REPORT OF EXTERNAL REVIEW PANEL OF THE CGIAR GENEBANKS OPERATIONS

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

1995

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

CONCLUSIONS/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 in relation to the Centre's total budget the GRU is underfunded.

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 partners 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.

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 review carefully the large number of grass and legume species at present in the Tropical Forage collection with a view to concentrating on these

species most relevant to its research needs or that are in danger of genetic erosion.

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

5. CIAT should increase staff for SHL and charge other units for service provided by SHL

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

7. All bean accessions should be placed in long-term storage as soon as possible.

8. A pilot cryopreservation project for *Manihot* should be initiated as soon as possible.

9. A classification should be made 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.

10. Applied research should be initiated by CIAT 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 and to enter seed number and seed weight per 100 seeds in the data base.
· More mechanization in seed processing.
· Estimation of seed longevity of various species at temperatures above freezing (accelerated ageing, 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.

11. When dehumidifiers need to be replaced in the medium-term storage unit, a larger unit to maintain 28% r.h. should be installed.

12. Efforts should be made by CIAT to establish field genebanks, under suitable

agro-ecological conditions, for cassava accessions and other *Manihot* species which are reported not to be adapted to CIAT headquarters conditions.

13. CIAT should intensify its efforts to promptly arrange for a formal duplication of the cassava germplasm collection and to request relevant information from national and international institutes holding "non formal duplications"

14. CIAT should establish the same seed health routine procedures, as done for seeds to be send abroad, for the materials distributed inside the CIAT-host country (Colombia).

15. CIAT should distribute information, as data bases, on the genetic distances between accessions, which will improve the efficiency of the use of germplasm in breeding programs.

16. CIAT should establish agreements with NARS-GRU's that have good scientific and technical capabilities.

17. The Panel commends the GRU for the early designation 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 technology. The Panel recommends continuing referring GRU core collection and designating cores in additional forage species as feasible.

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.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 Table 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 (BOT) Board of Trustees.

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

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

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, 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.

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

TABLE A-1. GRU IN THE CONTEXT OF GR ACTIVITIES ACROSS CIAT (1995)

GERMPLASM ACTIVITY	GRU	BRU	VRU	COMMODITY PROGRAMS	NRMR PROGRAMS	INST. DEVELP. 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** Univs.	**Colombian** Univs, **Brazil** (CENARGEN)	**Colombian** Univs, **Brazil** (CENARGEN), **U.K.** (Kew Gardens)
• BIOCH./MOLECULAR	**USA** (Univ. 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)	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	Ditto *CBN, MGRN*	Ditto TF-GRN, **Australia, Brazil**, ILCA

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 being cleaned 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:

6.1 *Phaseolus* beans germplasm

- 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

6.2 *Manihot* Germplasm

There are three cases of cassava germplasm duplication 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.

6.3 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

(See section on "Challenges/Opportunities").

B. PLANT SPECIES/TYPES ASSEMBLED AND CONSERVED IN THE GENEBANK

Table B-1.	Number of accessions (as per June 1995)		
	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%)

1. Phaseolus beans Collection

1.1 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).

1.2 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 B-1 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. polyanthus*, and *P. acutifolius* germplasm stored in those banks.

Table B-1. 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.

2. Cassava germplasm

2.1 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.

2.2 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 accesions is from Brazil, Paraguay, Colombia and Venezuela; and the lowest from the Amazon basin, Mexico and the Caribbean.

3. Tropical Forages Germplasm

3.1 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 B.3).

3.2 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 legumes and grasses are all deserving of increased attention.

However, the Panel queried the need for CIAT to focus on such a large number of Tropical Forages.

* Recommendation: CIAT should continue to review carefully the large number of grass and legume species at present 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.

4. 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.

Table B-3. *Forage Germplasm.* 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	1,036	998	657	341	293
Arachis	173	59	50	9	29
Calopogonium	581	536	410	126	121
Centrosema	2,596	2,451	2,231	220	1,050
Desmodium	3,245	2,904	1,917	987	737
Galactia	668	570	557	13	378
Leucaena	216	199	177	22	150
Macroptilium	659	615	608	7	466
Pueraria	288	258	234	24	116
Rhynchosia	510	445	228	217	33
Stylosanthes	4,034	3,607	2,871	736	1,101
Vigna	838	741	654	87	337
Zornia	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	149	91	89	2	-
Brachiaria	1,121	654	563	91	124
Hyparrhenia	117	53	40	13	4
Panicum	848	598	512	86	35
Paspalum	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

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

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 5.75 scientist-year 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. 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 (eg. 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 the CIAT 1995 core budget.

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. (Fig. A-2).

2. Administration and management

Currently, the Leader of the GD-SRG has been assigned as interim Head of the GRU. 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

Current total number of personnel assigned to the GRU is 42; their distribution per collection 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
BSc.	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**

Breakdown of the 1993-1995 GRU operational resources per major activities (U.S.$)

	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	193,400
Coordination and Services**	347,000	95,000	162,600
Total	**778,000**	**663,000**	**791,000**

* Does not include the cost of maintaining the Cassava field gene bank ($150,000)
** 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 C-3.

The medium term and long-term seed banks 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 C-4) 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 variability, sample for both active and active collections should be stored in the long-term vault.

2.d Plant Quarantine and Seed Health Facilities

Seed health testing facilities

CIAT's facilities for seed health testing include the Seed Health Laboratory (SHL) with the sections shown in Table C-4. 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.

Table C-3. Facilities at CIAT-GRU (as per June 1995)

	Description	Volume - Area	Capacity (No. accessions)
1. Seed Bank	Medium term (5-20 years)	$360m^3$	90,000
	Long term (30-50 years)	$260m^3$	100,000
	Drying room	$68m^3$	1,485
	Threshing/cleaning room	$260m^3$	transit
	Herbarium	$30m^3$	15,000
2. In vitro bank	Laboratory	$44m^3$	transit
	Growth induction	$11m^3$	1,800/yr
	Slow growth room	$32m^3$	6,720
3. Cryo bank	Cryopreservation	0	10,000
4. Germination lab.	Germination testing	0	7,200/yr
5. Seed health testing lab.	nine sections	$125m^3$	3,600/yr
6. Electrophoresis lab.	four sections	$44m^3$	1,000/yr
7. Highland location	seed multiplication	2 ha.	1,500/yr

Table C-4. Germplasm at CIAT (as per August 1995)

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

Post quarantine facilities at CIAT

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: Negotiate with ICA to permit first increase of forages in mesh houses to increase effective population size and reduce genetic drift.

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: Increase staff for SHL and charge other units for service provided by SHL

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

Phaseolus germplasm

1. Facilities

A new seed storage facility, built with a donation from the Italian Government, began operations in early 1990. The facility includes (a) a long-term storage room at -15 - 20°C; (b) a short-term storage room at 5 to 8°C and 35% relative humidity, and c) a seed drying room at 20°C with 35% relative humidity. The facility has a designed capacity for nearly 100,000 accessions in each long-term and short-term storage rooms (Table D-1); currently the short-term conservation room is occupied at about 90% of its maximum capacity with GRU germplasm, including 65% for core collection.

* **Recommendation**: When dehumidifiers need to be replaced on the medium-term storage unit, a larger unit to maintain as to 28% r.h should be installed.

Table D-1. Seed gene bank facilities for *Phaseolus* beans in the GRU

Purpose	Type	Features	Volume or area	Capacity (accessions)
Seed storage	Short-term[a] (5-10 years)	5 to 8 °C, 35% r.h. 10% seed moisture	360 m^3	45,900
Seed storage	Long-term[b] (50 years)	-15 to -20 °C, 6% - 8% seed moisture	260 m^3	49,680
Seed drying	Medium r.h. (short-term)	35% to 40% r.h.	34 m^3	1485
Seed drying	Low r.h. (long-term)	15% to 18% r.h.	68 m^3	715
Seed laboratory	Seed classif. and preparation	Air conditioned	101 m^2	-
Herbarium				
Lab.and office	Sample prep. Shelves	Air conditioned	8.8 m^2	-
Sample storage			20.6 m^2	15000
	Covered			
Threshing and cleaning		Open	236 m^2	-
	Covered			
Equipment storage		Open	24 m^2	-

[a] Plastic jars
[b] Aluminum foil bags

2. 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 meshhouses; 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 gemplasm;

(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. Meshouses are used for controlling outcrossing.

3. 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).

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

Table D-2. Safety Duplication of IARCs at *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	USDA,Pullman,WA, USA	No
	Phaseolus lunatus	1,548	744	48.0	Active	USDA,Pullman,WA, USA	No
	Phaseolus coccineus	597	172	28.8	Active	USDA,Pullman,WA, USA	No
	Phaseolus polyanthus	292	96	32.9	Active	USDA,Pullman,WA, USA	No
	Phaseolus acutifolius	271	118	43.5	Active	USDA,Pullman,WA, USA	No
	***Phaseolus* Total**	28,271	21,478				
	M. esculenta	5,632	4,567	89.8	Active	NAR'S each country	No formal
	M. spp	353				CENARGEN	No
	Cassava Total	5,985					

* Active, Base or Black-box
* No information available

Manihot germplasm

1. *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-3 presents information on the cassava *in vitro* gene bank and the associated field gene bank.

The *in vitro* gene bank has reached about its maximun 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 installed storage capacity.

Cassava clones in the *in vitro* gene bank are conserved under controlled temperature of 23-24°C, with alternating light for 12 hours of 1,000 lux and 12 hours night. 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.

2. Field gene bank

The field collection has historically been managed by the Cassava Program, but will probably be transfered to the GRU in 1996. The field area assigned to the cassava collection is about 6,0 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 presents more serious problems of adaptation. A large investment is made in greenhouse labor associated with the vegetative propagation of *Manihot* species.

3. Seed conservation

To Nov 1994, seed of 12 wild *Manihot* species from collecting missions by CENARGEN/EMBRAPA, targetting 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.

4. 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 considerably large representation. (Table D-4).

Table D-3. *In vitro* and field gene bank facilities-areas for the cassava germplasm collection - CIAT (June 1995).

In vitro gene bank

Purpose	Area (m^2)	Capacity (No. clones)	Observation
Laboratory micropropagation media preparation	44		4 laminar flow chambers
Growth induction room	11	6,000	5 tubes/clone[a]
Conservation room	32	6,720	5 tubes/clone[b]
		11,520	3 tubes/clone[b]
Greenhouse	45	356	5 plants/clone

[a] 18 mm tube size
[b] 25 mm tube size

Field gene bank

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.

Table D-4. *Manihot* Germplasm

Safety Duplication of IARCs Germplasm Collections - *Manihot*

CENTRE	SPECIES/GROUP	Total No. Accessions	No. Acc. Duplicated	%	Type* of duplication	Institute holding duplicated material	Overlap	Agreement with holding Institute
CIAT	*M. esculenta*	5,632	4,567	89.8	Active	NAR'S each country		No formal
	M. spp	353	*1			CENARGEN		No

* Active, Base or Black-box

*1 No information available

Tropical Forages Germplasm

1. 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 and screen house space for initial increase and multiplication (see Tables D-7 and 8), and facilities for field conservation of some species.

Prioritization of tropical forages germplasm

During 1990-1991, a thorough study was carried out to analyze the tropical forages germplasm at CIAT and prioritize among genera and species. At that moment, a total of 20,053 accessions of grasses and legumes was maintained in the germplasm bank (CIAT, 1991). Today, in 1995, total accessions maintained are 20,682, and the numbers of genera and species are similar to those in 1991 (Table D-5), thus, no substantial changes have occurred since then and the analysis is still applicable.

Table D-5. Composition of tropical forages germplasm in CIAT 1991 and 1995.

Taxon	1991 [a]			1995 [b]		
	Grasses	Legumes	Total	Grasses	Legumes	Total
Genera (no.)	47	102	149	46	110	156
Species (no.)	137	581	718	152	587	739
Accessions (no.)	2001	18052	20053	1999	18683	20682

a. Source: CIAT, 1991.
b. Source: CIAT database as of 31.01.1995.

The number of accessions per species ranges from one to over 1400, reflecting the relative importance of each species as initially defined by CIAT's Tropical Forages Program (TFP). In 1990, 289 of more than 700 species were represented by one accession only (CIAT, 1990). In order to concentrate efforts on the most relevant materials, CIAT's Genetic Resources Unit (GRU) and the former Tropical Pastures Program (TPP) established three categories at the species level in 1990. About 20% of the species (46% of the accessions) were classified as of immediate interest to the TPP, 58% (49%) as of intermediate, and 22% (5%) as of probable future interest, respectively. Establishing these categories was meant to assist in prioritizing germplasm activities (CIAT, 1991).

The present relative importance of different genera is indicated in Table 2, which shows both those genera with important holdings in the germplasm bank and those with the most samples requested and distributed.

Table D-6. Acquisition, inventory, and distribution of tropical forage germplasm by CIAT's Genetic Resources Unit in 1992 and 1993 (no. of accessions as of 30.09.1993) [a].

Genus and relative importance [b]		Short-term storage		Distribution in 1992-1993 (no. samples)
		New in 1992-1993	Inventory 1993	
Legumes				
o	*Aeschynomene*	20	999	107
++	*Arachis*	23	42	193
+	*Cajanus*	17	106	171
o	*Calopogonium*	8	535	232
++	*Centrosema*	32	2404	1128
+	*Chamaecrista*	14	305	288
+	*Codariocalyx*	2	37	116
++	*Cratylia*	0	14	119
+	*Desmodium*	149	2925	526
o	*Flemingia*	23	146	164
o	*Galactia*	15	565	446
+	*Leucaena*	4	198	104
o	*Macroptilium*	10	607	174
+	*Pueraria*	17	255	46
-	*Rhynchosia*	6	447	24
++	*Stylosanthes*	22	3586	808
-	*Teramnus*	10	379	110
o	*Vigna*	19	746	100
-	*Zornia*	5	1030	925
	Other	243	3284	635
Total legumes		639	18610	6416
Grasses				
+	*Andropogon*	0	100	6
++	*Brachiaria*	1	689	533
o	*Hyparrhenia*	0	60	66
+	*Panicum*	59	598	111
+	*Paspalum*	4	119	5
-	*Pennisetum*	0	53	62
	Other	14	454	20
Total grasses		78	2073	803
Grand total		717	20683	7219

a. Source: CIAT, 1993, modified.
b. Relative importance: ++ very important, + important, o intermediate, - not important at present.

Nevertheless, the relative importance of genera needs to be interpreted as a dynamic appreciation because it has changed over time and probably will do so in the future. For example, the legume genus *Zornia* was considered very important in the late 1970's and early 1980's while today nobody at CIAT works anymore with *Zornia*. On the other

hand since the mid 1980's the research into *Arachis* species with forage potential has become very substantial to the TFP. In addition, "new" genera and species became important when CIAT expanded the mandate of the Tropical Forages Program in 1992 to cover also the mid-altitude hillsides of tropical America. Our research has also expanded into the genera *Cajanus, Canavalia* and *Macrotyloma*, for instance.

Table D-7 Areas dedicated for field collections of tropical forages germplasm at CIAT stations at Palmira, and Quilichao, Colombia.

Genus	Palmira Acc(No.)	Area (m^2)	Quilichao Acc(No.)	Area (m^2)
Legumes				
Arachis	99	432	-	
Leucaena	163	9,520	-	
Grasses				
Andropogon and	77	1,800	-	
Brachiaria	69		586	7,069
Hyparrhenia	-		40	1,127
Panicum	-		500	10,798
Total	339		1,126	

Table D-8. Areas for initial increase and/or multiplication of tropical forage germplasm at the GRU-CIAT

Location	Purpose	Type	Species	Area (m^2)
Palmira	Initial increase[a]	Screenhouse	Legumes/grasses	384
	Initial increase[b]	Screenhouse	Legumes/grasses	216
	Initial increase[a]	Screenhouse	Legumes/grasses	156
	Initial increase[c]	Screenhouse	Legumes/grasses	156
	Postquarantine	Greenhouse	Legumes/grasses	100
	Initial increase	Field	Legumes	4000
	Mult./rejuvenation	Field	Legumes	8,975
	Mult./rejuvenation	Field	Grasses	10,608
Quilichao	Mult./rejuvenation	Field	Legumes	21840
	Mult./rejuvenation	Field	Legumes	18733
Popayán	Initial increase	Field	Legumes/grasses	5.400

[a] In production
[b] Before flowering
[c] Long days treatment

Duplicate Conservation for Safety

- The establishment of a duplicate 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, Commonweath 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-7).

Recommendations: Seek to develop a Memorandum of understanding with USDA for security Backup of forage legumes and grasses at NSSL.

Table D-9. (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		Overlap
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)	-	-	8
Centrosema	2451	215	(8.8)	1218	(49.7)	633	(25.8)	146	(6.0)	16	(1)	41
Desmodium	2904	82	(2.8)	375	(12.9)	378	(13)	282	(9.7)	35	(1.2)	9
Galactia	570	1		56	(9.8)	38	(6.7)	10	(1.8)	3	(1)	2
Macroptilium	615	12	(2)	57	(9.3)	98	(15.9)	155	(25.2)	12	(2)	4
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		1
Stylosanthes	3607	584	(2)	1617	(44.8)	870	(24.1)	63	(1.7)	6		43
Vigna	741	15	(19.2)	40	(5.4)	125	(16.9)	29	(3.9)	5		4
Zornia	1028	197	(7.3)	411	(40.0)	45	(4.4)	33	(3.2)	10	(1)	7
Other	4461	326		427	(9.6)	587	(13.2)	110	(2.5)	20		13
Total legumes	18614	1551		4738		3059		1085		196		132
Grasses												
Andropogon	91	4	(4.4)	7	(7.7)	35	(38.5)	-		0		0
Brachiaria	654	375	(57.3)	412	(6.3)	34	(5.2)	-		26	(4)	2
Hyparrhenia	53	15	(28.3)	12	(22.6)	12	(22.6)	-		0		0
Panicum	598	39 227	(6.5)	340	(56.9)	30	(5)	-		0		2
Other	599		(37.9)	33	(5.5)	76	(12.7)	-		0		2
Total grasses	1995	660		804		187		0		26		6
Other families	2											
Grand total	20611	1443		5542		3246		1085		222		138

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 parentesis is presented the percentage represented in each institution

E. GENEBANK STANDARDS

Phaseolus **beans germplasm**

1.Procedures and methods for germplasm conservation

Type 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) Aluminium 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, the maximum number of seeds per jar ranges between 1,200 to 4,000; for seeds of wild species the maximum is about 15,000. Seed inventory has been handled using as reference, fractions of the volume of the jars, as follows:

Plastic jar capacity 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.

Seed viability monitoring

There is no routine checking of the initial viability. However, to plan multiplication and regeneration, viability monitoring is done by batches based on seed age; 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 a emergence monitoring in sand, because of its high correlation with emergence under filed conditions. A batch of 600 accessions of *P. lunatus*, having more than six years of storage, is planned to be checked this year.

Quantity of material conserved.

Because seed capacity of the plastic jars varies with on 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-2 and E-3 show data on seed inventory of *P. vulgaris* and other cultivated *Phaseolus* species, respectively.

Table E-2. 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-3. 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 processed (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 all bean accessions in long-term storage as soon as possible.

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.

Monitoring and maintenance of conserved material - regeneration.

- As in the case of viability, routine monitoring of conserved 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 planned for a germination test, prior to a decision about regeneration.

Maintenance of adequate documentation systems

- 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. (E-5)

***Manihot* germplasm**

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 stakes from the field gene bank or *in vitro* (international exchange) and hence two types of protocols have been established (Fig. E-1). 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.

* Recommendations: Initiate pilot cryopreservation projet for *Manihot* as soon as possible.

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 NAR'S 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 - β enterase

isozymes. DNA fingerprinting is carried out on groups having similar morphological isozyme patterns.

Tropical Forage Germplasm

Procedures and methods for germplasm conservation

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

Types of containers used for conservation

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

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 from contamination when breeding systems are unknown, every species is treated as outcrossing.

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.

* Recommendations: Place all forage accessions in long-term storage as soon as possible.

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.

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 short-term storage conditions, germination ranged 71 to 89%; and 82 to 97% under long-term storage conditions.

- Information obtained from long- and short-term storage indicates that legume seed with initial high quality can be stored over a long period with no significant loss of germinability.

Regeneration

Regeneration has seldomly been carried out with selected legume species when seed quantity in the active collection was reduced.

Maintenance of adequate documentation system

- Documentation of the tropical forages collection is carried out with Sunsparck center 2,000 with total disk space of 126 Gigabytes and total memory of 128 Megabites, using a database inplemented on a data managment 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 (Tables E-8a and b, 1), and 7% have been biochemically characterized by isozymes and native seed proteins (Table E-9, Annex 1).

- The Tropical Forages (formerly Pastures) Program characterized acid soil adaptation of about 7,500 accessions (36%).

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.

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.

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 α ß 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.

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: The Panel commends the GRU for the early designation and use and use of the core collection methodologies. The methodologies used for the initial core were exellent and the referents in progress (GIS and molecular markers) are cutting edge technology. The Panel recommends continuing refering GRU core collection and designating cores in additional forage species as feasible.

G. RESEARCH AND PUBLICATIONS ON GERMPLASM CONSERVATION

1. Research

Research in plant genetic resources at CIAT has been targetted 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, specially forages.

2. Publications

Table G1. 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
Catalogs of germplasm	8	8
Total	**96**	**137**

* Directly related to GRU activities

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

H. ACCESSIBILITY AND EXCHANGE OF GERMPLASM

Phaseolus beans germplasm

1. Distribution of material.

- A total of 32,740 samples were distributed during the period 1992-1994. More than 26,700 (86%) was distributed to the CIAT commodity programs, while about 6,000 (14%) were distributed to NARS in developing and developed countries. The above samples comprise 16523 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 H1).

2. 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. This active use also provided valuable information with regard to specific traits found in the collection, highlighting the critical usefulness of a genebank to germplasm users.
(Table H-4).

Table H-1. *Phaseolus* Beans Distribution of *Phaseolus* germplasm (1992-1993)

	Number of accessions* (and Samples)		
	1992	**1993**	**1994**
Centre Staff in Host Country	6696 (12,74-1)**	3957 (7,9-70)	2151 (6,0-07)
Other IARC's			
NARS in Developing Countries	283 (365)	1317 (1,4-78)	612 (1,359)
NARS in Developed Countries	585 (835)	73 (374)	806 (1,501)
Private Sector in Developing			7 (10)
Countries		16(17)	
Private Sector in Developed			
Countries			
Others	19(19)		
Total	7,584 (13,9-60)	5363 (9,8-39)	3,576 (8,887)

* This is number of different accessions sent to each sector

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

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

* This is number of different accessions sent to each sector.

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

Note:

During 1979-94 the *in vitro Manihot* germplasm collection has distributed a total of 3,891 accesions. 1,531 out of 3,891 are different accessions

Table H-3. Distribution of Tropical Forages Germplasm

	Number of Accessions* (and samples)		
	1992	**1993**	**1994**
Centre Staff in Host Contry	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***	2,064	2,865	1,867

* This is number of different accessions sent to each sector.

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

*** This is the 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.

Table H-4 Traits evaluated in the *Phaseolus* collection[1] and number of promising accessions.

Traits evaluated	Accessions (no.)		Source[3]
	Evaluated	Promising[2]	
Resistance to disease/pest			
BCMV	21686	3079	FM
BGMV	1660	12	FM
Angular leaf spot	23848	221	MAPC/SS
Anthracnose	23924	1941	MAPC/SS
Common bacterial blight	23060	109	MAPC/SB
Zabrotes subfasciatus	10973	12	CC
Acanthoscelides obtectus	6550	8	CC
Leaf hopper	17706	487	CC
Apion	1600	100	CC,SB
Other traits			
Low P tolerance	2178	143	SB
Drought tolerance	5156	118	JW
DI genes	114	--	JW
Phaseolin types	658	--	JT
Photoperiod response	1655		JW

1. Includes all *Phaseolus* germplasm conserved at CIAT.
2. Includes approximate numbers, and some accessions should be rechecked for confirmation.
3. FM (Francisco Morales); MAPC (Marcial Pastor-Corrales); SS (Shree Singh); CC (Cesar Cardona); SB (Steve Beebe); JW (Jeff White); JT (Joe Tohme).

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.

Manihot Germplasm

1. 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 advance 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.

2. 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.

Forage Germplasm

1. 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).

2. 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-5).

Table H-5. 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*	17434	HND, CRI, COL
Brachiaria	*brizantha*	6780	BRA, MEX, VEN, CUB, CRI
Brachiaria	*decumbens*	606	COL, CRI, MEX, PAN, CUB
Brachiaria	*dictyoneura*	6133	COL, PAN, VEN, CRI
Brachiaria	*humidicola*	679	COL, MEX, VEN, PAN
Centrosema	*acutifolium*	5277	COL
Centrosema	*pubescens*	438	HND
Desmodium	*heterocarpon*	350	BRA
Leucaena	*leucocephala*	21888	COL
Pueraria	*phaseoloides*	9900	MEX
Stylosanthes	*capitata*	10280	COL
Stylosanthes	*guianensis*	184	CHN, PHI, PER
Stylosanthes	*guianensis*	2243	BRA
Stylosanthes	*guianensis*	2950	BRA

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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**. made to do 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. For those countries with different requirements a different cooperation scheme could be developed, based on training requirements.

Security of facilities and of databases

1. 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 for those cases when the public energy was off due to a variety of reasons. Because of its limited capacity, only key areas had priority for connection to this plant and from the very begining the Genetic Resources Unit has been considered as priority for this service.

Because Colombia suffered a critical drought period three years ago (1991-92), and also at the same time there has been an increase on the demand for energy in Colombia in the last years, the cost of this service has increased substantially. Due to these reasons CIAT invested in the acquisition of a new system, which includes two power plants with a total capacity of 2,500 Kw., which easily surpasses the total CIAT needs of energy. These two plants are alredy on operation and they work every day during the peak hours of energy requirements in the region (9:00 to 12:00, and 18:00 to 21:00). Also, when unexpectedly the regional energy system fails,. there is a system to connect inmediately all sections of the Genetic Resources Unit to these plants (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.

2. 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. Each set works completely independent from the others, so that if one fails it is inmediately replaced by the other one.

3. Seed bank doors alarms. The seed bank, for beans and tropical forages, has four metallic doors: main entrance, long term storage, short term storage and, the drying room. Each of these doors have an individual sound 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.

4. 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 on buttom on the inside; this can be used in case that 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.

5. Monitoring seed bank conditions and the respective equipment. There is a panel for a continous monitoring of the temperature and of the relative humidity of each one the rooms in the seed bank as well as of possible failures of the equipment. This panel is strategically located for a dayly monitoring routine. There is also a routine checking coordinated with security CIAT guard personnel, in case that something goes wrong during this period.

6. Building fire protection. All the sections of the Genetic Resources Unit have at least one fire extinguisher. In some laboratories, carbon gas extinguishers have been placed because chemical powdered extinguishers are not suitable or recommended.

7. 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. This study is also considering the possibility of installing sprinklers of carbon gas in those risky sections, which can be activated as soon as a fire is detected.

8. 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.

9. 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. Also, it is worth mentioning that 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.

J. CONSTRAINTS

- As implied in the preamble, the genetic resources collections held in trust at CIAT constitute a key component of CIAT business. Initially, CIAT assembled the germplasm collections mainly in order to support the breeding efforts by the Center's commodity programs. The increase in size of the collections and the acquisition of additional responsibilities by the GRU were not always matched with sufficient resources; in addition, the CGIAR-wide financial restrictions of the last few years have equally affected the GRU. To place the CG and CIAT in accordance with the emerging global system on genetic resources, will require a concerted effort geared towards improving some the facilities and priority operations of the center's genebank. In spite that CIAT has made available some limited additional resources for 1995-96, the needs for the next 5-6 years are greater.

***Phaseolus* Beans germplasm**

- The following needs were drawn based on the "Genebank Standards" by FAO/IPGRI

1. Facility needs

- Seed quality laboratory for monitoring viability.
- Temporary storage room for recently harvested seed.
- Additonal field space in a highland location to multiply and clean germplasm.

2. Staffing

From 18 support personal in 1990, the beans section of the GRU has been reduced to 13 core people since 1989.

3. *P. vulgaris*: Represents 90% of the *Phaseolus* collection.

- 16,200 accessions (63%) need seed increase.
- Seed age of materials calls for routine viability monitoring for multiplication.
- Monitoring viability of wild forms of *P. vulgaris*
- Backlog (6,400 accessions) needing processing, selecting accessions not represented in the bank.

4. *P. lunatus*: represents 5.0% of the collection

- 1,047 accessions for seed increase to meet standards. Large seeded accessions would require lowering down "preferred standards".

- Routine seed viability monitoring for multiplication
- Need backlog (1,299 accesions) processing.

5. Complex *P. coccineus - P. polyanthus* : represents 3.5% of the collection.

- 550 accessions for processing to meet standards.
- Due to outcrossing, growth cycle, and seed size, these species require specialized efforts.
- Need backlog (339 and 169 accessions respectively) processing.

6. Wild *Phaseolus* species, non-cultivated: represents 0.6% of the collection.

- Special environmental conditions (greenhouse) needed for seed multiplication, according to recent experience in the GRU.

***Manihot* germplasm**

1. Improved representation of diversity of cassava and wild *Manihot* species:

- Of the 28 countries outside of Africa where cassava is important, 22 have donated germplasm to the world collection. Thus, germplasm of some entire countries and particular ecosystems is lacking. As the target of conservation is genetic diversity, it is important to recognize landraces in ecological regions and not only the principal varieties accounting for production acreage.
- Exploration and characterization of native habitats are needed and basic studies in genetics, ecology and biogeography to contribute to concepts of interspecific relationships and distribution of diversity.

2. Knowledge of seed biology and physiology of *Manihot* spp.

- Wild species are outcrossing and sexually propagated, so several individuals from a population are usually collected or received in exchange as botanical seed.
- Seed biology studies are rudimentary for the genus and little is known about managing and safe storage, dormancy or germination.
- Conservation methods for *Manihot* spp, distinct from those for cassava, remain to be established, for *in vitro*, *in vivo* and for true seed options. These joints highlight the need for research.

3. Safety duplication

- The implementation of safety duplication in other institutes is needed. Resources will be needed to cover the operational cost for duplicate conservation.

4. Improved disease indexing methodology and completion of indexation.

- Improved assays for cassava vein mosaic virus (CVMV) and frogskin disease (FSD) are needed. About 41% of the base collection and 60% of the core collection have been indexed for known pathogens.

Forage Germplasm

Main needs in the tropical forage germplam collection:

- Formalized massive procedures for processing of germplasm through quarantine.
- Increased efforts in seed multiplication
- New collections with larger seed number
- Improved knowledge about breeding systems to avoid genetic drift during regeneration cycles.
- Research in seed conservation to predict seed behavior in storage.
- Automatic routine seed viability monitoring.
- Formalized seed health status for conservation and distribution.

Summing up, several constraints experienced by CIAT GRU in the past are also often experienced by NARS in Latin America, the first one becoming evident is a formal recognition of the importance of its broader role in conservation.

An expanded role of the CGIAR and CIAT in genetic resources will act as a leverage and thus contribute to keep the GRU's support at a level in concert with its basic responsibilities.

OPPORTUNITIES

- As stated previously, CIAT's focus has shifted from a solely productivity approach to a more demanding one that includes, in addition, conservation of the natural resource base.

- The very nature of the commodities for which CIAT holds germplasm collections in trust, leads to 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 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*.

- The two research objectives referred to above are also pursued by country programmes in areas where CIAT has already established a long tradition of technology transfer: Central America and the Andean region. Both areas share the characteristics of high agrobiodiversity, scarce trained human resources and limited physical resources. Therefore expectations in genetic resources towards CIAT go beyond a seed supply function.

- The above obviously have programmatic and financial implications. The GD-SRG has conducted a first appraisal of the status and needs for upgrading the basic facilities and operations of the GRU, i.e. related to CIAT's current mandate in genetic resources. While the financial requirements needed to meet the upgrading are being defined, it is clear that under optimal funding conditions, this task would take 5-6 years. If the current coverage of the collections is 50% for *Phaseolus* genus, 40% for cassava and 25-50% for tropical forages, based on geographic and ecological representation, any additional growth of the collections will require a strong research component not only to better define the composition of the collections, but also their improved conservation and utilization. Opportunities in this area are many.

- Two external reviews carried out at CIAT in 1994 and 1995 already indicated the opportunities for the GRU and BRU to strenghten already existing links and develop further complementary joint projects.

- Complementary opportunities for strategic research in agrobiodiversity include:

  - Development of genetic molecular maps (saturated with different markers, and referring to genetic stocks) for studies on genetic diversity (e.g. gene flow and evolution) at DNA level;

- Integration of GD assessment and GIS information for germplasm collecting and *in situ* conservation;

- Documentation of diversity of host plants and linkages with diversity of associated microorganisms (symbionts, pathogens) in order to understand coevolution and to design conservation and utilization strategies;

- Use of tissue culture technologies for developing *in vitro* gene banks;

- Use of cellular and molecular technologies for bridging inter-and-intra-species barriers to gene transfer will contribute towards broadening the genetic base.

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 in the Western Hemisphere and beyond. 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

Insuring the safety and full 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 at 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 also essential.

For safe duplication, preferably as black box entries, institutions such as other IARCs, regional organizations and NARS of developing countries, as well as public labs in the region can be considered.

Objectives

1. To develop protocols for reliable and massive plant health testing for the three collections;

2. 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 be also necessary.

3. To ensure adequate processing for effective conservation and duplication by installing a seed quality lab at CIAT, and through the development of appropriate infrastructure, and provision of 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 cassava 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 a gene bank. Cryopreservation offers a means for the 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 evaluate their potential for further utilization.

Objectives

1. To improve efficiency in the conservation of priority tropical forage germplasm by developing physical and chemical treatments that insure the 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 undomesticated *Manihot* and *Phaseolus* species that are conserved as seed germplasm.

2. To develop 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.

2. 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.

3. Once tropical forage species to be used in the future are better defined by CIAT and user partners, carry out similar studies aimed at ensuring that patterns of genetic diversity are properly documented and used for sampling and conservation strategies.

4. 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.

***Phaseolus* beans collected in recent years by CIAT GRU and NARS of Latin America.**

Year	No. countries	Phaseolus Species	No. accessions
1985	Argentina	wild vulgaris	26
		augusti	2
	Mexico NE	coccineus cult	1
		glaucocarpus	1
		leptostachyus	8
		neglectus	5
		scabrellus	3
		altimontanus	2
		vulgaris landraces	113
		xanthotrichus v. zim	4
	Guatemala W	coccineus wild	14
		leptostachyus	8
		lunatus wild	9
		macrolepis	1
		persistentus	1
		polyanthus wild	3
		tuerckheimii	2
		vulgaris wild	4
		xanthotrichus	5
1986	Argentina	augusti	4
		vulgaris landraces	156
		vulgaris wild	10
	Peru N	lunatus landraces	62
		lunatus wild + weed	8
		pachyrrhizoides	4
		polyanthus landraces	18
		vulgaris landraces	710
		vulgaris wild + weed	15
	Mexico N Centr	coccineus wild	15
		floribundus	2
		glabellus	5
		glaucocarpus	2
		leptostachyus	10
		maculatus	1
		neglectus	7
		pedicellatus	12
		pluriflorus	1
		polymorphus	3
		scabrellus	1
		vulgaris weedy	1
		xanthotrichus v. zim	11

Year	No. countries	Phaseolus Species	No. accessions
1987	Peru Central	augusti	4
		lunatus landraces	4
		lunatus wild	1
		pachyrrhizoides	18
		vulgaris landraces	139
		vulgaris wild + weed	10
	Mexico S Centr	chiapasanus	1
		coccineus wild	22
		esperanzae	9
		hintonii	1
		leptostachyus	15
		maculatus	2
		marechalii	2
		microcarpus	10
		nelsonii	5
		oaxacanus	2
		ovatifolius	1
		parvifolius	2
		pedicellatus	4
		pluriflorus	1
		polymorphus	2
		spec. nov.	1
		vulgaris wild + weed	6
		xolocotzii	1
	Guatemala	coccineus wild+ weed	12
		leptostachyus	18
		lunatus landraces	4
		lunatus wild	10
		macrolepis	1
		oligospermus	2
		parvifolius	2
		polyanthus wild	3
		tuerckheimii	3
		vulgaris wild + weed	8
		xanthotrichus	9
	Costa Rica Cen	costaricensis	11
		leptostachyus	2
		lunatus wild	14
		oligospermus	1
		polyanthus weedy	2
		talamancensis	1
		tuerckheimii	6
		vulgaris wild + weed	4
		xanthotrichus	5

Year	No. countries	Phaseolus Species	No. accessions
1988	Peru South	augusti	10
		vulgaris landraces	25
		vulgaris wild + weed	44
	Bolivia S Cent -	augusti	7
		lunatus landraces	12
		vulgaris landraces	64
		vulgaris wild + weed	6
1989	Colombia Centr -	flavescens	2
		lunatus landrace	1
		vulgaris weedy	1
	Peru NW	augusti	2
		lunatus landraces	36
		lunatus wild + weedy	2
		polyanthus landraces	6
		vulgaris landraces	28
		vulgaris wild + weed	5
	Ecuador N Cent -	augusti	2
		coccineus landrace	1
		lunatus landraces	100
		lunatus wild + weedy	5
		polyanthus landraces	3
		polyanthus weedy	4
		vulgaris wild + weed	4
1990	Ecuador South	augusti	1
		lunatus landraces	10
		lunatus wild + weedy	21
		polyanthus weedy	2
		rosei	1
		vulgaris wild	4
	Colombia Centr	lunatus landraces	26
		polyanthus hybrids	3
		vulgaris landraces	38
		vulgaris wild	3
1994	Bolivia South	augusti	4
		lunatus landraces	2
		vulgaris landraces	27
		vulgaris wild + weed	8
		Manihot wild	1
		Capsicum annuum	1
		C. baccatum	6
		C. chacoense	3
		C. eximium	2

Year	No. countries	Phaseolus Species	No. accessions
1995	Guatemala West	coccineus wild leptostachyus lunatus wild macrolepis polyanthus wild tuerckheimii vulgaris wild xanthotrichus	12 2 7 1 2 2 11 3
Total: 8	Total: 8 countries	Total taxa: *Phaseolus* 42 (minimum estimate, as new species are being described), *Capsicum* 4, *Manihot* 1.	Total collections: 2,224 (minimum estimate, as more separations are being done)

List of publications by GRU, BRU and SRG-GD staff for the period 1990-1995

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* 1. **Angel, F., Arias, D., Tohme, J.**, Iglesias, C. and **W.M. Roca.** 1993. Toward the construction of a molecular map of cassava (*Manihot esculenta* Crantz): comparison of restriction enzymes and probe sources in detecting RFLPs. Journal of Biotechnology. 31:103-113.

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BEAN GERMPLASM SECTION

Name	Position GRU	Undergraduate level	Functions	Years/ GRU
Hidalgo, Rigoberto	Associate	Ing.MSc. Agronomist Engineer	Curator	18
Rubiano, Hember	Assist.I	Agronomist Engineer	Multiplication,regeneration,characaterization,conservation,distribution.	20
Toro, Orlando	Exp. I	Tnlg. Agropecuary	Introduction,first increase of germplasm,collecting expeditions.	21
Arana, Gilberto	Tech. III	High shcool complete	Field characterization-multiplication	17
Becoche, Hector	Tech. III	High school incomplete	Greenhouse maintenance, germination tests	15
Herrera, Jorge L.	Tech. III	High shcool incomplete	Field multiplication	17
Castillo, Heynar	Worker I	High school incomplete	Inventory control	12
Córdoba, Porfirio	Worker I	High school incomplete	Field characterization-multiplication	9
Ortiz, Ignacio	Worker I	High school complete	Seed classification-distribution	7
Gil, Fanny	Worker II	Technician Chemical Analysis	Seed classification-distribution	7
Pérez, Gloria	Worker II	High school complete	Seed classification-distribution	10
Garzón, Luis E.	Tech. II	Tec. Agro-Industrial	Increase and maintenance of germplasm in Palmira station stations'	21
Guetocue, Lino J.	Worker II	High shcool incomplete	Increase and maintenance of germplasm in Popayan stations'	13
Valencia, Guillermo	Tech. II	4 Systems semester	Preliminary characterization and data transcriptions greenhouse and mesh-house	8

Total Bean Germplasm section: 14

CASSAVA GERMPLASM SECTION

Name	Position GRU	Graduate level	Functions	Years/GRU
Guevara, Claudia	Associate	MSc. Agronomy PhD. Agronomy	Curator	1
Mafla, Graciela	Assist.I	Biologist-Botany	1981-1990: Tissue Culture Laboratory in BRU, working in cleaning of virus, short-term conservation and long-term conservation. 1991 - present: in charge of the *In vitro* Management of *Manihot* germplasm at CIAT	15
Reyes Raúl	Lab. I	Biologist (Botany)	Interchange and Conservation	6
Roa Julio Cesar	Exp. I	Biologist	Cleaning and Conservation	6
Velasquez Elena	Tec. I	Biologist (Genetics)	Micropropagation in vitro	1
Montoya, Aseneida	Worker II	Executiv Secretary	Cleaning glasses, Greenhouse activities	6
Urrea, Carmen	Worker II	High school incomplete	Micropropagation and laboratory activities	6

Total *Cassava* Germplasm section: 7

FORAGES GERMPLASM SECTION

Name	Position GRU	Undergraduate level	Functions	Years/ GR
Ortiz, Amanda	Associate	Lic. in Biology and Chemistry MSc. Seed Technology	Curator	5
Torres, Alba Marina	Assist.II	Biologist	Curator of CIAT herbarium	7
Carabali Nehemias	Tech. I	High school complete	Coordination of the activities held in Quilichao and Popayan station's	2
Ciprian Arsenio	Tech. I	High school complete and Technician of systems	Coordination of the field activities of Palmira's station and data management	18
Morales Orlando	Tech. III	High school imcomplete	Long Term conservation and seed testing for monitoring	18
Reinoso Benjamin	Tech. III	High school complete and basic courses on computer programs	Maintenance of the field Palmira and now support work in herbarium	3
Zambrano Lorenzo	Tech. III	High school incomplete and basic courses on computer programs	Short term conservation, germplasm distribution and initial germination for multiplication	17
Tabares, Ariel	Worker I	High school incomplete	Maintenance of the field/Palmira	10
Rengifo, Alirio	Worker I	High shcool incomplete	Maintenance of the Greenhoses	22
Finscue Gugu, Arsecio	Worker I	High school incomplete	Maintenance of the field/Quilichao and Popayan	17
Vargas, Hugo	Worker I	High school incomplete	Seed Cleaning and support work in greenhouses	16
Borrero, Luis E.	Worker II	High school incomplete	Maintenance of the field/Palmira	6
Caviche, Ineldo	Worker II	High school incomplete	Maintenance of the field/Quilichao and Popayan	18

Total Forages Germplasm section: 13

SEED HEALTH LABORATORY

Name	Position GRU	Graduate level	Functions	Years/ GRU
Pineda, Benjamín	Associate	Agronomist Engineer MSc. Plant pathology	Head of the seed health Laboratory	5
Balcazar Socorro	Lab. I	Bacteriologist and C.L.	Preparation of working samples, preparation of media and substrates, bacteriological and mycological seed analysis.	6
Solis, Aracelly	Worker II	High school incomplete	Preparatory work, washing up and preparation of media and substrates	7

Total Seed Health Laboratory: 3

ELECTROPHORESIS LABORATORY

Name	Position GRU	Graduate level	Functions	Years/ GRU
Ocampo, Cesar	Assit. II	Biologist (Geneticist)	Research Assistant at the Genetic Resources Unit, (Laboratory Electrophoresis)	5
Hernández, Antonio	Tech. II	High school incomplete	Technician for the laboratory and greenhouse activities	5

Total Electrophoresis Laboratory: 2

STATISTIAN

Name	Position GRU	Graduate level	Functions	Years/ GRU
Andrade, Mercedes	Tech. Sta. I	Statistician MSc. Candidate System Engineer	Support in statistics, management and analysis of data; coordinator of databases	5

Total Statistician: 1

COORDINATION - GRU

Name	Position GRU	Graduate level	Functions	Years/ GRU
Debouck Daniel	Plan Geneticist	Ingénieur Agronome Certificat en Agronomie Tropicale Docteur en Sciences Agronomiques	Senior Scientist in charge of genetic diversity research projects for CIAT and IPGRI, and contributor to the CGIAR Consortium on Agrobiodiversity; presently coordinator of CIAT-GRU	
Albarracin,Sandra	Bilingual Executive Sec.	High school complete	Secretary in Genetic Resources Unit of CIAT, providing secretarial assistance for 41 persons in the Unit, including 1 Senior Staff, 3 General Administrative Staff and 37 professional, technicians and workers.	9

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. **Benjamin Pineda**
Seed Health Laboratory, Genetic Resources Unit

MSc. **Mercedes Andrade**
Statistics, Genetic Resources Unit

MSc. **Jaime Urdinola**
Plant Quarantine, ICA

ACRONYMS

AFLP	Amplified Fragment Length Polymorphisms
B	Bean
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 Agronomico Tropical de Investigacion y Enseñanza
CBD	Convention of Biological Diversity
CCMV	Cassava Common Mosaic Virus
CENARGEN	Centro Nacional de Recursos Geneticos
CG	Consultative Group
CGIAR	Consultative Group or International Agriculture Research
CGIAR-GR	CGIAR-Genetic Resources
CHN	China
CIAT	International Center for Tropical Resources
CIMMYT	Centro Internacional de Mejoramiento Maiz y Trigo
COL	Colombia
CIP	Centro Internacional de la Papa
CP	Cassava Program
CRI	Costa Rica
CsXV	Cassava X Virus
CUB	Cuba
DG	Director General
dsRNA	Double Strand RNA
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
F	Forages
FAO	Food and Agriculture Organization of the United Nations
FSD	Frog Skin Disease
GD	Genetic Diversity
GD-SRG	Genetic Diversity Scientific Resource Group
GIS	Geographic Information System
GR	Genetic Resources
GRU	Genetic Resources Unit
GTM	Guatemala
HND	Honduras

ACRONYMS

IARCs	International Agricultural Research Centers
ICA	Instituto Colombiano Agropecuario
ICWG	Inter-Center Working Group
ICWR-GR	Intercenter Working Group on Genetic Resources
IICA	Instituto Interamericano de Cooperacion en Agricultura
INIAP	Instituto Nacional de Investigacion Agropecuaria
IPGRI	International Plant Genetic Resources Institute
LA	Latin America
LAC	Latin American Caribbean
MEX	Mexico
NARS	National Agricultural Research System
NGO	Non Governmental Organizations
NIC	Nicaragua
NRMP	Natural Resource Management Program
PAN	Panama
PER	Peru
PHI	Philippines
PROFRIJOL	Programa de Frijol de Centro America
PROFIZA	Programa de Frijol de la Zona Andina
RAPD	Random Amplified Polymorphism DNA Markers
REDARFIT	Red Andina de Recursos Fitogeneticos
REMERFIT	Red Mesoamericana de Recursos Fitogeneticos
RIEPT	Red Internacional de Pastos Tropicales
SBSTA	Subsidiary Body on Scientific Technical and Technological Advice
SENA	Servicio Nacional de Aprendizaje
SGRP	System Wide Genetic Resources Program
SHL	Seed Health Lab
SINGER	System-Wide Information Network on Genetic Resources
SRG	Scientific Resources Group
TFP	Tropical Forages Program
TROPIGEN	Red Tropical de Recursos Geneticos
UNEP	United Nations Environmental Program
VEN	Venezuela
VRU	Virology Research Unit

Appendix III

PROGRAM FOR PANEL OF EXTERNAL REVIEW OF CGIAR GENEBANK OPERATIONS

THURSDAY AUGUST 3

8:00 - 9:00	Panel Meeting	
9:00 - 9:15	Genetic Resources in CIAT	R. Havener (RH)
9:15 - 9:40	Conservation and utilization strategy	W. Roca (WR)
9:40 - 10:05	Operations and status of germplasm collections	D. Debouck (DD)
10:05 - 10:30	Discussion	
10:30 - 10:45	**Coffee**	
10:45 - 11:10	Germplasm conservation research	J. Tohme (JT)
11:10 - 11:25	Discussion	
11:25 - 11:50	Challenges & Opportunities	D. Debouck (DD)
11:50 - 12:15	Discussion	
12:15 - 14:00	**Lunch**	
14:00 - 17:15	*Visit to GRU*	

FRIDAY AUGUST 4

8:00 - 9:30	Panel meeting with CIAT GRU Staff
9:30 - 9:45	Panel and WR (Leader, Genetic Diversity SRG)
9:45 - 10:00	NLI, ML, with DD (Genetic Diversity)
9:45 - 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

8:00 - 10:30	Panel meeting
11:00	Departure for Cali Airport

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE AND CGIAR SECRETARIAT

Review of Gene Banks operations
1995
see note 8/04

REPORT OF THE

FIFTH EXTERNAL PROGRAMME AND MANAGEMENT REVIEW

OF THE

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

(CIAT)

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

April 2000

Centre, and at the same time the visits have strong representational value in the field. Having a Board member in tow may give occasion for field staff to reinforce important contacts with host governments and other partners.

The Board interacts more frequently with the scientific staff at CIAT Headquarters, but this seems to be a matter of personal and professional interest rather than a deliberate part of its program of activities. The advantage of such interaction is that it allows the Board members to appreciate in more depth both the CIAT program, and the environment in which the scientists are working. Issues such as security, spousal employment, security of tenure, career planning and family implications of employment at CIAT are specific to context. Board members need to be aware of the whole picture in order to make appropriate decisions on policies and priorities. Arguably, this was a factor in the departure of the previous Director General. The Panel urges the members of the Board to increase their interactions with CIAT staff both at headquarters and in the field.

8.1.5.7 Varia

CIAT's Constitution and By-laws are clear and accessible. The Board Handbook is a valuable reference tool, kept current by the Board Secretary. Board Members are covered by health, accident and liability insurance. The Board has adopted the "Reference Guides on Roles, Responsibilities, and Accountability of Centre Boards of Trustees" published by the CGIAR Secretariat, and implements its recommendations for Board Chair evaluation.

The Board includes members capable of stepping in as interim Director-General, and of moving in to positions of Chair and Vice-Chair.

8.2 Centre Commissioned External Reviews (CCER)

The concept of CCERs emerged at the CGIAR Mid-Term Meeting in 1995, and was further developed by TAC and the CGIAR Secretariat. External reviews are considered the cornerstone of the CGIAR's system of accountability, and are expected to cover four major areas: program priorities and strategy, relevance and quality of science, achievement and impact, and governance and management. CCERs may be commissioned in any area that a Board may choose, but one of their main uses is to assess the relevance and quality of science. Thus evaluation of science is a key theme of the CCER concept.

CIAT describes its science evaluation process as follows: "CIAT's evaluation framework includes two dimensions: research strategy and quality of science. The strategic process evaluates if CIAT research has the right goals, meets stakeholder needs, is feasible, has adequate projected outputs, and the right resources and organisation to deliver these. The scientific quality review concerns issues such as: is our science rigorous, cutting edge, and of high international standards; are the methods used optimal

and is the peer review process appropriate. The Internally Commissioned External Review (ICER) concerns a review of the quality of science" [7]

The CIAT Board of Trustees monitors the quality and relevance of the research program through, *inter alia*, Centre Commissioned External Reviews (CCER). The Board follows a process that includes approving a list and plan for reviews. External consultants carry out the review. The Board approves the selection of a Chair for the review and Management then selects the rest of the CCER panel. A Board representative meets with the Chair, or confers with him or her by telephone to ensure that Board concerns are taken into account. The Management then comments on the report, which is sent to the Board for discussion, including actions to be taken on its recommendations or suggestions. A year later, a considerable part of a Board meeting is devoted to following up on implementation of the CCER recommendations and suggestions.

The Board considers the CCER to be a major element in evaluating the quality of science at the Centre. As such, CIAT's original plan was to conduct one review a year, following a planned schedule for projects or areas to be reviewed.

8.2.1 CCERs Conducted During the Review Period

External Review of the CGIAR Gene Banks operations 1995

Four CCERs were commissioned by the Board during the review period, covering Resource Management (1995), Genetic Resources and Biotechnology (1997), Crop Improvement (1998) and Soils, Plant Nutrition and Agricultural Systems (1999). In addition, an ICER commissioned by the CGIAR on Genebank Operations (1995) is considered by CIAT to be the equivalent of a CCER. The EPMR Panel refers to these in respective chapters.

8.2.2 Future Strategy

The Board plans to schedule CCERs covering all aspects of Centre activities such that they support the next EPMR. In addition, CIAT plans to commission a CCER on Management.

8.2.3 Overview and Assessment

The coverage of the CCERs is shown in Table 8.2. The Panel notes that the Project most reviewed was Genetic Resources which was the subject of two major reviews and was linked as a key partner in the 1995 CCER of *Resource Management*. Projects on Beans, Cassava, Rice and Tropical Forages were the subjects of a major *Commodity Improvement* CCER (1998) and were also strongly linked to two reviews, CGIAR *Genebank Operations* ICER (1995) and the *Resource Management* CCER (1995). The Biotechnology and Production Systems projects were reviewed twice, each of them being reviewed once as a main focus and once as a project linked to another

[7] Terms of Reference of the Review Panel, Internally Commissioned External Review (ICER) 1997, Integrated Conservation of Neotropical Genetic Resources (Project SB-1) and Enhancing the Understanding and Use of Agrobiodiversity Through Biotechnology Methods (Project SB-2).

review. Projects reviewed once as a main foci were Beans in Africa; Soils and Plant Nutrition; Hillsides; and Land Use; while Systemwide Soil, Water and Nutrition; IPM and the former Forest Margins Program were linked to a review. Projects not covered by a review during the period were Rural Agroenterprises, Linkages with NARS, Farmer Participatory Research, Impact Assessment, Ecoregional Program for Tropical Latin America and the former Savannah Program.

All CCERs mentioned the quality of science, although most of the assessments were based on observations of the panel and their experience, and none indicated the use of quantitative evaluation methods. Nevertheless, the CCERs did discuss quality of science explicitly, which aided the work of the Panel.

The CCERs were useful to the Panel's deliberations and made its tasks easier. The Panel emphasises that it comments in different chapters on the opinions presented by the CCERs and in most cases the Panel expresses its agreement.

The Panel commends CIAT's Board for commissioning the CCERs and for their quality— which in most cases was quite high – and for its plans for CCERs in the future. Each presented well argued, provoking recommendations and suggestions.

The Panel was concerned that in some cases the follow-up to the CCERs may not have been consistent. The Panel believes the Centre would benefit from a CCER on the broader NRM work and on participatory research.

Table 7.1
COVERAGE OF CIAT PROJECTS BY CENTER-COMMISSIONED EXTERNAL REVIEWS (CCER), 1995 - 1999

ICER/ CCER, Date	SB_1	SB_2	IP_1	IP_2	IP_3	IP_4	IP_5	PE_1	PE_2	Hill-Sides PE_3	PE_4	PE_5	SN_1	SN_2	SN_3	BP_1	SW_1	SW_2	SW_3	Forest Margin	Savannah
Plant Nutrition & Agriculture Systems 1999									●			●						•		•	
Commodity Improvement 1998	•	•	●	●	●	●	●														
Genetic Resources & Biotech. 1997	●	●						•				•									
Resource Management 1995			•		•	•	•			●	●				•					•	•
ICER-CGIAR Genebank Operations 1995	●		•		•	•	•														

● = main foci (one of)
• = linked to the Review

Code for the Projects:

SB_1	Genetic Resources	PE_1	Integrated Pest Management (IPM)	SN_3	Farmer Participatory Research
SB_2	Biotechnology and Agrobiodiversity	PE_2	Soils	BP_1	Impact Assessment
IP_1	Beans	PE_3	Hillsides		
IP_2	Beans in Africa	PE_4	Land Use	SW_1	Ecoregional Program for Tropical Latin America
IP_3	Cassava	PE_5	Sustainable Systems for Smallholders	SW_2	Soil, water & Nutrient Management
IP_4	Rice	SN_1	Rural Agroenterprises	SW_3	Participatory Research & Gender Analysis
IP_5	Tropical Grasses and Legumes	SN_2	Linkages with NARS'		

ICE895

Daoud, Layla

From: Daoud, Layla
To: Debouck, Daniel (CIAT)
Cc: Toll, Jane; Daoud, Layla; Innes, N.L.
Subject: Genebank Review responses
Date: Friday, March 14, 1997 7:27PM
Priority: High

Dear Dr. Debouck,

Thank you for sending the CIAT Board-approved responses to the recommendations in the genebank review. As I mentioned in our telephone conversation of today, we noticed that there were some discrepancies between the wording in the recommendations in the final report and those to which CIAT's Board responded. Prof. Innes has reviewed the report and the recommendations and responses (this is the procedure for all of the responses received) and has made some suggestions to change the wording in the recommendations for clarity. In some cases he has had to modify some of the Board-approved responses, but he has tried to make minimal changes and has attempted to retain CIAT's sentiments. You will find attached a revised version (as per Prof. Innes' suggestions) of the recommendations and responses attached. (I shall also send you the individual CIAT report with the relevant corrections - I'll send this in a second message in order to ensure that you receive both attachments). We would be grateful if you could please have a look at the suggested revisions and check with Centre management if this revised version is acceptable for publication in the Annex to the Genebank Review report.

<<File Attachment: ciatrec.doc>>

Please note that it will not be possible to include the responses provided by CIAT to the summary comments of the report. Most Centres responded only to the recommendations in their reports. Therefore, for sake of consistency, we plan to include only the responses to the recommendations in the Annex which will be published.

Please note also that Recommendation number 1 has been removed from the list of recommendations in the report and from the responses. There was no mention of recommendation 1 in the body of the report and Prof. Innes has therefore suggested we remove it from the list of recommendations, but that in order to accommodate CIAT's response a line be added at the bottom of the summary comments to the effect that "The Panel noted the heavy demands made on the GRU by the Commodity Programmes".

I understand that you will be away from the beginning of next week. I hope that by receiving the document today you will have a chance to review it.

We look forward to receiving your response.

Thank you.

Layla

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 databases 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.

The Panel noted the heavy demands made on the GRU by the Commodity Programs.

Recommendation 1

1. 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, re-collection may be more efficient than regeneration.

Response to Recommendation 1

In 1986, the Tropical Pasture Programme (TPP) established a list of 18 species of proven value as forage, and the GRU will concentrate on those in collaboration with the TPP as far as acquisition of germplasm is concerned. Given the agreement passed with FAO about the designate collection, the accessions included in the designated collection will be safely conserved. Under its present status and level of funding, the GRU is not prepared to take major steps towards the *ex situ* conservation of the 730 species of legumes and grasses if threatened by genetic erosion.

Recommendation 2

2. 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.

Response to Recommendation 2

Under its present status, level of funding and expertise available, the GRU will not assume responsibility for the conservation of these bacterial and fungal collections. Their maintenance is a task requiring skilled personnel and specific facilities; they will be kept as working collections by CIAT commodity programmes.

Recommendation 3

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

Response to Recommendation 3

This point is well taken, and after checks for seed viability and health, and adjustment to right seed moisture, materials of species with limited longevity will be progressively passed to the long-term vault.

Recommendation 4

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

Response to Recommendation 4

ICA is the sole authority to decide about plant quarantine regulations in Colombia, and all steps should be taken not to introduce diseases and pests. Protocols for quarantine are presently reviewed between GRU, Pathology and Virology programmes/ units and ICA so as to come up with a list of phytosanitary hazards and controls for preventing the introduction and spread of diseases and pests. Such prevention is likely to involve the development of new diagnostic kits (e.g. those using the PCR technique), as well as the allocation of new glasshouse space, in order to process more accessions/year (in order to clear backlogs asap), more individuals/accession (in order to limit genetic drift), and under safer procedures.

Recommendation 5

5. 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 the host country.

Response to Recommendation 5

The SHL focuses on checking materials shipped outside CIAT (nurseries, etc) by commodity programmes (2/3 of the 2,200) accessions checked annually on average). In the future, and in addition, the SHL is expected to: 1) check health aspects of accessions prior to their multiplication in the field, and 2) check health aspects of accessions prior to their handling in the different conservation systems. The SHL will be able to perform these tasks with additional personnel (1 professional and 1 lab clerck) and additional equipment and budget for operational expenses (consumables, chemicals).

The Centre intends following the same seed health routine procedures when processing all germplasm material at CIAT, irrespective of the source or destination of such material.

Recommendation 6

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

Response to Recommendation 6

As budget permits, this point shall be taken into account. In addition, two new drying facilities are being designed in the field operations area of the GRU, for the purpose of drying pods, panicles, fruits, etc, from periodical harvests.

Recommendation 7

7. Efforts should be made by CIAT to establish field genebanks, under suitable agro-ecological conditions, for cassava accessions and other *Manihot* species which are reported not to be adapted to CIAT headquarters conditions.

Response to Recommendation 7

Stakes of wild species of *Manihot* will be planted in Santander de Quilichao, where adaptation could be better (soils more sandy). In case this does not work, sites with other ecological conditions will be tested in Colombia.

Recommendation 8

8. CIAT should intensify its efforts to arrange promptly 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.

Response to Recommendation 8

An applied research programme has been initiated to test different growth media in order to make duplication in another institution possible. Once this protocol can be applied to all cassava genotypes, contacts will be made with international institutes for holding a duplicate.

Recommendation 9

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

Response to Recommendation 9

Security backups for the forage and bean collections are being discussed with NSSL-Fort Collins, and with CIMMYT. Pending on the progress of these negotiations, MOUs may be signed in the coming months (see above under 6). The intention is to sign MOUs when negotiations are completed.

Recommendation 10

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

Response to Recommendation 10

To ensure that CIAT adheres fully to the FAO/IPGRI International Genebank Standards it now has in place an 'Upgrading Plan' that involves the following five steps:

1. clearing backlogs and meeting standards of amount of seed
2. seed viability and health monitoring
3. long-term conservation
4. safe duplication
5. germplasm restoration to country of origin

If adequate resources can be secured for the GRU at the levels that have been requested, the 'Upgrading Plan' should be completed in ten years.

The accomplishment of recommendation 10 will be achieved within the 'Upgrading Plan'.

Recommendation 11

11. 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.

Response to Recommendation 11

CIAT will attempt to meet this recommendation within the 'Upgrading Plan' (see response to recommendation 10).significant part (6,539 accessions or 32% of total collection) of the tropical forage collection is already in long-term storage at CIAT. Plans have been made to secure the entire collection in long-term storage.

Recommendation 12

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

Response to Recommendation 12

the accomplishment of this recommendation will be met within the 'Upgrading Plan' (see response to recommendation 10).

Recommendation 13

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

Response to Recommendation 13

Such a project has been re-initiated in collaboration with IPGRI-HQ. A special project is being prepared to extend the testing of cryoconservation protocols for the entire collection.

Recommendation 14

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

Response to Recommendation 14

Agreed.

Recommendation 15

15. 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 technologies.

Response to Recommendation 15

Core collections at CIAT have been developed for common bean and cassava germplasm collections, given the size of the reserve collections for those commodities. As we can anticipate a higher distribution of the core collections, special seed increase

and handling (i.e. doubling plot size, and putting the old cold stores back into service) will be performed for them. Whenever relevant, these methodologies will be extended to other germplasm species (e.g. forages). The existing core collections will be further refined, with the user-friendly development of GIS, the development of novel marker technologies, and as 'novel' materials are released from the backlogs.

Recommendation 16

16. Applied research should be initiated by CIAT 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 database; 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 database; determine genetic purity with alternative pollen control systems for outcrossing species, especially forages.

Response to Recommendation 16

All these points are pertinent, and are being progressively implemented as part of the upgrading process.

Recommendation 17

17. CIAT should develop and distribute information as databases on genetic distances between accessions, which will improve the efficiency of the use of germplasm in breeding programs.

Response to Recommendation 17

The GRU can provide such information only for those accessions that have been included in specific genetic diversity studies, either with the BRU or with the commodity programmes. This information, when available, will be distributed together with the passport data.

Recommendation 18

18. A classification should be made 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.

Response to Recommendation 18

This recommendation will soon be dealt with by the Inter-institutional Relationships Office of CIAT and IPGRI-Americas; namely to examine training needs as expressed in the country reports prepared for the 4th FAO Technical Conference held in June 1996 at Leipzig.

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