yet not applicable to ICLARM, but could apply in future to freshwater fishes and marine invertebrates.

RECOMMENDATION. Through the SGRP, Centres should be encouraged to give high priority to publicizing to NARS the availability of germplasm for restoration, and to assisting NARS to develop expertise and facilities for such restoration.

Table A.6.1 Restoration of germplasm by CGIAR Centres from 1981 to 1995

	Aegilops sp.	ARTC	Barley	*Manihot sp.*	Chickpea	*Vigna sp.*	Forages	Groundnut	Lentil	Maize	MPTS	*Phaseolus sp.*	Pigeon pea	Potato	Rice	*Sorghum sp.*	Sweet Potato	Wheat
Argentina		x								x								
Bolivia				x														
Botswana						x									x	x		
Brazil										x								
Cambodia															x			
Cameroon											x							
Chile										x								
Dominican Rep.																	x	
Ecuador										x				x				
Eritrea			x															x
Ethiopia					x		x									x		
Gambia															x			
Guatemala										x								
Guinea															x			
Guinea Bissau															x			
Honduras												x						
India								x							x			
Iran	x				x				x			x						x
Kenya							x						x					
Liberia															x			
Mali						x									x			
Mexico												x						
Myanmar								x										
Nepal					x										x			
Nigeria											x				x			
Pakistan															x			
Panama																	x	
Paraguay				x														
Peru		x		x							x	x		x			x	
Philippines															x			
Rwanda												x			x	x		
Senegal															x			
Sri Lanka															x			
Sudan																x		
Tanzania						x							x		x			
Turkey																		x
Uruguay										x								

ARTC = Andean Root and Tuber Crops
MPTS = Multiple Purpose Trees and Shrubs

7. Future Outlook

At a time when global attention is focussed on biodiversity, the CGIAR Centres recognize that they have an increasingly important role in this area, working coherently with other CG Centres either directly or through the SGRP, and with FAO, NARS and NGOs and through the strengthening of international and regional networks. Continued support for NARS is seen as critical, through the supply of plant material and training of NARS staff thus enabling them to be partners in the global effort and take up their conservation obligations under the CBD.

Another consideration is the effect of NARS policy on terms and conditions of access under the CBD. Centre policy with respect to the collection of new material is inextricably related to the difficulty faced by Centres in estimating current coverage of their mandate crops and related species (see Section B.1). ILRI has stopped the collection of forages until developing country Governments complete their policies on terms and conditions of access under the CBD. Some Centres think that until they have a better objective assessment of current levels of genetic diversity in their existing collections, they should limit further collection to threatened populations, particularly of wild and weedy related species. Other Centres claim that they are able with confidence to identify gaps in their collections and are proposing to take steps to fill such gaps.

RECOMMENDATION. Centres should give high priority to determining more accurately coverage in collections held by them and when they are confidently able to identify gaps in these collections, or where genetic biodiversity is under threat, they should seek funding and partners, including FAO, to mount collecting expeditions.

B. PLANT SPECIES ASSEMBLED AND CONSERVED IN THE GENEBANK

1. List of species and categories

A list of species and categories in the *ex situ* collections of germplasm (PGR and FiGR) at the twelve Centres which were reviewed is included in Table B.1.1. In addition, the numbers of accessions that have been designated to FAO are listed in Table B.1.1. There is no table for ICRAF which is currently quantifying its genetic resources. For PGR accessions are grouped into four categories:

1.	Advanced Cultivars and Breeding Lines	AC & BL
2.	Landraces or Primitive Cultivars and Old Cultivars	LR & OC
3.	Wild/Weedy Species	WS
4.	Others	Others

Of CIAT's 41,061 *Phaseolus* accessions (of which 27,813 are already increased), 90% correspond to *P. vulgaris*, 5% to *P. lunatus*, 2% to *P. coccineus*, 1% to *P. polyanthus*, close to 1% to *P. acutifolius*, and about 0.6% to wild non-cultivated species. Most accessions of the cultivated species are landraces, with a very low percentage (less than 2%) of bred material, mostly in the *P. vulgaris* collection. A back-log includes duplicate material, material without passport data,

material recovered with poor viability and some material with full passport data. CIAT's cassava collection comprises about 87% of landraces and the remainder are advanced cultivars (277) and hybrids (293). The *in vitro* collection holds 5,632 clones of *Manihot esculenta*, an additional 353 accessions of 29 *Manihot* species and 3 undefined species, and a set of genetic stocks developed for molecular mapping.

The tropical forages germplasm at CIAT comprises 150 genera with more than 730 wild undomesticated species of possible forage potential. About 90% of the collections are legumes, 10% are grasses. Over 50% of the collection comprises the legume genera *Stylosanthes, Desmodium, Centrosema, Zornia* and *Aeschynomene*. CIAT has designated to FAO its current collection of *Manihot* cassava but only 64 and 65 per cent respectively of its *Phaseolus* beans and tropical forages.

At CIMMYT the bread wheat collection of 71,171 accessions makes up 52% of the total collection (136,637) of cereals. Sixty-five per cent of the bread wheat accessions are AC & BL, the remainder LR & OC. Only 36% of the bread wheats is designated to FAO while 93% of CIMMYT's maize collection (13,070 accessions) made up mainly of LR & OC is designated. Out of a total of 15,000 accessions of *Triticale*, made up entirely of AC & BL, 8151 (53%) are designated to FAO. CIMMYT's collections of barley, durum wheat and primitive and wild wheat are back-up to ICARDA.

In recent years CIP has successfully reduced its collection of potato through the elimination of duplicates to 6,190 of which 4,788 (77%) are designated to FAO. Sixty per cent of the potato collection are LR & OC. The bulk (98%) of CIP's sweet potato collection of 6,522 is designated to FAO, while 639 of 1,132 accessions of Andean roots and tubers (ART) are designated. As for potato, about 60% of the sweet potato accessions are LR & OC; the ART collection is composed of LR & OC.

At ICARDA, out of a total of 109,029 accessions only 3,645 have not been designated to FAO. The non-designated material has been mainly acquired since designation was made in June 1994.

The WANA region includes the primary centres of diversity of some of the world's major food crops, including those under WARDA's mandate: wheat, barley, chickpea, lentil, faba bean and a number of important pasture and forage legume species and the value of ICARDA's PGR collection is reflected by the numbers of accessions of these crops and their relatives. Barley (41%) and durum wheat (33%) make up the greater part of the cereal collection, with faba bean, chickpea and lentil each accounting for roughly one third of the food legume collection. The forage legume collection is comprised mainly of the genera *Medicago, Vicia, Trifolium, Lathyrus* and *Pisum*.

Accurate figures on accession numbers at ICRAF are not as yet available but the list of species covers *Sesbania* spp, *Irvingia* spp, *Grevillea robusta, Markhamia lutea, prosopsis africana*, West African MPTS species, *Inga* spp and *Bactris gasipaes*.

Much of ILRI's collection of forage germplasm of 13,470 accessions is made up of wild/weedy species (96%) and includes 1,258 species of 329 genera. Of the total collection of 13,470 accessions, 10,587 (79%) have been designated to FAO. Together, temperate and tropical

legumes make up more than 50% of the collection, which also contains temperate and tropical fodder trees, temperate and tropical grasses, and other temperate and tropical forages.

The GRU at IITA currently covers three different crop groups: crop species for which IITA has (or has once had) a specific crop improvement mandate and their wild relatives:

1. Cowpea, yam, rice, maize, cassava, plantain/banana, soybean, sweet potato and taro.
2. African indigenous food legumes: Bambara groundnut, African yam bean, Kersting's groundnut and miscellaneous legumes.
3. Cover crops, shrubs and multipurpose tree species.

The entire collections of cowpea, bambara groundnut and soybean have been designated to FAO, along with 98, 96 and 71 per cent for rice, yam and cassava respectively. These six species comprise 94% of a total collection of 39,765 with cowpea and rice as the largest part. Among a wide range of minority collections are small collections of maize, multiple purpose trees and shrubs (MPTS) and plantain/banana. For both rice and cowpea, LR & OC make up the greater part of the collections. There are 54 species of the 10% in wild species in the rice collection, 24 wild species in the *Manihot* collection and over 100 wild species of MPTS.

At ICRISAT the total collection of 110,374 accessions is comprised of sorghum (32%), pearl millet (19%), chickpea (16%), pigeonpea (12%), groundnut (13%) and minor millets (8%). LR and OC are the main components of each of the crop collections. With the exception of groundnuts, for which there are 175 interspecific derivatives, the 'Others' component is made up of genetic stocks. ICRISAT has designated 86% of its total collection to FAO.

All 1051 accessions of banana and plantain germplasm at IPGRI/INIBAP are designated to FAO.

The International Rice Genebank at IRRI only conserves species in the genus *Oryza*, and related genera in the Tribe Oryzae. In IRRI's large collection of 80,646 accessions of cultivated and wild species and their relatives are 76,614 accessions of *O. sativa* of which 75,354 are LR & OC and 1,260 are BL. The *O. glaberrimma* collection of 1,254 accessions is made up entirely of LR & OC. The remainder of the collection is made up of wild/weedy species. Of the IRRI's rice collection of 80,646 accessions 79,277 (98%) have been designated to FAO.

Rice species in WARDA's working collection include *Oriza sativa, O. glaberrima, O. longistaminata* and *O. barthii (Breviligulata).* There are 17,440 accessions in the collection but only 4,872, out of a total of 8,000 Upland rice accessions have been designated to FAO. AC & BL make up three quarters of the *O. sativa* collection while *O. glaberrima* is 100% LR & OC.

The FiGR collections at ICLARM comprise the live fish and cryopreserved spermatozoa of eight strains of Nile tilapia (*Oreochromis niloticus*): four African strains imported during 1988, 1989 and 1992 into the Philippines from Egypt, Ghana, Kenya and Senegal; four Asian farmed strains popularly known in the Philippines as 'Israel', 'Singapore', Taiwan' and 'Thailand'. 'Israel' is derived from founder stocks of Ghanian origin kept in Israel; 'Singapore' from a stock of Ghanian origin shipped from Israel to Singapore; 'Thailand' from a stock of Egyptian origin introduced to the Philippines via Japan and Thailand, and 'Taiwan' from a Taiwan stock that was probably of Ghanian origin.

Several Centres have bacterial/fungal collections. At these Centres the Panel recommended that an effort be made to duplicate the collections off-site and to declare that such collections are held 'in-trust' so as to keep them within the public domain and treat requests in a similar fashion to that devised for designated plant germplasm. Such collections should be catalogued and the data on them be added to SINGER.

RECOMMENDATION. Those Centres that hold bacterial/fungal collections should declare that these collections are held 'in-trust' and arrange for their duplication off-site. Such collections should be catalogued and the data on them be added to SINGER.

2. Estimate of coverage

The question of coverage was one that created great difficulty. 'Coverage' was defined as a "rough estimate of the percentage of the existing germplasm diversity in nature that is represented (in a genebank)."

Although the Centres contain the most comprehensive collections of their mandate crops and their wild relatives in existence in the world, responses to this question varied from a confident provision of an actual percentage figure for some crops through lengthy descriptions of what remained in the wild to a nil response. Some Centres emphasized the need for much more accurate quantitative estimates of true genetic diversity before an answer could be provided. Others stressed the need for exhaustive global databases before coverage could be estimated.

Despite these varied responses, the Panel gained the impression that Centres are usually able to identify gaps in their collections, to determine where new collections would be most rewarding and to pinpoint areas where resources are threatened with wipe-out. They are, however, with a few exceptions, some way from being able to provide an accurate quantitative figure for 'coverage'.

In several Centre reports the Panel either recommended that further collection work for specific requirements should be made or supported Centres' plans to make such collections.

One area that gives cause for concern is that of African maize germplasm which led the Panel to recommend that there is a need for action.

Most Centres are faced with the dilemma of knowing whether it is better to continue collecting and adding to material in their genebanks, or to give preference to the many jobs that are needed to be done on material already within their genebanks. There is no easy answer and where gaps are recognized in collections and where likely genetic wipe-out or heavy damage is perceived collecting expeditions will be necessary. At the same time, international standards on conserved material have to be attained and proper characterization and evaluation hold the key to better utilization of the large numbers of accessions that are already in the genebanks. While financial constraints are as limiting as they are at present it will not be possible to fulfil all the requirements that are necessary for optimization.

RECOMMENDATION. There is a need to collect and conserve African maize germplasm as soon as possible. A modality should be reached between IITA and CIMMYT in the context of the SGRP so that appropriate steps are taken.

C. GENEBANK MANAGEMENT, OPERATION AND RESOURCES

1. Organizational set-up within the Centres

The organizational set up of different Centres' genebanks or GRUs varies considerably (see Section A.2), both from the viewpoint of organization within a genebank and a genebank's own position within a Centre's general organizational structure.

Genebanks are generally part of Programs or Departments and in most cases the Head of a Genebank reports to a Head of a Program or Department, who in turn reports to a Deputy-Director General (Research or International Co-operation) or Director. There are, however, Centres where the Head of the GRU reports directly to a Deputy-Director General.

Some Centres are currently reviewing their organizational set-up.

The panel was pleased to note that a few Centres either had, or were considering the establishment of an Advisory Committee on Genetic Resources or its equivalent.

RECOMMENDATION. All Centres should consider establishing an Advisory Committee on Genetic Resources with specialists from different countries, preferably from NARS.

2. Administration and management

(a) Human resources

A few of the larger Genetic Resources Units (GRUs) have several internationally recruited senior scientists of PhD standard assigned to genebank management and research, some have two senior scientists (or equivalent), whilst the smaller Units have only one (or several scientists contributing part of their time to genetic resources work). These scientists have strong support from nationally recruited staff, some at MSc level, others of BSc and Technician standards. In general, these technicians are highly specialized and well-trained in the techniques and procedures used in genebank activities.

The TAC-Commissioned Stripe Review of Genetic Resources in the CGIAR in 1994 thought that genetic resources conservation and related research is by far the most important activity for the CGIAR in the long-term and should, therefore, be assured of adequate and secure funding. The perception of the Panel which visited Centres for the present Review was that the GRUs of most Centres, because of financial constraints, were understaffed in relation to their responsibilities and workload and to attaining the high standards expected of them.

(b) **Financial resources**

Centres were frank and helpful in providing budget and operational figures for the financial management of genetic resources activities. However, because of differences in the organizational structure among Centres the Panel found it difficult to apportion costs to different aspects of genetic conservation, research and utilization and to attain comparability between Centres, especially as some Centres included overheads while others did not. Subsequent to most of the individual reviews the Panel had access to SGRP financial statistics for genetic resources activities at each of the Centres for the years 1994, 1995 and 1996 (projected). It was therefore decided to include a summary of the financial figures from the SGRP tables in this Report.

Total spend for the eleven Centres in Table C.2.1. was US$million 14,184, 17,282 and 21,904 for 1994, 1995 and 1996 respectively. Ignoring inflation, this apparent trend of increased financial resources occurs for seven Centres with a large increase at IITA between 1994 and 1995. WARDA's expenditure for 1995 was down on 1994; ICRISAT had a reduction in 1995 compared with 1994 and a slight increase for 1996 over 1995, IRRI's 1996 figure is slightly down on that for 1995, and ICARDA's 1996 figure down on that for 1995.

The Panel felt that Centres had different perceptions of what constituted genetic resources activities and thought that the SGRP should commission a desk study by a consultant who is expert in the financial management of scientific research to quantify objectively the cost of different aspects of genebank operations across the Centres. Such a study should make it possible to identify the actual cost of running genebanks at different Centres and provide a breakdown in terms of current cost per accession of different crops.

RECOMMENDATION. The SGRP should commission a desk study by a consultant who is expert in the financial management of scientific research to quantify objectively the cost of running genebanks at different Centres and provide a breakdown of the current costs of maintaining accessions of different crops.

(c) **Physical plant**

Information on physical plant facilities at the eleven crop different Centres is summarized in Tables D.1.1. and E.1.1. (Appendix 6.). The Panel was generally satisfied with the basic equipment, power supply, alarm and security arrangements, and safety precautions against earthquake, fire, flood, theft etc. Where shortcomings were identified by the Panel they were highlighted in individual Centre reports and appropriate recommendations made. At some Centres there is considerable pressure on storage space with some nearly filled to capacity. CIMMYT is about to build new facilities and several Centres are reviewing the position with the intention of seeking funds to build new facilities and renovate old.

(d) Plant quarantine and germplasm health facilities

Centres adhere to national and international phytosanitary and certification requirements for the import and export of germplasm and collaborate closely with host country quarantine officers. Most Centres have their own Seed Health Unit (Laboratory) or equivalent, or are in the process of establishing one. Some of these Units are under the supervision of the National Quarantine Organisation of the host country. Material exported from a Centre is accompanied by an International Phytosanitary Certificate and for some Centres with a Health Certificate issued by the Centre.

The Panel was impressed with the rigorous standards of plant health set by the Centres which either destroy infected material if it presents a potential risk or try to clean it up to eliminate pathogens. Periodic inspection of plants, roguing, the use of fungicides and insecticides, and the use of rapid, accurate techniques for pathogen detection ensure the maintenance of health standards and Centres continue to strive to raise these standards to a higher level.

Post-entry quarantine isolation of facilities are under pressure and some Centres are taking steps to expand these facilities.

The Panel was informed that plant pathologists from the Centres had agreed that plant germplasm health statements should be developed and made available by all Centres. The Panel strongly supported such a move.

A serious problem faced by some Centres is a difficulty, particularly with virus-infected plants that are vegetatively propagated, in attaining the speedy and effective clean-up of infected material. Such clean-up creates strains on both human and financial resources (see Section E.1). Among recommendations made by the Panel at several Centres was one that suggested that Centres should seek to involve NARS in this process.

RECOMMENDATION. The preparation of germplasm health standards for genebank material should be prepared by each Centre as soon as possible.

RECOMMENDATION. Those Centres experiencing difficulty in their clean-up of infected material should seek extra resources and try to involve NARS in such clean-up.

Table C.2.1. Summary of expenditure (US$ 000) on genetic resources activities by eleven* CGIAR Centres reviewed by the Panel; figures are derived from SGRP Tables 1, 2 and 3.

	CIAT	CIMMMYT	CIP	ICARDA	ICLARM	ICRAF	ICRISAT	IITA	ILRI	IRRI	WARDA	Total
1994												
Research	1,344.0	1,002.9	1,102.0	991.0	1,008.0	1,935.9	671.2	520.3	2,421.0	1,365.0	214.0	12,575.3
Agenda Compl. Activities	0.0	0.0	440.0	264.0	198.0	0.0	191.7	0.0	0.0	445.0	70.0	1,608.7
Total	1,344.0	1,002.9	1,542.0	1,255.0	1,206.0	1,935.9	862.9	520.3	2,421.0	1,810.0	284.0	14,184.0
1995												
Research	1,663.0	1,033.8	1,176.0	1,007.0	1,278.0	2,199.9	715.3	1,605.0	2,731.0	1,487.0	163.0	15,059.0
Agenda Compl. Activities	0.0	0.0	481.0	382.0	502.0	0.0	57.7	67.7	0.0	733.0	0.0	2,223.4
Total	1,663.0	1,003.8	1,657.0	1,389.0	1,780.0	2,199.9	773.0	1,672.7	2,731.0	2,220.0	163.0	17,282.4
1996												
Research	1,728.0	1,275.8	1,764.0	1,114.0	2,631.0	4,334.0	782.6	1,693.9	2,821.0	1,487.0	288.0	19,919.3
Agenda Compl. Activities	0.0	0.0	506.0	51.0	577.0	0.0	0.0	70.1	0.0	711.0	70.0	1,985.1
Total	1,728.0	1,275.8	2,270.0	1,165.0	3,208.0	4,334.0	782.6	1,764.0	2,821.0	2,198.0	358.0	21,904.4

* IPGRI/INIBAP is omitted as its budget is incorporated with that of the IPGRI budget in the SGRP tables.

D. DESCRIPTION OF AVAILABLE FACILITIES, TYPES AND METHODS OF CONSERVATION

1. Short-, medium- and long-term conservation

The conservation and ancillary facilities and features at each of the Centres are summarized in Table D.1.1. These facilities were carefully inspected by the Review Panel. Where inadequacies in these facilities were perceived by the Panel they were itemized in the reports made to each individual Centre with appropriate recommendations. As is indicated under Section E, the buildings, facilities and equipment were generally of the quantitative and qualitative calibre needed to fulfil the requirements set by International Genebank Standards for active and base collections unless stated otherwise. Moreover, the technology and procedures adopted and followed by staff satisfied the Panel (unless stated otherwise). A serious problem, however, at several Centres is the lack of adequate facilities and resources for timely regeneration/multiplication.

New facilities are under construction at ICRAF, modifications are being made at ILRI and a new building is about to be constructed at CIMMYT for wheat and maize conservation. Several Centres are aware that shortage of storage space could create problems in the medium- to long-term. Some Centres are investigating the feasibility of building new facilities or modifying existing ones.

2. *In-vitro* conservation

Tissue culture facilities exist at Centres responsible for crops that are usually propagated clonally, i.e. CIAT (cassava), CIP (potato, sweet potato and ARTC), IITA (yam, cassava, plantain and banana, and cocoyam), ILRI (grasses), IPGRI/INIBAP (plantain and banana). Outline descriptions of facilities for *in vitro* storage at these Centres are also given in Table D.1.1. At CIAT steps are being taken to increase the *in vitro* storage capacity. At ILRI facilities are available for *in vitro* conservation and there is an *in vitro* laboratory but currently these facilities are not used for conservation, though technologies have been developed and tested for some grasses. ILRI considers it more practical to maintain field genebanks. A slow-growth method of storage is used for most material, and plantlets can normally be kept for one to two years without subculture to fresh media. IPGRI/INIBAP also has satisfactory protocols and facilities for *in-vitro* storage of banana and plantain.

Cryopreservation for long-term, low cost conservation, is under study at several Centres and CIAT expects to have soon an improved protocol applicable to all genotypes of cassava.

A recommendation on the need for International Genebank Standards for clonally-propagated accessions is made in Section E.2.

3. Field Genebanks

Field genebanks are important components of GRUs that have clonally-propagated species and crops to conserve. They are backed-up by storage rooms with conditions that usually allow storage of root and tuber propagules for up to a year. CIAT has an area of about 6 ha allocated to

a field collection of cultivated cassava and a small area 0.3 ha) for 29 wild *Manihot* species at Cali. Unfortunately many of the accessions are not adapted to conditions at Cali and the Panel recommended to CIAT that it should establish additional field genebanks under more suitable agro-ecological conditions.

IITA has a field genebank for cassava at Ibadan as well as a field collection at Ubiaja, Nigeria. Using an elegant minisett propagation technique IITA also has a field genebank of yam at Ibadan. A plantain/banana collection is maintained by the Plantain/Banana Improvement Programme at IITA's station at Onne, in East Nigeria and there is a small arboretum for MPTS at Ibadan.

CIP's strategy to conserve the genetic resources of its clonally propagated crops includes the annual propagation of potato and ARTC collections in a field genebank at Huancayo, and of sweet potato and other ARTC in field genebanks at La Molina and San Ramon (all in Peru). CIP faces a problem similar to that of CIAT with cassava in that many of the ARTC are poorly adapted to conditions that prevail at the Centre's experimental stations.

ILRI has field facilities with irrigation available at Debre Zeit and Zwai in Ethiopia for a field genebank with 1200 accessions of grasses.

Four major field genebanks act as Regional Field Genebanks for IPGRI/INIBAP in the Philippines, Honduras, Cameroon and Burundi.

ICRAF has several field genebanks. At the IITA station at Mbalmayo, Cameroon, there is a collection of 62 accessions of *Irvingia gabonensis* and seedlings of *I. wombulu* are being raised for planting out there in 1996. In Kenya the ICRAF/KEFRI/KARI station at Maseno has 95 accessions of *Grevilla robusta* and the station at Maseno has 46 accessions of *Markhamia lutea*. In Nigeria the NACGRAB station at Ibadan grows 55 accessions of *I. gabonense* and the IITA station at Onne also has 59 accessions. In Peru, the INIA station at Yurimaguas has 303 accessions of *Inga* spp as well as 134 accessions of *Bactris gasipaes*.

CIMMYT has a field genebank at Tlatizapan, Morelos, Mexico for its 150 accessions of perennial *Tripsacum* spp.

4. Duplicate conservation for safety

The Centres emphasized to the Panel their recognition of the importance of duplicates being placed off-site under safe and suitable conditions for safety. Considerable advances have been made in recent years in placing more duplicates off-site but there are few instances where complete collections were successfully duplicated in this way. Inter-Centre collaboration is helping in this respect and the agreements, both formal and informal, between Centres for this purpose have been highlighted in Appendix 5. Another approach to protect collections is by restoring duplicate sets to interested NARS in countries where genetic resources were collected (see Section A.6).

Details of the safety duplication of the Centres' genetic resources are given in Table D.4.1. Minor differences occur between accession totals in Tables B.1.1. and D.4.1. as a consequence of different sampling dates from the databases. There are no Tables D.4.1 for ICLARM and IPGRI/INIBAP.

The total of 28,271 accessions of *Phaseolus* beans in Table D.4.1. for CIAT represents only that part of the collection at CIAT which has already been increased (regenerated). CIAT has two formal agreements for holding a duplicate of the *Phaseolus* collection as black box, one with EMBRAPA, CENARGEN in Brazil and the other with CATIE, Costa Rica. Nearly 90% of the total increased collection is duplicated at CATIE or 55% of CIAT's total *P. vulgaris* collection. Although parts of the *Phaseolus* bean and tropical forage collections are duplicated in USDA genebanks, there is no formal agreement, and the Panel recommended that CIAT should seek to arrange such an agreement. There is no formal duplication of CIAT's cassava collection off-site, though it is estimated that there is duplication of 90% of the collection in different NARS and at IITA. CENARGEN holds a large representation of the wild *Manihot* spp. The establishment of a duplicate base collection of CIAT's tropical forages is regarded by the Centre as a high priority and discussions are underway with ILCA and NSSL in the USA. Nevertheless, a large proportion of the tropical forage collection is held as "common accessions" (in active duplication in ILCA, CENARGEN, CSIRO (Australia) and the University of Florida, USA). About 41% of legumes and 57% of grasses are jointly listed with these institutions, which serve as back-up to the CIAT collection. Also, 50% of the accessions from the "key species" is shared with these institutions.

Maize duplicate samples (a large part of the base collection) from CIMMYT's genebank are held at NSSL, USA and INIFAB, Mexico while wheat samples are held at NIAR, Japan; AWCC, Australia; NSSL, USA and ICARDA. Many maize accessions are also duplicated in active collections in other Latin American NARS genebanks. There are formal agreements with NSSL and ICARDA but not with the other organizations.

The ICARDA collection (durum wheat and wheat wild relatives) is presently stored at CIMMYT, but difficulties, which CIMMYT is confident of overcoming, have arisen in getting additional black-box, non-treated seed, through the Mexican Plant Quarantine Service.

Seed samples of about 3,000 of CIP's cultivated potato accessions have been duplicated at NSSL, Fort Collins, USA but there is no formal agreement. A new and more comprehensive batch of the genetic diversity found in Andean potato cultivars is ready for shipment to any genebank to be maintained as black-box, as soon as agreements are made with collaborating institutions. Although many of the accessions of wild tuber-bearing *Solanum* species from the collection at CIP are also maintained by other potato genebanks, a duplicate set of seeds has not been stored in another location, because CIP is still undertaking a program to rejuvenate and increase these seed stocks, some of which are more than 20 years old. With the exception of 213 accessions of wild *Ipomoea* species that are also maintained at Griffin, Georgia and North Carolina State University, USA, the seeds of *Ipomoea* species cannot be duplicated off-site until they are multiplied. There is, however, a duplicate (black-box) *in vitro* sweet potato collection of 4,950 (100% of *in vitro* collection and 93% of total) maintained under a formal agreement with IDEA, Venezuela. A duplicate (black-box) collection of *in vitro* potato accessions is being maintained by INIAP, Ecuador, under a formal agreement. INIAP maintains 3,720 accessions or 100% of the current *in vitro* collection. In addition, accessions of the *in vitro* potato collection that have been pathogen tested were duplicated at the Institut fur Resistengzenetic Bruntoch, Germany, which have been transferred to the German potato genebank at Gross Lusewitz (but no formal agreement). A large part of the ARTC collection maintained by CIP in Lima, Peru, is duplicated *in vitro* at CIP, Quito, Ecuador.

ICARDA's formal agreements with CIMMYT for duplicate storage of cereals have already been alluded to. Off-site duplication of ICARDA's genetic resources varies considerably across crops/species, with as much as 91% of a large lentil collection duplicated at NBPGR, India, but only 5 and 9% of wild *Hordeum* and wild *Triticum* respectively. Although not yet duplicated, formal arrangements are being made with FIA, Austria, for duplication of forage/pasture species, and 35% of the faba bean collection is already duplicated at FIA. Currently under preparation is an agreement between ICARDA and the Station Federal de Recherches Agronomiques de Changing (RAC), Switzerland, for duplicate storage of the *Lathyrus* collection. There is a formal agreement with ICRISAT for all accessions of chickpea and its wild relatives.

ICRAF has formal agreements with ILRI, KEFRI and NACGRAB, Nigeria for off-site duplication, and an informal arrangement with IITA for conserving MPTS species on-site at Ibadan. Duplication includes, or will include after seed multiplication has been completed: the *Sesbania* spp collection with 109 accessions at the ILRI genebank in Ethiopia; the *Irvingia gabonensis* collection which, for 55 out of the 62 total accessions is duplicated twice in live genebanks at 8 different sites in Western Kenya, and *Markhamia lutea* live genebanks in Western Kenya. An offer has been made by the Oxford Forestry Institute to arrange and pay for the long-term storage of tree germplasm at the Royal Botanic Gardens, Wakehurst Place, England. Networking arrangements exist with NARS in SADC countries for *Sesbania* germplasm.

IITA is developing a formal agreement with NSSL and Southern Regional Plant Station, Georgia, USA for the off-site duplication of cowpea and negotiations are underway with the National Plant Germplasm Institute of Italy in Bari for the same purpose. A small (1.7%) part of the wild *Vigna* collection is duplicated at the Belgium National Herbareum. In addition, 42% of the rice collection has been duplicated at IRRI and the National Seed Storage Laboratory in Japan. Most of the yam field collection held at IITA is the only existing collection, as most of the collections held previously by NARS have been lost. Unfortunately, though it has explored several possibilities, IITA has been unable to find an Institute willing to maintain a large collection of yam without a fee. In contrast to yam, 100% of IITA's sweet potato germplasm is duplicated at CIP.

ILRI has formal agreements with CIAT, RGB (Kew) and ISC (ICRISAT), Niamey and informal arrangements with CSIRO, Australia and USDA for off-site duplication of its forage collection. A total of 74% of the collection has been duplicated off-site but this figure contains a few unknown number samples which were duplicated in two or more institutions.

The Taiwan Banana Research Institute holds 414 accessions, representing 39% of IPGRI/INIBAP's banana and plantain collection, for safety storage. CATIE in Costa Rica has also agreed to store accessions *in-vitro* and IITA has been approached to store duplicates off-site for safety.

IRRI has an MOU with NSSL, USA, for black-box storage of its rice collections. Seventy-seven per cent of *O. sativa* is already duplicated, 54% of the *O. glaberimma* collection. Sixty-five per cent of IRRI's wild species collection is stored at NSSL.

The current WARDA rice collection was recovered mainly through duplicates maintained at IRRI and IITA. WARDA has formal agreements with IITA and IRRI that IITA will maintain the base collection for WARDA and IRRI will maintain the duplicates for safety, as WARDA itself

maintains only a working collection. The experience of the loss of WARDA's entire rice collection in Liberia and the subsequent restoration of much of it through duplicates stored at IITA and IRRI emphasizes very strongly the need for off-site duplication.

RECOMMENDATION. Centres should give high priority to the regeneration and multiplication of accessions that have not yet been duplicated off-site and all germplasm designated under the FAO/CGIAR Agreements should be placed for safety duplication in off-site genebanks as soon as possible.

RECOMMENDATION. That Centres should seek to establish formal agreements with NARS and other Institutes that hold, or are about to hold, duplicated material.

E. GENEBANK STANDARDS

1. Procedures and methods for germplasm conservation

The CGIAR Centres' Genebanks are part of the FAO Network of *Ex situ* Plant Genetic Resources Collections and aim to adhere to the FAO/IPGRI International Genebank Standards published in 1994. During its visits to Centres in Africa and Asia the Panel made use of a Checklist (see Appendix 7) to assess how well a genebank conformed to these Standards. The Checklist was not used for the first four Centres that were reviewed but care was taken to ensure that a proper assessment was made. In general, the Panel was satisfied that Centres were mostly attaining the necessary technical standards in their methods and procedures for both base and active collections and in their assessment of initial and regular monitoring of viability of seed. Where anomalies occur these were recorded in individual Centre Reports and recommendations made to remedy any short-comings.

Some Centres were experiencing difficulty in regenerating seed at a rate commensurate with their needs and, as discussed in Section D.6, most Centres need to improve considerably their arrangements for safety duplication of collections off-site.

Although International Genebank Standards are available for seed, they are not as yet available for vegetatively-maintained crops such as yams, cassava, potato and sweet potato, and banana and plantain. The Panel saw, however, that Centres involved with such crops had devised protocols and set standards that appeared to the Panel to be both reasonable and successful. The Panel noted the intention of CIAT and IPGRI, in conjunction with FAO, to draw up a set of International Standards for the *in vitro* storage of *Manihot* cassava. There is a need, however, for a comprehensive exercise to produce a document on Standards to cover all vegetatively-reproduced crops within the FAO International Network of Genebanks. Moreover, as research on cryopreservation technology is making rapid advances, and CIAT has a pilot scheme underway for the cryopreservation of cassava, such an exercise should take into account the eventual need for cryopreservation standards.

The health of some material at some Genebanks was a cause for concern to the Panel. Centres are increasingly and successfully addressing, through their research programmes, the problem of

detection of infected material, and are developing methods to eradicate diseases in such material but in both vegetatively- and seed-reproduced crops some Centres are finding it difficult, through lack of resources, to clean-up infected material at a satisfactory rate. For example, CIP has a backlog of infected potato germplasm and IITA seems to have an endless task in cleaning-up its collection of cowpea and wild *Vigna*.

The Panel was very impressed with "A manual of operations and procedures of the International Rice Genebank" published by IRRI in September 1995. The preparation of a similar manual by other Centres is therefore advocated by the Panel.

RECOMMENDATION. Each Centre should produce a manual of operations and procedures for its genebank(s).

RECOMMENDATION. WARDA should place, as soon as possible, its FAO-designated rice germplasm in an active collection that meets International Genebank Standards.

RECOMMENDATION. Several Centres should establish, as soon as possible, a full base collection of their mandate crops in long-term storage so as to meet International Genebank Standards.

RECOMMENDATION. All Centres should give high priority to the speedy regeneration of material that fails to reach International Standards and that all 'designated' material should be placed in long-term storage.

RECOMMENDATION. Steps should be taken as soon as possible to produce a set of International Genebank Standards for the production and maintenance of vegetatively propagated crops.

2. Maintenance of adequate documentation system

The Panel was impressed with the positive steps being taken by Centres to improve the quality of passport, management, characterization and evaluation data. However, not all Centres have given adequate support to their genetic resources data management efforts in the past. Several NARS representatives indicated that there is a need to develop in the data bases information on genetic distances between accessions and to distribute such information to breeders and other users of germplasm.

Although the Panel noted that several Centres were confident that their "databases were likely to be compatible with the System-wide Information Network on Genetic Resources (SINGER) when it becomes operational" the Panel was struck by the variation among Centres in their development and use of a documentation system for their genetic resources. Several Centres have developed excellent documentation systems to meet the requirements of their specific crops. For example, at CIMMYT different documentation systems (which are both good) are in use for maize and wheat, and the Panel thought that the power and user-friendliness of the International Wheat Information System (IWIS), which has been mainly developed by CIMMYT with some recent collaboration with IRRI, has potential for other self-pollinating or vegetatively-propagated

crops. IRRI has an excellent database but its current computing power, which is about to be upgraded, makes the recovery of data a slow process. Some of the smaller Centres are having difficulty in database management and need to upgrade both hardware and software. Additional equipment is likely to be needed at such Centres to provide full compatibility with SINGER. At ICRAF there is currently no computerized database for passport, management, characterization and evaluation data for their germplasm accessions, whilst at ICARDA electronic mail facilities are only at an early stage of development. Both WARDA and ILRI highlighted the needs for extra funds to upgrade their database management systems.

IRRI (rice), CIAT (forages) and CIMMYT (maize) are closely involved with the development of the SINGER project, and data were used in a pilot project (SINGER Demonstrator) to make the CGIAR Centres' germplasm databases accessible through the Internet on the World Wide Web.

Recently, there has been considerable activity in discussions among Centres. In October 1995, a SINGER Planning Meeting was held at CIMMYT in Mexico. The purpose of this meeting was to provide a forum for discussion on SINGER activities and to provide a basis for further project planning and implementation. A brief report was subsequently prepared by Dr Mark Perry (IPGRI), SINGER Project Leader, on the progress made and future plans and timetable for SINGER.

In view of the progress being made and the current input from experts in this field, the Panel was of the opinion that any changes to be made in the documentation systems at different Centres should be made in the course of developing SINGER.

F. DEVELOPMENT AND CHARACTERIZATION OF CORE COLLECTIONS

A core collection can represent most of the genetic diversity with a minimum number of accessions (5 to 30%). Characterization and evaluation costs are greatly reduced and efficiencies when screening for desired traits can be increased. However, there is considerable variation among Centres in producing core collections, with CIAT very much to the fore in utilizing GIS and molecular markers to produce core collections of *Phaseolus* beans and cassava. While CIMMYT has created a core collection for maize from Latin America, it has taken no action as yet to designate a wheat core collection, but is currently considering designating a core subset among a recent collection of wheat landraces in Mexico. IITA has a core collection of cowpea and plans to establish core collections of wild Vigna, yam and other crop germplasm. ICARDA, as part of the agreed programme of the International Barley Genetic Resources Network, has established a core collection of barley based primarily on geographical distribution and morphological assessment and could refine its designation by the use of marker gene technology. ILRI thought that the concept of core collections is not very useful for its forage collections because of the large numbers of genera and species covered and the relatively small numbers of accessions of each species. Although IRRI placed a moratorium on the development of core collections for rice in-house because other conservation efforts were deemed to be of greater priority, it has recently been looking at methods to select accessions for a core collection in collaboration with the University of Birmingham using both random and stratified methods and the application of GIS. IRRI does not believe it is necessary to develop a core collection to stimulate evaluation and use of its International Rice Collection, but thinks that one of the

advantages of core collections is to make possible duplicate safety storage at genebanks that are considerably smaller than that at NSSL, Fort Collins, USA, on which IRRI currently depends for off-site storage of duplicates of its large collection. Prior to establishing core collections of potato and sweet potato, CIP has concentrated on eliminating duplicates by using isozyme and morphological data and is now well placed to develop preliminary core collections which can be refined as more molecular marker and evaluation data are obtained.

RECOMMENDATION. Centres should take steps to further refine their designation of core collections but they should also continue to maintain in their genebanks accessions not in the core collections.

RECOMMENDATION. Core collections should be preserved in base, active and off-site duplicate collections.

G. RESEARCH AND PUBLICATIONS ON GERMPLASM CONSERVATION

There is considerable variation among Centres in the type, level and productivity of research. At the larger Centres there has been a gradual shift from collection and conservation to characterization and evaluation, with the quantitative assessment of genetic diversity now featuring high in their priorities. Much of the earlier research was carried out for practical, in-house purposes and largely accounts for the presentation of many of the results in Newsletters and Proceedings with (in general) relatively few publications in high quality, international, refereed journals.

The Panel was pleased to note that individual Centres are developing their own strengths in specialized areas which will probably give them a comparative advantage. Such specialization was seen by the Panel as an advantage to the System as a whole provided rationalization is possible through the SGRP. Although it is perhaps invidious to single out particular pieces of work the Panel was particularly impressed with the success of CIAT's cryopreservation research with cassava and its GIS and molecular marker studies, which were leading to more reliable assessment of genetic variation in its mandate crops and thus helping to identify duplicates, designate core subsets and to assess coverage; CIP's research to reduce the number of duplicate accessions in its potato collection, which was enabling it to reduce the collection to more manageable proportions; and CIMMYT's elegant research on population genetics in maize, which has led to the development of reliable regeneration methodologies to reduce genetic drift.

Most Centres have successfully introduced screening for valuable traits, especially for resistance/tolerance to pests/diseases and abiotic stresses and are increasingly making greater use of molecular marker technology for this purpose. Research on documentation systems is addressed in Section E.2. The Panel was also pleased to note the increased emphasis at all Centres on plant health, both for vegetatively- and seed-produced crops, and the progress being made in developing user-friendly, reliable disease-detection kits and methodologies to eliminate diseases, particularly viruses.

The multidisciplinary approach being used by the Centres for strategic research, both in-house, and through linkages with other organizations and centres of excellence, is already paying dividends. The Panel encouraged such an approach, which should serve to improve the Centres'

publication record in high quality journals. At the same time, the Panel identified a continuing need for applied research (the results of which should also be published) on procedures that will reduce operational costs and lead to greater efficiency. Moreover, the publication of catalogues to make readily available information to potential users, should not be neglected.

An objective of SINGER is to make information on accessions more readily available to users (passport and characterisation data by catalogue, CDRom and Internet).

RECOMMENDATION. Centres should place greater emphasis on the publication of results, whether of basic, strategic or applied research, in high quality, refereed, international journals. Simultaneously, Centres should continue to publish catalogues to make known to potential users the useful genetic variation available in their genebanks.

RECOMMENDATION. There is a need for a System-wide approach in the determination of research priorities among Centres.

H. ACCESSIBILITY AND EXCHANGE OF GERMPLASM

1. Distribution of material and information

The distribution of germplasm by the Centres over the period 1992-94, with the exceptions of ICLARM and ICRAF, is summarized in Table H.1.1. Some Centres were able to provide details of both the numbers of accessions and samples, others were not. An attempt was made to identify different recipients of the germplasm. Much of the material distributed is enhanced germplasm produced by Centres' plant breeders who make considerable use of material held in the Centres' genebank as parents in their hybridization and selection programmes. International Nurseries, which are client driven, or their equivalent, are the main vehicles for the evaluation of enhanced germplasm. In general, the policy of Centres is to provide germplasm freely, as well as related information, to any applicant. The differences between numbers of accessions and of samples, the differences between crops and the differences between recipients as well as the variation in distribution in different years, are exemplified by the three contrasting crops that are part of CIAT's mandate, namely *Phaseolus* beans, cassava and tropical forages. During the period 1992-94, CIAT distributed a total of 32,676 samples, representing 16,523 accessions of *Phaseolus* beans. It should be noted, however, that the total figure for accessions will contain duplicates, as the same accessions may be distributed in different years. Of that total of samples 43, 30 and 27 per cent were distributed in 1992, 1993 and 1994 respectively. In each year the number of accessions was roughly equal to half the number of samples. The main recipients were CIAT's breeders in Colombia, who received over 80% of the total samples, 91% of the 1992 distribution, and 67% of the 1994 distribution. Most of the other samples went to NARS, with developing countries receiving slightly more overall than did developed, mainly because of a marked difference in favour of developing countries in 1993. Interestingly, the private sector in both developing and developed countries received very few samples of either beans or cassava. The distribution of cassava from CIAT was of a much smaller magnitude than beans, with a total of 1,540 samples over the period 1992-94. Approximately four fifths of these samples were different accessions. In contrast to the situation for *Phaseolus* beans, NARS were the main

overall recipients of cassava, receiving 81% of the total samples, with NARS in developing countries receiving most. CIAT's staff in Colombia received 18% of the total and the private sector received only 1%. The picture for tropical forages from CIAT is different from both beans and cassava. During 1992-94, 10,289 samples of tropical forages were distributed, roughly three quarters of which were different accessions. All the recipients listed in Table H.1.1. received samples of tropical forages, with the private sector in developing countries receiving 3% of the total. CIAT staff received about half of the samples, with Centre staff in both the host country and other countries as beneficiaries. NARS in both developing and developed countries benefitted, with an unusually large number of samples despatched to developed country NARS in 1993.

During the period 1992-94 a total of 14,540 samples of maize was distributed by CIMMYT; 5,837 (54% of the total) of them were for CIMMYT staff, mostly in the host country, 6,147 (42%) were sent to NARS of which 1,354 were to developing and 4,793 to developed countries. The private sector received 556 (4%) of the seed samples; about three quarters of them went to developing countries. CIMMYT distributed a total of 16,183 samples of wheat from 1992-94; the number of distributed samples increased from about 3,000 in 1992 to 7,500 in 1993, and reduced to 5,700 in 1994. CIMMYT staff, mostly in Mexico, received 9,637 (59% of the total) for breeding work. The NARS received 6,342 samples (39%), mostly in developing countries. The private sector located in developed countries received only 204 (1%) samples, all in 1994.

The distribution by CIP of both potato and sweet potato samples during 1992-94 was mainly to developing countries: 93 and 95% out of respective totals of 11,787 for potato and 3,069 for sweet potato. Moreover, most samples went to NARS, with the private sector receiving about 3 and 0.3% of potato and sweet potato respectively.

During the period 1992-94, ICARDA distributed a total of 94,760 samples of wheat (30%), forages (22%), lentil (21%), chickpea (12%), barley (10%) and faba bean (5%). The GRU itself at ICARDA used 24,536 samples (26%) of this total for its own work and 5,655 samples (6%) were sent off-site for safety duplication. Of the rest of 64,569 samples, Centre staff received 25,530 and other IARC's received 1,694. NARS in developing and in developed countries were sent 24,662 and 12,651 respectively. The private sector received only 42 samples, all despatched in 1993.

Out of a total of 22,178 samples, covering a wide range of crops, released by IITA from 1992-94, half were distributed in 1992. Centre staff received about half of the total, mostly in the host country. Slightly less than half of the total was distributed to NARS, with developing countries receiving three times as much as developed. The private sector in developed countries received a total of 53 samples.

The main recipients of the 137,215 samples of germplasm distributed by ICRISAT from 1992-94 were Centre staff in India and NARS staff in developing countries, each receiving 39% of the total. Centre staff in other countries received 14% of the samples that were distributed. While the private sector in developing countries received a 3% share (mostly India?), no samples were distributed to the private sector in developed countries.

Over the period 1992-94 ILRI distributed 7,998 samples of forage germplasm, nearly 60% of which went to Centre staff in Ethiopia. NARS in developing countries received 26% of

that total, while NARS in developed countries received 3%. The private sector in developing and developed countries received 7 and 1% respectively.

During 1992-94, IPGRI/INIBAP distributed 1,344 accessions of Musa germplasm, primarily to NARS in developing countries (53%). CIRAD received 17% of the total germplasm, mostly for virus indexing, while other NARS in developed countries received 28%.

NARS in developing countries received half of WARDA's distribution of 8,195 rice samples over the period 1992-94. As might be expected from WARDA's collaborative efforts, 17% went to other IARCs, 20% to WARDA staff in Cote d'Ivoire and 9% to WARDA staff in other countries. The private sector received only 15 samples over the 3-year period; 240 samples were sent to "Others".

Although there is considerable variation across years, between crops and among recipients, the general picture is one in which a Centre's own staff, particularly in the host country, received the bulk of the germplasm that was distributed by Centres between 1992 and 1994. However, NARS in developing countries were the second largest beneficiary and NARS in developed countries the third. Exceptions were WARDA's rice samples, of which NARS in developing countries received 50%, and CIAT's cassava and IPGRI/INIBAP's banana and plantains for which NARS in developing, followed by NARS in developed countries, were the main beneficiaries. Tropical forages from CIAT were fairly evenly divided between Centre staff and NARS. The private sector received relatively little germplasm, with the private sector in developing countries benefitting to a slightly greater extent than that in developed.

The large number of accessions and samples which have been used by Centre staff and released to NARS in developing countries the CGIAR over the period 1992-94 is a measure of the importance of the CGIAR genebanks.

2. Germplasm utilization and impact

Reports on individual Centres highlight the considerable numbers of new breeding lines or varieties in developing countries that are direct releases from the Centres or are derived from such releases. Many of these new varieties have special features such as resistance to pests and diseases.

The successful impact of IRRI's rice varieties, and the contribution of IRRI's PGR to these varieties, is well known, as is the success of CIMMYT's maize varieties and hybrids and its wheat varieties. Other Centres have had their successes with varietal releases. For example, the highly successful potato variety CIP 24 in China, which is now grown in eleven other developing countries throughout the world and is derived from a clone originally from Argentina which has itself a complex pedigree.

However, the release of a variety does not necessarily ensure impact and success, (seed production or propagation problems are often a difficulty in the commercial spread of a variety in the farming community in developing countries) and it is probably fair to say that many of the varieties released by the Centres have failed to make the impact that was anticipated for them, though it is

likely that success will be recorded for an increasing number of varieties of a wide range of crops with Centre germplasm over the next few years.

A number of Centres are attaching much greater importance to assessing the impact of germplasm from their genebanks on varietal development in developing countries and several case studies are being made. The Panel thought it important that Centres should record, quantify and fully publicize their successes.

RECOMMENDATION. Centres should take steps to quantify, and publicize more effectively, the impact made as a consequence of the utilization of the genetic resources held by them.

I. TRAINING IN GENEBANK ACTIVITIES

Most Centres have provided and will continue to provide formal group training courses as well as individual training, often on-the-job, on germplasm conservation and management to scientists from NARS, both at Centre HQs and in the regions. Some courses are run jointly with IPGRI and FAO. Post-graduate and post-doctoral training is also available and post-graduate training for MSc and PhD theses involves collaboration with Universities.

There has been no significant training yet by ICLARM in aquatic genebanking, which is still largely a research area.

The Panel sensed that at times of financial constraint, training is likely to be given lower priority by individual Centres, which could be to the disadvantage of NARS, particularly those who are trying to establish their own genebanks. In some instances two or more Centres have run joint courses and the Panel wish to encourage such collaboration so as to make greater use of the complementary strength in technology and expertise among CGIAR Centres and reduce costs.

An appeal was made by staff at several Centres for better training opportunities for genebank staff, especially in emerging technologies with an important bearing on conservation, management and utilization of genetic resources. The Panel thought that, as some Centres were developing specialized expertise in different areas, it should be possible for IARC scientists to receive some such training at those Centres with a comparative advantage. Other training could be achieved in-house from scientists of other disciplines, or at recognized centres of excellence outside the CGIAR.

RECOMMENDATION. When planning training the CGIAR Centres should aim for more joint courses so as to make greater use of the complementary strengths and experience of different Centres and hopefully reduce costs.

RECOMMENDATION. Centres should review carefully and positively the training needs of both NARS personnel and their own genebank staff.

J. CONSTRAINTS

The Panel wishes to record the dedication and productivity of CGIAR Centres' staff in setting and maintaining high standards. A great deal has been achieved but much remains to be done in conservation, research and utilization of genetic resources, and extra resources are required.

The Panel identified a number of problems that need correction at different Centres and appropriate recommendations were made in individual Centre reports. A few Centres could, in the near future, run into difficulties through lack of storage space and the Panel also highlighted this potential problem where appropriate. The upgrading of computer facilities as part of the SINGER exercise will require extra finance and the Panel was pleased to learn that the SINGER project includes support for the upgrading of computer hardware and software. A constraint

identified by some Centres was the lack of funds for collecting expeditions. Common bottlenecks include adequate and timely regeneration and multiplication; better, more comprehensive characterization and evaluation, and the clean-up of disease-infected material.

The Panel thought it important that those IARCs which have *in vitro* collections, e.g. CIAT, CIP, IITA and IPGRI/INIBAP should be encouraged to address together the difficulties encountered in storage and maintenance of *in vitro* duplicated collections of CGIAR-mandated crops. In due course, cryopreservation may make such duplication easier.

Increased demands and the need for higher standards and training require a concomitant increase in human and physical resources to research and accommodate a Centre's mandated crops. The Panel detected that there had been a general reduction in staffing in recent years, though, as indicated in Table C.2.1., some Centres now appear to be increasing finance for genetic resources. Because of the growing size of the collections, the bottlenecks that have been identified, the additional administrative load as a result of the CGIAR's increased activities in genetic resources and the numerous tasks created as a consequence of the CBD and FAO's International Undertaking in Plant Genetic Resources, the Panel thought that resource allocation and staffing needs for the genebanks and their associated activities need to be re-evaluated.

As the Panel identified specific constraints at each Centre, Centres should now be in a stronger position to plan and cost on a priority basis the extra resources needed to overcome or minimize bottlenecks and to attain the necessary International Standards within an agreed timeframe. Such plans would make clear to the CGIAR and FAO the changes and investment needed to bring up genebank standards and activities to required levels, thus ensuring the safety of a large part of the world's useful genetic diversity and improving its management and utilization.

RECOMMENDATION. Centres should be asked to plan and cost, on a priority basis, the extra resources needed to overcome, within an agreed timeframe, the problems and bottlenecks identified by the Panel. This would make possible the preparation of a System-wide Strategic Plan to quantify the resources needed to meet fully International Genebank Standards and to improve the management and utilization of genetic resources at the Centres.

K. FUTURE OUTLOOK

At the conservation level Centres are recognizing the importance of obtaining a better definition of the genetic diversity to be conserved and of improved methods of conservation. Those Centres with vegetatively reproduced crops will continue their research on *in vitro* storage and sufficient progress has been made in cryopreservation research to indicate that the use of cryopreservation technology for some such crops is within reach. Research on genetic resources has advanced considerably with the development of genetic maps: molecular gene technology allied to GIS work is full of promise but much remains to be done. More effective utilization is also high on the priority lists of most Centres and the generation of information on useful sets of diversity, genepools and useful genes through the improvement and updating of databases is seen as being of key importance. All Centres will continue to strive to improve on their attainment of International Standards and they aim to increase the amount of material duplicated off-site. The

development of core sub-sets is seen by several Centres as necessary for the more efficient use and management of germplasm collections.

In situ conservation to complement *ex situ* will benefit from closer collaboration with NARS and NGOs.

Several Centres are attaching increasing importance to the raising of health standards by the development of diagnostic tests and kits and the allied production of disease-free seed and propagules.

A feeling prevails among some Centre staff that genetic resource scientists should no longer act only as curators but will have increasingly to become active partners in crop improvement, and at some Centres "pre-breeding" is seen as a necessary part of a genebank's activities. One of the strengths of CGIAR Centres is that each has a core of multidisciplinary scientists capable of contributing to research on, and utilization of, genetic resources. The Panel thought, however, that better inter-Centre collaboration, particularly in research related to conservation and utilization of genetic resources, would pay handsome dividends.

At a number of individual reviews, Regional and NARS representatives indicated that NARS could usefully play a more active part in contributing to the policy and strategy planning process at Centres, particularly when operational links between IARCs, NARS and NGOs are so important to the success of an integrated global framework.

Much remains to be done, and can be done, but the present levels of investment on genetic conservation and utilization and allied research at the Centres inevitably means that progress will be much slower than is desirable.

Appendix 1

TERMS OF REFERENCES FOR THE INTERNALLY-COMMISSIONED EXTERNAL REVIEW OF THE CGIAR GENEBANK OPERATIONS

This review is commissioned by the CGIAR's System-wide Programme on Genetic Resources (SGRP) and will be led by a Chairperson and an external team of experts, coordinated by IPGRI in consultation with the Inter-Centre Working Group on Genetic Resources (ICWG-GR).

The review will critically assess constraints and opportunities for the improvement of the CGIAR genebank operations in technical, scientific and financial aspects. It is expected to provide an opportunity to sustain and improve the quality of services offered by the genebanks, and thus enhance partner confidence and improve funding opportunities. The review and report should be completed before the end of 1995 and its report extensively discussed by the ICWG-GR before its formal submission.

The review will assess technical, scientific and financial aspects of each genebank according to the following:

1) general operations of genebanks (conservation facilities, regeneration/multiplication activities, characterization, germplasm viability testing, germplasm health aspects, germplasm distribution and documentation/information). The International Genebank Standards, endorsed by the FAO Commission on Plant Genetic Resources, will be used as a key reference for technical assessment;

2) general status of germplasm collections (number of accessions, comprehensiveness of the collections, coverage of species, etc.);

3) germplasm conservation research;

4) linkage and collaboration with partners (e.g. participation in regional networks, black box storage etc.);

5) status of safety duplication; and

6) opportunity for the restoration of duplicate samples.

Additionally, the review will also assess, though with lower priority than the above, (a) germplasm collecting/acquisition policies and activities; (b) training activities; (c) legal status of the collection; (d) status and function of genebanks within respective Centres; (e) examples of utilization/impact of Centre's germplasm; and (f) additional items relevant to each Centre in line with overall objectives of the review.

Based on analysis of review findings, the team will further:

- identify areas of strength as well as constraints for each genebank;

- develop a synthesis report describing constraints and opportunities on a system-wide level;
- develop a comprehensive proposal for upgrading and/or improving facilities and operations.

Review Process

Although some Centres will already have recently undergone a review process and will therefore have much of the key information needed by the Review team readily available, all Centres' genebanks including ICLARM should be visited. Information therefore should be made available prior to the visit for purposes of speed. Thus, the two major tasks of the team during each visit will be site veritication of the information gathered, plus interacting with staff and obtaining preliminary feedback with regard to the results of the review. It is important that the review team work to an agreed protocol based on a checklist covering the elements of the Terms of Reference. It may well be beneficial to have a preliminary review at one of the genebanks in order to examine the review process and the effectiveness of the checklist.

The focal person for the SGRP (Coordinator or Interim-Coordinator) will be located at IPGRI, Rome, and will support the review team in respect of information gathering and logistic arrangements.

Review Team

The review team consists of one team leader and 2/3 team members who will have specific expertise with regard to the location and mandate of Centres in question. It is expected that the team leader will visit all the genebanks, although the team members will vary according to the regional/technical needs of each Centre. Amongst other qualities, the team will need to have expertise in the key elements of genebank operations and practical experience. For example, whilst reviewing CIP, CIAT, IITA and IPGRI/INIBAP, they will need experience in *in vitro* conservation, and in respect of ICRAF, ILCA (ILRI), IITA, CIAT and CIP, field genebank experience. Input to the review from key CGIAR partners, such as NARS should be reflected in the team composition.

As described in the recent Agreement between FAO and the CGIAR Centres, FAO will also be involved in helping to define further the terms of reference and strategy development of the review, with the possibility of also sending representatives as part of the Review team to visit the various genebanks.

a. GENEBANK REVIEW PROGRAMME

Centre	Dates of Reviews	Chairman	Review Panel		
			FAO Rep.	Reg. Rep.	NARS Rep.
ICARDA	20-22 June 1995	N L Innes	N E Gaddes (U.K.)	A M Abou Zeid (Tunisia)	A M Abou Zeid (Egypt)
CIAT	3-6 Aug. 1995	"	E Arias (Mexico)	S Eberhart (USA)	M Lobo A (Colombia)
CIP	7-9 Aug. 1995	"	"	"	R Estrada (Peru)
CIMMYT	14-17 Aug. 1995	"	"	"	J Sanchez (Mexico)
ILRI	10-12 Sep. 1995	"	K Tao (USA)	R Feyissa (Ethiopia)	R Feyissa
ICRAF	13-15 Sep. 1995	"	"	E Chaggala (Kenya)	E Chaggala
IITA	17-20 Sep. 1995	"	"	SO Bennett-Lartey (Ghana)	SO Bennett Lartey
WARDA	22-24 Sep. 1995	"	"	R Vodouhe (Benin)	R Vodouhe
ICRISAT	15-18 Nov. 1995	"	N M Anishetty (India)	M Nakagahra (Japan)	K P S Chandel (India)
ICLARM	20-22 Nov. 1995	"	"	P Cunningham (Ireland)	M D T Abella (Philippines)
IRRI	24-27 Nov. 1995	"	"	H C Chin (Malaysia)	R Hautea (Philippines)
IPGRI/INIBAP	7-9 Dec. 1995	"	K. Tao (USA)	F Rosales (Honduras)	F Rosales

b. ADDRESSES OF PANEL MEMBERS

Dr N L Innes	Consultant, c/o Scottish Crop Research Institute, Dundee, UK
Dr Nour-Eddine Gaddes	FAO Regional Office, Cairo, Egypt
Dr Abdel-Moneim Abu-Zeid	Director, Genebank, ARC, Giza, Egypt
Dr Enrique Arias	Agricultural Officer, AGPC, FAO, Rome, Italy
Dr Steve Eberhart	Director, National Seed Storage Laboratory, USDA-ARS, Fort Collins, USA
Dr Mario Lobo,	CORPOICA-GRU, Medellin Antioquiar, Colombia
Dr Rolando Estrada	Faculty of Biological Sciences, "Universidad Macional Mayor de San Marcos", Lima, Peru
Dr Fernando Castillo	Post Graduate College, Monteillos, Mexico
Dr KarLing Tao	Agricultural Officer, AGPS, FAO, Rome, Italy
Dr Rogassa Feyissa	Director, Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia
Dr Ebby Chagalla	Kenya Forestry Research Institute, PO Box 20412, Nairobi, Kenya
Dr S Bennett-Lartey	Head of Genetic Resources Centre, Accra, Ghana
Dr Raymond S Vodouhé	Director of Crop Research Institute, BP 226-Bohicon, Benin
Dr N M Anishetty	Senior Officer, Plant Genetic Resources, AGPS, FAO, Rome, Italy
Dr M Nakagahra	Director General, National Institute of Agrobiological Resources, Tsukuba, Japan
Dr K P S Chandel	Acting Director, National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi, India

Dr P Cunningham	Professor of Animal Genetics, University of Dublin, Dublin, Ireland
Dr H C Chin	Emeritus Professor, Department of Agronomy & Horticulture, Universiti Pertanian, Malaysia, 03400 Serdang, Selangor, Malaysia
Dr R A Hautea	Director, Institute of Plant Breeding, University of the Philippines at Los Bonos, College of Agriculture, Laguna, Philippines
Dr F Rosales	Fundacion Hondurena de Investigacium Agricola (FHIA), Programa Internacional de Banano y Platano, Apdo Postal 2067, San Pedro Sula, Honduras

Appendix 3

LIST OF ITEMS TO CONSIDER FOR GENEBANK REVIEW

A. Policy Items

1. Institutional objective in germplasm conservation
2. Status of the genebanks within the Institute
3. Linkage with other germplasm conservation centres including regional and networking arrangements
4. Agreement with host country(s) on the ownership and movement of material
5. Institutional policy on material that is designated under the IARC's agreement with FAO
6. Restoration of germplasm
7. Future outlook

B. Plant species/types assembled and conserved in the genebank

1. List of species and categories (e.g. advanced cultivars; breeding lines; landraces or primitive cultivars; old cultivars; wild/weedy species).
2. Estimate of coverage.

C. Genebank management, operations and resources

1. Organizational set up within the institute
2. Administration and management
   a) Human resources
      - Type and number of staff in the genebank
      - Qualification of staff
   b) Financial resources
      - Core budget of the genebank
      - Complementary funding
   c) Physical plant
      - General layout
      - Storage facilities
      - Ancillary facilities
      - Power source (regular and standby generators)
      - Alarm and environment control systems
      - Safety against disasters such as earthquake, fire, flood, theft, etc

   d) Plant quarantine and germplasm health facilities

D. Description of available facilities, types and methods of conservation

1. Short-term conservation
2. Medium-term conservation
3. Long-term conservation

4. *In vitro* conservation
5. Field genebanks
6. Duplicate conservation for safety
   - Number of accessions in duplicate conservation and location

E. **Genebank standards**

1. Procedures and methods for germplasm conservation
   - Conservation chambers and space
   - Types of containers used for conservation
   - Initial viability and quality of material
   - Quantity of material conserved
   - Health of material
   - Monitoring and maintenance of conserved material
   - Regeneration

2. Maintenance of adequate documentation systems
   - Passport information
   - Characterization and preliminary evaluation data
   - Plant descriptor lists developed
   - Computer hardware and software in use

F. **Development and characterization of core collections**

G. **Research and publications on germplasm conservation**

H. **Accessibility and exchange of material**

1. Distribution of material and information
2. Germplasm utilization and impact

I. **Training in genebank activities**

J. **Constraints**

K. **Opportunities**

Appendix 4

Summary Comments and Recommendations from Individual Centre Reports

CIAT

Summary Comments

The Panel noted that CIAT was reviewing the future of the GRU and that a new Director-General and Deputy-Director General (Research) would ultimately influence the form, status and program of the Unit.

The Panel recognized that financial constraints are limiting CIAT's operations, but thought that the GRU is underfunded in relation to the Centre's total budget.

The Panel thought that there are dangers in making use of special Project funding for key areas of conservation and research.

The Panel was impressed with the successful way in which CIAT and NARS had involved farmers in the utilization of the Centre's germplasm (beans) and also noted that studies were currently underway at CIAT to assess, in a quantitative fashion, impact made by CIAT's genetic resources in partner countries.

The Panel was informed by CIAT's staff that the data bases used by CIAT for its mandate crops were likely to be compatible with the System-wide Information Network on Genetic Resources (SINGER) when it became operational.

The Panel was satisfied that for *Phaseolus*, forage and grass species CIAT's goal is to adhere to International Genebank Standards, as endorsed by FAO and published jointly by FAO and IPGRI in 1994. Inadequate staff and funds have precluded complete achievement of these standards. Recommendations are made to address specific deficiencies.

The Panel thought that exchanges involving staff of the GRU and NARS partners could have a beneficial and stimulating effect.

For the *Manihot* collection, CIAT and IPGRI's research on *in vitro* storage had reached the stage of drawing up International Standards for this vegetatively produced crop and wild relatives. The Panel noted the intention of CIAT and IPGRI, in conjunction with FAO, to draw up a set of International Standards in the very near future.

Recommendations

1. CIAT's Senior Management should address the heavy demands made on the GRU by the Commodity Programs.

2. CIAT should continue to review carefully the large number of grass and legume species in the Tropical Forage collection with a view to concentrating on those species most relevant to its research needs or that are in danger of genetic erosion. For some accessions, recollection may be more efficient than regeneration.

3. CIAT should review the position of its bacterial and fungal collections with a view to declaring these collections to be held in trust in the public domain.

4. For accessions with limited longevity, samples for both base and active collections should be stored in the long-term seed store.

5. CIAT should negotiate with ICA to permit first increase of forages in mesh-houses to increase effective population size and reduce genetic drift.

6. CIAT should assess the need to increase staff for SHL (considering charging other units for service provided by SHL). CIAT should consider establishing the same seed health routine procedures, as done for seeds to be sent abroad, for materials distributed within Colombia.

7. Dehumidifiers need to be up-graded in the medium-term storage unit to maintain 25 to 28% r.h. Dehumidified seed drying capacity should be expanded to replace the high temperature drier.

8. CIAT should establish additional field genebanks, under suitable agro-ecological conditions, for cassava and other *Manihot* species which are not adapted to headquarters conditions.

9. CIAT should intensify its efforts to promptly arrange for formal safety backup duplication of the cassava collection off-site and to request relevant information from national and international institutes holding "non-formal duplications". Formal agreements should be signed by both parties.

10. CIAT should seek to develop formal agreements for security backup off-site seed storage of tropical. forages.

11. CIAT should expand viability testing to obtain an initial viability test for all seed accessions and to permit monitoring as needed.

12. Because most accessions have sub-standard numbers of seeds, regeneration of these accessions and those with sub-standard viability should be done promptly.

13. Place seed of tropical forage in local and off-site long-term storage as soon as possible irrespective of seed numbers.

14. Initiate a pilot cryopreservation project for *Manihot* as soon as possible, based on CIAT research and on research on other crops at other institutions.

15. Initiate applied research to reduce costs for routine activities.

16. Make a classification of the training-user countries, based on the stage of development of GRU in each NARS. The information will make it possible to develop a strategy for coordinated research between NARS and CIAT, and/or service training of national researchers at CIAT headquarters, as well as the development of research projects by NARS researchers at CIAT.

17. CIAT should develop and distribute information in a data base on genetic distances between accessions, which will improve the efficiency of the use of germplasm in breeding programs. The CIMMYT IWIS software might be useful.

18. Tape backups of the GRU database should be made weekly and securely stored in a different building.

19. CIAT should continue refining GRU core collections and designating cores in additional forage species as feasible. The Panel commends the GRU for the early development and use of core collection methodologies. The methodologies used for the initial core were excellent, and the refinements in progress (GIS and molecular markers) are cutting edge technology.

CIMMYT

Summary Comments

The Panel commended CIMMYT for successfully planning and obtaining funding for the development of a new Genebank. The new building will improve the security of stored germplasm and make possible greater integration of two currently separate genebanks for wheat and maize. Adequate space will be available for landrace collections of maize and bread wheat held in other genebanks that should be promptly acquired by CIMMYT (nearly 50% for both crops).

The Panel was impressed with the elegant research at CIMMYT on population genetics, which first studied theoretical aspects of maintaining adequate, effective population sizes then developed practical methodologies for regenerating maize accessions.

The Panel was also impressed with the power and user-friendliness of the International Wheat Information System (IWIS), which has been mainly developed by CIMMYT with some recent collaboration with IRRI. As a global data base it has potential for other self-pollinating or vegetatively propagated crops. The Panel strongly supported the continued development of this system for wheat and anticipated that it could be useful to other CGIAR Centres as part of the System-wide Information Network on Genetic Resources (SINGER) when it becomes operational.

The Panel recognized that much of CIMMYT's successful breeding material was based on the utilization of genetic resources currently held in its wheat and maize germplasm collections. The International Nurseries for wheat and maize, which are client-driven, are the main vehicles for the evaluation of CIMMYT's enhanced germplasm.

The Panel commended CIMMYT for its effort to ensure the viability of seeds in Genebanks, as well as for its collaborative approaches to establish security duplicates off-site.

The Panel noted the commitment of CIMMYT staff to greater evaluation and utilization of genetic resources and to the importance attached by CIMMYT staff to pre-breeding for such utilization.

The Panel recognized the importance of regional networks for germplasm exchange, conservation and utilization and emphasized to CIMMYT management the need to help to ensure continued funding for such networks.

Although the Panel noticed that there were some difficulties to be overcome in the operation and security of the current genebank, it was satisfied with CIMMYT's goal of adhering to the International Genebank Standards, as endorsed by FAO and published jointly by FAO and IPGRI in 1994. This goal will be more fully achieved when the planned new Genebank facilities will be functional, hopefully in 1996. The few minor deficiencies are detailed in the recommendations.

The Panel was pleased to note that, in collaboration with CIMMYT breeders, systematic screening was underway on the wheat collection to ensure authenticity of accession names or derivations.

Difficulties were being experienced in obtaining entry to CIMMYT of ICARDA 'black-box' material because untreated seed did not fulfill Mexican quarantine regulations.

Recommendations

1. That CIMMYT should explore with IPGRI possible sources of funding to mount collecting expeditions to Central America and the Caribbean for maize and to Tibet for hexaploid wheat.

2. When IWIS is completed a review of bread wheat landraces in NARS should be made to ensure that all bread wheat landraces previously collected are in the CIMMYT global collection of bread wheat.

3. Staffing needs of MGB and WGB should be re-evaluated with the increasing workload, especially for additional and better qualified data management staff and the conversion of the temporary WGB Associate Scientist position to permanent.

4. Seed of all accessions of *Tripsacum* should be stored in the MGB active and base collections.

5. Security backup duplicates of all FAO designated germplasm should be placed in long-term storage in off-site genebanks as soon as possible.

6. The Maize Programme should assess the possibility of increasing the utilization of space-saving containers (i.e. aluminum foil bags) in the genebank.

7. CIMMYT should seek additional resources (internal and complementary) to accelerate regeneration of maize landraces currently in Latin American genebanks, as only about 50% are now in the MGB

8. The WGB should use morphological traits and agro-ecological information to promptly designate about 10% of the hexaploid wheat landrace collections as a core subset. The Panel commends the MGB for initiating action on the maize core subset, especially the cooperative work with the Biometry unit to develop improved methodologies. The MGB is encouraged to continue developing and refining the maize core subset.

9. The Panel commends MGB, WGB, Biometry and Biotechnology Units for the excellent research done and encourages continued cooperative research.

CIP

Summary Comments

1. The Panel was impressed with CIP's integrated, multidisciplinary approach in its germplasm conservation work which made good use of resources, especially in reducing, through elimination of duplicates, the number of accessions in its potato collection to more manageable proportions. However, the Panel noted that whilst the Center had in recent years increased the number of its mandate crops, there had not been a concomitant increase in financial and human resources to cope with the extra responsibilities. Thus, while the Panel recognized that financial constraints were limiting CIP's overall operations, it stressed that the Genetic Resources Department and the disciplines related to it are insufficiently supported at present to fulfill properly the Center's objectives in germplasm conservation, evaluation, and utilization.

2. The rigorous and successful procedures and methods developed by CIP for quarantine purposes, both for germplasm imported into Peru and for the distribution of large numbers of virus tested germplasm to many countries throughout the world, also impressed the Panel.

3. The Panel was assured that the data bases used by CIP for its mandate crops are likely to be compatible with the System-wide Information Network on Genetic Resources (SINGER) when it becomes operational.

4. As currently there are no specific International Genebank Standards for CIP's vegetatively produced crops, the Panel was unable to make a comparison of CIP's standards with an internationally established set of guidelines (a recommendation on International Standards for CIP's mandate crops is made below). The Panel was satisfied that CIP's goal is to adhere to International Genebank Standards for seed conservation, as endorsed by FAO and published jointly by FAO and IPGRI in 1994. However, insufficient staff, space and funds have precluded complete adherence to these standards. Recommendations are made to address specific deficiencies.

5. The Panel was pleased to note that CIP had utilized CIAT's expertise to train a CIP scientist in GIS technology. Communication on the potential and methodologies used in GIS work to Genebank staff by a specialist in this area could be beneficial.

Recommendations

1. CIP should take steps to formalize arrangements for all duplicate off-site security backup storage of its seed collections by USDA genebanks.

2. CIP, IPGRI, and FAO should be asked to produce, as soon as possible, a document on *in vitro* Genebank Standards to cover CIP's mandate root and tuber crops, as part of a comprehensive exercise to cover all vegetatively reproduced crops within the FAO International Network of Genebanks.

3. Immediate steps should be taken by CIP to store seed of all its wild *Solanum* species at -15°C irrespective of seed number.

4. Evaluate the need to add a scientist position associated with *in vitro* conservation and cryo-preservation. This scientist might have responsibilities for applied research as well as leadership for *in vitro* and cryo activities.

5. Install electronic access pads and monitoring devices on exterior and interior doors to seed stores, and *in vitro* conservation rooms, and replace locks on cold rooms to permit egress when locked.

6. Install a silica gel dryer that can be maintained at 15° to 20°C with about 35% RH to permit seed to be dried in paper packets to the optimum moisture for storage at 0°C. Seeds can be dried below optimum seed moisture for storage at 0 ° C and -15°C with current methods.

7. Review cryopreservation research at all institutions where there is such research and implement a pilot project as soon as possible.

8. Duplicate Collections in base and off-site security back-up long-term storage facilities as soon as feasible. The Panel also recommends priority for seed production whenever possible and storage in medium and long-term seed storage rooms and off-site locations irrespective of seed members.

9. Pilot project on cryopreservation of potato should be upgraded to routine activity as soon as feasible. Research to develop technologies for cryopreservation of sweet potato and ARTC merit high priority, including in-house and cooperative projects with NARS.

10. Additional laboratory space should be provided for conservation activities that are now inadequate, to expand molecular marker work, and to initiate routine cryopreservation of vegetative potato propagules when the pilot project is completed.

11. Investigate the feasibility of constructing a new facility for germplasm conservation that would include seed conservation, *in vitro* conservation, cryo-preservation, and associated processing and preparation activities. Design should include protection from losses due to earthquakes, vandalism, etc. Electronic monitoring devices (with access pad controls) that signal intrusion alarms to Security headquarters should be installed. Electronic control systems that monitor and signal alarms for all refrigeration and other vital equipment should be installed.

12. All accessions of true potato seed that are sub standard for inability or seed members should be regenerated as soon as possible and true potato seed should be obtained for accessions not yet in the seeds vaults.

13. Isozyme and morphological data should be used now to designate 20 to 30% of the potato collection as a preliminary potato core subset. A molecular marker and evaluation data are obtained, the core can be refined to 10 to 15% of the potato collection. The Panel further recommended that the core subset be given priority for virus clean-up.

14. Agro-ecological and morphological data should be used now to designate 30 to 40% of the sweet potato collection as a preliminary core subset. When PCR data are available, duplicates can be eliminated and the core can be refined to contain 10 to 15% of the sweet potato collection. This core should receive priority for virus clean-up.

15. Agro-ecological and morphological data should be used to designate a preliminary core subset in the ARTC where feasible. Because of the smaller number of accessions, percentages in the preliminary core may need to be higher than for potato or sweet potato. As additional landrace accessions are collected and molecular and other data are obtained, further refinement of each core subset will be desirable.

16. CIP should continue to maintain *in vitro* and/or in cryopreservation (as soon as feasible) the landrace clonal accessions of potato, sweet potato, and ARTC not designated as part of the core subset . These clones may be needed when screening for rare allelles and for improvement by gene transfer. The Panel further recommends that the total crop collection for each crop be grouped into agro-ecological groups (supplemented by molecular marker data when available), and that accessions within each agro-ecological sub-group be intermated to produce seed for each population to capture and preserve allelles (genes) for use by scientists as needed for screening and crop improvement. Seed of these populations should be preserved in the active, base, and off-site duplicate security backup collections.

17. Research should be conducted on procedures that will reduce operational costs such as greater use of computers, drying in paper packets, etc. Use of bar codes is suggested. Because all seed is stored in aluminum foil packets, dehumidification of the medium-term seed store is not needed.

18. Reinforce clean up activities to make more material available for distribution, and where possible, establish contracts with NARS to support and help the cleaning up process.

19. Introduce all available data at CIP on wild potatoes into the CIP's germplasm data base and accelerate the preparation of the wild potato species catalog to make this information readily available to users.

20. In co-operation with IPGRI, develop courses that improve and strengthen capabilities for Genetic Resources management in NARS; such courses should involve ARTC.

21. That CIP should increase partnership courses with other IARCs to optimize capabilities, resources, and to take advantage of the complementary strengths in technology and experience among the IARC's.

ICARDA

Summary Comments

The Panel was satisfied that in its technical operations the ICARDA Genebank (GRU) is adhering closely to International Genebank Standards, as endorsed by FAO and published jointly by FAO and IPGRI in 1994. There is, however, a need to duplicate more material off-site.

The Panel thought that the ICARDA Genebank is operating well, particularly in the collection , conservation and evaluation of cereals and some food and forage legumes. Approximately 75% of the total genebank holdings have been evaluated and 90% of the mandate crops (cereal and food legumes) have been evaluated. However, there is still need for conservation of pasture and forage crops and for evaluation of pasture crops.

The Panel noted the shift in priority for collection and conservation to characterization and evaluation, especially in the food and feed crops. It supports and encourages this change, and welcomes the increased efforts to study the genetic content of the collections and the screening for resistance to biotic and abiotic stresses. High priority should be given to the use of advanced molecular and biochemical techniques for four areas of characterization and evaluation: identification of genotypes, including duplicate collections; fingerprinting of genotypes; analyzing genetic diversity in collections or in

natural stand, and assembling core collections for the different crops. However, the Panel also recognized the tremendous degradation through overgrazing in the WANA region and the subsequent loss in biodiversity, particularly in wild species and pasture and forage species. It therefore strongly supports collecting such species for ex situ purposes and their in situ conservation.

The Panel strongly supports WANANET's activities and urges support of the Working Groups by member countries at national and regional levels. The Working Groups could help to improve communication so that there is more impact, particularly for the end-users of germplasm.

The Panel advises that the replacement/upgrading of documentation equipment should be considered and that lack of storage capacity, particularly for the Active Collection, could cause problems in the near future. The Panel also noted the difficulties caused by lack of low grade storage space for holding harvested material prior to processing.

The Panel thought that there was a need to strengthen appropriate research on seed physiology, particularly of forage and pasture seeds.

The Panel noted that ICARDA's communication strengths with the outside world were weak and encouraged ICARDA to seek ways and means of improving such communication.

ICARDA staff indicated that ICARDA may increase the storage of non-mandated germplasm. However, the Panel thought that space requirements in ICARDA's specialized seed stores should be carefully monitored, as there is increasing pressure for space, particularly in the Active Collection cold store. The Panel therefore advised caution in increasing storage of non-mandated crops.

The Panel was concerned to note the use of daily paid labour for highly skilled tasks.

Recommendations

1. Collecting by ICARDA should continue, particularly of threatened pasture and forage species in the WANA Region.

2. There is a need for more secretarial help in the GRU and there is a strong case for the appointment of a cereal curator.

3. High priority should be given to making arrangements for the safety duplication off site of more material, especially of forage/pasture species.

4. The Panel commended ICARDA for its policy of replacing its older PCs and urged the Centre to give such replacement high priority.

5. ICARDA should strengthen its capabilities in marker gene technology so as to refine the designation of its core collections.

6. ICARDA should explore the possibility of obtaining Special Project funding for training, especially for training on the job.

7. ICARDA should strengthen its research on seed physiology, particularly of pasture and forage seeds.

ICLARM

Summary Comments

ICLARM is at present concentrating its genetic research and conservation efforts on Nile tilapia, and Indo-Pacific giant clams, two species of pearl oysters, and up to ten species of sea cucumber. Future efforts may be extended to include carps, together with additional marine invertebrates and fishes.

The Panel noted that ICLARM is currently reviewing its structure and organization and is well advanced with plans for a new biodiversity and genetic resources programme that have yet to be approved by the ICLARM Board.

ICLARM does not intend to develop large *ex-situ* fish genebanks but will concentrate on strategic research, training, information and methods for natural resources management, and will assist NARS in a decentralized *ex-situ* conservation network.

ICLARM's successful efforts in networking, particularly in INGA, were noted and the Panel supported the expansion of INGA.

The Panel was impressed with ICLARM's database projects, FishBase and ReefBase, both of which contain significant information on FiGR. Close links have been established with the SINGER project. A separate genetic database system has been established to serve the needs of the Genetic Improvement of Farmed Tilapias (GIFT) project.

The Panel was also impressed with the genetic gains made in ICLARM's breeding/selection work in Tilapia and commended the Centre for its collaborative work in testing the improved populations in different countries under different conditions.

The Panel hoped that a formal agreement with the host country will be reached soon.

The GIFT Project is one of ICLARM's most important, productive and successful programmes and the Panel was of the opinion that when the GIFT Project ends in 1997, it is essential that means be found to continue and build on GIFT's current successes.

ICLARM will have to develop Germplasm Acquisition Agreements with source countries and Material Transfer Agreements with source countries and recipients, consonant with the emerging requirements of the CBD.

Recommendations

1. Priority should be given to generation and acquisition of information on FiGR at molecular level and on making this available through FishBase.
2. Cryopreservation activities should be supported at about their present level.
3. The case for maintaining the live tilapia broodstock collection should be re-evaluated in the context of its contribution to overall FiGR conservation.
4. ICLARM should try to have its collections duplicated for safety in other locations, preferably in other countries.
5. ICLARM should develop standards for FiGR in collaboration with appropriate organizations such as FAO and make these available for wider adoption for the conservation and management of FiGR
6. There is an urgent need for ICLARM to embark on formal training in FiGR, especially under the umbrella of INGA.
7. Extra resources should be sought to enable ICLARM to respond to the new challenges presented by the expansion in aquaculture and by developments in molecular biology.

ICRAF

Summary Comments

The Panel recognized that ICRAF s genebank is at an embryonic stage. The large number of species of multipurpose trees and shrubs (MPTS) found throughout the six eco-regions in which ICRAF is involved has inevitably meant that ICRAF has had to focus on a few key species. ICRAF s evolving strategy for genetic resource conservation and utilization is clearly outlined in Appendix V. The Panel thought it important that ICRAF clarify and publicize its policy with respect to its global responsibility for the genetic conservation of MPTS.

Because of the incipient nature of ICRAF s genebank, the Panel considered it advisable for the Centre to commission a mini-review of its new genebank by an external consultant in about two years, by which time the genebank will be fully operational and the research projects associated with it will be at a more advanced stage of development.

The Panel was impressed with the fact that ICRAF had, as an advisory body to the Director-General, an Advisory Committee on Genetic Resources with a membership of highly respected specialists from a number of different countries.

The Panel also noted the excellent and productive links between ICRAF and the Kenya Forestry Research Institute (KEFRI).

Recommendations

1. ICRAF s Board and Director-General should formulate and publicize the Centre's modified policy on the genetic resources of MPTS as soon as possible.

2. ICRAF should re-negotiate its MOU with ILRI on MPTS as soonas possible.

3. ICRAF should consider negotiating MOU's on MPTS with IITA and ICRISAT.

4. ICRAF should consider hiring a Socio-economist to determine the supply and demand of various species and a Taxonomist to undertake morphological studies.

5. ICRAF should pursue possibilities and avenues of acquiring funds for construction of a cold room.

6. Additional greenhouses should be constructed for research purposes within the GRU.

7. All ICRAF scientists involved in germplasm-related collections should operate through the MPT-GRU.

8. ICRAF should instal an incinerator for destroying material infected with important quarantine pests/diseases.

9. ICRAF should initiate awareness promotion campaigns on the dangers of, and the regulations that apply, to exchange of germplasm.

10. ICRAF's GRU should observe the FAO/IPGRI International Genebank Standards in the construction of its new facilities and have a follow-up review of these facilities and operations after two years.

11. The GRU should establish its database to maintain adequate documentation systems according to the International Genebank Standards.

12. Selection of core collections should be done using the taxonomic, morphological and molecular data. For isozyme data, starch gel electrophoresis should be used and as many enzymes as possible analyzed to be able to capture as much variation as possible.

13. Those populations of MPTS with the highest variation and that are most representative of the species should be selected as core collections. Populations with the most unique genes, but not necessarily with the highest variation, should also be conserved in long-term storage but not as core collections.

14. The Panel endorsed the GRU's intention to strengthen its research programme.

15. The GRU should increase its number of papers in scientific journals and other forms of publications.

16. ICRAF should intensify its research on tree improvement so that genetically improved material is released to NARS.

17. ICRAF should explore the possibility of seed multiplication of MPTS on a contract basis by NARS, NGO s and farmers.

ICRISAT

Summary Comments

The Panel observed with satisfaction that ICRISAT's Genetic Resources Unit (GRU) has been elevated to the status of a fully fledged Division (GRD), which confirms its international importance commensurate with the global mandate of five important crops.

The Panel noted that ICRISAT hoped to have a new Head of the Genetic Resources Division in post early in 1996.

The Panel was impressed with the lay-out of the genebank at ICRISAT and observed that, in general, the facilities and technical standards are in conformity with International Genebank Standards.

The Panel was concerned at the financial cuts sustained by the GRD and a 30% reduction in staff as a consequence of a voluntary retirement scheme, but recognised that financial constraints were responsible for such cuts. However, the Panel expressed doubts as to whether the GRD would be able to sustain the level of activities necessary to reduce current bottlenecks in its conservation work. Extra funding would be required to allow the GRD to continue ongoing research programmes.

Although research within the GRD has been at a relatively low level, collaboration with scientists from other disciplines at ICRISAT has had its successes. The Panel was pleased to note that the GRD is, as requested by the ICER on Genetic Resources, addressing the need for better, more effective multidisciplinary research using emerging molecular techniques.

The Panel felt that ICRISAT should examine very carefully its possible involvement in the assembly and maintenance of small, but diverse and representative collections

of regionally important non-mandate crops (as recommended by the ICER on Genetic Resources), unless extra resources become available for the Institute to fulfil its current obligations for existing, mandated crops. ICRISAT should also keep in mind its agreements with its host countries.

The Panel was pleased to note that ICRISAT is taking steps to appoint a Research Fellow for molecular marker work on the outbreeding crop pearl millet, thereby initiating action on the ICER's recommendation for such work. While such a short-term appointment will enable a start to be made, the Panel thought that more human and financial resources will have to be found to ensure meaningful progress in the molecular area.

The ICER recommendation that ICRISAT define clearly and rigorously the genepool of each of its mandate crops, including related wild species, has been partly addressed by the Institute with the short-term appointment of a visiting scientist to work on sorghum.

The Panel strongly endorsed the recommendation made by ICER that ICRISAT should urgently develop and implement a strategy for speeding up the process of transferring collections to long-term storage. The Panel made suggestions and recommendations that could reduce bottlenecks and accelerate germination tests, seed multiplication and drying. One such recommendation was that ICRISAT should consider contracting NARS to do seed multiplication. While ICRISAT tackles the problem of meeting International Standards for all, or most of its material, it should also investigate the advantages and disadvantages of transferring samples of all its active collections to long-term storage.

The Panel encouraged ICRISAT to look carefully at results from other Institutions on the cryopreservation of orthodox seeds, particularly in terms of cost implications vis-a-vis seed storage under low temperature/humidity.

The Panel observed a need at ICRISAT for research on seed physiology that is related to the genetic conservation of its mandate crops.

While the Panel was impressed with the GRD's herbarium of wild species of *Arachis*, it thought that a seed sample and a photograph of the accession and a plate of its chromosomes, would enhance the value of each herbarium sheet.

The Panel commended ICRISAT's Plant Quarantine Unit for its close and effective links with the NBPGR Plant Quarantine Service, which issues import licenses and phytosanitary certificates for export of material.

The GRD's new screenhouse for wild *Arachis* species that have to be maintained and propagated vegetatively is serving a very useful purpose. The screenhouse is also enabling the characterisation of accessions of seed-producing wild species under disease-free conditions and the seed production of such accessions. The Panel was

supportive of work that had been initiated on *in vitro* storage of vegetative material of legume crops, as this could lead to the easier conservation of wild non-seed-producing species. Cryopreservation technology may soon lead to the long-term conservation of wild species of *Arachis*.

The Panel was disappointed with the lack of short-term training courses on genetic resources at ICRISAT. It thought that for the future, such courses could be held jointly with other IARC's and NARS, both in the host country and in the regions. The Panel noted that ICRISAT is reviewing the needs of its own staff for training.

The Panel was impressed by the success of ICRISAT's germplasm, some of which was being used directly by farmers. A strong contribution to NARS has also been made by germplasm - derived hybrids and varieties.

The Panel thought that ICRISAT should develop and refine core collections of its mandate crops. It could benefit from greater use of Geographic Information Systems (GIS) technology in its genetic resources work.

Recommendations

1. ICRISAT should review its linkages with other Centres, networks and NARS with a view to developing formal agreements which are clear in defining respective responsibilities for genetic resources.

2. ICRISAT should seek to standardise its agreements for safety duplication and for collection procedures through the SGRP.

3. ICRISAT should give higher priority to the collection, conservation, characterisation and utilisation of wild related genepools of ICRISAT's mandate crops.

4. ICRISAT should consider strengthening its human resources in the GRD.

5. ICRISAT, as a matter of urgency, should develop and implement a strategy for speeding up the process of transferring its collections to the long-term storage facility.

6. ICRISAT should urgently review its arrangements for safety duplication off site of its collections with a view to ensuring that the appropriate legal arrangements with FAO are in place for timely transfer of duplicate samples of all accessions to acceptable long-term storage facilities in other countries.

7. ICRISAT should initiate a pilot programme on cryopreservation of existing germplasm and the GRD should enhance its research on excised embryo preservation.

8. Regeneration of seed could be enhanced by contractual arrangements with NARS, especially with countries of origin of germplasm of respective crops, from special funds.

9. At present there is no staff position of Senior Scientist responsible for Genebank operations, therefore ICRISAT should consider establishing a Senior Germplasm Scientist position to oversee and participate in the day-to-day genebank operations and to lead the research program on Seed Physiology related to genetic conservation of mandated crops.

10. A core subset of ICRISAT's mandate crops should be established in the first instance based on the agro-ecological and morpho-agronomic diversity (of highly heritable attributes). This should be further confirmed for at least two seasons and at three distinct locations (within a country and perhaps between countries) supported by clustering and component analysis. Further refinement should be possible using biochemical/molecular characterisation data (isozyme and DNA levels).

11. There is a need for in-depth studies on seed longevity and seed physiology of ICRISAT's mandate crops.

12. Opportunities for training of ICRISAT staff should be made available, either nationally or internationally, wherever expertise and facilities for appropriate technologies exist.

13. That solarization of sick plots, longer crop rotation, hot summer cultivation and soil sterilization methods may be appropriately incorporated for the amendment of soil in consultation with soil experts.

14. Appropriate locations would be identified within the host country or in the region for photoperiodic sensitive germplasm which could be regenerated/rejuvenated with the active collaboration of NARS. Wild species could be grown under *in situ* conditions, and landraces in the country of origin (if possible) or else maintained under controlled greenhouse conditions.

IITA

Summary Comments

The Panel was impressed with the amount of material from IITA's collections already designated to FAO. The Panel recognised that financial constraints are limiting, but thought that the GRU was underfunded in relation to the Institute's total budget. It also thought that the staffing position should be reviewed (a recommendation is made later).

The Panel was impressed with IITA's collecting record; for each expedition there is an appropriate publication/report.

The Panel noted that INIBAP had requested IITA to hold a tissue culture collection of *Musa*.

Power cuts are not infrequent at IITA. Fortunately for both the Genetic Resources Unit (GRU) and Biotechnology Research Unit (BRU) they have priority to the Centre's own generator and are covered 24 hours per day. Nevertheless, uncertainties at IITA emphasize the important need for IITA to have all its collections duplicated off-site.

The Panel was impressed with the care that IITA took in "back-up" checking for, and elimination of diseases, (particularly viruses) in existing and imported material but noted that the clean-up of collections seemed to be an endless task, especially for cowpea and wild *Vigna*. The Seed Health Unit (SHU) was providing useful information to the GRU on susceptibility to a range of diseases.

At Ibadan, the Panel visited IITA's mature agroforestry arboretum which was established in 1979 and it also visited the ICRAF/IITA/Oregon State University arboretum of multipurpose trees and shrubs (MPTS) which was established in 1991. The Panel was impressed to note the close and fruitful collaboration between IITA and ICRAF on MPTS and thought it timely for IITA and ICRAF to prepare and sign a Memorandum of Understanding (MOU) on MPTS (a recommendation to this effect is made later).

The Panel was satisfied that at a technical level IITA was adhering closely to International Genebank Standards, as endorsed by FAO and published jointly by FAO and IPGRI in 1994. Difficulties were, however, being experienced in placing duplicate collections off-site.

The Panel thought it important for CGIAR Centres which have in-vitro collections to address together the difficulties in placing duplicate collections of such material off-site.

The publication record of GRU scientists and their collaborators was indicative of a good team performance.

Recommendations

1. IITA should prepare and sign with ICRAF an MOU on MPTS as soon as possible.

2. IITA should to pursue its search for funding to support its proposal for the conservation of yam biodiversity for the development of sustainable agriculture.

3. As IITA has the capabilities and facilities to collect and conserve African maize germplasm, it should, after discussions with CIMMYT, seek funding to do so and ensure that a duplicate set of such a collection is deposited at

CIMMYT, in addition to depositing such material with NARS in the country of origin.

4. The scientific staff position of the GRU should be reviewed to increase support for the Unit programs.

5. As the GRU appears to be underfunded for the scale of required operation consideration should be given to increasing the financial support for the Unit.

6. There is insufficient storage space for yam tubers. Additional yam barn and tuber store are required to augment the existing facilities.

7. All FAO designated germplasm should be placed in off-site genebanks for duplicate safety storage as soon as possible. As many as possible of the field accessions of yam should be maintained in the form of seed and as in vitro cultures. The Panel endorsed the GRU's high priority to speed up the duplicate storage for safety.

8. The GRU should increase the regeneration standards of bambara groundnut to meet the International Genebank Standards(64%) = 75% x 0.85.

9. The Panel commended GRU, Biotechnology, Seed Health and Virology Units for their excellent publication record and the research that has been accomplished, and recommended continued cooperation between these Units on research.

10. IITA should intensify its efforts to arrange promptly for formal duplication of its in-vitro collection off-site.

11. IITA should continue to enhance its considerable collaboration with other CG Centres, NARS and NGO's to ensure that live collections are safe and grown under appropriate conditions.

12. IITA should seek ways and means to strengthen its molecular and GIS capabilities that are appropriate to genetic resources work.

13. IITA should continue to review carefully the number of crops and species in its GRU with a view to concentrating on those species most relevant to its research needs or that are in danger of genetic erosion.

ILRI

Summary Comments

The Panel noted that ILRI was currently in a transitional phase and that changes were also occurring in the facilities and human resources of ILRI's Genebank that will influence the future program of the genebank.

The Panel also noted and supported ILRI's intention to make use of the comparative advantage of ILRI's Nairobi facilities and expertise on molecular biology and GIS to strengthen the genetic resources research program. Stronger collaboration in these areas between ILRI and CIAT, particularly on forages, could also be mutually beneficial.

The Panel was informed by ILRI's staff that the data bases used by ILRI were likely to be compatible with the CGIAR System - wide Information Network on Genetic Resources (SINGER) The Panel supported ILRI's decision not to introduce future changes to its database programs until SINGER becomes operational.

The Panel was satisfied that ILRI's goal is to adhere to International Genebank standards, as endorsed FAO and published jointly by FAO and IPGRI in 1994. However, there is a need for ILRI to establish speedily a base collection which meets International standards (a recommendation to that effect is made later).

The Panel visited the seed production unit at Debre Zeit, where it saw regeneration of a wide range of genetic resources material in the field, as well as multiplication of large seed lots for evaluation and seed release purposes. It was impressed with the laboratory and field facilities, the organization, the efficiency and productivity of the unit and noted that training courses held at Debre Zeit for NARS scientists, NGO staff and farmers served to increase the likelihood of better utilization of ILRI's genetic resources.

The Forage Genetic Resources management at ILRI sought guidelines from IPGRI on priority setting for regeneration of forages collected by IPGRI and deposited at ILRI.

The Panel recognized the difficulty faced by ILRI in regeneration of the out-breeding species in its collection and commend the Centre for its work to determine optimum population size. A recommendation is made later whereby ILRI could speed up the process of seed regeneration/multiplication.

The Panel was concerned to note that plant quarantine standards within Ethiopia are largely based on visual inspection and supported the Centre in its efforts to improve the detection and elimination of plant diseases in imported and exported material. The panel noted ILRI's intention to establish a Post-entry Quarantine System at ILRI and fully supported such a move.

The Panel was informed that changes were being made in the Soil and Plant Nutrition Project that included the transfer of a Rhizobium collection of 230 strains to Genetic Resources where policy on access to an active collection will be the same as that followed for plant genetic resources.

Recommendations

1. ILRI should review the scientific staffing position within its genebank.

2. ILRI should give high priority to establish a full base collection which meets International Genebank Standards. The Panel also recommended that CIAT, ICARDA and ILRI should make clearer their policy on the location of base collections of forages.

3. ILRI should complete the initial germination tests for all accessions as soon as possible. The genebank should make improvements in order to meet all International Standards.

4. ILRI should take action to speed up the regeneration process, including considering the contracting out of multiplication with national programmes and NGO's. Inevitably, such a move will incur extra costs.

5. ILRI should continue to give high priority to characterization and preliminary evaluation of the key species of its forage genetic resources.

6. ILRI should intensify its efforts to provide more information with its samples.

7. ILRI should intensify its cooperative research with centres of excellence and universities in the important areas of seed physiology, molecular genetics, anti-nutritional factors and characterization.

8. Germplasm evaluation and characterization information should be made available to help utilizers easily identify materials of potential interest.

IPGRI/INIBAP

Summary Comments

The Panel was impressed by the close and productive links between the Katholieke Universiteit Leuven (KUL), Belgium and IPGRI/INIBAP. KUL's research strengths in molecular and cell and tissue culture technologies provide a strong basis for enhancing the genetic conservation and utilization of bananas and plantains.

The Panel agreed with IPGRI/INIBAP's concern about the need to collect more representative genetic diversity of wild and edible species of *Musa*, particularly in

view of the need to find different sources of resistance to the major diseases and pests of plantains and bananas. However, the Panel also thought that among the cultivated and wild forms in the *Musa* collection there is a need to utilize more fully molecular techniques and characterization data to quantify genetic variation in the existing collection and to identify duplicates.

The Panel noted the successful international network of IPGRI/INIBAP for *Musa* taxonomic studies, breeding, cultivar evaluation and disease resistance screening.

The Panel welcomed IPGRI/INIBAP's efforts to improve off-site duplication of its *Musa* collection for safety purposes, but was concerned to note that currently only 39% of the collection held at KUL has so far been duplicated.

The protocols developed by KUL for genetic conservation of *Musa* gemplasm *in-vitro* will provide useful guidelines in the development by FAO/IPGRI of Genebank Standards for vegetatively propagated crops.

The Panel observed that, as a non-banana producing country, Belgium does not require KUL to have a phytosanitary certificate or import permit for the importation of *Musa* germplasm, but for export purposes KUL follows international phytosanitary requirements.

The Panel commended INIBAP/KUL for their close collaboration with the three virus indexing centers located in France, Australia and Taiwan. Although disease detection kits for *Musa* are being developed through contracts with appropriate centers of excellence, much remains to be done. Methods for eliminating viruses from infected material are also being sought.

The Panel was very impressed with the excellent research that has been done at KUL on cryopreservation of meristems of *Musa*. In view of the extensive interest in, and active research on, the cryopreservation of vegetatively propagated crops which are part of the CGIAR Centres' mandates, the Panel thought that cryopreservation work should be given high priority in the System-wide Initiative on Genetic Resources. Centers that are involved in cryopreservation research should, therefore, be encouraged to share their results and experiences as soon as possible, preferably in the forum of a workshop/colloquium organised by the Inter-Center Working Group on Genetic Resources.

The Panel was satisfied that in the development of its database and information exchange, INIBAP aims at compatibility with the System-wide Information Network on Genetic Resources (SINGER).

The Panel was concerned to note the lack of direct feed-back from recipients of *Musa* germplasm on characterization and performance and urged IPGRI/INIBAP to continue to emphasize to their partners the importance and urgency of such feed-back.

Recommendations

1. The recent collecting missions and the expected collection in South China, Indonesia and islands of the East-Africa coast will increase the number of accessions at ITC as well as the demand for them. Therefore, the Panel recommended that an extra technician for routine culture and multiplication of germplasm should be considered in the 1996 budget.

2. The virus indexing activity should be completed as soon as possible. The development of therapeutic methods to clean infected accessions should also be given high priority.

3. The Panel noted with satisfaction that a user-friendly cryopreservation technique for meristems has been developed for *Musa* by KUL and recommended that IPGRI/INIBAP should speed up the process for establishing the base-collection of banana germplasm by cryopreservation, at least for some cultivars.

4. IPGRI/INIBAP should try to complete off-site safety duplication of the *Musa* germplasm collection as soon as possible.

   Genetic stability is an important requirement of *in vitro* conservation. While the use of molecular markers (e.g. RAPDs) to evaluate stability is important, the Panel recommended that a combination of approaches, including morphological (in field and *in vitro*), isozymes, and molecular (RFLP, RAPDs, etc.) would be more appropriate and need to be developed. Additional research topics could also include:
   - Cryopreservation of *in vitro* cultures of cultivars which are sensitive to the current method
   - Seed storage for long-term conservation and dormancy breaking
   - Long-term pollen storage
   - Use of molecular techniques for diversity studies and characterization.

5. ITC customers should be provided with more information on plant characteristics and with the different names given to each accession, so as to assist them in making decisions on material requested from the ITC.

6. A systematic field evaluation should be made to check the general appearance of plants of cultivars maintained at the genebank. Accessions could be selected at random and evaluation done at IPGRI/INIBAP's field reference collections, under specific agreements with host institutions. This will also help in completing ITC records on plant characteristics of collected accessions.

IRRI

Summary Comments

The Panel was very impressed with the excellent organization, quality and productivity of staff, technical operations and facilities of IRRI's genebank, and commended IRRI for the status and importance that the Institute accords to genetic resources. The IRG at IRRI is one of the best in the CGIAR System and serves as a model for others to emulate. With the updating of computer facilities, the IRG's performance will be further increased.

IRRI is currently engaged with collaborators on an impact study of the contribution made by germplasm from the genebank. The Panel was disappointed to learn that in the pedigrees of many of IRRI's varieties, details of germplasm accessions are not recorded.

The Panel noted that IRRI's collections of *Azolla* and aquatic legumes were unique. The issue of collections of microbes and other organisms which currently do not fall within the category of material designated to FAO, should be addressed by the ICWG-GR.

The Panel commended IRRI for its publication "Manual of Operations and Procedures of the International Rice Genebank". Other Centers could benefit from using this manual as a basis for the preparation of manuals on the genetic resources of their own mandate crops.

The Panel was encouraged to note the widespread networking arrangement that is possible as a consequence of the project *Safeguarding and Preservation of the Biodiversity of the Rice Genepool*. It advised IRRI to extend this network to include the NARS of more countries from Africa and Latin America.

The Panel was satisfied with the current arrangements and policy for material designated under IRRI's Agreement with FAO.

In research, there is a gap in the field of seed physiology with respect to storage. After 35 years, the Center is well established and running efficiently. More effort should now be focused on research to solve problems such as seed dormancy and to explore other alternative methods of storage such as cryopreservation and the use of ultra dry seeds. The setting up of the molecular biology laboratory will be very useful in biosystematics studies. Research on regeneration of accessions should be expanded with the aim of keeping regeneration to a minimum and also to extract as much information as possible from those accessions which are due for regeneration.

Research workers appear to be mainly international staff. Local staff members should also be encouraged to conduct research. As the system becomes streamlined and computerized, this should allow them some time for research.

The Panel observed that the IRG's Standard Order Form was in line with the FAO/IPGRI draft Material Transfer Agreement (MTA). Although IRRI does not currently use a Germplasm Acquisition Agreement (GAA), written documentation accompanies each consignment of germplasm that is sent to IRRI. These documents state clearly that germplasm should become part of the rice collection at IRRI and may be distributed freely to research workers world wide.

The Panel commended IRRI for its good publication record on genetic resources.

The Panel was very pleased to note that NARS in both developing and developed countries comprised a significant number of the recipients for the genebank. The large number of samples distributed yearly indicates the importance that rice researchers worldwide put on the IRG's germplasm collection. Moreover, the use of several accessions has had a major impact on rice improvement.

The Panel was pleased at the positive impact that training at IRRI had made to the upgrading of NARS capabilities in genetic resources work, not only on rice but in other crops as well.

Recommendations

1. IRRI should arrange and sign formal agreements with WARDA and IITA to cover the collaborative work on genetic resources of rice undertaken by the respective Centers.

2. IRRI should consider duplicating its rice collection in more than one location and it should arrange to duplicate off-site for safety purposes those accessions that are currently stored only at IRRI.

3. IRRI should review its policy on core collections so as to develop sub-sets for special purposes.

4. More research is required on seed physiology related to seed storage. Such research should include studies on the effect of long-term storage on viability, vigor, and chromosome aberrations.

5. The IRRI germplasm database should be made widely accessible as early as possible, using available electronic communication technologies (e.g. on-line through Internet; local area network; CD-ROM format, others).

6. A regular monitoring system should be adopted to continuously appraise the utilization of its distributed germplasm. Since IRRI scientists themselves are

the biggest recipients and users of the germplasm, and directly responsible for major efforts in genetic enhancement, varietal development, and rice research in general, an in-house germplasm utilization monitoring system should be readily established.

7. IRRI management should take steps to ensure the continued employment of key laboratory technicians in IRRI's International Rice Genebank to enable the Institute to continue to fulfill its obligations under the Agreement with FAO and to meet fully International Genebank Standards.

WARDA

Summary Comments

The Panel was informed that WARDA's present policy is not to house a genebank at WARDA but to utilize the rice genebanks at IRRI and IITA, with whom WARDA has a formal agreement whereby IITA stores material from WARDA in a base collection and duplicate samples are deposited at IRRI. WARDA is currently reviewing its policy, a new agreement is being negotiated with IRRI and there is a possibility, provided funds become available, that WARDA may build a large seed storage facility to increase the size its working collection.

WARDA staff emphasized to the Panel the importance of rice germplasm to the success of WARDA's on-going research programmes, particularly in providing to WARDA's breeders and their NARS partners useful sources of genetic resistance/tolerance to a wide range of pests/diseases and abiotic stresses. African indigenous germplasm has been largely untapped but shows considerable promise. Additionally, *Oryza glaberrima* is a source of genes controlling traits (such as resistance to blast, to rice yellow mottle virus (RYMV), tolerance to drought and acidity, and excellent vegetative growth capable reducing weed damage) that are particularly useful to breeders. Current breeding is directed at unlocking and utilizing this source of useful genes to produce improved varieties.

The close links that WARDA has established with its NARS partners are enhanced through the operation of Task Forces. These Task Forces are theme oriented teams, with NARS and WARDA members who meet annually to define priorities and set courses of action.

In addition to contributing to the International Network of Germplasm Evaluation of Rice(INGER), from its upland rice programme WARDA distributed 8245 samples representing 4,615 accessions of upland rice over the three-year period 1992-94. It also distributed samples of lowland, mangrove and Sahel irrigated rice but details are not available.

In view of the large numbers of rice samples/accessions regularly being imported to, and exported from, WARDA, the Panel was pleased to note that WARDA has been successful in obtaining funding from DANIDA to set up a Quarantine Facility for rice at M'bé. Backstopping for this facility will initially be provided by the Danish Government Institute for Seed Pathology (DGISP). When robust disease detection methods became available, WARDA should utilize such methods in its Quarantine Facility.

The Panel thought that at an appropriate time an assessment should be made of the agreement between IITA and WARDA to ensure that the requirements of both Centres, their partners and clients, continue to be met.

As seed of some of the material designated by WARDA to FAO is being stored under conditions that lie out with those recommended for International Standards, it would be appropriate for WARDA, IITA and FAO to discuss the legal standing (in relation to WARDA's agreement with FAO) of such material.

Recommendations

1. The Panel noted WARDA's reconsideration of its "no genebank policy" and recommended WARDA to place its whole FAO designated germplasm collection in an active collection which meets the International Genebank Standards.

2. WARDA should complete off-site duplication for safety purposes as soon as possible.

3. The characterization at WARDA is done on an agro-morphological basis. If WARDA is going to build up its genebank, the constitution of a core collection for each ecology (upland, lowland, mangrove, and Sahel irrigated) will be needed. The use of molecular markers will be necessary to help designate the accessions for upland, lowland, mangrove and Sahel irrigated core subsets.

Appendix 5

ACRONYMS AND ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
AFLP	Amplified Fragment Length Polymorphisms
AFNETA	Alley Farming Network for Tropical Africa
AFRNET	African Feed Research Network
AIHD	Australian Institute for Horticultural Development
AIT	Asian Institute of Technology, Bangkok, Thailand
AKVAFORSK	Norwegian Institute of Aquaculture Research
AnGR	Animal Genetic Resources
ARCS	Austrian Research Centre at Seidersdorf
ARTC	Andean root and tuber crops
ASI	Advanced Scientific Institutions (in developed and developing countries)
AVRDC	Asian Vegetable Research and Development Center
AWCC	Australian Winter Cereal Collection
B	Beans
BARN	Bean Advanced Research Network
BCMV	Bean Common Mosaic Virus
BFAR	(Philippine) Bureau of Fisheries and Aquatic Resources
BGRP	Biodiversity and Genetic Resources Program
BOT	Board of Trustees
BP	Bean Program
BRA	Brazil
BRU	Biotechnology Research Unit
C	Cassava
CAC	Coastal Aquaculture Centre (ICLARM), Solomon Islands
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CBD	Convention on Biological Diversity
CCMV	Cassava Common Mosaic Virus
CCRRSP	Coastal and Coral Reef Resource Systems Program
CENARGEN	Centro Nacional de Recursos Geneticos
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research
CGIAR-GR	CGIAR-Genetic Resources
CHM	Clearinghouse Mechanism (of the Convention on Biological Diversity)
CHN	China
CIAT	International Center for Tropical Agriculture
CID	Crop Improvement Division IITA
CIFOR	Center for International Forestry Research, Jakarta, Indonesia
CLSU	Central Luzon State University
CIMMYT	Centro Internacional de Mejoramiento-Maíz y Trigo
CIP	Centro Internacional de la Papa
CITES	Convention on International Trades of Endangered Species
COL	Colombia

CONABIO	Mexican National Commission for the Study and Use of Biodiversity
CONDESAN	Consortium for the Sustainable Development of the Andean Ecoregion
COSCA	Collaborative Study of Cassava in Africa
CP	Cassava Program
CPGR	Commission on Plant Genetic Resources
CRI	Costa Rica
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CsXV	Cassava X Virus
CUB	Cuba
DANIDA	Danish International Development Agency
DEGITA	Dissemination and Evaluation of Genetically Improved Tilapia in Asia
DG	Director General
DGISP	Danish Government Institute for Plant Pathology
dsRNA	Double Strand RNA
EARRNET	East Africa Roots Crops Research Network
ELISA	Enzyme Linked Immuno-Sorbent Assay
EMPRAPA	Empresa Brasileira de Pesquisa Agropecuaria
EMR	External Management Review
EPR	External Programme Review
ESU	Evolutionarily Significant Unit
FAC	Freshwater Aquaculture Center
FAO	Food and Agriculture Organization of the United Nations
FIA	Federal Institute of Aerobiology
FiGR	Fish Genetic Resources
FONAIAP	Fondo Nacional de Investigaciones Agropecuarias, Venezuela
FORTIPAPA	Fortalecimiento de la Investigación y Producción de Semilla de Papa, Ecuador
FSD	Frog Skin Disease
FUNDAGRO	Fundación para el Desarrollo Agropecuario, Ecuador
GAA	Germplasm Acquisition Agreement
GD	Genetic Diversity
GIFT	Genetic Improvement of Farmed Tilapias
GIS	Geographical Information Systems
GR	Genetic Resources
GRIP I	Genetic Resource Information Package I
GRU	Genetic Resources Unit
HQ	Headquarters
IARC	International Agricultural Research Center
IARSP	Inland Aquatic Resource Systems Program
IBGRN	International Barley Genetic Resources Network
IBPGR	International Board for Plant Genetic Resources
IBTA	Instituto Boliviano de Tecnologia Agropecuaria
ICA	Colombian Agriculture and Livestock Institute
ICARDA	International Center for Agricultural Research in the Dry Areas
ICD	International Corporation Division
ICLARM	International Center for Living Aquatic Resources Management
ICRAF	International Centre for Research in Agroforestry

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICWG	Inter-Center Working Group
ICWG-GR	Inter-Centre Working Group on Genetic Resources
IDEA	Institute of Advanced Studies, Venezuela
IFPRI	International Food Policy Research Institute
IICA	Instituto Interamericano de Cooperación para la Agricultura
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases
ILRI	International Livestock Research Institute
IMER	Internally Managed External Review
IN	International Nursery Co-operator Network
INGA	International Network on Genetics in Aquaculture
INIA	Instituto Nacional de Investigación Agraria, Peru
INIAP	Instituto Nacional de Investigaciones Agropecuarias, Ecuador
INIBAP	International Network for the Improvement of Banana and Plantain
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias, Mexico
INGER	International Network of Germplasm Evaluation of Rice
INTA	Instituto Nacional de Tecnologia Agropecuaria, Argentina
IPGRI	International Plant Genetic Resources Institute
IPR	Intellectual Property Rights
IRAT	Institute de Recherche en Agriculture Tropical
IRRI	International Rice Research Institute
ISC	ICRISAT Sahelian Centre
IUCN	World Conservation Union, Gland, Switzerland
IWGRN	International Wheat Genetic Resources Network
IWIS	International Wheat Information System
KARI	Kenyan Agricultural Research Institute
KEFRI	Kenyan Forestry Research Institute
LAC	Latin American and Caribbean
LAMP	Latin American Maize Project
MENA	Middle East and North Africa
MGB	Maize Germplasm Bank
MOU	Memorandum of Understanding
MPA	Marine Protected Areas
MPTS	Multiple Purpose Trees and Shrubs
MPT-GRU	Multiple Purpose Tree- Germplasm Resource Unit
MTA	Material Transfer Agreement
MTP	Medium-term plan
NACGRAB	National Centre for Genetic Resource Conservation and Biotechnology, Nigeria
NARS	National Agricultural Research Systems
NBPGR	National Bureau of Plant Genetic Resources
NCSU	North Carolina State University, USA
NFFTRC	National Freshwater Fisheries Technology Resource Center
NGO	Nongovernmental Organization
NPQS	National Plant Quarantine Service

NSSL	National Seed Storage Laboratory
ODBC	Open Data Base Connectivity
OFI	Oxford Forestry Institute
ORSTOM	Institut Francais de Recherche Scientifique pour le Developpment en Cooperation
PCR	Polymerase Chain Reaction
PGR	Plant Genetic Resources
PHMD	Plant Health Management Division
PQS	Plant Quarantine Service, Nigeria
PRACIPA	Programa Andino Co-operativo de Investigación en Papa
PRAPACE	Programme Régional de l'Amélioration de la Culture de la Pomme de Terre et de la Patate Douce en Afrique Centrale et de l'Est
PRECODEPA	Programa Regional Co-operativo de Papa, CIP network in Central America and the Caribbean
PROCIPA	Programa Co-operativo de Investigaciones en Papa, CIP network in Southern Cone
PROFIZA	Programa Cooperativo Regional para la Zona Andina
PROFRIJOL	Programa Cooperativo Regional de Frijol para Centro América, Mexico y el Caribe
PROINPA	Proyecto de Investigación de la Papa, Bolivia
RAC	Station Federal de Recherches Agronomiques de Changing, Switzerland
RAPDs	Random amplified polymorphic DNA
RCMD	Resources and Crop Management Division, IITA
REDARFIT	Red Andina de Recursos Fitogenéticos (Andean Network on Plant Genetic Resources)
REMERFI	Red Mesoamericana de Recursos Fitogenéticos
RIEPT	Red Internacional de Evaluación de Pastos Tropicales
RFLPs	Restriction Fragment Length Polymorphisms
RRPMC	Regional Research Program for Maize and Cassava
RYMV	Rice Yellow Mottle Virus
SADC	Southern Africa Development Community
SARH	Secretaria de Agricultura y Recursos Hidráulicos
SBSTTA	Subsidiary Body for Scientific, Technical and Technological Advice
SEAFDEC	Southeast Asian Fisheries Development Center
SGRI	System-Wide Genetic Resources Initiative
SGRP	System Wide Genetic Resources Program
SHL	Seed Health Laboratory
SHU	Seed Health Unit
SINGER	CGIAR System-wide Information Network on Genetic Resources
SIS	Svalbard International Seed Bank, Norway
SISTEM	Species Information Seed, Trials and Environment data Management
SRG	Scientific Resources Group
SSA	Sub-Saharan Africa
TAC	Technical Advisory Committee of the CGIAR
TAES of Texas A&M	Integrated Information Management Laboratory of Texas Agricultural Experiment Station
TFP	Tropical Forages Program

TPP	Tropical Pastures Program
TROPIGEN	Red Tropical de Recursos Geneticos
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USDA-ARS	United States Department of Agriculture-Agricultural Research Service
VRU	Virology Research Unit
WANA	West Asia and North Africa
WANANET	WANA Plant Genetic Resources Network
WARDA	West Africa Rice Development Association
WGB	Wheat Genebank

LINKAGES OF CGIAR CENTRES WITH OTHER GERMPLASM CONSERVATION CENTRES, INCLUDING REGIONAL AND NETWORKING ARRANGEMENTS

CIAT

CIAT's wide ranging collaborative links in genetic resource conservation are summarized in Table A.3.1.

The GRU collaborates with the Programa Cooperativo Regional de Frijol para Centro América, México y el Caribe (PROFIJOL) and Programa Cooperativo Regional Para la Zona Andina (PROFRIZA); bean networks for Central America and the Andean region, respectively. Both the GRU and BRU are also members of the Cassava (Biotechnology) Network, where a subnetwork deals specifically with cassava genetic resources. The BRU has also been instrumental in the creation and development of the Bean Advanced Research Network (BARN) with important participation of the GRU. The GRU has been collaborating in the Red Internacional de Evaluación de Pastos Tropicales (RIEPT), an evaluation network developed for tropical forages.

The GRU has on-going linkages with partners of the regional plant genetic resources networks sponsored by IPGRI: REDARFIT for the Andean Region, and REMERFI for Central America, as well as with the Amazonian network TROPIGEN.

The GRU is involved in the organization of a Latin American and Caribbean (LAC) Alliance in Agrobiodiversity Conservation. This is a CIAT initiative, in partnership with IPGRI, Centro Internacional de la Papa (CIP) and Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), and responds to the CGIAR System-wide Genetic Resources Program (SGRP). The participation of LAC countries in a first scoping workshop with regional organizations such as FAO, Instituto Interamericano de Cooperación para la Agricultura (IICA), Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), will be convened by the LA UNEP Office in Mexico.

CIAT has formal agreements with CENARGEN, Brazil, and CATIE, Costa Rica, for the duplication of *Phaseolus vulgaris* collections. Although duplicate sets of CIAT's *Phaseolus* are stored in USDA's active and base collections, there is no formal agreement.

CIMMYT

For wheat CIMMYT deals with three informal networks, 1) The Global Wheat Genetics Resources Network, and 2) the International Nursery Cooperator Network (IN), and the Genetic Resource Information Package I (GRIP I).

The Global Wheat Genetic Resources Network has been initiated recently. A global database associated with the network is being developed and is expected to distribute information to users in the future. The IN has been in existence for more than 30 years and works on a reciprocal basis for seed exchange. The GRIP network is collecting information on pedigrees of released and named wheat and has involved all continents.

The Wheat Genetic Resources Unit interacts with national agricultural research systems (NARS) by acting as a backup for national collections; responding to requests for germplasm and by acquiring specific germplasm from national program to be included in the bank; asking for assistance in verifying the identity of accessions in question; requesting evaluations that cannot be conducted in Mexico; and participating in collection expeditions.

During 1989, CIMMYT and International Center for Agricultural Research in the Dry Areas (ICARDA) entered into an agreement whereby the global base collections for bread wheat and triticale are to be maintained by CIMMYT while global collections of durum wheat and wheat wild relatives are to be maintained by ICARDA. Each center provides back-up service to the other, so that both collections are safeguarded in at least two locations.

The MGB has a cooperative arrangement with the USDA National Seed Storage Laboratory (NSSL) for duplicate storage, which has been formalized with the signing of a Memorandum of Understanding (MOU). There is a separate MOU between NSSL and CIMMYT for the duplicate storage (as black box) of CIMMYT's wheats by the NSSL. The MGB has also cooperated with the Latin American National maize banks of Mexico, Guatemala, Colombia, Ecuador, Peru, Chile, Argentina, Brazil, Paraguay, Venezuela, Costa Rica, Cuba, Honduras, Bolivia in the regeneration and back-up storage of maize landraces since 1992 with complementary funds provided by USAID and USDA. Current agreements for this work will end in 1996, but new ones are planned to pursue the on-going work of conserving Latin American maize germplasm. The MGB has supported the Latin American Maize Project (LAMP) by providing accessions to the countries of origin, in germplasm evaluation, and other types of participation. The project has constituted a well coordinated international network for maize germplasm conservation. A subsequent LAMP-type project will be proposed to further develop the existing Latin American maize conservation, evaluation and utilization network in this project. Both germplasm networks (LAMP and the regeneration project) have significantly strengthened the conservation of maize germplasm which was collected in the region by the Rockefeller Foundation and the US National Research Council, in the 1940s and 1950s and also those collected in Latin America in more recent years.

Table A.3.1. CIAT COLLABORATIVE LINKS IN GR CONSERVATION (1992-95)

	BEANS	CASSAVA	TROPICAL FORAGES
ACQUISITION	NARS: **Mexico, Guatemala, Perú, Ecuador,Colombia**	NARS: **Argentina, Guatemala, Brazil, Salvador, Bolivia**	NARS: S.E. **Asia, Colombia, Brazil**
CHARACTERIZATION/DIVERSITY			
• BOTANICAL	**Belgium** (Gembloux), **USA** (Fort Collins), **Colombian** Univs.	**Colombian** Univs, **Brazil** (CENARGEN)	**Colombian** Univs, **Brazil** (CENARGEN), **U.K.** (Kew Gardens)
• BIOCH./MOLECULAR	**USA** (Univ. of Calif.,Davis; Univ. Wisconsin), **Italy** (Bari)	**Brazil** (CENARGEN), **USA**: (Wash. Univ.; Univ. Georgia); **U.K.** (Univ. of Bath)	**U.K.** (Bristol),**Brazil** (Univ. of Sao Paulo)
SAFETY DUPLICATION	**Brazil** (CENARGEN), **Costa Rica** (CATIE)		
• SHARED COLLECTIONS	**USA** (USDA, Pullman and Fort Collins)	NARS	**Brazil** (CENARGEN), **Ethiopia** (ILCA), **Australia** (CSIRO), **USA** (Univ. Florida)
RESTORATION	Initiating: NARS **(Guatemala, Peru, Ecuador)**	--	--
CAPACITY BUILDING	Redafit, Remerfit, OEA, IICA, COLCIENCIAS, LAC, IARCs	Redafit, Remerfit, OEA, IICA, COLCIENCIAS, LAC, IARCs, CBN, MGRN	Redafit, Remerfit, OEA, IICA, COLCIENCIAS, LAC, IARCs, TF-GRN, **Australia, Brazil**, ILCA

CIP

For several decades there have been ongoing activities for the *ex situ* conservation of native potato cultivars in South America. Many national potato collections are still maintained by institutions like INTA in Argentina, Universidad Austral de Chile, IBTA in Bolivia, INIAP in Ecuador, ICA in Colombia, FONAIAP in Venezuela, ICTA in Guatemala and INIFAP in Mexico. In Peru, several potato collections are maintained by several Universities and regional offices of INIA. All these institutions generally face problems of funding to properly maintain these potato collections in field genebanks. International collaboration has upgraded the potato collections in Bolivia and Ecuador where PROINPA and FORTIPAPA have been created with Swiss funding and the technical assistance of CIP.

INIAP (Ecuador's National Agricultural Research Institute) collaborates with CIP in maintaining an off-site duplicate set of the *in vitro* potato collection in a "black box". The Austrian Research Center at Seibersdorf (ARCS) also collaborates with CIP in the cleaning up of some potato genotypes.

With the exception of Argentina and Chile, countries in Latin America do not maintain collections of wild potato species. CIP has promoted the development of an Inter-genebank Potato collaboration to share databases and genetic materials, and conduct joint research projects to improve current conservation procedures.

Until recently, NARS in Latin America have not been involved in the *ex situ* conservation of wild *Ipomoeaco* species. Prior to 1985, very few small sweet potato collections were maintained by NARS in Latin America and the Caribbean. Since then, CIP in collaboration with NARS from Mexico, Guatemala, Honduras, Nicaragua, Panama, Jamaica, Dominican Republic, Cuba, Saint Vincent, Venezuela, Colombia, Brazil, Ecuador, Peru, Bolivia, Paraguay and Argentina has conducted a systematic collection of existing native sweet potato cultivars. CIP has also received donations from the USDA sweet potato collections maintained in Puerto Rico, South Carolina, North Carolina, and Georgia. In addition, the sweet potato collections that used to be maintained by ACIAR, AVRDC, and IITA were transferred to CIP.

The International Institute of Advanced Studies (IDEA) in Venezuela collaborates with CIP in the maintenance of an off-site duplicate set of the *in vitro* sweet potato collection in a "black box". The Australian Institute for Horticultural Development (AIHD), Victoria, provides a valuable collaboration for the cleaning up of sweet potatoes of the Asian countries in the SAPPRAD network.

The networks like PROCIPA for the countries in the southern cone of South America (Argentina, Brazil, Chile, Paraguay, and Uruguay), PRACIPA for the Andean countries (Peru, Colombia, Venezuela, Bolivia, Ecuador), and PRECODEPA for Central America and the Caribbean

(Mexico, Panama, Costa Rica, Dominican Republic, Cuba, El Salvador, Guatemala, Honduras, Haiti), do not include activities for the conservation of genetic resources in Latin America. Some countries maintain active collections for conservation and breeding purposes but most breeding programs in LAC relay heavily on the collections of wild and cultivated potatoes and sweet potatoes maintained at CIP.

Formal Safety Duplication agreements include those between CIP and institutes in Venezuela and Ecuador. At present there are no formal agreements between CIP and USDA for storage of duplicate collections.

ICARDA

There are strong links with other germplasm conservation centers, with a formal agreement between ICARDA, IPGRI (IBPGR), whereby IPGRI has established its Regional Office to WANA at ICARDA and a building with 7 offices is currently under construction at ICARDA to house IPGRI staff. Currently, space is made available to IPGRI within the GRU building. In addition, ICARDA has an agreement with IPGRI whereby a copy set of ICARDA's genetic resources data is deposited for safety at IPGRI, Rome.

Although not part of the Genetic Resources Unit at ICARDA, other IARC staff make use of the Unit's germplasm. These include an ICARDA chickpea (kabuli) breeder from ICRISAT based at ICARDA, as well as two wheat breeders from CIMMYT, one for durum wheat the other for bread wheat. As part of this International Center collaborative process, an ICARDA barley breeder is based at CIMMYT, Mexico. ICARDA is a partner with ILRI and CIAT in the CGIAR Forage Genetic Resources Initiative.

Other formal links include one between the N.I. Vavilov All-Russian Scientific Research Institute of Plant Genetic Resources and ICARDA which encompasses joint collecting missions, evaluation and exchange of genetic resources information and material.

Safety Duplication agreements with ICARDA include:

- The Federal Institute of Aerobiology (FIA), Austria for the ICARDA Medicago and Vicia germplasm collections and the National Bureau of Plant Genetic Resources (NBPGR) of India for the lentil germplasm collection.

- The International Maize and Wheat Improvement Center (CIMMYT) for conservation of the base collection of bread wheat, with ICARDA providing a backup, whilst ICARDA is responsible for conserving durum wheat and wild relatives of wheat with a back-up at CIMMYT. ICARDA stores a duplicate collection of triticale for CIMMYT and

CIMMYT stores a duplicate collection of ICARDA's base collection of cultivated barley and its wild progenitor Hordeum vulgare sub. sp. spontaneum

- The International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), for all accessions of chickpea and their wild relatives.

- Currently under preparation is an agreement between ICARDA and the Station Federal de Recherches Agronomiques de Changing, Switzerland (RAC) for duplicate storage at RAC of the ICARDA Lathyrus germplasm collection.

- A key development in recent years in WANA has been the co-sponsorship, together with FAO, ICARDA and IPGRI of the WANA Plant Genetic Resources Network (WANANET), in which ten countries have become active and through which research activities based on recommendations from six Working Groups have been initiated. These activities focus on building databases, identifying gaps in collections and gathering information on genetic erosion and involve cereal, horticulture crops, pasture and forage crops an in situ conservation strategies. WANANET has its Secretary, a member of staff from IPGRI's WANA Regional Office at ICARDA and ICARDA is represented on its Committees and Working Groups. WANANET has a remit that extends well beyond ICARDA's mandate crops and it is possible that other IARC centers in addition to IPGRI and ICARDA could have useful contributions to make to WANANET's wide brief. The Panel felt, that through WANANET's working groups on Cereals; Food legumes; Pasture, Forage and Range Species; and In situ and Biodiversity, it could play on increasingly important role in helping to assess priorities, to formulate projects, to ensure maximum utilization of germplasm from ICARDA, to help record impact in the different WANA countries from germplasm provided by ICARDA and to ensure that stronger NARS with comparative advantage in specific areas can contribute to regional well-being. Interaction within WANANET would be complementary to that of annual meetings held between ICARDA staff and scientists from individual NARS. Another source of information that could serve to improve the utilization of ICARDA's germplasm resources is that of Regional efforts in WANA to collate Country Reports as part of the preparation for the Fourth International Technical Conference on Plant Genetic Resources which will be held in Leipzig, Germany, in June 1996.

ICARDA is also an active member of the International Barley Genetic Resources Network and has a role in the International Wheat Genetic Resources Network.

ICLARM

ICLARM is a member of the World Conservation Centre (IUCN) and has been invited to assist IUCN in global assessments and documentation of the status of threats to freshwater fish species.

In addition to the two marine protected areas (MPAs) controlled directly by ICLARM, ICLARM is undertaking collaborative studies on a large newly-proclaimed MPA surrounding the Arnavon Islands group in the Solomons. To examine the rate of recovery of previously overexploited stocks of invertebrates ICLARM is also developing collaborative studies of MPAs in the Caribbean. ReefBase, ICLARM's database on coral reefs (ReefBase) contains details of the world's coral reef MPAs.

ICLARM is the Member-Coordinator of the International Network on Genetics in Aquaculture (INGA) and has multiple interactions with its members as they develop their own FiGR and biodiversity research agendas. The INGA currently has 14 members: Bangladesh, China, Côte d'Ivoire, Egypt, Fiji, Ghana, India, Indonesia, Malawi, Malaysia, the Philippines, Thailand and Vietnam and ICLARM. The membership of INGA is expected to grow, including Latin American/Caribbean members. The Centre has close collaboration with FAO (numerous institutions and agencies advanced scientific institutes and NARS) on aspects of biosafety and codes of practice for transfers of aquatic germplasm. It also works closely with FAO and multiple collaborators (universities, museums, governmental organizations and NGOs) on biological databases - principally the FishBase - that contain biodiversity and genetic resources information. These activities are linked to SINGER. ICLARM wishes to replicate further its cryopreserved tilapia sperm holdings and is in contact with potential partners in developed and developing countries that have or might wish to develop cryopreservation capabilities.

ICRAF

In the absence of a physical unit ICRAF has relied very heavily upon collaboration with other genebanks. Germplasm is obtained from other institutes and ICRAF's small holdings of germplasm are stored at various genebanks. Seeds of orthodox species are stored at 4°C at the KEFRI Tree Seed Centre; ILRI genebank in Addis Ababa, Ethiopia; ICRISAT Sahelian Centre, Niamey, Niger; and the IITA genebank in Ibadan, Nigeria. An agreement exists with the National Genebank of Kenya to store seeds of Kenyan tree species in long-term storage at -20°C. An offer has been made by the Oxford Forestry Institute to arrange and pay for the long-term storage of any tree germplasm at the -20°C facility at the Royal Botanic Gardens, Wakehurst Place, England.

Live-genebanks have been established with the National Centre for Genetic Resource Conservation and Biotechnology (NACGRAB) in Ibadan, Nigeria, and with KEFRI in Kenya. Networking arrangements exist with National Genebanks in SADC countries for *Sesbania* germplasm. There is an MOU between ILRI (formerly ILCA) and ICRAF which is likely to be revised. No MOU exists with IITA or ICRISAT. There are cordial and productive links between the Kenya Forestry Research Institute (KEFRI) and ICRAF.

ICRISAT

The major research work of ICRISAT's Genetic Resources Division (GRD) is organized into independent projects and carried out in close collaboration with scientists from ICRISAT, NARS and other IARC's. GRD has excellent relations with the National Bureau of Plant Genetic Resources (NBPGR, New Delhi, India) and pursues work of joint germplasm exploration, evaluation and publication of results. India being the country of origin of pigeonpea, the safety duplicate conservation of pigeonpea germplasm will also be based in the genebank of NBPGR. The GRD has a good understanding with ICARDA (Syria), Kenya Agricultural Research Institute (Kenya), and the South African Development Community (SADC) Plant Genetic Resources Centre (SPGRC) in Zambia. The GRD is also involved in pursuing its research objectives in Asian countries jointly with the Cereals and Legumes Asia Network (CLAN) which has its headquarters at ICRISAT, Patancheru. Memoranda of Agreement for duplicate conservation of pigeonpea were signed with the National Bureau of Plant Genetic Resources/Indian Council of Agricultural Research (NBPGR/ICAR).

IITA

For yam genetic resources, the GRU collaborates with IPGRI on various aspects of activities both directly and through the System-wide Genetic Resources Program (SGRP). The GRU is also involved in the African Yam Network's activities, one of which is the project on the collection and conservation of yam biodiversity. The GRU assisted the network in formulating the concept, as well as in drafting the project proposal on the collection and conservation of yam biodiversity which was submitted to donors for funding support. In addition, the GRU organizes a specialized training course on the collection, characterization, and conservation of yam germplasm to train research scientists and technicians from member countries to help the implementation of the project's activities.

For cassava genetic resources, the GRU collaborates with CIAT and IPGRI both directly and under SGRP. The area of collaboration covers the study of genetic resources, exploration, and collection of cultivated and wild *Manihot* spp., the exchange and use of germplasm. Under the Global Cassava Genetic Resources Network, established during the Joint CIAT/IITA/IPGRI International Workshop on Cassava Genetic Resources held at CIAT, Cali in 1992, the IITA GRU is responsible for and coordinates the collection, documentation, and conservation of cassava genetic resources in Africa. Two NARS scientists from each Latin America, Africa and Asia, and one scientist each from IITA, IBPGR and CIAT constituted the nine member steering committee. The committee monitors the most urgent activities at the regional level, particularly the establishment of a regional data base and regional conservation of a base collection. IITA collaborates with and assists NARS in these activities. The GRU provides backstopping support to the Regional Research Project for Maize and Cassava (for West and Central Africa) and the East Africa Root Crops Research Network (EARRNET) for the implementation of the activities

on the collection, characterization, and conservation of farmers' cultivars in Africa, an objective of the networks.

For sweet potato genetic resources, the GRU collaborates with CIP. The GRU continues to maintain *in vitro* cultures of about 500 accessions, as a back-up to the original collection of about 1,000 accessions that was transferred to CIP, when the mandate for the genetic improvement of this crop was moved from IITA in 1989.

The GRU collaborates with IRRI and WARDA for the collection, documentation, conservation, and use of African rice germplasm as well as *O. sativa* land races collected in Africa. It collaborated very extensively with IRAT/ORSTOM and IPGRI in exploration and on the exchange of rice germplasm in the second half of the 1970s. The GRU sends rice germplasm to IRRI, and to the National Seed Storage Laboratory in Japan for duplicate storage. Despite the fact that the rice improvement mandate has been transferred from IITA to WARDA, the IITA GRU continues (with the agreement of WARDA) to maintain and
distribute the existing rice germplasm collection of over 12,000 accessions available in its gene bank. WARDA scientists also draw materials from this collection.

Through the joint IITA/ICRAF/Oregon State University multipurpose tree project, the
GRU collaborates with ICRAF in conserving multipurpose tree species on site at IITA. The GRU assists the project to store the seeds in its gene bank for use by ICRAF and the Alley Farming Network for Tropical Africa(AFNETA). As the management of the Institute's arboretum established in Ibadan since 1978 has recently been transferred from RCMD to the GRU, it is envisaged that the existing collaboration between the GRU and ICRAF will be further enhanced.

Though there is no formal agreement made between GRU/IITA and ILRI or CIAT for forage legumes, collaboration in various ways exists with these two Institutes, because of overlapping coverage of species as well as IITA's strategic location in West Africa. Cowpea and many wild *Vigna* species and several other leguminous species available in the GRU could be used as forage. One of IITA's objectives in cowpea breeding is to breed dual-purpose varieties for grain and forage. Currently the collaboration between the GRU and ILRI and CIAT is confined to the area of germplasm exchange. In addition, GRU assists ILRI's program based at IITA to store seeds of herbaceous legumes for experimental purposes. Presently a concept note is being developed between ILRI and the GRU, with the involvement of CIAT and IPGRI on a collaborative project on the conservation and utilization of forage germplasm in West Africa.

For cowpea germplasm the GRU has established links with the National Seed Storage Laboratory at Fort Collins, USA, the Plant Germplasm Institute at Bari, Italy, and the Belgian National Botanical Garden in Meise, for back-up storage of cowpea and wild *Vigna*. The GRU collaborates with advanced Institutes and Universities in America and Europe for studies of the genetic

resources of cowpea and wild *Vigna*, in taxonomy, cytogenetics, germplasm diversity, and the identification of resistant genes for the control of post-flowering pests of cowpea.

ILRI

In the past, ILRI has collaborated with several other CGIAR Centres in research on plant genetic resources, including CIAT (collection and duplication of germplasm, virology and information exchange on forages), ICARDA (seed production and training), ICRAF (fodder

tree collection, conservation and training), IITA (virology) and IPGRI (collection, training, seed health and information exchange).

Currently, the forage genetic resources activities are closely linked with those of CIAT and CSIRO, the other two major tropical forage genebanks and also with ICARDA for temperate forage germplasm. There is a formal memorandum of understanding with ICRAF for work on multipurpose trees (MPT) genetic resources. General collaboration on genetic resources and training is with IPGRI, Ethiopian Biodiversity Institute, Genebank of Kenya and SADC regional genebank. A global forage genetic resources network is in the planning stages and funding has been allocated from the System-wide Genetic Resources Initiative (SGRI) to hold a consultation to establish the network. It is proposed that this network will cover international and national institutes in both developed and developing countries.

The genetic resources work is also linked to users through the provision of small experimental quantities of seeds of forage germplasm from the ILRI genebank and larger quantities of seed of a limited number of promising species to begin national forage seed production. The users include national programme scientists and NGOs.

IPGRI/INIBAP

Four major field genebanks have agreed to act as Regional Field Genebanks for IPGRI/INIBAP:

Bureau of Plant Industry, Davao, Philippines.
Fundacion Hondurena de Investicacion Agricola, La Lima, Honduras.
Centre Regional Bananiers et Plantains, Njombe, Cameroon.
Institut de Recherche Agronomique et Zootechnique de la Communaute Economique des Pays des Grand Lacs, Gitega, Burundi.

There is an agreement between IPGRI/INIBAP and the Taiwan Banana Research Institute (TBRI), Taiwan, whereby TBRI holds duplicates in safety for IPGRI/INIBAP. CATIE, Costa Rica and IITA, Nigeria, have been approached to store duplicates *in-vitro* and CATIE has already agreed.

IRRI

The International Rice Genebank has close collaboration with many national genebanks, particularly in South, Southeast and East Asia. Many national collections are duplicated in the International Rice Genebank. IRRI also collaborates with WARDA and IITA.

Safety duplicate storage of the International Rice Genebank Collection is undertaken at NSSL, Fort Collins, USA, under an agreement signed on June 3, 1993, that formalized a long-standing arrangement between the two genebanks.

Although a Rice Genetic Resources Working Group was established in August 1991, under the Chairmanship of Dr R S Rana, at that time Director of NBPGR, New Delhi, this working group has not been effective for lack of resources.

A major 5-year project (1993-95) Safeguarding and Preservation of the Biodiversity of the Rice Genepool, funded by the Swiss Development Cooperation (SDC), links IRRI with national genetic resources programs in Asia, Africa and Latin America. The project has a budget of $3.256 million, allocated to three components:

- conservation of rice genetic resources;
- on-farm conservation research; and
- strengthening national programs.

WARDA

WARDA promotes the sharing of rice germplasm collected from the region or developed by WARDA with its NARS partners and other users and WARDA's materials are made freely available for any agriculture research or breeding purposes. WARDA has strong links with national programs in West Africa, most of whom do not have effective functional seed storage facilities. Therefore, some collections from NARS in West Africa are sent to WARDA for conservation.

In 1977, IITA, IRRI, IRAT, ORSTOM and WARDA signed a collaborative agreement on rice germplasm collection and conservation in Africa. WARDA's germplasm program since then has involved the acquisition, collection, utilization and conservation of West African indigenous cultivars, landraces and wild species. In 1993, WARDA signed an agreement with IITA for medium- and long-term conservation of total rice genetic diversity at IITA, Ibadan, Nigeria.

WARDA's Collaborative Links in Genetic Resources Conservation (1991-95)

ACQUISITION	NARS: 14 countries in West Africa CIAT, Colombia IRRI IITA ORSTOM, IRAT
CHARACTERIZATION Botanical Bioch./Molecular	 IITA, Ibadan, Nigeria CIAT ORSTOM, Montpellier, France
SAFETY DUPLICATION Shared Collection	IITA IRRI, Los Banos, Philippines NARS in West Africa
RESTORATION	NARS (Liberia, Guinea, The Gambia, Guinea Bissau, Sierra Leone, Nigeria, Senegal)
CAPACITY BUILDING	Other IARCs

Table E.1.1 A check list for genebank standards **Appendix 7**

1.	Type of collections		Ac ____	B ____
2.	Back up generator		A ____	N ____
3.	Fire precautions (fire fighting equipment ____, alarm system ___, high temp.cut off ___,lightening rod ___)		A ____	N ____
4.	Security		A ____	N ____
5.	Refrigeration standards and equipment		A ____	N ____
6.	Safety of personnel (instruction ____, alarm ____, door open from inside ____)		A ____	N ____
7.	Construction and insulation standards		A ____	N ____
8.	Storage containers (sealed can ___, laminated bag ___, sealed bottle ___, other ___)		A ____	N ____
9.	Storage temperature (___°C, ___ RH for B)	P ___	A ____	N ____
	°C, ___ RH for Ac)		A ____	N ____
10.	Temperature monitoring		A ____	N ____
11.	Seed moisture content (___ %)		A ____	N ____
12.	Method and equipment for moisture content determination		A ____	N ____
13.	Accession sizes	P ___	A ____	N ____
14.	Regeneration standards (___ %)		A ____	N ____
15.	Methods of regeneration (no.of P1 ___,Dur. ___, source ___)		A ____	N ____
16.	Initial viability monitoring		A ____	N ____
17.	Viability monitoring period (___ yrs)		A ____	N ____
18.	Viability monitoring test method		A ____	N ____
19.	Equipment for germination test, detection of empty seeds and removing dormancy		A ____	N ____
20.	Handling procedures before storage		A ____	N ____
21.	Seed drying equipment and conditions (___ °C, ___ % RH)		A ____	N ____
22.	Seed cleaning		A ____	N ____
23.	Information about samples (___ % passport data, ___ % characterisation data, ___ % evaluation data)		A ____	N ____
24.	Agreement for duplicating samples		A ____	N ____
25.	Seed packing room (required ___)		A ____	N ____
26.	Seed exchange (packing ___, passport data ___, evaluation data ___, germ. method ___, mode of reproduction ___, quarantine ___, no. of viable seeds ___)		A ____	N ____
27.	Personnel and Training		A ____	N ____

Ac=Active collection; B=Base collection; A=Acceptable Standard; P=Preferred Standard; N=Needed Improvement

Table B.1.1. ***Ex situ*** **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

		Accessions					
Centre	**Crop/species**	**AC & BL**	**LR & OC**	**WS**	**Others**	**Total**	**Designated to FAO**
CIAT	Phaselous Beans	39,903(97)		1,158(3)	-	41,061	26,395
	Manihot Cassava	5,632(94)		353(6)	-	5,985	5,985
	Tropical Forages	-		28,.894(100)	-	23,894	15,448
TOTAL		**45,535(64)**		**25,405(36)**	-	**70,940**	**47,828**
CIMMYT	Barley				9,084(100)	9,084	
	Bread Wheat	46,261(65)	42,910(35)			71,171	25,638
	Durum Wheat	11,158(70)	4,782(30)			15,940	
	Primitive & Wild Wheat		7,245(61)	4,549(39)		11,794	
	Rye				202(100)	202	
	Triticale	15,200(100)				15,200	8,151
	Teosinte			161(100)		161	153
	Tripsacum sp			15+(150)*(100)		15	15
	Maize	209(2)	12,861(98)			13,070	12,188
TOTAL		**72,828(53)**	**49,798(36)**	**4,725(3)**	**9,286(7)**	**136,637**	**46,145**
CIP	Potato	996(16)	3,694(60)	1,500(24)	-	6,190	4,788
	Sweet Potato	1,489(23)	3,829(59)	1,204(18)	-	6,522	6,419
	Andean Roots & Tubers	-	1,132(100)	-	-	1,132	639
TOTAL		**2,485(18)**	**8,655(63)**	**2,704(20)**	-	**13,844**	**11,846**

* Field genebank at Tlatizapan, Morelos, Mexico

AC - Advanced Cultivars; BL - Breeding Lines; LR - Landraces or Primitive Cultivars;
OC - Old Cultivars, WS - Wild/Weedy Species

Table B.1.1. ***Ex situ*** **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

		Accessions					
Centre	**Crop/species**	**AC & BL**	**LR & OC**	**WS**	**Others**	**Total**	**Designated to FAO**
ICARDA	Barley	2,687(12)	19,735(88)	-	-	22,422	21,413
	Wild *Hordeum*	-	-	1,670(100)	-	1,670	1,599
	Bread Wheat	1,909(24)	5,925(76)	1(<1)	-	7,835	7,776
	Durum Wheat	328(2)	17,718(98)	-	-	18,046	17,816
	Wild/prim. *Triticum*	15(1)	21(1)	1,767(98)	-	1,803	1,691
	Aegilops	-	-	2,841(100)	14(,1)	2,855	2,797
					TOTAL	**54,631**	**53,092**
	Faba Bean	96(2)	4,359(98)	-	-	4,455	4,419
	Faba Bean BPL	-	-	-	5,248(100)	5,248	5,087
	Chickpea	2,483(26)	7,198(74)	1(<1)	-	9,682	8,854
	Wild *Cicer*	-	-	292(100)	-	292	291
	Lentil	1,214(16)	6,263(84)	-	-	7,477	7,385
	Wild *Lens*	-	-	434(100)	-	434	420
					TOTAL	**27,588**	**26,608**
	Medicago (annual)	73(1)	8(<1)	7,724(99)	-	7,805	7,421
	Vicia	-	110(2)	5,243(98)	-	5,353	5,087
	Trifolium	-	1(<1)	3,400(100)	-	3,401	3,194
	Lathyrus	1(<1)	9(1)	1,672(99)	-	1,682	1,516
	Pisum	6(<1)	3,502(99)	45(1)	-	3,553	3,450
	Medicago (peren)	-	84(13)	567(87)	-	651	5,016
	Other forages	-	26(1)	4,339(99)	-	4,365	
					TOTAL	**26,810**	**25,684**
TOTAL		**8,812(8)**	**64,959(6)**	**29,996(27)**	**5,262(5)**	**109,029**	**105,384**

Table B.1.1. *Ex situ* **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

		Accessions					
Centre	**Crop/species**	**AC & BL**	**LR & OC**	**WS**	**Others**	**Total**	**Designated to FAO**
ICRISAT	Sorghum	4,359(12)	29,474(84)	418(1)	935(3)	35,186	28,122
	Pearl Millet	142(1)	19,425(92)	688(3)	936(4)	21,191	20,891
	Chickpea	655(4)	16,122(93)	135(1)	332(2)	17,244	16,458
	Pigeonpea	1,764(14)	9,909(77)	530(4)	682(5)	12,885	11,228
	Groundnut	4,966(33)	8,774(59)	309(2)	804(5)	14,853	9,387
	Minor millets	98(1)	8,802(98)	115(1)	-	9,015	8,810
TOTAL		**11,984**	**92,506**	**2,195**	**3,689**	**110,374**	**94,896**

Table B.1.1. ***Ex situ*** **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

		Accessions				
Centre	**Crop/species**	**AC & BL**	**LR & OC**	**WS**	**Total**	**Designated to FAO**
IITA	Cowpea (*Vigna unguiculata*	720(4)	14096(86)	1651(10)*	16467	16467
	Rice (*Oryza* spp.)	760	11391(92)	164(1)~	12315	12091
	Bambara groundnut (*Vigna subterranea)*	-	2035(100)	-	2035	2035
	Yam (*Dioscorea* spp.)	176(6)	2699(94)	-	2875	2772
	Cassava (*Manihot* spp.)	1291(55)	780(33)	259(11)#	2330	1655
	Soybean (*Glycine* max	633(47)	725(53)	-	1358	1358
	African yam bean(*senostylis stenocarpa)*	-	130(100)	-	130	
	Maize (*Zea mays)*	734(61)	466(39)	-	1200	
	Plantain/banana (*Musa* spp.)	100(22)	350(78)	-	450	
	Auxilliary tree and shrubs species (over 100)	14(4)	-	300(96)@	314	
	Taro (*Colocasia* and *Xanthosoma*)	-	60(100)	-	60	
	Green gram (*Vigna radiata*)	-	79(100)	-	79	
	Winged bean (*Psophocarpus tetrangonobus*)	-	45(100)	-	45	
	Lima Bean (*Phaseolus lunata*)	2(13)	13(87)	-	15	
	Lablab bean (*Lablab purpurea*)	-	42(100)	-	42	
	Pigeon pea (*Cajanus cajan)*	-	13(100)	-	13	
	French bean (*Phaseolus vulgaris)*	-	9(100)	-	9	
	Kersting's groundnut (*Kertstingiella goecarpa)*	-	9(100)	-	9	
	Rice bean (*Vigna umbellata)*	-	7(100)	-	7	
	Jack bean (*Canavalia ensiformis)*	-	5(100)	-	5	
	Sword bean (*Canavalia gladiata*	-	4(100)	-	4	
	Mucuna (*Mucuna pruriens)*	-	2(100)	-	2	
	Mexican yam bean (*Pachyrhizus tuberosus)*	-	1(100)	-	1	
TOTAL		**4430(11)**	**32961(83)**	**2374(6)**	**39765=**	**36,378**

* = Consists of 54 species ~ = Consists of 10 species # = Consists of 24 species

@ = Consists of over 100 species = excludes 217 accessions of sweet potato

Table B.1.1 *.Ex situ* **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

		Accessions					
Centre	**Crop/species**	**AC & BL**	**LR & OC**	**WS**	**Others**	**Total**	**Designated to FAO**
ILRI	Temperate fodder trees (55)[1]	0(0)	-	293(100)	-	293	90
	Tropical fodder trees (325)[1]	5(<1)	-	1,821(100)	-	1,826	1,421
	Temperature grasses (89)[1]	164(13)	-	1,070(87)	-	1,234	638
	Tropical grasses (254)[1]	97(4)	-	2,208(96)	-	2,305	1,807
	Temperature legumes (160)[1]	152(5)	-	2,606(95)	-	2,758	2,329
	Tropical legumes (270)[1]	57(1)	-	4,727(99)	-	4,784	4,109
	Other forages - Temperature (51)[1]	26(17)	-	127(83)	-	153	115
	Other forages - Tropical (54)[1]	1(1)	-	116(99)	-	117	78
TOTAL	**(1258)[1]**	**502(4)**	**-**	**12,968(96)**	**-**	**13,470**	**10,587**

[1] Number of species

Table B.1.1. ***Ex situ*** **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

Centre	Species	BL	Accessions LR & OC	WS	Total	Designated to FAO
IRRI	*O. alta*			10	10	10
	O. australiensis			25	25	25
	O. barthii			224	224	222
	O. brachyantha			17	17	17
	O. eichingeri			23	23	23
	O. glumaepatula				37	37
	O. grandiglumis			10	10	10
	O. granulata			22	22	20
	O. latifolia			37	37	34
	O. longiglumis			6	6	6
	O. longistaminata			134	134	134
	O. meridionalis			43	43	43
	O. meyeriana			8	8	8
	O. minuta			65	65	65
	O. nivara			468	468	369
	O. officinalis			247	247	223
	O. punctata			54	54	54
	O. rhizomatis			19	19	19
	O. ridleyi			17	17	17
	O. rufipogon			712	712	656
	O. glaberrima		1,255		1,255	1,242
	O. sativa	1,260	75,354		76,614	75,615
	Hybrids			587	587	416
	Chikusichloa aquatica			1	1	1
	Hygroryza aristata			4	4	4
	Leersia hexandra			1	1	1
	Leersia perrieri			1	1	1
	Leersia tisseranti			3	3	3
	Porteresia coarctata			1	1	1
	Rhynchoryza subulata			1	1	1
TOTAL		**1,260**	**76,609**	**2,777**	**80,646**	**79,277**

BL= breeding lines; LR&OC = landraces and old cultivars; WS = wild species

Table B.1.1 List of species and catagories of IPGRI/INIBAP's Musa germplasm

Genus	Accessions	Section	Accessions	Species/group	Accessions	Advanced cultivars	Landraces or primitive/old cultivars	Wild species
Ensete	4	(Ensete)	4	gilletii	1			1
				ventricosum	2			2
				Unknown	1			1
Musa	1046	Australimusa	28	Fe'i	9		9	
				jackeyi	1			1
				lolodensis	2			2
				maclayi	7			7
				peekelii	5			5
				textilis	4			4
		Callimusa	2	coccinea	2			2
		Rhodochlamys	8	laterita	2			2
				ornata	3			3
				sanguinea	1			1
				velutina	2			2
		Eumusa	1000	acuminata	81			81
				balbisiana	20			20
				balbisiana?	3			3
				basjoo	1			1
				beccarii	1			1
				boman	1			1
				schizocarpa	12			12
				acuminata x schizocarpa	5			5
				AA	225	2	223	
				AAA	152		152	
				AAAA	15	14	1	
				AAAB	18	14	4	
				AAB	309		309	
				AABB	3	1	2	
				AB	7	1	6	
				ABB	60		60	
				ABBB	4		4	
				BBB	1		1	
				BBBB	1	1		
				AA?	5		5	
				AAA?	2		2	
				AA/AAA?	1		1	
				AAAA?	2	1	1	
				AAB?	4		4	
				AAS	1		1	
				2n	3	3		
				3n	1	1		
				4n	9	9		
				Unknown	53	26	23	4
		Eumusa x Australimusa	4	AAT	4		4	
		Eumusa x Australimus?	1	AAT?	1		1	
		Unknown	3	Unknown	3		?	
Unknown	1	Unknown	1	Unknown	1		?	
TOTAL	**1051**		1051		**1051**	**73**	**813**	161

*** All 1051 accessions have been designated to FAO**

Table B.1.1. ***Ex situ*** **Collections of Plant Germplasm at CGIAR Centres Percentages for each horizontal line are given in parenthesis**

		Accessions					
Centre	**Crop/species**	**AC & BL**	**LR & OC**	**WS**	**Others**	**Total**	**Designated to FAO**
WARDA	*O. sativa*	10,314(77)	3,164(23)	-	-	13,478	Only Upland rice germplasm
	O. glaberrima	-	1,882(100)	-	-	1,882	has been designated (4,872
	O. sativa x						out of a total of 8,000)
	O. glaberrima	1,200(100)	-	-	-	1,200	
	O. breviligulata	-	-	759(100)		759	
	O. longistaminata	-	-	121(100)	-	121	
TOTAL		**11,514(66)**	**5,046(29)**	**880(5)**	**-**	**17,440**	**94,896**

Table B.1.1. List of Nile tilapia (*Oreochromis niloticus*) germplasm held by ICLARM

Origin	Date of collection	Present No.	
		M	F
FOUNDER STOCK			
Egypt (First Collection)	May 1988	13	28
Egypt (Second Collection)	August 1989	8	33
Egypt (Third Collection)			
1. Monsour	October 1992	0	8
2. Manzalla		5	10
3. Timsah Lake		5	6
4. Ismailia		3	2
5. Abassa		34	32
6. Marriot		53	53
7. Idku		3	0
Unreadable tags		7	23
Ghana			
1. Volta River System	October 1988	1	28
Kenya	August 1989	38	18
1. First generation progeny from a founder stock collected in Aug. 1988			
Senegal			
1. Dagana	October 1988	45	13
2. Dakar-Bangos			
Israel			
(Ghana)	1974	46	85
Singapore			
(Ghana)	1979	66	72
Taiwan			
(Ghana)	1983-84	63	71
Thailand			
(Egypt)	1987	64	35
REPLACEMENT STOCKS			
Ghana		51	44
Kenya		8	5
Senegal		35	5
Israel		30	30
Singapore		43	45
Taiwan		17	18
Thailand		56	14

Table B.1.1 - ICLARM (cont.)

Origin	Date of Collection	Present No.	
		M	F
EGYPT (Third Collection)			
1. Monsour		11	14
2. Manzalla		19	18
3. Tismah Lake		22	28
4. Abassa		26	43
5. Marriot		38	45
Unreadable tags		0	2
SELECTED STOCKS			
Base Population	1990	61	155
First Selection	1991	66	106
Second Selection	1992	49	77
Third Selection	1993	55	87
Fourth Selection	1994	59	137

Table B.1.1. Cryopreserved sperm of Nile tilapia (*Oreochromis niloticus*) stocks held by ICLARM

Strain	No. of Fish Cryopreserved	Straw No. per Fish
FOUNDER STOCKS		
Israel	32	1 - 12
Singapore	58	1 - 18
Taiwan	52	1 - 13
Thailand	36	1 - 13
Egypt	16	1 - 10
Ghana	36*	2 - 8
Kenya	37	1 - 12
Senegal	21*	2 - 8
SELECTED STOCKS		
Base Population	49	1 - 6
First Selection	66	1 - 7
Second Selection	72	2 - 7
Third Selection	47	1 - 6
Fourth Selection	74	1 - 7

* Includes Replacement Stocks

Table D.1.1.Conservation facilities for *Phaseolus* beans and tropical forages at CIAT

Facility	Purposes	Features	Volume or area	Capacity (accessions)
Seed storage	Medium-term[a] (5-20 years)	5 to 8 °C, 35% r.h. 10% seed moisture	360 m^3	90,000
Seed storage	Long-term[b] (30 to 50 years)	-15 to -20 °C, 6% - 8% seed moisture	260 m^3	100,000
Seed drying	Heated air	30°C	34 m^3	715
Seed drying	Low r.h. (long-term)	20°C	68 m^3	1,485
Thresh & clean	Processing	35% r.h.	260 m^3	-
Seed laboratory	Seed preparation		101 m^2	-
In vitro				
Laboratory		Air conditioned	44 m^2	3,600/yr
Growth room		5 tubes/clone [c]	11 m^2	3,600/yr
Slow growth	23-24°C	5 tubes/clone [d]	32 m^2	6,720
Cryo preservation				
Laboratory	Preparation	Growth chambers	0	
Cryo-storage	Long-term	Cryo-tanks	0	
Seed Health	Laboratory	9 sections	125 m^2	8,000
Greenhouse		5 plants/clone	45 m^2	356
Electrophoresis	Laboratory		44 m^2	1,000/yr
Herbarium				
Lab.and office	Sample prep.	Air conditioned		-
Sample storage	Cabinets		8.8 m^2	
High land fields	Regeneration		20.6 m^2	15,000
Equipment	Covered		2 ha	1,500/yr
storage			24 m^2	-

a. Plastic jars; b. Aluminum foil bags; c. 18 mm tube size; d. 25 mm tube size

Table D.1.1. Conservation facilities at CIMMYT

Facility	Features	Volume	Capacity (accessions) Maize	Wheat
Maize Germplasm Bank:				
Active Collection[a]	0-2°C; 30-40% RH[b]	138 m^3	10,920	
Base Collection[a]	-15°C; ambient RH	145 m^3	17,820	
Seed Dryer	20°C; 23-30% RH	30 m^3	2,000 kg	
Wheat Germplasm Bank:				
Active Collection	4-5°C; 20% RH			90,000
Base collection	-2-4°C; ambient RH			180,000 1,000kg
Seed Dryer	25 °C; 35-45% RH			
New Germplasm Bank to be constructed in 1995-96				
Active Collection	0-2°C; 25-28% RH	240 m^3	18,000	108,000
Base Collection	-18°C; ambient RH	240 m^3	29,000	108,000
Seed Dryer	20°C; 23-35% RH	30 m^3	2,000 kg	2,000 kg

[a] Both active and base storage areas are practically full to capacity; [b] A dehumidifier is not used, but the refrigeration equipment maintains this RH.

Table D.1.1. Conservation facilities at CIP

Facility	Features	Area/Vol.	Capacity(accessions)
Potato *in vitro* conservation:			
In vitro propagation	18-22°C, 60-70% RH, 16hr@3000 lux	22.5 m^2	1680 (6t)***[a]
In vitro conservation	6-8°C, 60-70% RH; 16hr@1000 lux	22.5 m^2	6306 (4t)*
Sweet potato *in vitro* conservation:			
In vitro propagation	20-22°C; 60-70% RH; 16 hr@3000 lux	23.4 m^2	6000 (6t) **
In vitro conservation	16-18°C; 60-70% RH; 16hr@2000 lux	13.9 m^2	5100 (3t) **
Andean root & tuber crops conservation:			
In vitro propagation	18-22°C; 60-70% RH; 16hr@3000 lux	7.50 m^2	712 (6t)***[a]
In vitro conservation			- - -
Seed conservation:			
Medium-term storage	0°C; aluminum foil packets	35 m^3	25000[b]
Long-term storage	-15°C; aluminum foil packets	15 m^3	10000[b]
Dryer	Over silica gel for 1 to 2 weeks; 17°C	27 m^3	150 acc
Room	Seed cleaning & processing	21 m^2	100 acc/day
Room	Seed drying, counting, germinating	21 m^2	150 acc
***In vitro* ancillary facilities:**			
Laboratory	Media preparation and chemical storage	41 m^2	10-20 lt media/day
Laboratory	Washing and sterilization	37 m^2	650 units/day
Laboratory	Aseptic transfer (potato, ARTC)	30 m^2	
Laboratory	Aseptic transfer (sweetpotato)	23 m^2	
Clonal maintenance:			
Curing room (sweetp.)	28°C; 90% RH	9 m^3	500/week
Storage rooms (3)	Ambient temperature (Huancayo)	30 m^2	6000
Tuber storage (2)-potato	4°C; 80-90% RH	16 & 19 m^3	4000
Root storage-sweetpotato	12°C, 80-90% RH	37.0 m^3	2000
Cryopreservation of vegetative propagates:			
Laboratory	Preparation for Cryopreservation		- - -
Cryo-vault	Cyro-tanks under security		252[c]
Molecular analysis and genome mapping:			
Laboratory	Electrophoresis	23 m^2	65 samples/week
	RFLP	30 m^2	120 samples/week
	PCR, RAPD, MSS	30 m^2	96 samples/week

* Number of tubes of 25 x 150 mm

** Number of tubes of 18 x 150 mm

*** Number of tubes of 16 x 150 mm

[a] 7.5 m^2 of this area is used for other research projects and distribution of pathogen tested materials. Other 7.5 m^2 is used for ARTC propagation.

[b] Maximum number of packages of about 2000 potato seeds. Species with larger seeds reduce the number of accessions in storage.

[c] 1 cryo-tank (34 lt.) is stored in a cold room used for research.

Table D.1.1. Conservation facilities at ICARDA

Facility	Features	Volume or Area	Capacity (accessions)
Short-term	5-10°C, <30% RH	84 m^2	Variable
Medium-term (Active)	5°C; 30% RH	366 m^3	120,000
Long-term (Base collection)	-20°C; no RH control	240 m^3	70,000
	25°C; 20% RH		
Seed dryer			

Table D.1.1. Planned conservation facilities* at ICRAF

Facility	Purposes	Features	Area of Volume	Capacity (Accessions)
Genebank:				
Seed storage	Medium term Conservation	0-5°C 20-30% RH	22 m^2	9000
Seed drying	Dehumidifier	15°C, 10-15% RH	22 m^2	2000
Seed storage	Long-term Conservation	-20°C	4 upright freezers	
Laboratories:				
Seed reception			26m^2	
Seed testing			52m^2	
Seed despatch			17m^2	
Fumigation/ quarantine			26m^2	
Molecular genetics			38m^2	

* - all under construction

Table D.1.1. Conservation facilities at ICRISAT

Facility	Purpose	Feature	Area or Volume	Capacity (Accessions)
Seed store	Short term storage, seed withholding, seed cleaning, processing and packaging for medium and long term conservation, seed drying cabinets display of variability	18-20°C,30-40% RH	680 m^3	
Seed store (6 units),	medium-term conservation	4°C,20 and 30% RH, in screw capped plastic bottles (groundnut) and aluminium cans (others)	2 x 266 m^3 (groundnut)	20,640 accessions
	active collection		4 x 125 m^3 (others)	119,670 accessions
Seed store (3 units),	long-term conservation base collection	-20°C,4-6% seed moisture content, in vacuum sealed aluminium foil packets	3 x 125 m^3	65000 cereals 21000 pulses 10500 g'nut ----- 96500 -----
Screen house	Propagation of wild groundnut accessions	air cooled	260 m^2	200 accessions
Seed drying cabinets (2 units)	seed drying	18-20°C and 15-20% RH in cloth bags	2.6 m^3 combined	400 legume or 700 cereal accessions
Seed laboratory	Seed germination tests, seed physiological and cytological work	air conditioned 25°C and 40-50% RH, germinators, incubators, computer for GB management data processing, mettler balance, microscope etc.	235 m^3	
Seed preparation room	seed packaging for distribution, and sowing	air conditioned 25°C and 40-50% RH	164 m^3	
Herbarium and meeting room	keeping herbarium and for staff meeting	air conditioned 25°C and 40-50% RH	164 m^3	

Table D.1.1. Conservation facilities at IITA

Facility	Purposes	Features	Area or Volume	Capacity (Accessions)
Seed store (2 units)	long-term conservation	-20°C 5-7% seed mc. in sealed containers	220m³ (combined)	60-70,000
Seed store (2 units)	medium-term conservation	5°C;30% RH	409m³ (combined)	60,000
Seed store or drier	seed withholding or drying	17°C <10% RH	69m³	
Tuber store	tuber storage of yam	20°C, 50-60%RH	157m³	2000
Yam barn	tuber storage of yam	shelves with thatch roof under open air	63m³	1100
In vitro Laboratory (Ibadan)	preparatory laboratory	air conditioned 25°C, 50-60% RH	86m³	
	culture rooms for germplasm conservation for breeding lines	air conditions 18-25°C, 50-60% RH 5-10 tubes/clones		
		conditions as above, many tubes/clones	61m³	
In vitro Laboratory (Onne)	preparatory laboratory	air conditioned 25°C, 50-60% RH	22m²	
	culture rooms for breeding lines and germplasm conservation	air conditioned 18-25°C, 50-60%RH 5-10 tubes/clones	20m²	600
Seed Laboratory	seed germination test, cytological work	air conditioned 25°C, 50-60% RH	165m³	
Drying and canning room	seed drying and packaging for long-term conservation	air conditioned room 22-26°C; 40-50% RH drying cabinets, 20°C, <10% RH	43.2m³	
Computer/meeting room	for germplasm documentation or for meeting	air conditioned room 25°C, 50-60% RH computers	58.05m³	
Herbarium & office	keeping herbarium specimen & office	air conditioned 26°C, 50-60%	150m³	
Seed preparation	seed threshing cleaning & sorting	ambient conditioned	100m²	
Screenhouses	seed multiplication, seed rescue, virus clean-up	insect proof screen net	1532m²	

Table D.1.1. Conservation facilities for forages at ILRI

Facility	Purposes	Features	Volume or area	Capacity (Accessions)
Genebank:				
Seed storage	Medium term	8°C, 30% relative humidity	80 m^3	9000
	Medium term*	8°C, no relative humidity control	80 m^3	9000
	Long term (16 freezers)	-20°C, 5-8% seed moisture	3.2 m^3	4000
	Short term	10-15°C, 45% relative humidity	50 m^2 floor space	5000
Seed drying	Dehumidifier	25% relative humidity, 15°C	12 m^3	1200 (15000/yr)
Laboratories:				
General	Virus testing General preparation		45 m^2	
Germination and health	Seed testing		20 m^2	
Pathology	Isolation laboratory		8 m^2	
In vitro	*In vitro* culture		15 m^2	
Rhizobiology	Rhizobia collection		20 m^2	
Systematics	Taxonomy and cytology		20 m^2	
Herbarium	Herbarium collection		20 m^2	

* Operational in early 1996

Table D.1.1. Conservation facilities at IPGRI/INIBAP

Facilities	Features	Area	Capacity
Short-term Conservation Room	28±1°C 24h light (63 µE/m²/s)	16m²	756 Acc*
Medium-term Conservation Room	16±1°C 75% RH 24h light (25 µE/m²/s)	26m²	1404 Acc
Long-term Storage	Liquid Nitrogen Containers (- 196 °C)	-	3888 tubes
Greenhouse	28±2°C 70-90% RH 16h light (90 µE/m²/s)	80 m²	720 plants

* Acc = Accessions

Table D.1.1. Conservation facilities at IRRI

Facility	Purposes	Feature	Area or Volume	Capacity (Accessions)
Seed store, base collection	Long-term conservation	-18 to -20 °C 6% MC sealed aluminium cans	163.86 m^3	108,060 accessions at 2 cans/accession
Cooling unit/ dehumidifier		2 sets of air-cooled condensing units		
Alarm/ environment control		Fully automatic control system to operate cooling units		
		Red light indicator signals open door		
Seed store, active collection	Medium-term conservation	+3 +/- 1 °C 40% RH aluminium foil bags	927.57 m^3	109,956 accessions at 400-500 g/accession
Cooling unit/ dehumidifier		3 sets of air-cooled condensing units		
Alarm/ environment control		Fully automatic control units to operate cooling units		
		Installation of magnetic door-interlock system		
Seed drying room	Seed drying	15 °C, 15% RH In cheese cloth bags when wet, transferred to paper bags after drying	135.71 m^3	10,368 accessions at 1.5 to 2.0 kg/accession
Cooling unit/ dehumidifier		One split system refrigeration unit One desiccant wheel dehumidifier		
Alarm/ environment control		Electronic thermostat, electronic humidistat		
		Visual alarm indicating that conditions are beyond tolerance levels		

Table D.1.1 contd.

Alarm/ environment control common to seed conservation areas (base, active, drying room)	Maintaining optimal conditions	Installation of digital temperature and relative humidity read-out gauges on wall of seed processing room. Installation of PVC curtain near entrance. In base and active storage rooms: connection of chart to note fluctuation of temperature and relative humidity Safety against earthquake and flood : Cold rooms are separated from main building and laid on floating foundation. Doors have rubber gaskets preventing air and water leakage.	
Power sources for seed conservation areas (base, active, drying room)		From NAPOCOR with 7.5 mega volts amperes (MVA) supplying 6.9 to 13.8 kilowatts. IRRI's standby generators with 7.5 megawatts. Dedicated generators with 6.0 kilowatts, 3 ø, 230 VAC, 60 Hz	
Screenhouse	Living collection of wild species, seed rescue and multiplication	Special purpose beds and pots	>4,000m^2
Seed processing and seed cleaning room	Processing and cleaning, packing and distribution	21 ^oC, 40 % RH, equipped with dehumidifiers, aluminium foil sealer, digital balance, computers, can sealer, analytical balance, seed blowers, dust collector, printers	169.25 m^2

Table D.1.1. contd.

Germplasm nursery and headhouses	Seed production, initial seed cleaning, threshing of fresh harvests	One nursery used for cultivation of low viability, low seed stock accessions of cultivated rice. The other is used for propagation of wild rice accessions. Convection oven, Memmert oven, mini-hydrotiller, power weeder, vacuum emasculator, Vogel threshers	> 4000 m^2, some space allocated to INGER	
Seed testing and characterisation laboratory	Viability test, seed test, dormancy breaking, seed distribution	Five seed germinators, distiller, grain enlarger, convection ovens, Mettler balance, computer, lab oven	Shared with INGER	Germination capacity 5,000 samples/week
Data management laboratory	Networking (IRGCIS), data management and encoding characterisation information	DEC server and five personal computers, and printers		
Molecular marker laboratory	Research	Refrigerators, Mettler balances, electrophoresis power supply, centrifuges, gel dryer, ice maker, Nanopure water system, pH meter, Protein BioRads electrophoresis equipment, freezer, slab dryer, multipoint stirrer, microwave oven, transilluminator, shaker, camera system, PCR thermocycler	Shared with INGER	
Conservation Support and Research Lab	*In Vitro* germination, and research. Facilities for cytogenetical studies and tissue culture.	Refrigerators, optical microtone, automatic dehumidifier, convection incubator, sterilizer, fumehood, laminar flow, magnetic stirrer, Ohaus balance, Microspin, pH meters, centrifuge, photo microscopes, microscope, automatic dispenser, computer, tissumizer, hot plate, computer and printer		

Table D.1.1. Conservation facilities at WARDA M'be-Station

Facility	Features	Volume/Area	Capacity (Accessions)
Cold room for working collection	18-22°C 20-30% RH*	82 m^3	8,000
Seed dryer	Ambient RH 30-35°C	3.6 m^3	1,000
Cold room for seed exchange and for regional trials	4-12°C 20-30 RH	280 m^3	20,000
Proposed cold** room for working collection	4-12°C 20-30 RH*	280 m^3	20,000
Seed cleaning and seed processing lab.			
Seed germination and testing lab.			

* Dehumidifiers used
** Plan to be completed 1996-97

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
CIAT	***Phaseolus* Beans**						
	Phaseolus Vulgaris	24,563	21,448	87	Black Box	CATIE, Costa Rica	Yes
			3,124	13	Black Box	CENARGENm Brazil	Yes
			7,859	32	Active; base	USDA, Pullman, WA, USA, NSSL	No
	Phaseolus lunatus	1,548	744	48	Active; base	USDA, Pullman, WA, USA, NSSL	No
	Phaseolus coccineus	597	172	29	Active; base	USDA, Pullman, WA, USA, NSSL	No
	Phaseolus acutifolius	271	118	44	Active; base	USDA, Pullman, WA USA, NSSL	No
	Phaseolus Total	**28,271**	**21,478**				
	M. esculenta	5,632	4,567	90	Active	NARS each country	No formal
	M. spp	353				CENARGEN	No
	Cassava Total	**5,985**					

Table D.4.1. Tropical forage germplasm conserved at CIAT and shared with other important institutions' (number of accessions) 1995

Genus	CIAT	ILCA		CENARGEN		CSIRO		Univ.Fl.		PI	
Legumes											
Aeschynomene	998	70	(7.0)	228	(22.8)	140	(14.0)	44	(24.4)	88	(8.8)
Calopgonium	536	23	(4.3)	260	(48.5)	54	(10.1)	5	(1)	-	-
Centrosema	2451	215	(8.8)	1218	(49.7)	633	(25.8)	146	(6.0)	16	(1)
Desmodium	2904	82	(2.8)	375	(12.9)	378	(13)	282	(9.7)	35	(1.2)
Galactia	570	1		56	(9.8)	38	(6.7)	10	(1.8)	3	(1)
Macroptilium	615	12	(2)	57	(9.3)	98	(15.9)	155	(25.2)	12	(2)
Pueraria	258	1	(5.6)	7	(2.7)	48	(18.6)	1	(-)	-	-
Rhynchosia	445	25	(16.2)	42	(9.4)	43	(9.6)	7	(1.5)	1	
Stylosanthes	3607	584	(2)	1617	(44.8)	870	(24.1)	63	(1.7)	6	
Vigna	741	15	(19.2)	40	(5.4)	125	(16.9)	29	(3.9)	5	
Zornia	1028	197	(7.3)	411	(40.0)	45	(4.4)	33	(3.2)	10	(1)
Other	4461	326		427	(9.6)	587	(13.2)	110	(2.5)	20	
Total Legumes	**18614**	**1551**		**4738**		**3059**		**1085**		**196**	
Grasses											
Andropogon	91	4	(4.4)	7	(7.7)	35	(38.5)	-		0	
Brachiaria	654	375	(57.3)	412	(6.3)	34	(5.2)	-		26	(4)
Hyparrhenia	53	15	(28.3)	12	(22.6)	12	(22.6)	-		0	
Panicum	598	39 227	(6.5)	340	(56.9)	30	(5)	-		0	
Other	599		(37.9)	33	(5.5)	76	(12.7)	-		0	
Total Grasses	**1995**	**660**		**804**		**187**		**0**		**26**	
Other families	2										
Grand Total	**20611**	**1443**		**5542**		**3246**		**1085**		**222**	

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
CIMMYT							
	Teosinte (WS)	127	unknown	-	-	-	-
	Tripsacum (WS)	14+(150)*	unknown	-	-	-	-
	Maize (LR&OC)	12,861	10,334	80	base	NSSL, USA	Yes
			3,423	27	base	NINFSP, Mexico	Yes
	Maize (AC)	209	96	46	active	NSSL, USA	Yes
	Bread wheat	71,171	8,487	12	base	NIAR, Japan	No
			27,000	38	black box	NSSL, USA	Yes
			27,000	38	black box	ICARDA	Yes
					base	AWCC, Australia	No
	Triticale	15,200	10,000	66	black box	NSSL, USA	Yes
			10,000	66	black box	ICARDA	Yes
	Durum	15,940	4,368	27	base	NIAR, Japan	No
			5,000	32	base	ICARDA	Yes
	Barley	9,055	4,385	48	base	NIAR, Japan	No

* In the field genebank at Tlatzipan, Morelos, Mexico

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
CIP	*Ipomoea babatas*	5,318	4,950	93	*In vitro* (black box	IDEA, Venezuela	Yes
	Ipomoea spp. (wild weeds)	1,204	213	18	Seeds Active	USDA, Griffin, Georgia & North Carolina State University, USA	No
	Solanum spp. (cult)	3,694	3,694	100	*In vitro* (black box)	INIAP, Ecuador	Yes
			3,000	81	Seeds (base)	German Potato Genebank	No
			272	7	*In vitro* (Active)	(Gross Lusewitz), Germany	No
	Solanum spp.(wild)	1,567	600	38	Seeds (Active)	USA and German/Dutch Potato Genebank	No
	Solanum spp. (breeders' & misc)	996	120	12	*In vitro* (Active)	German Potato Genebank (Gross Lusewitz), Germany	No
	Other Andean root and tuber crops (native cults)	1,125	632	56	*In vitro* (Active)	CIP, Ecuador	

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
ICARDA	Barley	22,470	5,238	23	Black box	CIMMYT	Yes
	Wild *Hordeum*	1,623	88	5	Black box	CIMMYT	Yes
	Durum wheat	18,036	7,435	41	Black box	CIMMYT	Yes
	Bread wheat	7,836	1,238	16	Black box	CIMMYT	Yes
	Other cult. *Trit.*	465	-	-	-	CIMMYT	Yes
	Wild *Triticum*	1,340	127	9	Black box	CIMMYT	Yes
	Aegilops	2,854	2,622	92	Black box	CIMMYT	Yes
	Chickpea	9,586	4,894	51	Black box	ICRISAT	Yes
	Wild *Cicer*	291	-	-	-	ICRISAT	Yes
	Lentil	7,407	6,771	91	Black box	NBPGR	Yes
	Wild *Lens*	433	-	-	-	-	-
	Faba bean	4,434	1,554	35	Black box	FIA	Yes
	Medicago (ann)	7,845	-	-	-	FIA	Yes
	Trifolium	3.396	-	-	-	-	-
	Vicia	5,349	-	-	-	FIA	Yes
	Lathyrus	1,590	-	-	-	FIA	In preparation
	Pisum	3,553	-	-	-	-	--
	Other forages	5,129	-	-	-	FIA	In preparation

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
ICRAF	MPTS	549	109	20	Base	ILRI	Yes
			55	10	Active	NACGRAB	Yes
			59	11	Active	IITA	No
			46	8	Active	KEFRI	Yes
			42	8	Active	KEFRI	Yes
			52	9	Active	KEFRI	Yes
			72	13	Active	KEFRI	Yes
			94	17	Active	KEFRI	Yes
							Yes
		TOTAL	**529**	**96**			Yes

Table D.4.1. Safety Duplication of ICRISAT Germplasm Collections (1995)

Centre	Crop/Species	Total No. Accessions	No. Acc. duplicated	%	Type of duplication	Institute holding duplicated material	Agreement with holding institute
ICRISAT	Sorghum	35186	13370	38	Base	NSSL, USA	
	(*Sorghum bicolor (L.) (Moench)*		1000	4	Active	SPGRC, Zambia	Yes
	Pearl Millet	21191	4000	19	Base	SRGB, NSSL, USA	
	(*Pennisetum glaucum (L.) R.BR.)*		125	1	Base	NBPGR, IARI, India	
			1000		Active	SPGRC, Zambia	
	Chickpea(*Cicer arietinum L.)*	17244	4000	24	Active	ICARDA, Syria	
			683	4	Active	PGRC, Ethiopia	
			2000	12	Active	IARI, India	
			500	3	Active	INIA, Mexico	
			2584	15	Active	NARC, Pakistan	
			1500	9	Base	ICARDA, Syria	Yes
			3396	20	Base	USDA, USA	
			2031	12	Base	NSSL, USA	
	Pigeonpea (*Cajanus cajan (L.) Millsp.*	12885	1957	15	Base	NBPGR, India	Yes
			931	7	Base	KARI, Kenya	Yes
	Groundnut (*Arachis hypogea L.)*	14853	4200	28	Active	ISC, Niger	
	Small Millets	9015	351	4	Base	NSSL, USA	

Table D.4.1. Safety Duplication of ICRISAT Germplasm Collections (1995)

Centre	Crop/Species	Total No. Accessions	No. Acc. duplicated	%	Type of duplication	Institute holding duplicated material	Agreement with holding institute
IITA	Cowpea	14,826	4,423	30	active and base	USDA,Southern Regional PI Station, Georgia and USDA National seed Laboratory, Fort Collins	Formal agreement is being developed
	Wild Vigna	1,547	260	17	base	Belgian national Herbarium, Meise	-
	Rice	12,150	5,066	42	active and base	4,166 accession at IRRI, Philippines 1,500 accessions at the National Inst, of Agrobiological Resources, Japan	As a back-up storage, but no formal agreeement has been made
	Yam	2,875	300	10	field genebank	National Program in Togo	-
			93	3	field genebank	National Program in Benin Republic	-
			200	7	field genebank	The Genetic Resources Centre, Bunso Ghana	-
	Cassava	2,075	435	21	field genebank	National Root Crop Research	-
			300	5	field genebank	Institute Nigeria Republic of Benin	-
	Wild Manihot	159	159	100	active	CENARGEN, Brazil	
	Sweet Potato	217	217	100	*in vitro* culture	CIP, Lima Peru	These are part of the 1,000 accessions transferred from IITA to CIP. IITA has agreed to hold part of this as a back-up for the African region
	Soybean	1,358	638	47	active and base	364 acc. at University of Illinois and NSSL, Fort Collins, USA	No specific agreement was mase as most of the IITA collection is introduction and many accessions are advanced breeding lines
	Musa	350	310	89	active *in vitro* culture collection	INIBAP Transit Center, Belgium	No specfic agreement

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
ILRI	**Forages**	6,052	1,630	27	Active	CIAT	Yes
			381	6	Active	CIMMYT	No
			601	10	Active	CSIRO	No
			588	10	Active	ICARDA	No
			24		Active	ICRISAT	No
			908	15	Active	ISC - Niamey	Yes
			25		Active	IITA	
			250	4	Base	RGB - Kew	Yes
			98	2	Active	USA	No
		TOTAL	**4,505**	**74**			

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
IRRI	*O. Sativa*	76,615	59,038	77	black box	NSSL	Yes
	O. glaberimma	1,254	675	44	black box	NSSL	Yes
	Wild species	2,777	1,803	65	black box	NSSL	Yes

Table D.4.1. Safety duplication of CGIAR Centres' Genetic Resources (1995)

Centre	Duplicated material	Total No. of Acc.	No. Acc Duplicated	%	Type of Duplication	Institute holding duplicated material	Agreement with Institute
WARDA	*O. Sativa*	2,550	2,300	90	base	IRRI	Yes
	O. Sativa	5,928	2,300	39	base	IITA	Yes
	O. glaberimma	1,882	1,500	80	base	IITA	Yes

Table H.1.1 Distribution of germplasm by CIAT (1992-94)

a) *Phaseolus beans*

	Number of accessions (and samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	6,697(12,741)	3,957(7,970)	2,151(6,007)
Centre Staff in Other Countries	-	-	-
Other IARCs	--	-	-
NARS in developing countries	283(365)	1,317(1,478)	612(1,359)
NARS in developed countries	585(835)	73(374)	806(1,501)
Private Sector in developing countries	-	-	7(10)
Private Sector in developed countries	-	16(17)	-
Others	19(19)	-	-
TOTAL	**7,584(13,960)**	**5,363(9,839)**	**3,576(8,877)**

b) *Manihot cassava (in vitro)*

	Number of accessions (and samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	163(163)	29(29)	81(81)
Centre Staff in Other Countries	-	-	-
Other IARCs	-	-	-
NARS in developing countries	175(182)	243(290)	185(279)
NARS in developed countries	21(47)	200(262)	131(191)
Private Sector in developing countries	7(7(	6(6)	-
Private Sector in developed countries	-	3(3)	-
Others	-	-	-
TOTAL	**366(399)**	**481(590)**	**397(551)**

c) **Tropical Forages**

	Number of accessions (and samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	305(369)	1,005(1,250)	1,043(1,833)
Centre Staff in Other Countries	1,168(1,495)	296(310)	-(0)
Other IARCs	153(155)	346(603)	44(58)
NARS in developing countries	578(906)	404(576)	846(1,051)
NARS in developed countries	175(186)	1,057(1,071)	72(72)
Private Sector in developing countries	82(125)	75(104)	38(43)
Private Sector in developed countries	10(10)	6(6)	_(0)
Others	1(1)	49(53)	12(12)
TOTAL	**2,472(3,247)**	**3,238(3,973)**	**2,054(3,069)**

Table H.1.1. Distribution of germplasm by CIMMYT (1992-94)

a) Maize

	Number of (samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	(1,963)	(3,121)	(2,719)
Centre Staff in Other Countries	-	(2)	(32)
Other IARCs	-	-	-
NARS in developing countries	(302)	(584)	(468)
NARS in developed countries	(610)	(1,991)	(2,192)
Private Sector in developing countries	(233)	(35)	(156)
Private Sector in developed countries	(108)	(16)	(8)
Others	-	-	-
TOTAL	**(3,216)**	**(5,749)**	**(5,575)**

b) Wheat

	Number of (samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	(2,266)	(6,221)	(994)
Centre Staff in Other Countries	(12)	(112)	(32)
Other IARCs	-	-	-
NARS in developing countries	(561)	(584)	(3,793)
NARS in developed countries	(115)	(1,160)	(699)
Private Sector in developing countries	-	-	-
Private Sector in developed countries	-	-	(204)
Others	-	-	-
TOTAL	**(2,954)**	**(7,507)**	**(5,722)**

Table H.1.1. Distribution of germplasm by CIP (1992-94)

		Number of (samples)			
		Potato		Sweet Potato	
		In vitro	Tubers	*In vitro*	Cuttings
To developing countries	1992	(862)	(2245)	(573)	(217)
	1993	(1384)	(3280)	(726)	(302)
	1994	(1134)	(2030)	(1053)	(35)
To developed countries	1992	(212)	(46)	(66)	(0)
	1993	(333)	(0)	(0)	(0)
	1994	(254)	(7)	(97)	(0)
TOTAL	**1992**	**(1074)**	**(2291)**	**(639)**	**(217)**
	1993	**(1717)**	**(3280)**	**(726)**	**(302)**
	1994	**(1388)**	**(2037)**	**(1150)**	**(35)**

Table H.1.1. Distribution of germplasm by ICARDA (1992-94)

a) By recipient

	Number of (samples)		
	1992	**1993**	**1994**
Centre Staff	(12180)	(7160)	(6190)
Other IARCs	(54)	(1640)	-
NARS in developing countries	(4552)	(7244)	(12856)
NARS in developed countries	(5167)	(3987)	(3497)
Private Sector in developed countries	-	(42)	-
TOTAL	**(21953)**	**(20073)**	**(22543)**
GRU's own work	**(9114)**	**(5209)**	**(10213)**
Safety duplication	**(655)**	**(1000)**	**(4000)**

b) By crop or groups

	Number of accessions (and samples)		
	1992	**1993**	**1994**
Barley	1922(3075)	2702(4196)	1845(2095)
Wheat	7533(12539)	3722(5406)	7759(10571)
Lentil	(3985(6627)	2336(3749)	6257(9469)
Chickpea	2129(2979)	2148(3200)	4167(5274)
Faba bean	1120)1278)	2034(2705)	398(414)
Forages	3745(5224)	5617(7016)	6394(8933)
TOTAL	**20434(31722)**	**18559(26282)**	**26820(36756)**

Table H.1.1. Distribution of germplasm by ICRISAT (1992-94)

	Number of (samples)		
	1992	1993	1994
Centre Staff in Host Country	(18,567)	(22,545)	(12,850)
Centre Staff in Other Countries	(3,015)	(10,711)	(5,561)
Other IARCs	(45)	(96)	(30)
NARS in developing countries	(13,085)	(24,481)	(15,753)
NARS in developed countries	(361)	(178)	(367)
Private Sector in developing countries	(1,563)	(1,940	(811)
Private Sector in developed countries	(0)	(0)	(0)
Others	(3,815)	(342)	(1,099)
TOTAL	**(40,451)**	**(60,293)**	**(36,471)**

Table H.1.1. Distribution of germplasm by IITA (1992-94)

	Number of (samples)*		
	1992	1993	1994
Centre Staff in Host Country	(3,662)	(3,034)	(3,470)
Centre Staff in Other Countries	(200)	(20)	(104)
Other IARCs	(1,200)	(11)	(264)
NARS in developing countries	(3,656)	(1,221)	(2,852)
NARS in developed countries	(2,018)	(173)	(240)
Private Sector in developing countries	-	-	-
Private Sector in developed countries	(11)	(42)	-
Others	-	-	-
TOTAL	**(10,747)**	**(4,501)**	**(6,930)**

* Details of number of accessions not available; total accessions were about 90% of total samples

Table H.1.1. Distribution of germplasm by ILRI (1992-94)

	Number of accessions (and samples)		
	1992	1993	1994
Centre Staff in Ethiopia	980(1627)	718(1382)	966(1663)
Centre Staff in Other Countries	42(74)	36(36)	0(0)
Other IARCs	45(45)	160(184)	77(77)
NARS in developing countries	290(606)	454(888)	332(562)
NARS in developed countries	139(148)	43(44)	18(18)
Private Sector in developing countries	100(107)	117(157)	153(294)
Private Sector in developed countries (includes NGOs)	37(37)	18(18)	31(31)
Others	-	-	-
TOTAL	**1,633(2644)**	**1,546(2709)**	**1,577(2645)**

Table H.1.1. Distribution of germplasm by INIBAP (1992-94

	Number of accessions		
	1992	1993	1994
Centre Staff in Host Country	3	0	0
Centre Staff in Other Countries	0	0	0
Other IARCs (IITA)	0	19	14
NARS in developing countries	149	107	452
NARS in developed countries	90	211	72
Private Sector in developing countries	0	0	0
Private Sector in developed countries	0	0	0
Others (CIRAD)	54	106	67
TOTAL	**296**	**443**	**605**

Table H.1.1. Distribution of germplasm by IRRI (1992-94)

	Number of (samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	(15,021)	(15,311)	(14,461)
Centre Staff in Other Countries	-	-	-
Other IARCs	(1,397)	(104)	(110)
NARS in developing countries	(3,415)	(5,194)	(2,616)
NARS in developed countries	(1,906)	(4,792)	(1,730)
Private Sector in developing countries	(67)	-	(117)
Private Sector in developed countries	(85)	(88)	-
Others	(228)	(429)	(6,987)
TOTAL samples	**(22,119)**	**(25,918)**	**(26,021)**
Unique accessions	**17,735**	**21,661**	**20,251**

Table H.1.1. Distribution of rice germplasm by WARDA (1992-94)

	Number of accessions (and samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	150(350)	350(440)	600(800)
Centre Staff in Other Countries	-	120(300)	300(450)
Other IARCs	200(400)	200(300)	450(700)
NARS in developing countries	600(1200)	650(1400)	860(1600)
NARS in developed countries	-	-	-
Private Sector in developing countries	-	10(10)	5(5)
Private Sector in developed countries	-	-	-
Others	20(40)	-	50(200)
TOTAL	**970(1900)**	**1,330(2450)**	**2,315(3755)**