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Introduction

The ICER (Internally Commissioned External Review) panel met at CIAT Cali Colombia, from November 16 21 1997 Previous to the Cali visit the Panel had been provided with documents pertaining to the review The first half of the review consisted of reading documents, meeting with the Director of the Genetic Resources, phone conversations with our liaison to the Board of Trustees visits to the laboratories greenhouses and fields of CIAT and numerous discussions with the research staff The latter half of our meeting involved deliberation and writing of our final report On the last day we discussed w'th the Director General and the Director of Genetic Resources our findings

We found many strengths in the Genetic Resources Directorship The staff is deeply committed to the mission of CIAT, is actively engaged in numerous important research areas and is highly interactive The objectives of the SB-01 and SB-02 units have recently changed there is less emphasis on the development of cultivars for direct use by farmers and an increased emphasis on pre-breeding activities The organization of the Directorship has also changed from a program-based structure to one based on projects At the same time the percent of total funding committed to specific donor funded projects has increased These factors have lead to challenges for CIAT in redefining its role in tropical agriculture and for the staff in defining research direction CIAT has great potential for carving out a new unique role The utilization of native genetic variation, via new quantitative methods will allow CIAT to incorporate the variation found in its germplasm banks quickly into prebreeding populations Likewise the utilization of molecular techniques and genetic transformation will speed the incorporation of new genetic variants into tropical corps The Directorship has identified several new directions including the establishment of a Biodiversity Assessment Regional Laboratory that will respond to new opportunities in research and funding

First we present a series of comments which identify the significant findings of our committee Next we give our recommendations and then discuss the issues raised in the Terms of Reference for SB 01 and SB 02

Comments

1 The panel was impressed with the hard work and dedication of the scientists in the Directorate of Genetic Resources The individuals we met had a deep commitment to the mission of CIAT to tropical agriculture and to the people it serves The research staff in the DGR has done a commendable job of keeping abreast of the latest scientific issues of incorporating recent scientific developments into the work of CIAT and of networking with other institutions The strong connections that staff has forged between the project groups and various other institutions worldwide keeps the work at CIAT current and in step with the continuously changing directions of science The quality and dedication of the research staff, from the program leaders to the technicians in the labs and fields is a major strength of CIAT

2 CIAT and DGR have several assets that make it nearly unique on an international scale and will allow CIAT to maintain a strong international position The extensive germplasm collection the vast field and greenhouse space, and the staff to support these facilities offers the opportunity to study and incorporate germplasm from wild species and landraces into pre breeding stock Recent studies have indicated that such transfer of native germplasm into pre-breeding stock can be done relatively rapidly (the QTL approach of Tanksley) thus making the germplasm resource of CIAT directly accessible to development and assuring CIAT a singular niche in tropical agriculture

3 The research objectives of the DGR have recently broadened and include areas such as *in situ* conservation socio economic considerations and native biodiversity that were not traditionally a major focus or strength of CIAT At the same time the change from program to project format has resulted in scientific objectives that are short term and often tied to specific funding opportunities Finally budget cuts have resulted in a decrease in staff All of these issues together are beginning to blur the focus of the research activities The staff is very earnestly trying to accomplish these multiple objectives and is simply spread too thin, both in human resources and in expertise

It is imperative for the maintenance of CIAT s central position in international agriculture that this situation be remedied CIAT s reputation is based on past accomplishments in the development and distribution of new varieties Breeding activities are now being turned over to NARS with the exception of some regions in Africa CIAT needs to very carefully define its new role in international agriculture so that it remains a conspicuous player and so that it retains the attention of its donors In this light the objectives of DGR need to be very carefully defined and managed so that the existing research staff can produce outstanding research that will not only stand up to international standards but also maintain the central role of CIAT in international agriculture Such research

already exists at CIAT the QTL work on rice is a good example and such an approach could be extended to other crops

4 Changes in the nature of funding appear to have an effect well beyond just the reduction in support The tight linkage of funding to specific objectives and donor support has both broadened the range of research and narrowed the flexibility and discretion of work within the units Moreover the commitment for support is necessarily shortened reducing the likelihood of long term projects that may well have the greatest ultimate benefit for CIAT Many aspects of SB-01 and SB 02 do not fit well within the project format The clearest example is the germplasm conservation activities which are a basic mandated function of CIAT independent of projects However the panel agrees with the rationale behind the change from programs to projects The project format does not necessarily preclude adequate support and flexibility Portions of the core budget could be set aside for support of the germplasm conservation and for support of core SB-02 activities thus providing security and flexibility while maintaining accountability

A final aspect of funding is significant Because of the increased need to identify outside funds a natural tendency exists to expand the range and nature of research at CIAT CIAT must necessarily respond to its donors However if funding opportunities are not carefully evaluated in the context of CIAT s objectives and current work, the units will become diffuse and it will be difficult to identify major accomplishments with CIAT The panel already detects a tendency towards producing small studies in a wide range of areas

5 CIAT is by definition an international facility Yet CIAT is increasingly identified with Colombia It is appropriate that Colombia s interest is acknowledged as host country Colombia s changing agricultural basis and its desire to emphasize tropical fruits are all reasonable concerns for CIAT However with the proposed establishment of the Biodiversity Assessment Regional Laboratory and the current discussions with the Von Humboldt Institute CIAT will need to monitor its international representation

The proposed Biodiversity Assessment Regional Laboratory presents a window of opportunity for CIAT Because of the change in emphasis in CIAT from development of new varieties to agrobiodiversity the establishment of such a facility will provide both scientific and funding flexibility The DGR has a clear set of guidelines to determine which species and avenues of research will be pursued

6 Important information and tools (processes and gene sequences) related to modern biotechnology are now protected by intellectual property rights (IPR) Private multinationals or national public organizations are usually not eager to provide high-cost research products or processes to CIAT because such products would

have to be released free of charge to third parties thus reducing their own potential royalty return As a result increasingly more private and public institutions in DCs and LDCs request assurance that their IPR will be honored and that results of any jointly developed research will also be protected

According with the DRAFT VERSION 5 presented to ICER for comments CIAT is currently revising its IPR policies The main objectives are under the prevailing IP environment to permit exchange of genetic materials and techniques and to ensure that the results of projects reach the intended beneficiaries in developing countries

CIAT should choose to exercise legal protection if such action is needed for developing critical strategic research alliances or to prevent appropriation of products intended to reach partners in developing countries The draft document presents four protocols to be used in each particular case depending on what material or process is being exchanged However it needs to clarify to end users and partners what is meant by material derivatives ' as stated in Protocol I It is clear that as a CG Unit CIAT must assure that germplasm is freely available to all countries But by requiring that recipient countries can not seek IP protection for new cultivars (see UPOV definition) eventually derived from germplasm received from CIAT may create some concern to breeders working in public or private national programs

When discussing a new project which includes the use of proprietary genetic material (e g 35-S promoter) or proprietary processes (use of Bt genes for plant protection) CIAT should take into consideration, as part of a general policy, the possible effects of the IPR in the deployment of the potential outcomes of that project CIAT could become liable for distributing material that it knows to be of proprietary nature Intellectual Property Laws usually allow for the freedom of use for research purposes However as all countries in Latin America for instance, are part of the Trade Related Intellectual Property (TRIPs) Agreement and follow the rules of the World Trade Organization (WTO) NARSs may not be able to use the genes or processes deployed by CIAT to produce varieties for commercial purposes Furthermore CIAT should consider along with other CG Centers, the strategic need to research for new molecular assets that would be protected by the CG System to be licensed to partners in developing countries

7 Biosafety One of the most widely discussed subjects inthe Biotechnolgy world is the biosafety of transgenic plants The UNCED Conference held in Rio de Janeiro in 1992 set the background scenario for many years to come when member countries of the Convention of Biological Diversity discussed the transboundary movement of living modified organisms CIAT is an International Research Center and therefore should be leading research in the area of risk assessment of traits which will be introduced in its mandate crops Of major importance are the studies involving plants which have their Center of Origin in Latin America and are likely to benefit from transgenic traits e g cassava and common beans The Panel sees a project in this area as an excellent opportunity

for networking and collaboration with NARS in individual developing countries and with private and public Institutions from the North

The Panel recognizes that CIAT has already prepared its Biosafety Guidelines in 1991 (BOT approved) and has formed its institutional Biosafety Committee (IBC) with the participation of an interdisciplinary group that includes representation from the Colombian National Agricultural Institute The IBC has recommended that the Center s DG make the decisions on permission for field testing Genetically Modified Organisms(GMO)

The Panel also understands that the Colombian regulatory framework is currently under review and a final regulation will be issued by Government in early 1998 With this legal instrument in place CIAT will be able to apply for field tests in Colombia All transgenic research has so far been carried out in containment (laboratory and greenhouse), using techniques for handling GMOs CIAT s biosafety guidelines have been designed according to the experience of DCs e g OECD and USDA, and its IBC monitors technological and legislative developments worldwide for updating CIAT s guidelines

8 Network and Capacity Building CIAT is recognized world wide for its capacity to coordinate and implement the Cassava Biotechnology Network (CBN) CBN s impact includes the incorporation dissemination and updating of farmers perspectives into biotechnology priorities transfer of new biotechnology tools for cassava to national programs and the development of participatory projects that increase the relevance of R&D targets The CBN has provided an entire new opportunity to laboratories and scientists in developing countries by distributing 40 small-grants and organizing three international scientific meetings on three continents CIAT also coordinates the Beans Advanced Research Network (BARN) which was organized in 1990 and has provided the opportunity for two scientific meetings and participates in the Rockfeller Foundation Rice Biotechnology Network The Panel recognizes that all CBN s effort should not come to a loss because of lack of funds and urges the scientific and donor community to support its continuation based on the excellent outcome provided so far

CIAT is also beginning to be highly praised in the Latin American region for the training courses and in service training it has provided since 94 Through these mechanisms CIAT has made available to partners a range of genetic materials, culture lines molecular maps probes vector strains genomic and cDNA libraries and state-of -the-art methodologies This effort has to be continued because it gives to scientists and laboratories in the region the comparative advantage of learning in their own language with less expensive travel and housing costs

9 External Reviews We would like to compliment CIAT for the excellent documents presented to the Panel and for the presentations prepared by members of the Team Their willingness to present their project results made our analyses much easier to prepare However we would like to comment on the length of the review With the amount of information that a Panel has to analyze it would be useful to add two extra days to the Panel work That would certainly allow for a more profound review of the scientific aspects of every line of research and to allow the panel to reflect on its findings Receiving the documents via e-mail would allow more time for reading and would also speed up the process on arrival It may be a good idea to invite at least one of the members of this Panel to the next review giving this person the very good opportunity to review the progress and the implementation of our recommendations

Recommendations

- Establish a position assigned to SB 01 for computer/data base support This position was eliminated during budget cuts but is essential for the implementation of the recommendations from the 1995 CGIAR genebank review panel

- Provide additional expertise in the area of population genetics and evolutionary biology either by collaborative arrangements or by future staff positions

- Stabilize a molecular biology position assigned to SB-02 project

- Establish firm and formal links with IARCs to draw from state-of-the art research

- Publish the conservation methodologies developed at CIAT in international journals so that these technologies become widely disseminated Include these and other methodologies on CIAT s Internet Home Page when possible

- Continue rigorous peer review to promote research of international standards

- Establish a computer based monitoring system for germplasm conservation operations

- Provide core budget support for the germplasm activities of SB-01 so that budget stability is achieved and that the Upgrading plan can be achieved

- Provide more flexible core budget for the strategic gap-filling approach in the biotechnology very fast moving field

- Provide appropriate fields to maximize environmental variation and gene x environment interactions for germplasm collections at Palmira

- Characterize the cassava germplasm collection before it is placed in in vitro storage The decision to place the cassava collection into in vitro culture should be carefully deliberated

- Establish a pilot program for field collections of essential germplasm

- Develop a friendly-user GIS system to allow for methodology to be transferred to partners and NARSs

- Establish the Biodiversity Assessment Regional Laboratory and implement the guidelines that have already been written (Genome Research in Agrobiodiversity at CIAT)

- Consider a cassava breeding program which incorporates wild germplasm, similar to the current program in rice and bean QTL s

- Contribute in a limited manner to in situ conservation efforts by providing guidelines and genetic information to other agencies such as Ministries of the Environment or conservation agencies

- Establish with urgency an agreement on biosafety with Colombia taking into full account internationally established procedures such as OECD guidelines

- Review formal interactions with NARS based on the broader mission of CIAT

- Combine when possible external reviews to reduce the burden on the staff

SB-01 Integrated Conservation of Neotropical Genetic Resources

The direction and hence title of the SB-01 unit is a result of the Internally Commissioned External Review on Gene Bank Operations by CGIAR in August 1995 and the new project framework introduced at CIAT in mid 1996 Activities carried out by the former Genetic Resources Unit and other projects related to conservation are grouped into a single conservation project Integrated Conservation of Neotropical Genetic Resources " ICNGR

The general objectives of ICNGR include 1) the assembling of germplasm collections that are fully available to users that meet international standards and that are fully relevant to the purpose of conservation 2) to contribute through training to building the capacity in conservation sciences and techniques within the region and 3) to develop *in situ* conservation methodologies for farmer landraces and wild relatives

I Project Goals

The specific objectives of SB-01 are given as

- To make FAO collections fully meet international standards
- To make FAO collections and their pertinent information fully available
- To make FAO collections genetically and socially relevant
- To contribute to the formation of human resources in conservation methodologies in the region
- To provide scientific input in *in situ* conservation of farmers landraces and wild relatives

Related objectives identified by the SB-01 include

- To improve or develop conservation techniques integrating conventional and modern biological technologies and focusing on *ex-situ* collections of mandate germplasm with linkages to *in situ* conservation on farm or in protected areas

- To assess and characterize the structure and diversity of genetic resources of wild and cultivated mandate species selected non-mandate species and associated organisms through the use of analytical genomic technologies and agroecological information

- To make genetic resources, databases, and genetic stocks and pertinent information available to users at CIAT and in partner institutions

The following outputs have been used by the panel to measure progress towards the research goals

- CIAT mandate germplasm collections maintained with state of the art conservation techniques and made globally available Germplasm samples tested for freedom from major pests and pathogens
- Distributed Neotropical genetic resources better characterized at the species and genetic levels
- Improved germplasm conservation methods using seed and field techniques
- Improved germplasm conservation methods using *in vitro* and cryopreservation techniques
- Genetic structure characterized within and between gene pools of *Phaseolus* and *Manihot* using molecular markers
- Agroecological information integrated with genetic diversity using GIS and molecular makers (beans cassava and tropical forages)
- Genetic material distributed to partners
- Databases maps probes strains assembled and made available to partners
- Capacity building activities in conservation technologies and processes organized with national partners
- Strengthened links with other CIAT projects through common biological approaches

Below we address each of the questions posed in the TOR in turn

1 Are the research goals and priorities clearly identified and is the process to measure this adequate?

The research goals and priorities are clearly set by the unit and it adequately measures its progress towards these objectives The first priority of the unit is to conserve its germplasm collection according to international FAO standards Table 1 indicates the conservation goals for seed and other categories of the SB-01 Records of number of accessions placed into storage measure progress towards this goal Quality of conservation technologies is measured by monitoring of viability of stored material Figure 1 is an example of the unit s conservation strategy showing the management of germplasm for *Phaseolus* and tropical forages Table 2 is an example of the type of monitoring SB-01 undertakes for the quality of stored germplasm This example shows the percent of germination for stored *Phaseolus* and forages over the last 4 years The second area of work for SB 01 distribution of germplasm resources is also well documented by records Records of publications and tallying of hands-on training activities courses conferences and posters monitor the third and fourth aspects of the unit s work research and human resources

Table 1 Proposed amounts of seed and categories for conservation

Weight gr / 100 sem	FORAGE						*PHASEOLUS*					
	5°C		20°C			TOTAL	5°C		20 C			TOTAL
	Distrib	Monitoring	Base	Repatriation	Duplicates		Distrib	Monitoring	Base	Repatriation	Duplicates	
< 1	9 000	6 000	6 000	6 000	6 000	33 000						
1 10	7 000	2 000	2 000	2 000	2 000	15 000						
10 – 30	3 000	1 000	1 000	1 000	1 000	7 000						
> 30	1 000	1 000	600	300	600	3 500	1 000	1 000	600	300	600	3 500
									600	300	600	1 500 *

* Alternate option if not enough seed is produced

Fig 1 Flow Chart for Germplasm Management of *Phaseolus* and Tropical Forages

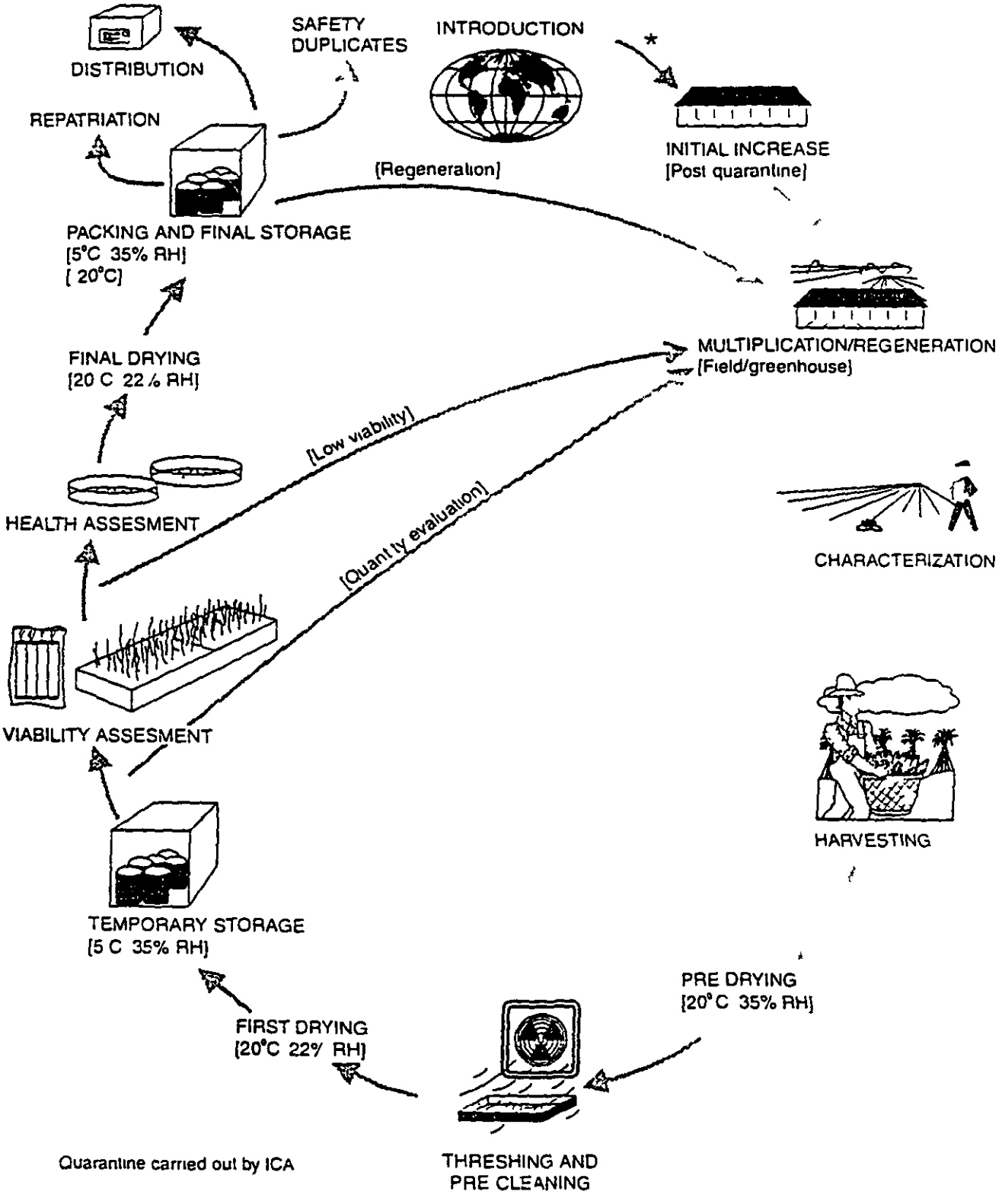

Table 2 Germination tests for *Phaseolus* and forages during the last 4 years

	Phaseolus Germination (%)					Forages Germination (%)				
	0	1 50	51 84	85 100	TOTAL	0	1 50	51 84	85 100	TOTAL
1994						1	5	101	91	198
1995						0	14	33	239	286
1996	96	404	756	571	1 827	0	0	0	0	0
1997	2	89	401	1 416	1 908	0	0	7	189	196

2 Does the research respond to the stakeholders needs?

CIAT holds in trust for the peoples of the world an essential and irreplaceable germplasm collection ICNGR is striving to reach and maintain FAO international standards in its curatorship of the germplasm collection The unit is responsive to requests for germplasm and its provides carefully monitored material to other organizations The research work of the unit is essential in developing techniques and strategies for conservation that can be applied towards other species and can be transferred to NARS We conclude that the work of the SB01 unit is highly responsive to the stakeholders needs

3 Are milestones well indicated and can their achievement be monitored?

Milestones for acquisition and maintenance of the germplasm collections are clear and the record keeping can monitor their achievement as discussed above

4 Are the research objectives feasible within the indicated time frames?

Based on the accumulated knowledge and experience of CIAT, the proposed research objectives of the unit are ambitious and feasible within the indicated time frames only if adequate resources are provided Essential concerns such as eliminating the backlog of material to be placed in storage GIS documentation computerization upgrading and accessibility of records are all feasible within the projected time frames with adequate resources The goal of the unit is to provide secured stability in germplasm conservation services (short term conservation long term conservation viability monitoring safety duplication and repatriation) for twenty years by establishing appropriate facilities and staffing Such a goal is feasible with appropriate resource commitments (discussed separately below)

5 Is research attention to *in-situ* conservation adequate?

The role of CIAT *in-situ* conservation of agrobiodiversity is discussed in the context of several research projects The nature of such work is not specified Our understanding is that SB-01 in collaboration with SB 02 view their roll as identifying geographical areas

of concern and interest (e g molecular marker studies indicate that a specific geographical region has high diversity) and providing knowledge and protocols for the *in situ* maintenance of such diversity Only a limited role of SB 01 (and SB-02) in *in situ* conservation is appropriate given the other objectives and responsibility of the unit Moreover, *in situ* conservation is not an endeavor to be undertaken lightly Conservation of genetic resources, either as landraces by farmers or as wild species in preserves has a whole set of issues methodologies and constraints that have not been previously undertaken by CIAT Particularly for wild species there are other organizations (Ministries of the Environment conservation agencies) whose mission and experience make them much more suitable agencies to undertake conservation of species important to agrobiodiversity

6 Is the proposed research fully reflected in the project documents and do the work plans represent the project objectives?

Currently the research is fully and clearly reflected in the project documents and the work plans represent the project objectives But in this context our interviews with staff revealed a great concern for the ability to complete specified research projects because of uncertainty in funding for any given project (This issue is discussed below)

7 Is projected output and impact well defined and feasible

The SB-01 Unit has a clear understanding of it s projected output and the impact and importance of its output The projected outputs are feasible given adequate resources

II The Research Program

The research of the SB-01 program is in several distinct areas united by the theme of conservation of genetic resources The unit has the significant and major responsibility of providing for germplasm conservation which includes both the introduction and propagation of new accessions into the collection and the maintenance of the current collection Table 3 gives the current status of the germplasm collection at CIAT Maintenance of the collection is accomplished either by long term storage of seeds (beans and forage) or by tissue culture and field plots (cassava) There has been significant recent progress in this area by the modernization of facilities (cold storage seed germination room) and by the input of data in the SINGER system and the use of GIS data with passport information

The SB-01 unit also has the responsibility of distributing germplasm to NARS and other organizations Table 4 illustrates this function for the distribution of forage germplasm This work involves propagation of the material and certification of the health of the germplasm so that it can be safety utilized (without disease or pathogen) in another region The unit assures the safety of material by the seed health laboratory and by tissue culture production and monitoring of cassava

Table 3 Status of the Phaseolus beans and of the tropical forages germplasm collections conserved at GRU-CIAT (1997)

Germplasm collection	Genera	Species	Origin No countries	Total No access
Phaseolus beans	1			
P vulgaris		1	91	25 454
Other cultivated spp		4	53	3 002
Wild spp		22	12	167
Subtotal	1	27	97	28 623[1]
Tropical Forages				
Legumes	102	614	69	18,559
Grasses	48	165	41	1 916
Subtotal	150	779	74	20 475
Manihot				
M esculenta	1	1	24	5,537
Wild spp	1	30	*	330
Subtotal	1	31	24*	5 867
Total	152	837	195	54,965

Table 4 Distribution of Forages germplasm (1994-1997)

	Number of Accessions (No of Requests)			
	1994	1995	1996	1997
Centre Staff in Host Country	1 893(52)	623(38)	569(30)	216(27)
Centre Staff in Other Countries	125(4)	9(1)	60(5)	
Other IARC s			113(1)	
NARS in Developing Countries	503(28)	312(16)	348(17)	295(15)
NARS in Developed Countries	35(2)		97(3)	54(2)
Private Sector in Developing Countries	21(4)	55(11)	28(4)	3(2)
Private Sector in Developed Countries	7(2)	34(4)		
Others (Includes Universities)	647(25)	100(15)	105(8)	485(13)
TOTAL	3,231(117)	1 133(85)	1 320(68)	1 053(59)

Another responsibility of the unit is to develop new conservation technologies The unit has close collaborations with SB-02 and several types of genetic markers have been used to monitor the collection for duplicates (electrophoretic markers DNA fingerprinting and AFLP s) Other significant activities include *in vitro* preservation for cassava. storage effects on seed dormancy (cassava) zygotic embryo culture for safe international transfer (cassava) and pathogen detection in seeds (beans) The groups have also collaborated on studies of genetic diversity with both cultivated and wild germplasm of beans and cassava SB-01 has also been actively involved in training of researchers and in transferring the technology for germplasm conservation developed at CIAT Table 5 shows the recent training activities of the unit

Table 5 Number and type of capacity building activities

Type of capacity transfer	**Number of events**
Courses with input from project staff	13
Hands-on training in GRU facilities	57
Research thesis supervised by SB-01 staff	18
Scientific communications in conferences workshops etc	31
Scientific posters in congresses	3

1 Are the proposed research activities and methodologies used appropriate to achieve the expected outputs?

The proposed research activities and methodologies in general are appropriate to achieve the expected outputs The GRU has good procedures in place for the placement of germplasm into the collection, for the maintenance of the collection and for its distribution The work of SB-01 can serve as a model for future research on genetic diversity for a wide range of agriculturally important species

The proposed research of the unit is in the area of assaying biodiversity for appropriate collection strategies and in developing (in collaboration with SB-02) genetic markers Both of these areas of research are flourishing and are providing clear contributions to the general area of agrobiodiversity The studies of native and cultivated bean biodiversity and the identification of separate gene pools in several native species is an advancement that will have direct applications for the germplasm collection In view of these interesting basic scientific discoveries it is curious that there is very little direct collection of new accessions by the unit Because of the mass of basic genetic information gathered on wild bean species the scientists of SB 01 are clearly in the best

position to mount additional collecting trips They have the greatest understanding of genetic diversity of *Phaseolus* in the wild and it is the unit s mission to preserve biodiversity Given the rapid depletion of native germplasm it is urgent that accessions be collected expeditiously The unit has expressed a keen interest in increasing its collection activities

Another issue rests with the nature of the collections One issue that needs to be carefully addressed is the nature of sampling for a given species or crop At one end of the spectrum is the idea that only a single individual need be sampled because it represents the gene" of the species and that multiple accession add little Such concepts of germplasm collections are reflections of species concepts in the past and are in ignorance of the mass of data, which indicates the high degree of variation within species The other extreme suggests that every population and every variety is distinct and ought to be collected and preserved Such concepts do not reflect current understandings on the reticulating nature of lineages CIAT, because of its basic work in distribution of genetic variation, is in a good position to determine how sampling and collection should be done based on the genetic structure of gene pool In the case of wild *Manihot* species the germplasm collection is often represented by only a few accessions and should be bolstered in collaboration with NARS

2 Is the research original and is the balance between basic and strategic research adequate?

Is the proposed science rigorous, of international standards, and is a peer review process in place to assure those standards?

SB-01 appropriately balances basic and strategic research The non-curatorial aspect of the unit s work provides new conservation methodologies to other organizations and thus will have a wide effect on how conservation is practiced The work on genetic diversity in secondary and tertiary gene pools has importance both for basic and strategic research, it furthers the understanding of basic plant genetics and it provides an example of how genetic variation is structured within a species Several of the studies are highly original The study of AFLP variation to assess variation and domestication in *Phaseolus* was the first study to use these new markers in such a manner The studies of germplasm genetic diversity at CIAT use a wide variety of molecular techniques reflecting the strength of the SB-02 unit Many of these studies now rest within the field of population genetics In this area CIAT would be greatly helped by additional expertise in the area of genomic and population genetic analysis Many of the issues in population studies rest not so much on technique as on sampling and data analysis The science conforms to international standards A peer review process is in place manuscripts are given to a committee of two anonymous colleagues who evaluate and comment on the manuscript before it is sent for publication

3 Are past research results and review recommendations used in present and planned activities?

The proposed program and research of SB-01 is strongly influenced by past research results For example the proposal for more intense germplasm sampling in *Phaseolus* stems from the research on AFLP markers that have indicated separate gene pools in several species Likewise research results indicate evidence for gene migration between cultivated forms of *Phaseolus* and some of the wild ancestors Such work can also be used to direct collecting efforts to weed-crop complexes

The proposed activities of the SB 01 have also made use of past review recommendations The response of the SB 01 to the comments and recommendations of the external review panel of the CGIAR genebank operations of CIAT are discussed below

4 Have the recommendations of the review of the genebank been implemented?

The external review panel of the CGIAR genebank operations made several recommendations in its 1995 review of the genebank Many of these have been implemented and several have not We discuss only those areas where implementation is not complete

CGIAR Genebank Panel Comments

A. *The Panel recognized that financial constraints are limiting CIAT s operation but thought that in relation to the Center s total budget the GRU is undefined*

The current panel is of the opinion that financial constraints are still limiting the operation of the genebank The genebank is the core activity of the GRU (SB-01) and is an activity that is essential for CIAT's role in CGIAR We view the genebank as the single most important activity of the Division of Genetic Research Strides have been made to increase facilities but several key areas need attention additional cold storage for seed, renovation of seed cleaning areas and most importantly attention to computerization and mechanization of the work

B *The panel thought that there are dangers in making use of special project funding for key areas of conservation and research*

The ICER panel also shares this concern The genebank and germplasm conservation are core activities that are not always directly identifiable to a project The lack of a clear funding commitment to the genebank jeopardizes the conservation of germplasm that CIAT must maintain based on the FAO CIGAR agreement

C *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 SB-01 has responded by producing an Upgrading Plan The Upgrading plan is not yet entirely implemented due to financial limitations The Upgrading Plan includes

a clearing backlogs and meeting standards of seed quantities
b seed viability and health monitoring
c long-term conservation at CIAT
d safe duplication
e restoration

The previous panel set forth a series of 18 specific recommendations, which have been addressed either by management or by the SB 01 Implementation of several of these recommendations awaits additional financial resources for the unit The current ICER was impressed with the earnest response of the SB-01 to the CIGAR genebank review The response of the SB-01 to the comments and recommendations of the CIGAR panel has lead to vast improvements in the maintenance and storage of collections, other improvements are planned

CIGAR Genebank Panel Recommendations

We will not discuss each of the recommendations by the CIGAR panel but will highlight as examples some of the recommendations and the response of the SB-01

A CIAT should negotiate with ICA to permit first increase of forages in mesh houses to increase effective populations size and reduce genetic drift '

The previous panel raised the issue of genetic drift in the management of forages and other crops Our field observations during this visit indicated a great concern by the SB-01 staff for eliminating genetic drift Seed collections are monitored on a per plant basis and then bulked only after equal representation is achieved Both the equal contribution of each plant to the gene pool and the overall increase in sample size of the collection is now adequate to prevent genetic drift

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

This has been accomplished and cryopreservation is now effective for *Manihot* germplasm Several modifications have been made to the cryopreservation technique and now both control and recalcitrant genotypes can be effectively stored Currently studies of the long term viability of cryopreservation are underway It is hoped that this technology will soon be transferred to the routine storage of portions of the cassava germplasm collection

Other aspects of the CIGAR review panel s recommendations are currently being addressed or await implementation The CIGAR review panel suggested

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 to identify species where the active collection should be stored at –19C*
- *use of bar codes*
- *computer programs to enter germination results compute means and enter in data base*

Many of these improvements are yet to be implemented The SB 01 unit has given a very high priority to the computerization and mechanization of routine operations However these improvements can not be made without the hiring of a computer/data base specialist in this area Such a position had been in place but was eliminated due to budget cuts

The SB-01 unit has done a good job of improving the handling, storage and maintenance of the FAO germplasm It has made many improvements in the curatorial facilities and procedures for germplasm conservation and this was done in the face of a declining budget The SB 01 unit has a tremendous obligation for maintain the FAO germplasm in trust, and it meets this obligation with a strong sense of responsibility and dedication

5 Is research progress adequate and according to projected outputs and impact?

The progress of research has moved along quickly with several papers being published in refereed journals The progress of the germplasm conservation activities is discussed above

6 How are research outputs used and by whom

The research outputs are used both strategically by the community of researchers interested in agrobiodiversity and by basic scientists in population biology and enthnobotany The studies of *Phaseolus* gene pools are illustrative These studies have identified multiple gene pools within species this discovery leads to very practical recommendations for the collection of genetic diversity On the other hand such studies are inherently interesting to both enthnobotanists and population biologists as well The work has demonstrated multiple domestication which provides basic information on the development of agriculture The occurrence of two separate gene pools suggests some ancient lineage diversification most likely associated with biogeographical factors which is of interest to population and evolutionary biologists

7 Is the quality and quantity of various research publications adequate?

Yes Given the major responsibilities of the SB 01 for germplasm maintenance and conservation, the degree of active participation of staff in original research and publication is good The number of international publications from the unit is realtively small with most publications being in local sources As additional advances are made in the process of germplasm conservation publications should result from this work Moreover the collaborations between SB 01 and SB 02 will support a continuous yield of international publications

8 Is the research work adequately linked with the work in the IP projects?

Yes, there is close linkage to the IP projects The SB-01 provides the basic resources for the IP projects and there is a close relationship between the two groups in the areas of germplasm distribution and characterization One of the real strengths of CIAT is the strong and cordial relationship among the groups of the DGR On paper the groups appear separate but in actuality there is a great deal of overlap with researchers active in multiple areas

9 Are the projects making adequate use of GIS tools and socio-economic input?
10 Has the germplasm CIAT holds in trust adequately been documented and made available?
11 Is the genetic resources activity of CIAT adequately lined to the System-wide Genetic Resources Program and SINGER?

The SB-01 has a backlog of accessions that need to be propagated and placed into storage This material is necessarily less available than other material For collections that have been processed, the material is adequately documented and is available The passport data for each collection includes GIS information The genetic resources activity of CIAT is linked to SINGER The unit has purchased a new computer and for SINGER activities and collections are being entered into the database Collection data is available on the World Wide Web 27 568 accessions for *Phaseolus* 5 541 accessions of cassava, and 23 939 for tropical forages GIS information is included and can be used for the construction of distribution maps Future plans are to increase the GIS capacity for providing collection information This capacity for mapping geographical regions and then targeting collection sites has been used to identify and collect wild bean populations in Ecuador Socioeconomic considerations are used in guiding collections of some landraces Some collections are made solely for their socioeconomic importance Linkage to SWGRP is still premature since it has not yet full been implemented

Project SB-02 **Enhancing the Understanding and Use of Agrobiodiversity Through Biotechnological Methods**

I PROJECT GOALS

Are the research goals and priorities clearly identified and is the process used to measure this adequate?

According to the documentation presented to the ICER project SB 02 has the following goals and objectives

Project Goals to contribute to the improvement and use of genetic resources and to promote agrobiodiversity conservation through the integrated application of modern molecular and cellular biotechnologies in tropical countries

Related objectives identified by SB 02 are

Objective 1 Understanding the genetic diversity of wild and cultivated species for the use and conservation of improved genetic resources

Objective 2 Accessing exotic or novel genes and gene combinations to broaden the genetic base of cultivated crops

Objective 3 Collaborating with CIAT partners to access and enhance agrobiodiversity

The priorities of SB 02 came from on-going projects prior to the transformation of the organizational system in Genetic Research from a program driven model to the present project system SB-02 unit was organized in the second half of 1996 The measurable outputs take into account the work developed with CIAT mandate crops and are clearly presented in the Annual Report and summarized as follows

Objective 1

OUTPUT 1 1 **Genetic diversity characterized at the intra-and inter-specific levels**

I) The wild bean (*Phaseolus*) core collection was characterized using seed protein and AFLP markers

- Major genetic groups were identified in Mesoamerica, Colombia, the northern Andes of Ecuador and northern Peru Germplasm from northern Peru was genetically the most distinct of all the geographical regions
- Colombian accessions appeared to be highly introgressed containing germplasm from the Mesoamerican and southern Andean gene pools

II) Studies of the molecular phylogeny of *Phaseolus* have been initiated Accessions of Phaseolus species can be grouped based on the region of geographic origin

- The South American species were clustered into two groups *P vulgaris* and *P costaricensis* and are clearly separate from *P lunatus* and and its closely related congeners
- The moleuclar data idicate the existence of two major gene pools in wild Lima beans The species *P augusti P bolivianus and P pachyrrizoides* do not form distinct geneic clusters but rather grade into each other in a continuum The three species are not clear cut entities warranting taxonomical ranking by species

II) A study of the genetic structure of both Mesoamerican and Andean common bean was carried out on the material in the core collection

- RAPD data provided new and more accurate quantification of the genetic distances between Mesoamerican races Race M was split into two distinct groups Races D and J were closely related but could be distinguished with RAPDs
- The Andean cultivated bean core collection was analyzed with AFLPs and showed that most landraces grouped closely together There is no systematic differentiation among accessions despite their having different geographical origins The results have lead to a new hypothesis on bean domestication in the Andean region that is currently being tested

IV) Genetic variability of Colombian and selected Central American and Brazilian *Manihot* species were evaluated by AFLPs and microsatellites to determine the species relationships and to provide insight into cassava domestication

- *M aesculifolia M brachyloba*, and *M carthaginensis* were most distant from cassava (*M esculenta*) *M esculenta* subsp *flabellifolia* and *M esculenta* subsp *peruviana* were indistinguishable and were most closely related to the crop The latter finding supports recent taxonomic classification of *M flabellifolia* and *M peruviana* as subspecies of *M esculenta* and the hypothesis that ancestors of cassava can be found within this group The crop germplasm presented a narrower range of variation than most wild species Species-specific bands that could be useful in detecting introgression and gene flow were also identified

V) AFLP fingerprinting was used to analyze African cassava germplasm and allowed better discrimination among accessions

- Estimating genetic similarities by AFLP in cassava accessions from Africa and Latin America was more informative than by other methods used to date such as isoenzymes RLFPs and RAPDs AFLP analysis could also detect possible genotypic duplications in 10 of the 20 cassava landraces studied

VI) A survey of the genetic diversity present among 18 major Cuban rice cultivars was conducted using isoenzyme RAPD and AFLP markers

- AFLP markers proved very efficient in detecting polymorphisms even among closely related cultivars The study revealed a high degree of genetic similarity among the cultivars, which were all used for rice improvement programs conducted in Cuba

during the last 20 years These data as well as previous studies conducted on Latin American rice varieties point to a very narrow genetic base in rice breeding programs

VII) A large collection of Colombian cassava bacterial blight (CBB) isolates have been characterized using DNA probes generated from the pathogen genome

- High levels of pathogen diversity at the molecular level are being related to geographic specialization of pathogen populations
- A very sensitive PCR-based technique for detecting the CBB pathogen in cassava tissues was developed This diagnostic technique has an important practical use for the establishing clean germplasm propagules for the international movement of cassava materials

VIII) In a collaborative effort with CORPOICA Colombia the genetic characterization and evaluation of variability of 36 *Passiflora* species and 100 genotypes of the Colombian *Musa* collection were carried out using RFLP and RAPD markers The findings contribute to a better understanding of the taxonomy of the *Passiflora* and to the clustering of the *Musa* accessions according to genome type

OUTPUT 1 2 **Useful genes and gene pools have been identified and/or localized and integrated with agroecological information**

I) Seed proteins were used to screen Andean bean germplasm for phaseolin types and Mexican wild *P vulgaris* for arcelin

- The main phaseolin types found in nuñas are T , C , and H, followed by other types present at much lower frequencies New phaseolins found only in nuñas were also identified
- A new arcelin variant arcelin 7 was found in some wild *P vulgaris* populations from Chiapas Mexico The wild accessions with arcelin 7 were resistant to the Mexican weevil

II) Common bean agronomic traits such as tolerance to low phosphorus are being tagged, using mapping populations established with recombinant inbred lines (RILs) derived from the inter-gene-pool cross DOR 364 x GI 9833 These lines are polymorphic among many combinations of Mesoamerican and Andean genotypes

- Several RAPDs and SCARs markers were identified for BGMV and CBB, providing a first step towards marker-assisted selection

III) Microsatellites sequences were isolated in Phaseolus and primers designed to provide access to high-resolution markers for bean germplasm characterization population genetic studies and gene tagging

IV) Cassava genome studies were further refined by developing of the first molecular map of the crop

- The map consists of 20 linkage groups spanning 940 cM and is estimated to cover about 70% of the cassava genome The map was used to elucidate genome organization in cassava Initial data suggest that cassava is a fully diploidized segmental allopolyploid
- The saturation of the map is continuing with microsatellites developed at the University of Georgia and with Expressed Sequence Tags (ESTs) developed at CIAT

V) The characterization and mapping of genetic resistance to cassava bacterial blight (*Xanthomonas axonopodis pv manihotis* or Xam) was begun

- Preliminary results indicate a major gene on the M linkage group which explains 80% of variance for resistance to CBB The work is complemented by mapping receptor kinases to define the cassava xam pathosystem by using degenerate primers from the cloned rice gene Xa21 Significant homology to a gene associated with resistance to *Xanthomonas* in rice has been reported in cassava, but a role in the cassava *Xanthomonas* reaction has not yet been demonstrated Analyses are continuing utalizing degenerate primers synthesized over additional conserved domains that are homologous cassava cDNAs

VI) A strategy for developing durable resistance to rice blast was proposed by integrating the characterization of virulence in Colombian isolates MGR-DNA fingerprinting of pathogen isolates and tagging of resistance genes with major Colombian MGR lineages

- The monitoring of the genetic structure and virulence diversity of pathogen populations was conducted on blast isolates recovered from 26 Latin American rice cultivars These cultivars exhibited complementary resistance to lineages of the pathogen
- Virulence analysis of more than 500 blast isolates showed no single isolate expressing compatibility with both Pi 1 and Pi 2 genes Testing the lineage exclusion hypothesis on stable blast resistance is under way by anayzing crosses made between several blast-susceptible parents exhibiting complementary resistance

VII) A gene pyramiding program for incorporating blast resistance genes in to several commercial rice varieties of Latin America was initiated

- RFLP and microsatellite markers from the rice molecular map were used to screen two doubled haploids for tagging resistance genes
- One RIL mapping population was used to dissect the resistance of O Llanos 5 (a highly durable resistant commercial variety) RFLP SCAR, and AFLP markers linked to several resistance genes were identified

VIII) Genome research of *Brachiaria* species focused on tagging and fine mapping the apomixis locus with molecular markers and on localizing the apomixis locus on a complete *Brachiaria* genetic map constructed with heterologous probes from rice and maize RFLP maps

- Two hybrid mapping populations were generated by crossing a *B brizantha* and *a B decumbens* clone to the same tetraploidized sexual *B ruziziensis* biotype Linked primers were identified after screening 600 RAPD and 82 AFLP primer combinations using bulk segregant analysis

- A SCAR was designed from the RAPD primer linked to the apomictic phenotype in the *B ruziziensis* x *B brizantha* population at a distance estimated at 4 cM in *the B ruziziensis x B decumbens* population and 13 cM in the *B ruziziensis x B brizantha* population
- RFLP probes from the Cornell rice map linked with the SCAR and with the apomixis gene were also identified

Objective 2

OUTPUT 2 1 **Exotic genes and gene combinations accessed and utilized**

I) Viable, fertile hybrid plants have been obtained following *backcrossing P vulgaris x P acutifolius* F1 hybrids to the common bean Interspecific hybridization was facilitated by certain genotypes of both species embryo culture and backcrossing strategy Congruity backcrosses increased the rate of fertile hybrids and the recombination of both genomes as shown by protein and molecular markers

- After several cycles of selection and pyramiding of resistance sources several lines, highly resistant to bacterial blight (CBB) have been developed Other agronomic characters of the common bean parents have been retained
- Resistance to BGMV and leaf hoppers are important traits for broadening the genetic base of common bean by interspecific hybridization

II) A highly prolific meristematic common bean callus was produced following several subcultures of cotyledon nodes in a new medium with high levels of cytokinin Efficient rooting of regenerated shoots was possible following micrografting of stem tips onto decapitated seedlings Preliminary experiments of transformation using biolistics and *Agrobacterium tumefaciens* have shown the suitability of this tissue culture system for transformation of the common bean

III) Transgenic cassava plants were produced following *A tumefaciens*-mediated transformation of somatic cotyledonary leaves of variety M Per 183 The plasmid used for transformation was pGV 1040 and expression of marker genes *gus* and *bar* was observed in regenerated plants Southern hybridization demonstrated the stable integration of T-DNA mostly as single inserts Fully grown plants expressed high tolerance of the herbicide "Basta' (150 mg/l ppt) in greenhouse tests

IV) Integration of transgenic cassava into a broader pest and crop management approach is an alternative strategy for controling the cassava stem borer

- A binary vector (pBIGCRY) that harbors the chimeric gene cryIA(b) was constructed, and placed it between the 35S CaMV promoter and a polydenilation signal from the nopaline synthase gene of *A tumefaciens* The construct contains the *gus* intron reporter gen and the *nptII* antibiotic resistance gene
- Transformation studies of cassava variety Venezolana the most important local cultivar in the Colombian North Coas were initiated

V) A cryopreservation technique for cassava was developed using chemical cryoprotection and dehydration-cooling to recover viable plants from shoot tips of a range of cassava varieties

- The culture and dehydration of shoot tips before cryoprotection and freezing, and the use of cytokinins in the recovery medium were critical to the successful recovery of plants from liquid nitrogen Plant recovery varies from 10% to 70% depending on the genotype
- Recalcitrant genotypes have been studied and their response to crypreservation significantly improved
- A rapid freezing protocol was recently developed and is currently being evaluated for genotypic response along with the use of encapsulation (alginate beads) of shoot tips

VI) Evaluation of the genetic stability of cassava cultures conserved *in vitro* for 10 years has shown no apparent genotypic variation at DNA level

VII) An advanced backcross method was implemented for rice The method is based on a successful demonstration by Tanksley in tomato of increasing yields by recovering positive alleles from wild species using molecular markers that otherwise would be overlooked based on the phenotype of the parent and identifying molecular markers for the alleles of interest to aid their incorporation

- Mapping populations from elite irrigated and upland rice varieties and three wild species (*O rufipogon*, *O barthii* and *O glaberrima*) were developed Some BC2F2 families showed a transgressive segregation for yield resulting in increases of as much as 15% The data were confirmed on BC2F3 families Preliminary QTL analysis provided information on the putative linkage between RFLP markers and yield components

VIII) A methodology for generating transgenic indica rice was developed

- Current resistance to RHBV (Rice Hoja Branca Virus) in commercial varieties is controlled by a single gene therefore broadening the resistance base against RHBV is of great importance Constructs containing the RHBV-nuclear protein for cross protection, and the anti-sense RHBV-NS4 major protein both viral genes were placed under the control of the 35S CaMV promoter and incorporated in transgenic plants using biolistics
- More than 150 plants were obtained from several transformation events Southern analysis indicated single and multiple gene insertions Segregation of 3 1 among offspring of transgenic plants was obtained These plants were challenged with RHBV in the greenhouse Resistant plants were selfed and their progeny challenged again with the virus Significant delay of disease development and reduced symptom occurred in transgenic plants compared with the nontransgenic control
- A few plants showed immunity to the virus

IX) Rice anther culture breeding has been established at CIAT for speeding up gene pool development recovering the fertility of wide crosses and producing permanent mapping populations for genetic tagging The response of indica rice genotypes to anther culture by modifying of the culture conditions was improved demonstrating that genes controlling response in japonicas can be introgressed into indicas

X) The rice anther culture technology has been transferred to Latin American rice breeding programs with support from the RF Several Latin American and Caribbean countries have implemented anther culture for rice breeding

XI) Transgenic plants of *B decumbens* (4X apomictic) were generated using biolistic technology on isolated mature embryos In the experiments equal amounts of the pAct1D construct (containing the *gus* gene under the control of the actin 1 promoter actin 1 intron) and of the pTRA 151 construct (harboring the *hph* selective gene for hygromycin resistance and driven by the 35S CaMV promoter were used Southern analysis confirmed the integration of DNA

OUTPUT 2 2 **Mechanisms of genetic variability to biotic and abiotic stresses and quality factors searched, identified, and measured**

I) Differential display techniques to search for gene products specific to resistant genotypes to the bean weevil (*Acanthoscelides obtectus*) have been implemented Work with poly A(+) isolated during pod-filling state was developed Transcription (RT) PCR products were separated and bands present in resistant, but absent in susceptible genotypes, were isolated and used for probe hybridization Two bands out of 52 isolated bands gave positive hybridization in dot blot with bulked RNA from resistant *Phaseolus lunatus* genotypes Confirmation of positive hybridization is underway, using Northern blots

II) Significant differences among genotypes for amylose content were mapped and except for two genotypes, differences existed for gelatinization temperature and maximum viscosity at the beginning with a tendency to stabilize afterwards

- Gels did not show structural changes nor syneresis during various storage periods The range of amylose content in 630 accessions from the cassava collection was 15% 28%
- Low amylose content was identified in a wild *Manihot* species

III) The feasibility of selecting and improving cassava genotypes with 2 mg/g of beta carotene in the roots and 30 times more in the leaves was demonstrated Genetically the transport of beta-carotene to roots seems to be under the control of major genes and its accumulation, is under quantitative genetic control Molecular marker-assisted selection could contribute to breeding for high carotene cassava

IV)A rapid non-destructive simple assay for cyanogenic potential in cassava was recently developed Using the enzyme-based dip stick' technique cyanogenic potential of more than 100 progenies was measured ranging from as low as 100 to as high as 2000 mg HCN/kg in root dry wt Gene mapping can now be integrated with breeding

V) Acid soil tolerance is a key trait for developing superior *Brachiaria* forage germplasm A collaborative project is searching for mechanisms result in *Brachiaria* tolerance to soil acidity The overall approach includes

- designing a multiple stress nutrient solution to simulate acid soil conditions

- investigating a number of traits that might contribute to differential acid soil adaptation to P and N deficiencies with special focus on root architecture
- constructing a cDNA library enriched for acid soil stress induced genes from roots of the best adapted (*B decumbens*) cultivars

Initial results indicate

- significant increase in citric acid in root tissue in response to the presence of Al was detected Citric acid apparently does not accumulate only in root apices but also in mature parts of the root axes where it could be involved in Al detoxification
- Al-P interaction in root apices and a possible link between Al-toxicity and nutrient uptake capacity And, root acid phosphatase activity significantly increased in *B ruziziensis* only when responding to nutrient limited conditions

Objective 3

OUTPUT 3 1 **Networks, conferences, workshops, and training courses on agrobiodiversity and biotechnology organized and conducted in cooperation with partners**

- Networks

The organization and promotion of and the participation in biotechnology networks is a key CIAT strategy for developing effective collaboration with institutions from both developed and developings The network approach provides opportunities for acquiring information, capacity building and training on most aspects of biotechnology for a particular crop or group of crops

In 1988, CIAT initiated the Cassava Biotechnology Network (CBN) in 1990 CIAT founded the Beans Advanced Research Network (BARN) and since 1985 CIAT is an active member of the Rice Biotechnology Program a global effort by the Rockefeller Foundation

For CBN a full-time coordinator maintains contact with stakeholders publishes newsletters, organizes scientific meetings, and coordinates developing country participation in capacity-building programs and linkages with ARIs and CG centers especially CIAT and IITA The CBN has encouraged and/or promoted the participation of ARIs in cassava biotechnology research these have grown from a handful of laboratories in 1988-1990 to nearly 50 in 1996 1997 The CBN has organized three international scientific meetings on three continents and a small-grants program for promoting cassava biotechnology research through collaboration on topics of high priority

The CBN membership has grown to more than 300 persons two thirds of whom work in 26 cassava-growing countries including collaborators from applied disciplines and from NGOs and farmer processor organizations

• Training

As a basic element of CIAT s role to bridge biotechnology research with developing countries, more than 650 scientists or technicians from 25 developing countries participated in international conferences regional workshops specialized training courses and in-service training

• Research tools

CIAT has generated or acquired and adapted a range of research tools including genetic stocks genes gene constructs linkage maps and probes culture lines cloning vectors, bacterial strains, and the corresponding information and databases These ' materials" (about 22 classes in all) have been fully available to CIAT partners under various transfer arrangements

• Partnership

To accomplish its mission and objectives, the CIAT Biotechnology Research Unit, now the Project SB-02 has developed a wide spectrum of formal and informal collaborative mechanisms both within CIAT and with institutions public and private developed and developing countries

•Linkages with other CIAT projects genetic resources conservation (SB-01) increasing productivity (IP 1 IP 2 IP 3 IP-4 and IP-5) integrated pest management (PE-1), soil conservation (PE-2) land use (PE 3), regional cooperation (SN-2), and participatory research (SN 3)

• Linkages with public institutions

  - International (5 IARCs and 3 others)
  - NARS including ARIs (Colombia 11 Other in South America 17 Central America and the Caribbean Region 9 Southeast Asia, 4 and Africa,2)
  - Public ARIs (Europe 12* and North America 12*)
  - Linkages with private ARIs 6*)

* 12 linkages involved formal cooperation (some through projects)

• Fund raising

During 1994-1997 a range of organizations (including international foundations international institutes governmental bodies and regional agencies) funded the activities of Project SB-02 A total of 22 specific research activities were funded by 17 organizations Nine activities received one time donations, three projects ended in 1996-1997, while the extension of another is being negotiated

Does the research responds to stakeholders needs?

Given that the large community which interacts with CIAT ranges from small family-farmers to industry driven large farmers from public funded research institutions (NARS ARIs) to private multinationals located in Latin America Caribbean Asia, and Africa, SB-02 has tried to maintain a high level of responsiveness to stakeholders while keeping as close as possible to the CIAT mission

Are milestones well indicated and can their achievements be monitored?

SB 02 milestones are somewhat fluid in time due to the nature of the research being developed However the achievements can be clearly identified in all three major objectives as seen above

Are research objectives feasible within the indicated time frames?

Research objectives are clear but in some cases very ambitious The time frame is feasible given some extra support in personnel (see Section III) and that the maintenance of funding can be secured

Is the proposed research fully reflected in the project documents and do the workplans represent the project objectives?

The research proposals are fully reflected in the workplans and represent the respective objectives However there is a great anguish among the scientists due to the very short period covered by funding in each of the core funded activities (e g availability of funds reevaluated every January) Usually biotechnological results do not mature in short time periods and if forced to do so can lead to lower quality results

Are projects output and impact well defined and feasible?

The SB-02 annual report covers the 94-97 period The project outputs and impact have been well defined and presented Most of the research lines within Objectives 1 and 2 present a proposal for feasible future activities given that the funds can be provided

II *THE RESEARCH PROGRAM*

Are the proposed research activities and methodologies used appropriate to achieve the expected outputs ?

Objective 1 Understanding genetic diversity

(see comments on SB-01)

Objective 2 Broadening the genetic base of crops

In this topic the proposed research activities and methodology used are in general adequate The projects produced the first lines of transgenic plants covering three species *Manihot Brachiaria* and *Oryza* Preliminary steps were taken to identify the best tissue for transformation of *Phaseolus* Only with more experimental work will the group be able to understand fully the complexity of introducing new genes into commercial varieties and be able to observe the pleiotrophic effects caused by the creation of many new loci Due to funds limitation and in order to increase the interaction with partners CIAT could contact NARS and other Institutes in the region (e g Cenargen/Embrapa (Br), Cinvestav (Mex)) which are developing state-of-the art transformation protocols for crops of the region This could avoid duplication efforts and speed up the outputs of projects Aspects regarding the IPR of the genetic material will be discussed in the appropriate section

Regarding the cryopreservation technique for cassava and the rice anther culture methodology CIAT has to be congratulated for the effort in developing the protocols that have reached a phase that they can be transferred to any interested partner The same is valid for the enzyme-based dip stick technique for the detection of the cyanogenic potential in cassava

The results of the use of the advanced backcross method (Tanksley method) as applied to rice and beans deserve to be mentioned as some of the most convincing results showing the importance of the new DNA technology when applied as support for the use of genes from wild species for yield improvement

Is the research original, and is the balance between basic and strategic research adequate?

The research proposals are original to our knowledge In Biotechnology it becomes very difficult to assure anyone for more than three to six months that the research is totally original The basic areas are covered within CIAT mandate crops but in some cases projects will have to broaden their focus Genomic interaction of the novel genes in transgenic plants scientific risk assessment upon environmental release of genetically modified plants application of QTLs in different genetic backgrounds and are some of the areas that need to receive much more attention given the quality of research results CIAT should maintain Viewing strategic research as ' research which has a strategy as to how to develop the desired products and deliver them to those who need them (G J Persley CIAT BRU Review Report 1992) SB 02 has improved the contact with partners in the Latin America and Caribbean region in Europe and in the United States through personal contacts during which the team leaders have taken good advantage of the opportunities to gain new knowledge and capabilities

The transfer of technology to NARS and other organizations in LDCs has been developed into a horizontal collaborative activity which has evolved as much as possible for collaborative research projects As part of this cooperation with NARS conferences

workshops, and training courses constitute a strong component of information and technology dissemination

The Cassava Biotechnology Network (CBN) developed a strong orientation towards end-user needs and perspectives It has carried out or promoted several case studies of priority setting and impact assessment with the participation of farmer organizations NGOs, and NARS Some findings have become recommendations for research and development within and outside the Network

However we feel that much more can be done in that direction given that scientists can use sufficient funds to travel and participate from international meetings and interinstitutional agreements

Is the proposed science rigorous, of international standards, and is a peer review process in place to assure those standards?

See comments on SB-01 for peer review and above for comments on scientific rigor

Are past research results and review recommendations used in present and planned activities?

Taken as a milestone the CIAT BRU review report (1992) many of the recommendations have been followed in the scientific review of the projects However probably due to changes in the *modus operandi* from programs to projects due to the growing internal demand from the Natural Resources newly created Directorate and to the changing mission from applied breeding to agrobiodiversity screening and prebreeding it seems that SB 02 has spread its activities much too thin and therefore lost focus A priority setting exercise is taking place within the group as proposed in the document Genome Research in Agrobiodiversity at CIAT' presented to the ICER Panel and should be continued

Is research progress adequate and according to projected outputs and impact?

Research progress could be more adequate if SB-02 teams could complement some positions with postdoctoral fellows and in some cases hire a new very specialized person (see Section III) As discussed before SB-02 was structured in the second half of 1996 and carried most of the projected outputs and impact of the Biotechnology Research Unit (BRU) The outputs presented in the Annual Report introduce all the results obtained in the 94 97 period without a time scale reference Therefore it became very difficult to individually judge the outputs

As outputs listed for the next three years SB-02 lists

Genetic structure characterized within and between gene pools of *Phaseolus* and *Manihot* using molecular markers

Genetic diversity of cassava bacterial blight pathogen characterized and resistance genes identified using molecular markers
Genetic diversity of rice blast pathogen characterized and resistance genes identified using molecular markers
Molecular mapping of apomixis gene(s) and genes for resistance to spittle bug in *Brachiaria*
Agroecological information integrated with genetic diversity using GIS and molecular markers (beans cassava and tropical forages)
Transgenic rice with resistance to RHBV field tested in Latin America and incorporated into IPM schemes
Novel genes (Bt proteinase inhibitors etc) accessed and utilized in IPM schemes for insect resistance by genetic transformation in cassava beans rice and *Brachiaria*
Novel genes (starch quality carbohydrate metabolism postharvest conservation seedling vigor etc) accessed and utilized for quality modifications, using genetic transformation of cassava beans and rice
Apomixis gene(s) isolated and cloned for homologous (*Brachiaria*) and heterologous (other crop spp) transformations
QTLs for yield and quality traits identified and utilized in rice beans and cassava
Useful traits (biotic/abiotic stress resistance) transferred through interspecific hybridization in *Phaseolus*
Field studies of risk assessment (biosafety) organized with the cooperation of the biotech private sector and NARS
Cellular and molecular genetic techniques developed for assessing and enhancing agrobiodiversity (novel DNA markers biomolecular statistics genetic engineering)
Databases maps probes strains assembled and made available to partners
Capacity building activities in conservation technologies and processes organized with national partners
Awareness programs and capacity building of NARS organized for assessing and enhancing agrobiodiversity through molecular and cellular techniques

How are research outputs used and by whom?

The immediate clients of SB-02 are CIAT scientists working in germplasm development, sustainable productivity and natural resources management projects Transfer of technology in this case is through involvement of CIAT scientists, as early as possible in the process of acquiring and developing research Once a given technology has been developed for routine use it is shifted to other CIAT projects or units Some more basic aspects of the technology remain under Project SB 2 as a way of saving capital and operational resources

Is the quantity and quality of the various research publications adequate ?

The average number of publications per scientist belonging to SB 02 could be higher giving the qualifications of research members and the infrastructure available However we understand that the group has many more activities such as organization of the external training workshops in house training production of numerous reports preparations for reviews and of many project proposals for external funding We find

the group very geared to produce more and better publications if they could only see some of the heavy bureaucratical burden reduced

Is the research work adequately linked with the work in the IP-projects ?

As shown in the Annual Report 94 97 and very clearly marked in the Medium Term Plan 1998 2000 SB projects IP projects and PE projects are planed to correlate well both by using partially dedicated common personnel and research results

Are the projects making adequate use of socio-economic input ?

SB-02 benefits from the direct contact that CIAT maintains with stakeholders A major contribution comes from CBN in the case of cassava where major decisions have been taken based on direct demands from the small farmer For the other crops priority is given to projects which are likely to have major socio-economic impacts

III *RESOURCES AVAILABLE*

Is the right organization in place and can the expected outputs be delivered with the available resources (facilities, staff) ?

Facilities and organization

As clearly explained in the MTP 1998 2000 (p 80) CIAT has undergone a stepwise review of its internal organization At the moment the project based management is in place with possible alternatives such the formation of Scientific Units' under discussion because scientists felt that projects alone would not be enough to sustain the internal organization However a scientific unit is an affinity group rather than a formal operational entity'

ICER was presented with a proposal basically prepared by SB 01 and SB-02 scientists (Agrobiodiversity Team) which introduces a more formal design to organize the infrastructure management and account for new internal and external demands that are forcing CIAT to respond to new challenges

To accommodate changes the document suggests the maintenance of the **Genetic Resources Unit** to give support to SB-01 and other related projects and the establishment of two entities the **Genome Research Laboratory** and the **Biodiversity Assessment Regional Laboratory** in substitution for the actual Biotechnology Research Unit which at present gives support to SB 01 SB 02 and other related projects

The Genome Research Laboratory will house activities linked to genome characterization, genome modification and clonal propagation of plants and will be run with CIAT s approved budget while the Biodiversity Assessment Regional Laboratory will be implemented and equipped through joint partners contribution to house activities related to crops outside CIAT s mandate It will depend on additional resources provided by outside sources

We find that the proposed structure will give the Agrobiodiversity Team the extended flexibility they need to participate in the very fast moving biotechnology world It will re-focus their activities to mandate crops allowing at the same time for the opening of a new window of opportunities which will signal to the internal and external public (donors and partners) that while prepared to respond to the challenge the Team will only do it if outside funding and human resources can be contemplated

The document also proposes the change of the current SB-02 project tittle to '*Genome Research for Promising Tropical Crops*

The domain of this project includes basic responsibilities at CIAT, such as monitoring advanced research in plant molecular and cellular biology worldwide, bringing to CIAT and developing countries selected outputs with potential pay off in terms of applications outsourcing of special services in public and private ARIs (e g large-scale sequencing genetic constructs for transformation etc) biosafety in DNA research and testing of transgenic plants, and updating and training of CIAT personnel in biotechnology

The genomic work carried out in this project will be linked through projects with the research of national institutions in developing countries In dealing with nonmandate crops, the role of project SB 02 will consist of providing the necessary biotechnology inputs for integration into crop improvement at the national and regional levels

This project will use molecular/cellular genetic tools for assessment, modification, and mass propagation of agrobiodiversity in research areas such as analysis of diversity and relationship with the spatial distribution of genetic resources genotyping genetic resources with value in prebreeding strategies identification and localization of genes, gene combinations, and chromosome parts responsible for agronomic traits development of marker assisted selection strategies genetic transformation using single genes first later on more complex transformation using map based cloned genes clonal multiplication of plants by bioreactor and artificial seed technologies

Staff

SB-02 comprises a team of 11 75 scientists/year composed of 5 scientists from the core and 6 75 scientists belonging to special projects To be able to respond to the new demands described above the Team needs to maintain the present positions and assure the opening of at least three postdoctoral positions

Specifically the maintenance of the molecular genetics and the plant breeding (QTLs) positions are critical for the development of on-going mandate crops related lines of research The support of a population geneticist is strongly needed and the acquisition of a molecular biologist is required to respond to the growing demands If the later is not possible due to funding contingencies the Team needs to garantee this support by 'outsourcing with ARIs or within the CG system

Budget (see general comments)

How do projects exploit strategic alliances with NARSs, Universities, NGOs and private sector ?

To meet the challenges posed by the application of biotechnology to agrobiodiversity, Project SB 02 has developed collaborative linkages with a range of institutions worldwide During 1994-1997 the following linkages* were established by Project SB-02 (see details in the Annual Report 94 97)

(i) With public-sector partner institutions

- 5 IARCs and 3 other international organizations
- 10 Colombian institutions
- 17 institutions in other South American countries 9 from Central America, Mexico and the Caribbean
- 4 institutions from Southeast Asian and 2 from Africa
- 12 Advanced Research Institutions (ARIs) of 7 countries in Europe
- 11 ARIs in North America

(ii) With private ARIs collaborative linkages have been established with 6 private biotechnology organizations in 4 countries

(*) Very often collaboration involved developing formal projects with special funding

Links with NGO's have been established through the Cassava Biotechnology Network

APPENDIX I

TERMS OF REFERENCE OF THE REVIEW PANEL

INTERNALLY COMMISSIONED EXTERNAL REVIEW (ICER) 1997

INTRODUCTION

CIAT's research evaluation framework includes two major dimensions research strategy and quality of science The strategic review process evaluates if CIAT has the right goals, meets stakeholder needs is feasible has adequate projected outputs and the right resources and organization 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

The quality and the relevance of the research program is monitored by the BOT through among others mechanisms the Internally Commissioned External Review (ICER) An ICER is conducted by outside consultants their selection and terms of reference are BOT approved CIAT's BOT adopted a schedule in which annual ICERs evaluate progressively the entire research program of the center over a five year cycle to coincide with the EPMR. The schedule for the ICER for the next five years is attached TAC in deliberating this recently put as condition to assign value to the ICER that they must be provided with names and TOR of the panel and receive the report and management response to the recommendations

THE 1997 REVIEW

The 1997 ICER will concern the research area "Saving Agro-biodiversity" which is mainly concentrated in projects SB 1 (Integrated conservation of neo-tropical genetic resources) and SB-2 (Crop germplasm development through increased utilization of biodiversity) This includes most of the germplasm conservation and biotechnology activities of the center The review will also cover pre breeding activities (broadening the genetic base of the mandate crops of the CIAT commodities beans, cassava, rice and tropical forages) which forms part of projects IP 1-5

The event is scheduled to take place November 17-21 This date was chosen as the earlier proposed date would have coincided with major international biotechnology events

TERMS OF REFERENCE OF THE CONSULTANTS

The consultants to conduct the ICER will be required to deliver a written report of their findings with recommendations at the end of their assignment Their review shall respond to the following concerns

I Project goals

-Are the research goals and priorities clearly identified and is the process to measure this adequate
-Does the research respond to the stakeholders needs
-Are milestones well indicated and can their achievement be monitored
-Are the research objectives feasible within the indicated time frames (risk assessment)
-Is research attention to in situ conservation adequate
-Is the proposed research fully reflected in the project documents and do the workplans represent the project objectives
-Are projected output and impact well defined and feasible

II The research program

-Are the proposed research activities and methodologies used appropriate to achieve the expected outputs
-Is the research original and is the balance between basic and strategic research adequate
-Is the proposed science rigorous of international standards and is a peer review process in place to assure those standards
-Are past research results and review recommendations used in present and planned activities
-Have the recommendations of the review of the genebank been implemented
-Is research progress adequate and according to projected outputs and impact.
-How are the research outputs used and by whom
-Is the quantity and quality of the various research publications adequate
-Is the research work adequately linked with the work in the IP-projects
-Are the projects making adequate use of GIS tools and socio-economic input
-Is the germplasm CIAT holds in trust adequately documented and made available
-Is the genetic resources activity of CIAT adequately linked to the System-wide Genetic Resources Program and SINGER

III Resources available

-Is the right organization in place and can the expected outputs be delivered with the available resources (budget, facilities staff)
-How do the projects exploit strategic alliances with NARS Universities NGOs and the private sector

APPENDIX II

SCHEDULE FOR THE REVIEW PANEL

Internally Commissioned External Review
CIAT Projects on Saving Biodiversity SB-01 & SB-02
17 – 21 November 1997

Sunday 16

Reserved for Panel Work Examination of Reports and TORs

Monday 17

08 00	Telecommunication with Dr Wallace Beverdorf
08 30-10 00	Meetings with Directores and Project Managers
10 00-12 00	SB-01/02 Project Staff Brief Presentations
14 00-17 00	Reserved for Panel Work

Tuesday 18

08 00-10 00	Genetic Resources Unit Drs D G Debouc C L Guevara and R. Hidalgo
10 00-12 00	Biotechnology Research Unit Drs W Roca, J Tohme Z Lentini M Fregene I Sánchez, F Angel, A Mejía, S Beebe C Iglesias C Martínez.
14 00-16 00	Visit to Greenhouse and Field with SB 02 Biotechnology
17 00-18 00	"Happy Hour VIP Room

Wednesday 19

08 00-10 30	Panel Work with Drs W Roca and D G Debouck
11 00-12 00	Panel Work with other CIAT Scientists Drs John Miles Fernando Correa, Anthony Bellotti
13 30-15 00	Visit to Field and Genetic Resources Unit
15 00-16 00	Seminar Dr A M Thro CBN (Nariño Room)

Thursday 20

08 00-09 30	Orientation of Future Work and Vision (Tayrona Room) Meeting with Drs W Roca D Debouck A Bellotti S Beebe M Fregene C Iglesias Z Lentini A Mejía I Sánchez, A M Thro J Tohme V Verdier F Angel
10 15 10 45	Telecommunication with Dr Wallace Beverdorf
10 45 11 30	Brief Presentation of Cryopreservation R Escobar Biotechnology Lab
11 30-	Reserved for Panel Work
17 00-18 00	"Happy Hour Consultations with CIAT Scientists VIP Room

Friday 21

08 00-12 00	Reserved for Panel Work
13 00-14 30	Presentation of Recommendations by Panel to the Director General (Dr G Scobie Office)
14 30-17 00	Reserved for Panel Work Final Report
20 00	Dinner at Director General s Residence

Saturday 22

Departures

APPENDIX III

ADDRESSES OF THE PANEL MEMBERS

DR. BARBARA SCHAAL
Professor
Department of Biology
Washington University
St. Louis U S A

DR. KEN-ICHI HAYASHI
Board Member of ISNAR
Advisor to JIRCAS JAPAN
Former DG, National Institute of Agrobiological Resources, JAPAN

DR. MARIA JOSE AMSTALDEN SAMPAIO, Ph.D
Advisor to Director of EMBRAPA
Biotechnology & Biosafety
EMBRAPA, Brasilia
Brazil

RESPONSES TO THE RECOMMENDATIONS MADE BY THE EXTERNAL REVIEW PANEL OF ICER 97[1]
(2 November 1999)

Introduction Within the schedule of internally commissioned external reviews (ICER) a review was conducted on CIAT's work in bio-diversity activities mainly located in Projects SB-1 (the GRU) and SB-2 (the BRU) The review panel was chaired by Dr B Schaal an evolutionary population biologist from Washington University at St Louis USA and panel members were Dr M J Sampaio biologist of EMBRAPA Brazil and Dr K-I Hayashi geneticist and head Japanese delegation to the CBD The review was conducted November 17-21 1997

The Panel commented favorably on the quality and relevance of CIAT's work in bio-diversity They considered the work done in SB-1 and SB-2 of high scientific quality contributing to international development and working well with partners within CIAT NARS and ARIs They noted that CIAT staff is deeply committed to the Center's mission and is abreast of the latest scientific issues

They highlighted some of the important achievements made by these projects including the development of a cryo-preservation technique for cassava rice anther culture techniques to detect cyanogenic potential in cassava the QTL backcross method applied in rice the use of AFLP variation to study the domestication of beans development of transgenic rice plants with resistance to Hoja Blanca Virus molecular markers for developing durable resistance to rice blast and construction of a genetic molecular map for cassava

The panel made valuable comments on scientific directions suggesting -a new initiative to incorporate wild germplasm into cassava breeding -to launch a new effort to assess risk in transgenic traits in beans and cassava -to develop user friendly GIS based systems and -to establish a regional bio-diversity assessment laboratory Although they expressed some concern about the breadth of the activities they did not formulate this in a specific recommendation

Of particularly importance is their recommendation that CIAT should exercise legal protection for its intellectual property rights in order to access advanced technology and to ensure that benefits of the research by CIAT reach the intended beneficiaries in the developing countries The panel also recommends that CIAT consider closer links with regional partners in the development of transformation protocols and to out-source to ARI s large scale sequencing and genetic constructs for transformation

The panel expressed concern about the reduced funding especially in view of the fact that the scope of work has broadened

[1] November 1998

The following lists each of the recommendations made by the Panel conducting the ICER 1997 of the Projects SB-1 and SB-2, together with the response by CIAT

PLEASE NOTE The recommendation is in *ITALICS* the CIAT response in ROMAN characters and the update of 1998 is in BOLD The 1999 update is indicated as such

1 *Establish a position assigned to SB-01 for computer/data base support This position was eliminated during budget cuts but is essential for the implementation of the recommendations from the 1995 CGIAR genebank review panel*

The position of documentation specialist was maintained but unfilled during the reorganization when projects were formed It will be upgraded and used for computer documentation mainly to unify the germplasm databases and monitor germplasm flows through the extension of bar coding Filling this position will be simultaneous with the reassignment of computer specialists for each collection These specialists were initially working for the commodity programs but were transferred to the information systems unit

Time is allocated by the Information Unit to provide the required operational support to the upgrading plan

Update 1999 The demands for this exceeded the time available from the Information Unit Thus starting in 2000 a documentation specialist will be working full-time in the GRU

2 *Provide additional expertise in the area of population genetics and evolutionary biology either by collaborative arrangements or by future staff positions*

This point was also raised during the Review of the Biotechnology Research Unit in 1992 Using funds from the Strategic Research Initiative the Agro-biodiversity Team established a collaborative research activity with Purdue University in population genetics for the period 1996-97 That scheme will be continued and could serve as a model for other consultancies in specialized areas such as evolutionary biology

The population biology consultancy will be shared with one on bio-informatics to respond to needs

Update 1999 as before

3 *Stabilize a molecular biology position assigned to SB-02 project*

The discipline of molecular biology is of high relevance to almost all CIAT activities in areas such as genetic transformation genetic engineering and studies of resistance mechanisms Such position will also strengthen CIAT capacities in the development and distribution of gene constructs and diagnostic tools The position should be a full time position that could start initially at the Postdoctoral Fellow level CIAT has prioritized fund raising for this position

This recommendation should be a priority since there is no molecular biologist at CIAT Considering funding constraints, strong efforts are being made to obtain special funding for this position One project proposal has been submitted and a second one will be submitted early in 1999

Update 1999 There has been no progress made in funding this position

4 *Establish firm and formal links with ARIs to draw from state-of-the-art research*

CIAT has been successful in doing this from the beginning Formal and informal contacts have been established with a wide range of ARIs (see SB-02 report pp 279-283) to draw from advanced research and to contribute to training efforts at CIAT With the emerging of IPR the formation of such linkages might be facilitated

Priority is given to link with recently created plant genome research initiatives with public and private organizations in developing and industrialized countries CIAT has adopted an IPR policy

Update 1999 CIAT has been successful in attracting the biotechnology institute of the State University and the plant physiology research from the National University to relocate in the CIAT campus thus creating a considerably increased pool of highly trained scientists

5 *Publish the conservation methodologies developed at CIAT in international journals so that these technologies become widely disseminated Include these and other methodologies on CIAT's Internet Home-Page when possible*

Novel scientific results related to improvements in germplasm conservation techniques (e g safe protocols for the cryo-conservation of cassava) are being published Guidelines for the management of field collections are being co-published with IPGRI The Manual of the genebank at CIAT is also under preparation and to be published CIAT will review what material is appropriate to make available on the Internet

The guidelines for the management of field collections are being co-published with IPGRI (currently in proof reading stage) The Manual of Operations of the Genebank at CIAT is being prepared in both Spanish and English, and will be available first in a paper form, by mid 1999

Update 1999 GRU has planned to develop a web site in 2000 which will also include documentation on conservation methodologies the GRU database the MTA internet germplasm request options etc

6 *Continue rigorous peer review to promote research of international standards*

Different peer review mechanisms are in place such as annual reviews with external observers CCERs etc In addition manuscripts are often sent to external reviewers in addition to the CIAT Publication Committee and prior to the journal peer review process

No further updates

7 *Establish a computer based monitoring system for germplasm conservation operations*

This recommendation links with recommendation # 1 above The logical framework of all germplasm conservation operations that will serve programmers has already been established for bean and forage collections It has been developed for the *in vitro* cassava collection The interactive link with the field genebank will be developed soonest

The computer-based monitoring system for the 70,000 accessions held at CIAT is now under development with the help of the Information Unit of CIAT, and will be well advanced in 1999 It matches with the flow chart of operations It will also link with the bar coding system requested from the 1999 CIAT capital fund

Update 1999 Progress has not been made as planned The modules introduction first multiplication and distribution are developed while three others are under development

8 *Provide core budget support for the germplasm activities of SB-01 so that budget stability is achieved and that the Upgrading plan can be achieved*

This point was also mentioned by ICER 95 The yearly capital budget allocation will include provision for improving facilities and equipment needed to comply with the upgrading plan In 1997 the seed viability and drying facilities were greatly improved This year the cold store area will be expanded

Core support remains available for the routine operation of the GRU Initial steps taken for the development of an endowment fund shall be pursued further in close contact with IPGRI and the System-wide Program on Plant Genetic Resources (SGRP)

Capital allocations permit upgrading of the facilities But the budget to execute the upgrading plan remains extremely tight. Alternative funding sources are sought, such as assistance through special projects, System-wide Genetic Resource Program, special donor support, etc

Update 1999 The system-wide investment plan as requested by TAC has been prepared and additional funding was provided to detail the cost of the genetic resources units of the CGIAR and the cost of the upgrading of all accessions to FAO standards This process is terminating early 2000 and should result in the search for funding to execute the up-grading proposed

9 *Provide more flexible core budget for the strategic gap-filling" approach in the biotechnology very fast moving field*

This recommendation is related to recommendations 2 and 3 CIAT agrees that additional resources are required for biotechnology research especially to provide more flexibility to respond to needs and opportunities CIAT intends to allocate increased core resources to SB-2 At the same time it will prioritize fund raising through special projects for such research The concept of a core nucleus complemented by a rotating research capacity to respond to specific needs and opportunities will be pursued

Project proposals have been or are being submitted for funding specific research and development needs

No further update

10 *Provide appropriate fields to maximize environmental variation and gene x environment interactions for germplasm collections at Palmira*

Pending resource availability such studies on the G x E interactions for selected groups of germplasm will be carried out in Quilichao Popayan and Tenerife the substations currently in use

No further updates

11 *Characterize the cassava germplasm collection before it is placed in in-vitro storage The decision to place the cassava collection into in vitro culture should be carefully deliberated*

The placement of all cassava clones in the *in vitro* collection is done systematically since it serves as a back-up to the field genebank In addition, all countries will only accept vitro plants in germplasm exchanges due to phytosanitary regulations Until cryo-conservation has been fully developed and implemented the cassava collections will be maintained both as *in vitro* collections and in the field genebank The latter shall allow to continue with germplasm characterization mainly for novel traits (e g root shape starch characteristics micronutrient content carotene content etc)

No further updates

12 *Establish a pilot program for field collections of essential germplasm*

The research proposed for core funding includes targeted germplasm explorations since genetic erosion continues in urban areas in Latin America (relevant for wild beans and forages) and along seashores around the Caribbean or in the southern Amazon basin (relevant for wild cassava) The plans also took into consideration new needs by commodity projects (e g for additional germplasm of *Arachis Brachiana Calliandra*, etc)

Wild bean germplasm has been collected in Costa Rica this year around San Jose, and the recently created network for plant genetic resources of the Caribbean has been contacted about collecting cassava species in coastal areas with the collaboration of IPGRI

Update 1999 National governments are increasingly reluctant to permit collection missions or place new collections under auspices of the FAO Thus CIAT has placed emphasis on the upgrading of existing collections and less so on new collections until the ownership of genetic resources has been clarified

13 *Develop a user-friendly GIS system to allow for methodology to be transferred to partners and Nards*

The current GIS system that has been developed at CIAT relies on the unique information about climate soil physical geography and land use which can be extremely helpful for regeneration of germplasm accessions to advise users about the right ecological variants guide further germplasm explorations link with genetic composition of samples anticipate germplasm evaluation for abiotic but also biotic factors etc The making available of these databases through the GIS system to project staff and research partners is overdue Graphical user interfaces are being developed to make these tools accessible to CIAT and NARS staff Current staff changes in the relevant Project should allow us to comply with this recommendation by late 1998

Update 1999 The FLORA MAP is now available on CD format analyzing germplasm collections on a geographic base This is advertised on the web The 20 years of pasture evaluation data are being linked with the GIS database to enable NARS and others to target germplasm request according to adaptation to defined geographic areas

Progress is made We expect access via the internal network early in 1999

14 *Establish the Genomic Research Regional Laboratory and implement the guidelines that have already been written (Genome Research in Agrobiodiversity at CIAT)*

The establishment of the Biodiversity Assessment Regional Laboratory should be seen in the context of the document Genome Research in Agrobiodiversity at CIAT", presented to the ICER Panel The focus of the research will be on the characterization and modification of genomes and the conservation of genetic resources Thematic research on agrobiodiversity with CIAT's mandate crops will form the basis for extending genomic methodologies to other promising tropical species General themes of this research will include assessment of genetic diversity and identification of useful genes modification of plant genomes for broadening crop genetic bases and improving germplasm conservation strategies Special attention will be given to wild relatives and land races as sources of genetic variability for improving economic traits The current project SB-02 and the Biotechnology Research Unit will be renamed as Genome Research for Promising Tropical Crops and Genome Research Laboratory" respectively, to better reflect needs of NARS in biotechnology and have available the latest advances in plant molecular and cellular biology worldwide To respond to the demand in the area of genomic assessment an infrastructure to support regional cooperation in non-mandate crops is proposed as Genomic Research Regional Laboratory

Recent global developments strongly indicate that CIAT should pursue crop genomic research The proposed laboratory infrastructure will host research on non-mandated species for cooperation with NARS, including the private sector IPR management will be critical A proposal is under preparation to cooperate in biotechnology research development with the private sector

Update 1999 No further progress to report

15 *Consider a cassava breeding program which incorporates wild germplasm similar to the current program in rice and bean QTL s*

The advanced backcross QTL scheme developed by S Tanksley (Cornell Univ) initially proposed for self –pollinated crops is currently being evaluated for crops

such as cassava Population development has started by crossing elite cassava genotypes with three wild Manihot species selected on the basis of interspecific relationships defined by AFLPs and microsatellites In the meantime we are adjusting marker-assisted selection with cassava genepools for traits such as Cassava Bacterial Blight root and starch quality and whitefly resistance

CIAT is in an advanced stage of recruitment of a cassava geneticist. He/she will undertake research on the use of wild *Manihot* spp to improve cultivated cassava

Update 1999 The cassava molecular geneticist was appointed in July 1999 While his workplan includes the above research priority is given to the development of germplasm for Latin America with resistance to the African Mosaic Disease (ACMD) The recent arrival of the vector of this virus greatly increases the probability of an outbreak of ACMD in Latin America

16 *Contribute in a limited manner to in situ conservation efforts by providing guidelines and genetic information to other agencies such as Ministries of the Environment or conservation agencies*

Steps have been taken along this recommendation with the publication of results about space gradients of genetic diversity for some wild bean species and selected forages That information has been sent to the Biodiversity Institutes in Latin America which are often the technical bodies for the implementation of *in situ* conservation policies (e g the selection and location of protected areas) Another line of research has been developed with a focus on *in situ* conservation practices and management with a first paper published on wild-weed-crop complex and the management of rural disturbed habitats Such research will continue as we have identified these two major lines of research as feasible and with a high probability of impact in the near future Additional research collaboration in in-situ conservation will be sought

A specific example of this year is the collaborative work between the University of Costa Rica, the bean network PROFRIJOL and CIAT Threatened areas with valuable wild (mainly bean) germplasm were identified and recommended for protection The wild material was also collected as a safety measure

Update 1999 Jointly with IPGRI an international course was conducted in 1999 on in-situ conservation in Bolivia

17 *Establish with urgency an agreement on biosafety with Colombia taking into full account internationally established procedures such as OECD guidelines*

Once Colombia has issued the biosafety regulation and implementation policies formal applications for field testing of genetically modified organisms (GMOs) will be presented to the National Biosafety Committee In addition SB-01/02 will where appropriate continue research on field studies associated with GMOs A project on gene flows between crops and their wild relatives is currently under development It will involve NARS of Latin America with an important technology transfer component in view of needs in regulation policies for the introduction and management of transgenic plants The proposal builds on CIAT's previous works on gene flow and experience with molecular markers

Until the Colombian biosafety regulation is in place, we are making preparations to move to Peru and/or Costa Rica for field testing of transgenic rice CIAT management continues to encourage Colombian authorities to adopt biosafety regulations soonest. We are submitting a project proposal on gene flow as a strategic step for biosafety risk assessment in the region

Update 1999 The Colombian bio-safety regulations are now in place CIAT has submitted an application for testing transgenic rice and cassava under field and greenhouse conditions respectively A project proposal on gene-flow analysis has been approved for funding to start in 2000

18 *Review formal interactions with NARS based on the broader mission of CIAT*

CIAT scientists actively participate in the organization and conduct of the biannual meeting of the Latin American biotechnology network Such meeting will provide an opportunity to present and discuss to CIAT partners the research projects of SB1 and SB2 Also this year a planning meeting has taken place with EMBRAPA divisions involved with Genetic Resources and Biotechnology A joint action plan is in preparation Similar contacts with Colombian institutes are made frequently We will seek to expand such interactions to other countries of Central America and the Andean region CIAT also participates in the debates with the CG private sector committee which has a biotechnology bias

Planning meetings with NARS of Colombia and Brazil continue, but implementation for other countries has been slow due to lack of resources

No further up-date

19 *Combine when possible external reviews to reduce the burden on the staff*

CIAT implements this practice ICER Annual Review and specific conferences or courses are linked to the maximum possible to reduce burden of staff and review a particular aspect of our research program from different angles Nevertheless we are aware that the burden of reviews and donor reporting remains heavy

No further updates