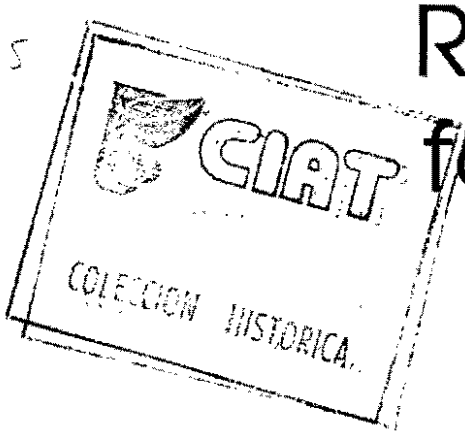
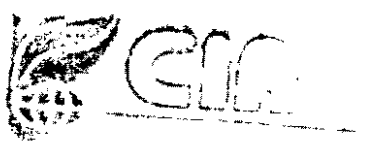
Funding Request for 1995



With the Program
and Budget for 1994-1995



CIAT
International Center for Tropical Agriculture
Centro Internacional de Agricultura Tropical

Contents

Introduction

CIAT's 1992 *Medium-Term Plan* describes, in operational terms, the program plans and funding requirements for 1993-1998. But that year the core budget was underfunded by about 25% and short-term prospects for increased funding were poor. Consequently, in December 1993, the CIAT Board of Trustees approved an *Action Plan* in which important changes in the Center's research agenda, organization, and management were made. The *Action Plan* aims to help the Center meet new challenges and seize new opportunities while operating within limited financial resources.

When formulating the *Action Plan* the Board took into account trends within and outside the CGIAR system that directly affected CIAT's research content, organization, and funding, and its links with other institutions. These trends were:

1. In the post-Cold War era, national governments of developed countries must act vigorously on environmental issues, reduce domestic budget deficits and economic recession, support economic reform in Eastern Europe and the former Soviet Union, and aid the peace process in the Middle East. One consequence of such competing demands is a sharp decline in their contributions to the CGIAR's core budget.

2. Agenda 21 and the Biodiversity Convention, both products of the Earth Summit held at Rio de Janeiro in 1992, are being widely adopted as "blueprints" for sustainable development.

3. The emergence of regional trading blocks has spurred many developing countries to introduce sweeping economic reforms to achieve high rates of market-oriented economic growth.

4. These and other events have led to important shifts in the agricultural priorities of many developing countries: farmers are now expected to maintain food security through more efficient production of staples, satisfy rising domestic demand for industrial raw materials, and provide ever larger supplies of export commodities. Moreover, they must do all this without incurring unacceptable environmental costs. The potentially conflicting demands represent enormous challenges for agricultural research.

5. Increasingly, CIAT's partners—especially those in Latin America—want the Center to orient its expertise toward the objectives and strategies of a region that aims for significant economic growth in agriculture and related manufacturing within the context of sustainable agricultural development.

6. Responding to the emerging trends in agricultural development, the CGIAR has called on various international centers to emphasize issues specific to given ecoregions, and develop mechanisms whereby other international centers can also focus their work on these ecoregions.

7. Increasingly, through intercenter cooperation, individual centers are pooling scarce resources, thus synergizing their efforts.

With this background, the *Action Plan* calls for a Center that is scientifically and technologically strong; is in tune with the changing expectations of the CGIAR, research and development partners, and other stakeholders; is organizationally adaptable to changing demands; and is closely linked with partner institutions in developed and developing countries.

This document describes the main elements of the *Action Plan*, summarizes program highlights for 1993, presents CIAT in the process of fully implementing its *Action Plan*, and describes the resources needed for 1994-1995 to make the *Plan* a reality. The document contains two appendices:

Appendix 1: CIAT's Areas of Competence. Describes the core and complementary competences called for by the *Action Plan*, and which underlie the present *Program and Budget* document. Competences are quantified in terms of specialists and/or positions.

Appendix 2: Financial Tables.

I. CIAT's Action Plan

CIAT's Mission and Strengths

By using its research and technology development skills, CIAT endeavors to help developing countries achieve agricultural growth, distribute the resulting benefits equitably to alleviate poverty, and maintain or even enhance the agricultural resource base. To fulfill this mission, CIAT draws on three areas of strength, which together characterize the Center.

1. *Commodities:* The Center researches four commodities for which it has either a global mandate (beans, cassava) or a restricted mandate (tropical pastures for acid, infertile soils; rice for Latin America and the Caribbean). With appropriate technologies, these four commodities hold enormous potential for contributing to sustainable agricultural development.

2. *Agroecosystems:* Through its more recent commitment to research on the forest margins, hillsides, and savannas of Latin America, the Center is gaining expertise on vital resource management issues of these agroecosystems.

3. *Strategic research competences:* CIAT's expertise in a wide range of agricultural and related disciplines enables it to conduct path-breaking research on themes that cut across crops and agroecosystems.

A major challenge for CIAT is to generate new interest and commitment among research partners and donors to exercise these strengths in a coordinated and complementary fashion. The Center must actively design research around links between its mandate crops and other species, and among commodity, resource management, and land use issues.

Research Programs

CIAT has six research programs:

- Beans
- Cassava
- Rice
- Tropical Forages
- Hillsides
- Tropical Lowlands

Although this program structure reflects a continuing commitment to the Center's crop mandates, it has little meaning unless commodity research extends from conservation and utilization of genetic resources to networking with research partners and clients.

The investment of donors' resources in these activities is justified by the importance of (1) beans, cassava, and rice in the livelihoods and diets of the poor; (2) tropical forages as an essential input of livestock production and as a key component of sustainable farming systems; and (3) hillsides and tropical lowlands as agroecologies in Latin America.

Starting in 1994, all activities of CIAT's research programs are being restructured along project lines. Each program delineates its research in terms of *project areas*, which are subdivided into projects and subprojects. Chapter IV gives details on these projects and their budgets.

Scientific Resource Groups

Through its scientific resource groups (SRGs), CIAT can effectively encourage innovation within the various scientific disciplines that contribute to its mission.

Each group comprises the Center's scientific expertise in one of five areas and their respective research units. The five groups, their respective units, and overall objectives are:

1. **Genetic Diversity (Genetic Resources Unit).** Collect, conserve, analyze, evaluate, and distribute genetic diversity within and among selected species to support germplasm development. Help other institutions in Latin America characterize, conserve, and monitor a wide range of plant genetic diversity.

2. **Germplasm Development (Biotechnology Research Unit).** Identify sources of useful genetic variability; assemble and recombine this variability into pools and complexes for variety development (using both conventional and biotechnology approaches); devise efficient selection techniques for rapid enrichment with desirable genes; and promote networks for disseminating improved germplasm.

3. **Disease and Pest Management (Virology Research Unit).** Provide tools for detecting and monitoring pests and pathogens, gene complexes that can provide durable resistance, and biological control agents. Provide new knowledge on resistance mechanisms and the dynamic relationships among pests, diseases, natural enemies, and their plant hosts.

4. **Production Systems and Soil Management (Soils Research Unit).** Develop sustainable systems that combine plant species to increase productivity, maintain adequate soil cover, cycle nutrients efficiently, and increase soil organic matter.

5. **Land Management (Geographic Information Systems).** Analyze current patterns of land use and develop tools for designing sustainable land management strategies, including analysis of community action and government policies.

The expertise of the first three groups relates mainly to CIAT's mandate commodities and their wild relatives. But, in its role as a conveneing center for ecoregional research, where its work cuts across crops and agroecologies, the Center will apply, in selected cases and with the collaboration of national partners, its capabilities to the integration of other species in sustainable farming systems.

The Center will step outside its commodity mandates only where this would enhance its contributions to resource management and related work in the hillside and lowland tropical environments of Latin America. In Africa and Asia, its commodity research will focus exclusively on beans, cassava, and tropical forages.

The fourth and fifth scientific resource groups will focus primarily on forest margins, hillsides, and savannas in Latin America, but should also provide significant input for commodity programs and the other scientific resource groups.

The five research areas to which these groups correspond are described in Appendix 1.

Scientific resource groups are new to CIAT. Initially, they were established to provide continuity and cohesiveness to the work of scientists operating in given areas of competence across different research programs. When implementing the *Action Plan,* however, scientific resources groups quickly became important sources of project identification and/or generation. In fact, the projects identified by the scientific resource groups contributed heavily to the mandates and objectives of CIAT in general, and to the objectives of different research programs in particular. Hence, the scientific resources groups were given the opportunity to formulate, in conjunction with the research programs, their own research projects. While the specific research units attached to the scientific resource groups already have ongoing research projects, the scientific resource groups, as yet, do not have their own research projects approved and financed.

Projects: The Hub of Activity

CIAT's experience shows that agricultural research can no longer be organized around broad-based research programs. Not only are such programs inflexible vis-à-vis constantly changing external demands and opportunities, but their outputs are also more difficult to document and highlight in a world that continually looks for results, feedback, and proof of relevance. Donors are increasingly interested in funding well-designed projects that generate tangible outputs with measurable impact in finite periods of time. In turn, by structuring its research along project lines, CIAT can maintain a highly flexible and dynamic research program that can respond to the expectations and priorities expressed by the CGIAR, CIAT's national and regional research partners, and donors and potential investors in CIAT's overall research program.

As the *Action Plan* was being implemented, projects were identified and developed as centers of activity, resource allocation, and accountability. The project-based organization of CIAT today is shown in Figure 1: the field defined by the axes "Scientific Resource Groups" and "Programs" is the domain of the projects, which, although differing in extent, cut across any number of research programs and scientific resource groups. But, for the sake of organization and accountability, each project is assigned to the research program or scientific resource group to which it most contributes.

This *modus operandi* guarantees a high degree of interdependence and fluidity among projects. At the same time, the Center is assured that the sum total of the projects directly contributes to the mandates and objectives of each research program and SRG—and therefore to the overall mission and objectives of CIAT.

By organizing research along project lines (see Chapter IV), CIAT introduced a total budget approach to funding these projects. Budgets for core and complementary projects are integrated, thus enabling staff and management to better ascertain the real cost of any activity; report expenditures for auditing; identify inefficiencies in resource utilization and constraints on outputs; and assess project performance.

Relationships between Core and Complementary Funding

CIAT scientists generate outputs related to specific crops and agroecosystems through projects that are "housed" in six research programs and five scientific resource groups. Most financial resources are assigned or attributed to projects, so that the Center's total budget is the sum of resources assigned to all projects together, with some central costs that cannot readily be attributed to projects (e.g., administration and maintenance).

With projects as its key operational and budgetary unit, CIAT is able to achieve full transparency and accountability in its priorities, outputs, expenditures, and income. This enables the CGIAR, other donors, and national partners to see clearly how resources are deployed and the purposes for which they are used. Core resources provided by the CGIAR constitute the main part of CIAT's budget. These resources are assigned to projects according to priorities determined with the CGIAR and TAC. These priorities form the backbone of CIAT's project structure and these resources are its lifeblood.

But the project structure also enables the Center to attract other donors and investors. Priority is placed on attracting additional funding for outputs that contribute directly to the achievement of CIAT's core goals within its CGIAR mandate. Complementary funds are also sought to speed up and extend the scope of application the Center's core outputs (e.g., through regional germplasm networks).

Complementary resources can also be used to produce other complementary outputs and services demanded by CIAT partners, especially in Latin America and the Caribbean, where the Center fulfills an ecoregional function. These complementary outputs are closely related to CIAT core outputs and capacities (e.g., training in molecular markers or GIS methods). The resources generated to deliver these outputs allow CIAT to expand the capacity of its scientific resource groups (e.g., through extra visiting scientists or postdoctoral fellows).

Thus, CIAT's project structure enables it to merge funds from a variety of sources into a single total budget. These resources are deployed synergistically to produce an interrelated set of core and complementary outputs. All outputs derive from CIAT's core capacities, which expand or contract according to the resources available.

Organization

Figure 2 shows the management structure for executing CIAT's project-based work program (Figure 1). Not necessarily evident from Figures 1 and 2—but important in the Center's organization—is the emphasis on decentralized decision making, coupled, where possible, with delegation of authority and responsibility to the project level. This "empowerment" of scientists and scientific teams is moderated by research leaders (who represent specific research programs and SRGs) and by overall coordination at the directors' level. These reporting lines are expected to provide the Center with the necessary balance of flexibility on the one hand, and coordination and synthesis of research efforts on the other.

Figure1. The Project-based Organization of CIAT Today.

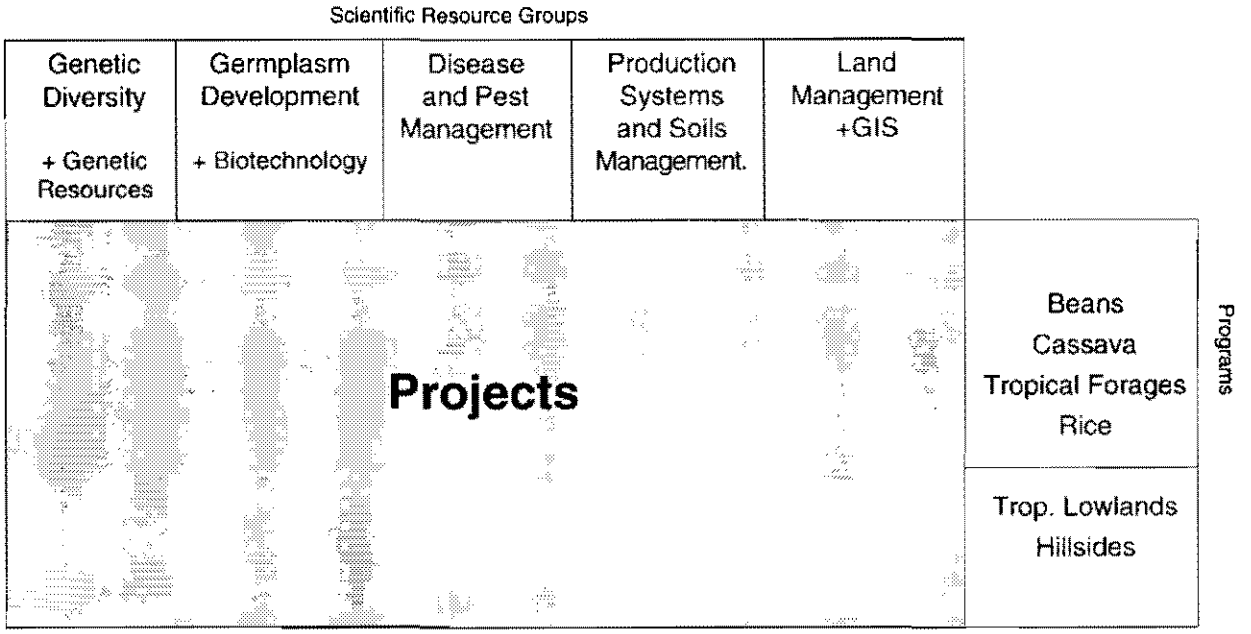
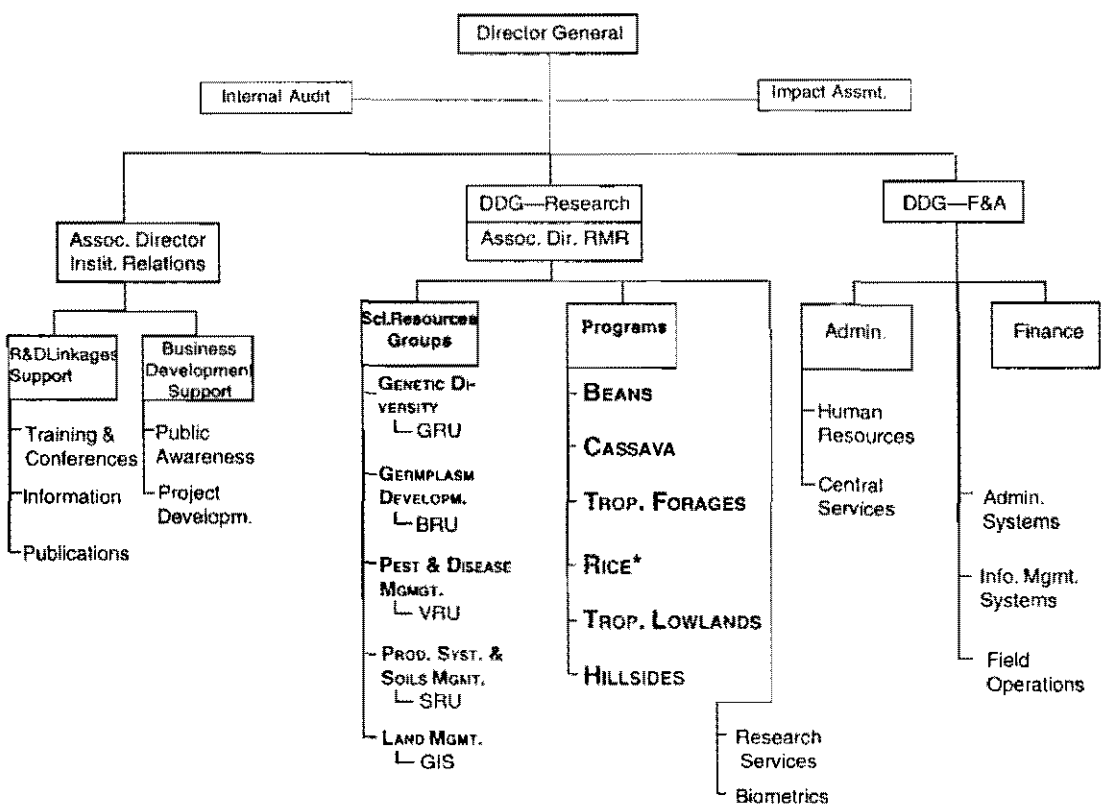


Figure 2. CIAT Organizational Chart



*Through 1994 as a program funded with core (and complementary) funds. Core funds will be used after 1994 for rice projects focused on blast (lowland and upland) and on upland rice. Other lowland rice activities of high regional priority will be funded with complementary funds.

II. Program Highlights

Beans

The Bean Program has a central objective of ensuring that national programs in sub-Saharan Africa, Latin America, and the Caribbean have access to the full range of genetic diversity—27,000 accessions—in CIAT's germplasm collection. National programs often cannot afford to test all these materials, so they rely on CIAT to provide entries with desired traits.

In 1993 a bean core collection of 1,400 entries, representing the genetic variation of the entire CIAT collection, was completed and fully characterized, using RAPD markers and phenotypic data. It was distributed to six countries in Latin America and sub-Saharan Africa.

The Bean Program also wants to give the world scientific community access to useful genes in wild *Phaseolus vulgaris* accessions and their relatives. The success of the arcelin gene is evidence of the usefulness of wild genetic material. It was found in a wild accession from Mexico, and conveys resistance to the Mexican bean weevil. RAPD markers were used to define groups within the *P. vulgaris* collection that are distinct at the molecular level. Recombinant types were found, suggesting natural gene flow between wild and cultivated forms, and among gene pools. Molecular data are now being matched with agroecological data to map the distribution of wild *P. vulgaris* diversity, using GIS to determine areas for future collection, or in situ conservation, or both.

Low phosphorous availability is a common constraint in most bean production regions. We evaluated the bean core collection for low P tolerance at two sites in Colombia. Germplasm from the Chiapas gene pool in Mexico, and from the highland gene pool in Peru, showed significantly greater levels of tolerance to low P than other genotypes. A larger group of accessions from these two gene pools is now being tested to identify the extent and levels of low P tolerance.

The Bean Program is devolving the coordination and management of regional bean research networks to national programs. In 1993, we successfully transferred guidance of the Central American and Caribbean bean research network (PROFRIJOL) to national programs. But network participants still request intensive inputs and advice from CIAT headquarters. Devolution does not necessarily reduce CIAT's workload.

Funding has been secured for the third phase of the bean research networks in the Great Lakes region of Africa (RESAPAC) and in the Andean Region (PROFRIZA). About $1 million goes to each network for 3 years, enabling the devolution of both networks to national programs.

A 5-year bilateral project for bean improvement in Malawi has been funded by ODA at a total of 1.04 million pounds sterling. This project allows CIAT to maintain one breeder in Malawi, who will provide significant support to the Southern Africa regional network. This network is now formally sponsored and cofunded by SACCAR, and supported by CIAT through the regional network in eastern Africa, which is funded by CIDA and USAID.

Cassava

Cassava is the single most important crop in sub-Saharan Africa; per-capita production exceeds 100 kg/year in 18 of 31 countries. Cassava production increased at an annual rate of 3.2% from 1981 through 1991—faster than population growth. The crop's adaptation to low fertility and drought explains this growth. Drought tolerance enables cassava to contribute greatly to food security in Northeast Brazil and the drier areas of southern and eastern Africa. Cassava cultivation seems to be extending into the northern, sub-Sahelian regions of West Africa.

But genetic diversity in sub-Saharan Africa is far narrower than in the Americas. Brazilian research programs, IITA, and CIAT are developing germplasm adapted to the biotic and abiotic stresses of drier ecosystems. This joint project is funded by IFAD. Materials selected at four sites in Northeast Brazil were recombined and sent in 1993 to IITA as 10,000 F1 true seed. Seed lines from these materials look promising in field trials at Kano, in the dry savanna of northern Nigeria.

Superior performance in advanced yield trials of 33 clones from CIAT indicates that germplasm adapted to drier areas in Latin America has great potential in sub-Saharan Africa. We are currently preparing a proposal to extend this project to other regions of Africa and to the northern coast of Colombia, where drought is severe.

Pest control measures must be integrated with cultural practices to enhance cassava's biotic and abiotic environment thus realizing the potential of improved germplasm in marginal conditions. Two major projects were begun in the last 15 months: an integrated pest management project in Northeast Brazil, funded by UNDP; and an integrated crop and soils management project in Southeast Asia, funded by the Sasakawa Foundation.

The IPM project is introducing parasites and predators for biological control, evaluating resistant varieties, and testing cultural and sanitation practices for managing pest and disease complexes in the seasonally dry and semiarid regions of Northeast Brazil. A principal challenge is to involve farmers and processors in participatory research, using their knowledge to set priorities, and to evaluate and implement solutions. CIAT headquarters supports a major training effort to give extensionists and researchers the skills to diagnose pest problems and evaluate technology with farmer participation.

The integrated crop and soils management project in Southeast Asia builds on 5 years of collaborative research with national programs. This has produced a range of technology options for maintaining soil fertility and controlling erosion in cassava-based systems. As in IPM, the challenge is to involve farmers in the evaluation, selection, and adaptation of the most promising technologies. Research planning has begun in pilot study areas in China, Indonesia, Thailand, and Vietnam. CIAT headquarters provides support in economics, participatory research, land use characterization, and training of trainers.

Construction of a molecular linkage map for cassava has progressed significantly. The map is being drawn from F1 segregation data on RFLPs and single-dose polymorphisms of RAPD markers. The work uses an F1 population of 90 plants derived from a cross between two elite cassava lines; Nigeria 2 is resistant to the African Cassava Mosaic Virus, and ICA Cebucan has high photosynthetic rates. Eight linkage groups have been identified. We expect the first map framework to be available in late 1994. The map will allow us to

introgress more efficiently specific chromosomes fragments from exotic germplasm into various genetic backgrounds, and locate genes for cassava improvement.

Developing a transformation protocol for cassava has advanced well. Genomic analysis of 6-month-old cassava plants confirmed the presence of both NPT II and GUS foreign genes introduced through this transformation protocol. These developments place CIAT in the world forefront of cassava transformation.

More than 130 scientists from 20 countries attended an international meeting on cassava flour and starch, organized in collaboration with CIRAD-SAR, and held at CIAT in January 1994. Papers dealt with current and potential end uses of cassava, its physico-chemical properties, bioconversion and byproduct use and treatment, new products, and the results of integrated production, processing, and marketing projects.

Rice

Of the 239 rice varieties released in Latin America and the Caribbean since 1967, 89 were derived from CIAT germplasm, mainly for irrigated lowlands. In 1992-93, 65% of all varieties released in the region were based on CIAT-derived germplasm. Several promising lowland rice lines will be released as varieties through CORPOICA and FEDEARROZ in Colombia, and ICTA in Guatemala.

A 3-week training workshop was organized to share CIAT's anther culture protocol with 20 scientists from 10 institutions in 8 countries. Anther culture lines are now being evaluated by several national programs, particularly in the Southern Cone.

After the decision to cease core funding for CIAT's irrigated/lowland rice program in 1994, we began intensive consultations with CORPOICA and FEDEARROZ in Colombia, and with national programs in Venezuela, Brazil, Peru, Ecuador, and the Southern Cone. Our partners showed a strong preference for a cofunded project governed by the participating institutions, which would work on breeding for durable blast and sheath blight resistance and continued development of improved gene pools with desirable traits—highest priority research topics in irrigated rice. CIAT was asked to develop a project proposal. At this stage, it would be premature to judge the feasibility of starting the project, with full regional funding, by the end of 1994. We seek to exploit the synergies of national programs, rice producer organizations, and CIAT.

In upland rice, after the release of Oryzica Sabana 7 in Colombia, another CIAT line was released as Progresso in Mato Grosso, Brazil, where 600,000 ha of rice are grown yearly. Seed of Progresso are being multiplied; more than 3,000 ha will probably be sown next season.

Adoption studies show that subsistence farmers on Colombia's north coast are enthused about Oryzica Turipana 7, the upland rice variety that ICA released in 1993. Bolivia released a line from a similar cross as SACIA-1; another is ready for release in the Brazilian Amazon.

Obtaining durable resistance to the many races of rice blast disease remains the main challenge of lowland and upland rice breeding. Collaborating with Purdue University and IRRI, CIAT has progressed well in characterizing the genetic structure of blast, particularly

the numerous races found in Colombia. Screening, identifying, and tagging resistance genes using molecular markers has also advanced.

Results in 1994 support the hypothesis that the blast races' ability to accumulate virulence is limited. None of the 400 blast isolates so far tested has combined virulence that can overcome all the resistance genes in the CIAT gene pool. Accumulating these genes should give durable resistance. Thus, a second cycle of recurrent selection was completed in a population specially designed to pyramid different blast resistant sources. Extracted lines are being multiplied. They will be sent to IRRI, WARDA, and national programs in the LAC for evaluation under widely different blast populations.

We identified four new resistance sources to rice hoja blanca virus (RHBV) and are using them to broaden the genetic base of resistance. We have selected and regenerated rice plants transformed for resistance to hygromycin, an antibiotic marker. We transformed these plants using a microparticle acceleration method, and will test them for incorporation of selected RHBV sequences and for expression of viral gene proteins that were introduced. We will then test transformed plants for RHBV resistance.

In March 1994, the 9th Latin American and Caribbean Rice Conference organized by CIAT, IRRI, and EMBRAPA, was held at Goiania, Brazil. This conference, attended by 400 scientists from the region's important rice areas, is held every 2 or 3 years and remains the only regional forum for rice research discussion. Participants called for CIAT's continued involvement in developing the research project on irrigated/lowland rice.

Tropical Forages

CIAT's Tropical Forages Program is collecting and making available to national programs and farmers a genetically varied array of more than 100 species. The program seeks diverse germplasm with high forage potential plus other attributes that help sustain productivity in tropical farming systems such as ability to contribute to nutrient cycling, increased organic matter, and carbon sequestration in acid soils.

In 1993 the program began studies on the genetic diversity of the CIAT germplasm collection to plan in situ and ex situ conservation and use of the germplasm. Isoenzyme reaction showed that 294 of the 300 accessions of *Stylosanthes capitata* in our ex situ collection were unique. A joint project for in situ and ex situ conservation of promising *Arachis* species is being developed by ICRISAT, CENARGEN/EMBRAPA, and CIAT.

ILCA, CSIRO, and CENARGEN participated in a CIAT workshop on the genetic resources of tropical forages. This resulted in the formation of an international network for conservation and distribution of forage germplasm. The network has two main objectives. First, to link all institutions working with forages genetic resources and willing to make these resources internationally available. Second, to develop a standardized information network easily accessible to the world scientific community.

In 1990 we began a project to introduce elite forage germplasm to Southeast Asia. Selected grasses and legumes are now being evaluated in on-farm trials in the Philippines, Indonesia, Malaysia, and Thailand. We plan trials in Laos, Vietnam, and southern China in 1995. Regional network funding is precarious, so we are consulting with ILCA on the

possibility of including the Southeast Asian forages network in ILRI's global feed resources initiative. CIAT would continue coordinating the network.

Forage germplasm from CIAT has shown promise in eight West African countries. Germplasm evaluation has been brought into the ILCA-sponsored Pan-African feed resources network.

Spittlebug resistant gene pools of *Brachiaria* will be ready for regional evaluation by national programs within 2 years. A gene conferring apomixis in *Brachiaria* has been conditionally marked. The goal is to fine map the apomixis gene to improve efficiency in *Brachiaria* breeding, eventually cloning and transferring it to other crops.

Progress has been substantial in understanding the epidemiology of anthracnose in *Stylosanthes guianensis* and in its molecular characterization. This work is cofunded and carried out jointly with EMBRAPA and CSIRO. Advanced breeding program lines continue to show stable resistance to anthracnose. Associated with *Brachiaria*, these lines have increased milk production by Friesan-cross cows at Quilichao, Colombia, from 5 to 8 l/day, or more than 50%.

Hillsides

SDC funding of the hillsides project in Central America has allowed the Program to expand from three to five senior staff positions. The new positions are for a soils specialist and a resource economist in Central America. Financial support from DANIDA has added an anthropology postdoctoral fellow at CIAT. The first official meeting of the Central American project was held in May 1994 with representatives from IARCs and regional and national partner institutions. Research priorities were set and a 6-month workplan outlined.

A case study in the eastern hillsides of Honduras showed that itinerant agriculture is more sustainable than previously thought. Colonization of forested hillsides by migrants, practising shifting cultivation with legume cover crops, was found to sustain productivity for as long as 20 to 80 years within the same rotational fallow system. Forest-to-pasture conversion in steep hillsides seems due to low or declining productivity of lowland dairy farming.

A central issue of resource management in the hillsides is whether human pressure on land use irreversibly changes the soil's productivity potential. Maximum yield trials, using beans, maize, and cassava as indicator crops, were planted across six hillside land uses, ranging from 40-year-old secondary forest to intensively cropped cassava land. Results indicate that fertilizer application can correct soil degradation due to harmful cropping practices.

Research on farmers' indicators of soil regeneration showed that earthworms were a widely used indicator in the study site. Soil macrofauna were surveyed, modelled on research conducted in the Colombian Llanos. The lowest biodiversity of macrofauna was found in the intensively cultivated bean-maize-cassava land use form. Cassava is often the last crop in the rotation before fallow.

Simulation modelling over a 35-year horizon was used to assess the effects of improved hillsides practices. Regional benefits are estimated at $380 million for erosion control and $280 million for improved fallow.

Tropical Lowlands

Scientists in the Tropical Lowlands and Tropical Forages Programs documented how grasses and legumes, adapted to acid soils, contributed to carbon sequestration in the tropics. Soil organic matter was measured in pastures of deep-rooted adapted species at Carimagua and on farms in the Colombian llanos. They had 28 to 70 tons per hectare more carbon in soil organic matter than the native savanna.

Grass-legume associations gave better animal performance and carbon sequestration than improved grasses alone. Furthermore, the quality of organic matter was superior in grass-legume associations. The quantity and diversity of microfauna appear to be a good indication of nutrient availability in the soil. Total macrofauna populations, particularly of earthworms, were 4 to 4.5 times higher in the grass-legume pastures than in the native savanna or even gallery forest sampled. The macrofauna biodiversity was also much greater.

III. Financial and Budgeting Information

For details of the financial years 1992, 1993, 1994, and the 1995 funding request, see Tables 1 to 13 in Appendix 2.

1993 Financial Year

Core Program

The CGIAR core funding for CIAT was US$25,262,000 for the 1993 fiscal year. Adjusted for inflation (the CIAT inflation was 7.53% between 1992 and 1993), this was $2 million, or 13%, below the income received from the CGIAR in 1992. This reduction was somewhat mitigated by an increase in self-generated income ($2.27 million in 1993 versus $1.19 million in 1992). CIAT dealt with this reduced funding by cutting down its support staff (8.3% or 112 positions), delaying recruitment of senior staff for vacant positions, and downsizing the administrative and service infrastructure.

Operating expenditures. Total operating expenses were $28,553,000, which included $1,450,000 for cessation payments to departing junior staff. Compared with 1992, operating expenditures by area of expenditures were as follows (all amounts are expressed in 1993 U.S. dollars):

Area	1992	1993	Percent change
Research and Research Support	19,440,000	19,852,000	+2.1
Institutional Development Support (without Seed Unit)	2,408,000	2,354,000	-2.3
Management, Administration, Central Services	6,483,000	6,347,000	-2.1

Capital expenditures. The Capital Fund is annually credited with the annual depreciation charge, which, in 1993, was $1,809,000. Capital expenditures are financed out of the Capital Fund and consisted of $2,377,000 for new capital and $1,012,000 for replacement capital. At the end of the year, the balance of the Capital Fund was $2,536,000.

Earned income. Self-generated income amounted to $2,272,000. The primary source of this income was from CIAT's Colombian peso investments.

Donor funding. Actual income from CGIAR donors was $25,262,000. Taking into account self-generated income, total available funds for the 1993 core program were $27,534,000.

Operating fund balance. With total income amounting to $27,534,000, and expenditures of $28,553,000, a deficit of $1,019,000 was registered, which was charged to the Operating Fund. The balance of that Fund at the end of the year was $2,926,000.

Complementary Activities

In 1993, complementary activities amounted to $4,788,000 (see Table 2, Appendix 2). List 1 (shown at end of section) identifies the various projects involved.

1994 Financial Year

A summary table (Table 3.1 at the end of section) shows the 1994 working budget for core and complementary activities, and the corresponding estimates for 1995.

Prospects for the Year

While the Board-approved budget for 1994 requires core funds of US$33,461,000, the funding realities in the CGIAR are such that CIAT may expect to receive $24,250,000.[1] Together with the expected self-generated income of $1,500,000, total available resources are estimated at $25,748,000. When adjusted by the inflation experienced by CIAT, this is almost exactly 4 million dollars below the levels of 1993.

In view of such a significant shortfall, the Board of Trustees approved, in late 1993, an Action Plan which provides a basis on which CIAT can fulfill its mission within the limited financial resources expected for 1994. The definition and organization of projects that resulted from implementing the Action Plan are described in Chapter IV.

As shown in Table 1 (Appendix 2), the requirements for executing the entire research program as described in Chapter IV are $25,750,000 for core, and $7,030,000 for complementary funding. To the core budget must be added $2.0 million for costs of phasing out activities in 1994. The 1994 income is projected to be equivalent to the budget base, thus leaving a one-time deficit equal to the phase-out costs of $2.0 million. The Center, however, is making a determined effort to underspend the working budget of $25,750,000 where possible (e.g., through late recruitment for vacant positions) to reduce the projected deficit as much as possible. This, together with planned underspending of the capital budget, is expected to keep the Center's income in line with expenditures for the entire financial year.

Working Budget

Operating expenditures. The working budget calls for operating expenditures of $24,150,000, plus $1,600,000 of depreciation charges (see immediately below)[2]. This budget includes 67 core-funded senior staff positions (down from 79 in 1993) and 1,028 support staff (down from 1,225 in 1993--see Table 9 in Appendix 2).

[1] At the end of June 1994 the CGIAR Secretariat indicated that CIAT might receive the amount recommended at the ICW94, i.e., $25,000,000. However, this information may not be confirmed until September or October of 1994.

[2] In addition to the Working Budget, $2,000,000 are set aside for phase-out costs of selected activities.

Capital expenditures. Capital expenditures for the year will be financed from the Capital Fund created from the annual depreciation charge. This depreciation charge in 1994 is expected to be about $1.6 million. (As mentioned above, a current strategy is to forcibly lower the depreciation charge in order to bring expenditures in line with expected income.)

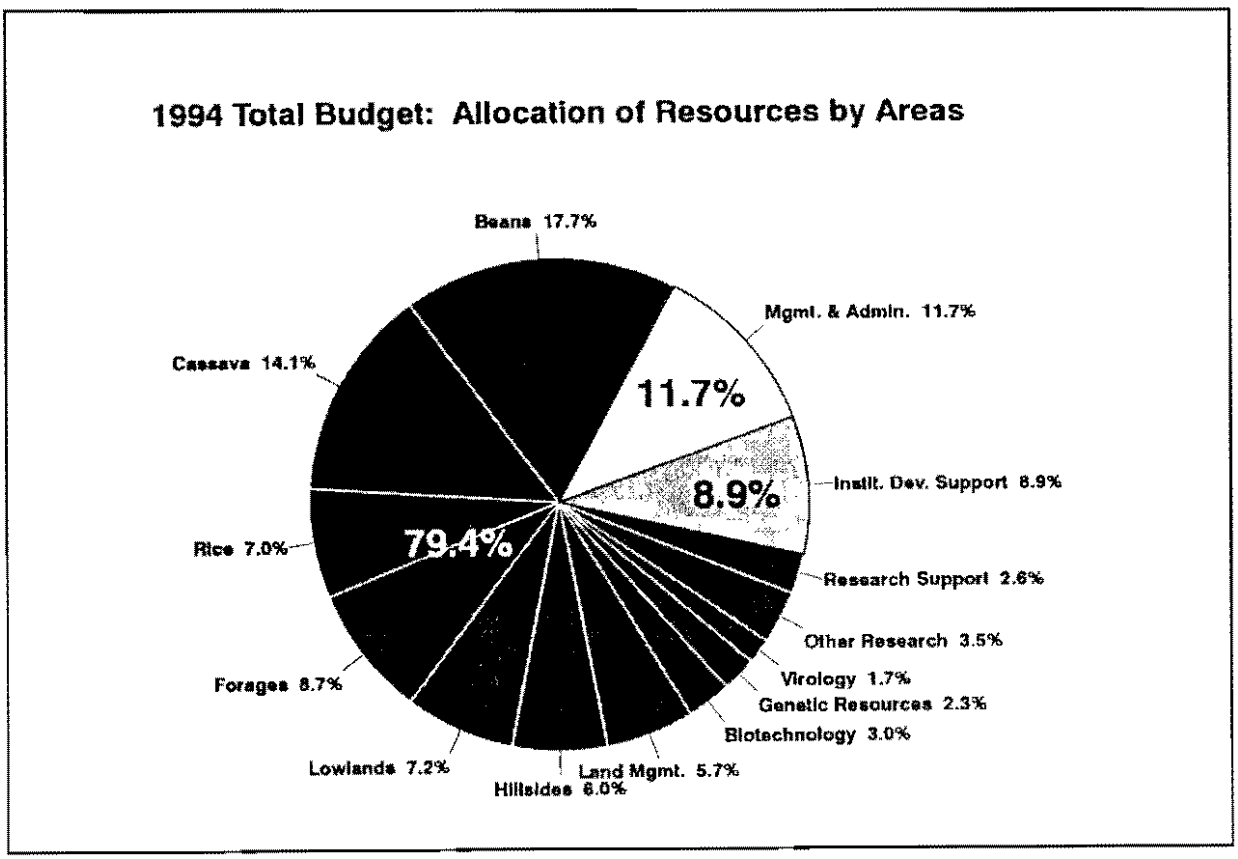
Complementary Activities

In 1994, CIAT expects to spend $7,030,000 on complementary activities (Table 2, Appendix 2). These activities are further described in the project structure and identification presented in Chapter IV.

Funding Request for 1995

As shown above, CIAT's expenditures in 1994 are expected to be US$25,750,000, which is insufficient to pursue the Center's operational mandate. In fact, we would argue that the minimum amount required to implement the TAC-endorsed MTP is $27,500,000 expressed in terms of 1992 dollars, or about $32,000,000 in 1994 dollars. In view of continuing revaluation of the Colombian Peso, this translates into a funding requirement for 1995 of US$34,000,000.

Nevertheless, CIAT realizes that a funding request of $34,000,000 for core activities is unrealistic under present CGIAR funding scenarios. The Center has made every effort to



implement its Action Plan (see Chapter I) with a budget of $27,500,000 for 1994, or $29,150,000 in terms of 1995 dollars (adjusted for inflation and revaluation of the Colombian Peso).

CIAT is presenting a 1995 funding request of $27,500,000 in 1994 dollars, but requests that the CGIAR recognize that the local inflation rate—brought about by the continuing strong revaluation of the Colombian Peso—is projected to be at least 6.0% during 1994-95. This would raise CIAT's funding request to $29,150,000 in 1995 dollars.

Chapter IV of this document summarizes all CIAT project activities taking place in in 1994 and projected for 1995. As shown in Table 3.1, total requirements for core in 1995 amount to $28,250,000 in 1994 dollars. Subtracting our estimate of self-generated income ($750,000) gives the amount of core resources required from the CGIAR: $27,500,000 in 1994 dollars.

Relabelled Activities

In this budget request, we have included $1,250,000 of "relabelled" activities that were previously classified as "complementary." These activities are as follows:

1) **Project BA12: Collaborative bean research network for Eastern Africa (EABRN)** $840,000

Justification: CIAT's involvement in bean research for Africa was originally funded under a special project. Even so, much of the Center's work there was simply an extension of the core-financed research CIAT carries out in other bean-growing regions of the world. If we relabel a larger portion of the CIDA-funded bean work in Africa, a total of 88% of the Center's work on beans in Africa will be considered "core." The remainder will consist of money channeled through CIAT for use by national programs in the region.

2) **Project CI11: Ecologically sustainable cassava plant protection in South America and Africa** $410,000

Justification: This covers the CIAT-executed portion of a UNDP-funded project designed to develop and implement sustainable plant protection systems that will enable small-scale cassava producers to increase yields and reduce pesticide use. CIAT believes this portion of the work is fully within the domain of its core-type activities. In fact, in earlier versions of the MTP, and with the full participation of UNDP, CIAT consistently proposed that this portion of the project be included in core.

New or Redirected Activities

The funding request of $27,500,000 (1994 dollars) includes $2,450,000 for activities that are newly funded or were previously classified as complementary but could be redirected to form part of CIAT's core program. These activities are as follows:

A. New Sources for Core Activities

1) **A new restricted core contribution from the Colombian Government** $1,200,000

Justification: At the end of July 1994, the Colombian Government announced its intention to contribute to the core budget of CIAT starting in 1994. This contribution is restricted in the sense that it will have to be spent on specific projects already included in CIAT's core budget.

2) **Project NT12: Training in resource management** $170,000

Justification: CIAT has submitted a training project proposal to the Inter-American Development Bank with expected 1994 expenditures amounting to $463,000. Of this amount, $170,000 is for training undertaken by CIAT itself; the rest is for joint training activities with other institutions in the region. In the workplan financed by core, CIAT eventually needs to include a minimum amount for training in resource management. We believe that $170,000 is adequate for this purpose. There is a high probability that the training project will be financed by IDB retroactive to 1 January 1994.

3) **Project HC11: Hillsides, Central America** $500,000

Justification: This project was recently approved by the Swiss Government for financing and is now being implemented. In designing the project and fine-tuning its work plan earlier this year, CIAT worked hard to make the project an integral part of the Center's resource management research. As it stands the project has every characteristic of a core-type activity.

B. Redirected Activities

1) **Projects RP11, RP13, VP13: Rice biotechnology** 150,000

Justification: CIAT receives special project funding from the Rockefeller Foundation for a series of biotechnology projects (mostly on rice). These activities are generally of an exploratory nature. They involve the use of such tools as anther culture for rice improvement, DNA fingerprinting and RFLP markers to develop durable resistance to rice blast, and genetic transformation for resistance to the hoja blanca virus. The results have convinced us that it is worthwhile, even necessary, to make the exploration of new biotechnology tools a core activity. The Center therefore proposes that Rockefeller Foundation money be added to CIAT's core budget.

2) **Projects FD12, FS13, FS14: Forage development in Asia**.....$190,000

Justification: This Australian-supported work anticipates forage development activities that CIAT's MTP proposes be initiated in 1996. CIAT wishes to consolidate the present special project activities, recasting them in the form of an early (1994) version of the forage development work in Asia, as proposed in the MTP.

3) **Project CI12: Improving agricultural sustainability in Asia: Integrated crop-soil management for cassava-based production systems**.....$240,000

Justification: This project, funded by the Sasakawa Foundation in Japan, could be redesigned to de-emphasize development, training, and networking and orient the work more toward research and technology development. With these changes, the project will be an extension into Asia of CIAT's resource management work for Latin America.

Table 3.1 shows the proposed deployment of financial resources expected to be available in 1995 ($27,500,000 in 1994 dollars from the CGIAR and $750,000 from self-generated income).

Operating vs. Capital Expenditures

Operating expenditures amount to $26,650,000, while the depreciation charge in 1994 is expected to be about $1,600,000. Unfortunately, this does not allow for upgrading existing capital infrastructure or even expanding CIAT's capital endowment, as would be required under normal circumstances.

Complementary Activities

As shown in Table 3.1, expected complementary activities in 1995 will amount to $4,558,000.

Table 3.1 Working Budget for 1994, and Estimated (Request) Budget for 1995. (In current U.S. dollars)

Program/Area	Working budget 1994					Estimated 1995				
	Core		Complementary			Core		Complementary		
	SYs	Amount	SYs	Amount	Total	SYs	Amount	SYs	Amount	Total
Beans	**15**	**4,552**	**2**	**1,249**	**5,801**	**15**	**4,552**	**2**	**1,154**	**5,706**
Phaseolus Diversity	1.5	485	-	-	485	1.5	485	-	-	485
Yield Stability	3.8	1,138	-	232	1,370	3.8	1,138	-	4	1,142
Sustaining Bean Productivity in Latin America and the Caribbean	2	758	1	355	1,113	2	758	1	395	1,153
Sustaining Bean Productivity in Sub-Saharan Africa	7.7	2,171	1	662	2,833	7.7	2,171	1	755	2,926
Cassava	**12**	**3,592**	**1**	**1,028**	**4,620**	**12**	**3,592**	**1**	**789**	**4,381**
Manihot Genetic Diversity	1.6	587	-	112	699	1.6	587	-	-	587
Improved Cassava Gene Pools	4	1,262	-	54	1,316	4	1,262	-	24	1,286
Integrated Crop Management	4.9	1,184	-	340	1,524	4.9	1,184	-	331	1,515
Cassava Markets	0.6	218	-	172	390	0.6	218	-	116	334
Institutional Development	0.9	341	1	350	691	0.9	341	1	318	659
Rice	**4.7**	**2,044**	**-**	**240**	**2,284**	**3.7**	**1,944**	**-**	**150**	**2,094**
Lowland Rice Improvement	1.8	606	-	145	751	1.5	581	-	85	666
Upland Rice Improvement	1.2	491	-	38	529	1.0	466	-	20	486
Reducing Losses to Rice Pests	1.7	947	-	57	1,004	1.2	897	-	45	942
Tropical Forages	**9.3**	**2,711**	**-**	**130**	**2,841**	**9.3**	**2,711**	**-**	**9**	**2,720**
Forages Diversity	2.6	698	-	20	718	2.6	698	-	-	698
Forage Improvement	2.9	919	-	9	928	2.9	919	-	9	928
Forage for Acid Soils	3.8	1,094	-	101	1,195	3.8	1,094	-	-	1,094
Tropical Lowlands	**6.4**	**2,025**	**1**	**346**	**2,371**	**6.4**	**2,025**	**1**	**341**	**2,366**
Brazilian Cerrados	2.5	686	-	79	765	2.5	686	-	94	780
Colombian Llanos	1.4	615	-	81	696	1.4	615	-	47	662
Forest Margins	2.5	560	1	186	746	2.5	560	1	200	760
Interprograms	-	164	-	-	164	-	164	-	-	164
Hillsides	**5.6**	**1,521**	**-**	**429**	**1,950**	**5.6**	**1,521**	**-**	**370**	**1,891**
Sustainable Agriculture for Andean Participatory Research	1.6	594	-	210	804	1.6	594	-	151	745
	1	256	-	219	475	1	256	-	219	475
Sustainable Agriculture for Central America	3	671	-	-	671	3	671	-	-	671
Biotechnology	**3**	**686**	**-**	**282**	**968**	**3**	**686**	**-**	**282**	**968**
Molecular Characterization and Analysis of Genetic Diversity	1	226	-	90	316	1	226	-	90	316
Biochemical and Molecular Characterization of Plant Adaptation to the Environment	1	177	-	90	267	1	177	-	90	267
Gene Transfer and conservation of Genetic Diversity	1	283	-	102	385	1	283	-	102	385

(Continued)

Table 3.1 Working Budget for 1994, and Estimated (Request) Budget for 1995. (In current U.S. dollars)

Program/Area	Working budget 1994					Estimated 1995				
	Core		Complementary			Core		Complementary		
	SYs	Amount	SYs	Amount	Total	SYs	Amount	SYs	Amount	Total
(Continued)										
Virology	**2**	**543**	**-**	**-**	**543**	**2**	**543**	**-**	**-**	**543**
Characterization of Plant Viruses	1.1	309	-	-	309	1.1	309	-	-	309
Control of Plant Viruses Affecting CIAT's Mandate Commodities	0.9	234	-	-	234	0.9	234	-	-	234
Genetic Resources	**-**	**757**	**-**	**-**	**757**	**1**	**857**	**-**	**-**	**857**
Land Management	**5**	**1,408**	**-**	**475**	**1,883**	**5**	**1,408**	**-**	**-**	**1,408**
Impact Assessment	**1**	**382**	**-**	**60**	**442**	**1**	**382**	**-**	**-**	**382**
Research Management	**2**	**426**	**-**	**-**	**426**	**2**	**426**	**-**	**-**	**426**
Scientific Resources Groups	**-**	**112**	**-**	**-**	**112**	**-**	**112**	**-**	**-**	**112**
Strategic Research Initiatives	**-**	**107**	**-**	**-**	**107**	**-**	**107**	**-**	**-**	**107**
Visiting Scientists	**-**	**56**	**-**	**-**	**56**	**-**	**56**	**-**	**-**	**56**
Total Research	**66**	**20,922**	**4**	**4,239**	**25,161**	**66**	**20,922**	**4**	**3,095**	**24,017**
Research Support	**1**	**865**	**-**	**-**	**865**	**1**	**865**	**-**	**-**	**865**
Research Services	-	97	-	-	97	-	97	-	-	97
Field Operations	1	184	-	-	184	1	184	-	-	184
Carimagua	-	366	-	-	366	-	366	-	-	366
Information Management	-	218	-	-	218	-	218	-	-	218
Institutional Relations	**5**	**2,627**	**-**	**293**	**2,920**	**5**	**2,627**	**-**	**463**	**3,090**
Management and Administration	**4**	**3,836**	**-**	**-**	**3,836**	**4**	**3,836**	**-**	**-**	**3,836**
Board of Trustees	-	258	-	-	258	-	258	-	-	258
Central Administration	4	2,078	-	-	2,078	4	2,078	-	-	2,078
Central Services	-	1,500	-	-	1,500	-	1,500	-	-	1,500
Subtotal	**76**	**28,250**	**4**	**4,532**	**32,782**	**76**	**28,250**	**4**	**3,558**	**31,808**
Price Increase	-	-	-	-	-	-	1,650	-	-	1,650
Total	**76**	**28,250**	**4**	**4,532**	**32,782**	**76**	**29,900**	**4**	**3,558**	**33,458**

List 1. Complementary activities in 1993 ('000 US$).

Activity	Senior Staff	Expenses	Donor
1. *Bean Program*			
Eastern, southern, and Great Lakes Region of Africa	4	1,109	USAID/CIDA/SDC
Andean region	1	367	SDC
Central America Network	-	137	SDC
Research on *Phaseolus* germplasm	-	54	Italy
Genetic improvement	-	168	Belgium
Bean improvement	-	44	Iran
IPM development system	-	62	IDRC
Competition and survival of *Rhizobium*	-	29	BMZ/GTZ
Improvement of chilling tolerance	-	7	BMZ/GTZ
Visiting scientist	-	92	SDC
International workshop on beans	-	29	BMZ/GTZ
Microbiology	-	46	Various
2. *Cassava Program*			
Development of cassava germplasm	-	2	IFAD
Development of production and processing technologies (NE Brazil)	-	100	Kellogg Foundation
Development of cassava in Ecuador	1	72	FUNDAGRO
Cassava processing in Colombia	-	133	IDRC
Cassava flour utilization	-	42	France
Cassava molecular mapping	-	108	Rockefeller Foundation
Physiology research	-	44	Australia
Biological control of cassava mite	1	271	UNDP
Cassava biotechnology network	1	228	Netherlands
Cassava Asia	1	156	Japan
Cassava - effects of phosphorous	-	56	France
Importance of *Neosiulus idaeus*	-	18	BMZ/GTZ
Control of cassava pest	-	58	DANIDA
Field testing of improved cassava fluor	-	11	NRI
Development of rapid assay	-	6	NRI
3. *Rice Program*			
Rice biotechnology research	-	161	Rockefeller Foundation
Upland rice improvement project	-	33	France
The impact of public intervention	-	30	Italy
Pilot linkage program	-	3	USDA
4. *Tropical Forages Program*			
CSIRO forage seeds - Asia	1	115	Australia
Legume selectivity by grazing animals	-	37	SDC

(Continued)

List 1. (Continued.)

Activity	Senior Staff	Budget	Donor
5. *Forest Margins Program*			
Project identification	-	24	BMZ/GTZ
6. *Hillsides Program*			
Soil conservation	-	125	BMZ/GTZ
Study migration, settlement patterns, and resources management	-	33	Rockefeller Foundation
7. *Savannas/Lowlands Programs*			
Research for improving native grasslands	1	68	Japan
8. *Genetic resources*			
Taxonomic revision of species	-	10	ODA
9. *Research Support*			
Farmer participatory research	1	77	Kellogg Foundation
10. *Training and conferences*			
Training trainers	-	300	IDB
Training materials	-	98	ISNAR
12. *Capital and replacement*	-	225	CIDA/USAID/IDB/IDRC/ Rockefeller/Others
TOTAL	12	4,788	

Bean Project Area BP: *Phaseolus* Diversity

Purpose: To help raise common bean productivity by maintaining, characterizing, and deploying genetic resources

Rationale: The *Phaseolus* collection at CIAT is one of the best collections in the world. These materials represent the biodiversity of the genus, which is the evolutionary consequence of interactions between species and the diverse and changing biotic and abiotic environments they occupy.

To use the germplasm more efficiently, we need to better define the genetic structure of common bean (*Phaseolus vulgaris*) and related species, using biochemical and molecular markers to complement conventional ecogeographic and agromorphological assessments.

Phaseolus genetic resources are essential for continued genetic improvement of common bean. To ensure that the collection can be distributed and used efficiently requires that we use appropriate techniques to conserve the germplasm, evaluate it thoroughly, and document the results.

Benefits: This project benefits bean farmers and consumers by better enabling researchers to exploit the genetic potential of *P. vulgaris* for overcoming major constraints of production and consumption.

Research Partners: IFPRI, MINSALUD, University of Gembloux (Belgium), WHO, various national research institutes

Project BP01: *Phaseolus* Conservation

Purpose: To preserve, update, and document the world genetic collection of *Phaseolus* beans

Output and activities:

- Safely conserved germplasm of *Phaseolus*, including the five cultivated species and their wild relatives
  - Update and manage the collection to ensure that seed quality and quantity are optimal for short- and long-term conservation.
  - Improve current conservation techniques.
  - Document genetic variation within the collection, using modern techniques for data management and analysis.
  - Make the germplasm available to researchers in national and international organizations.

Senior staff:

Germplasm specialist	0.15
GRU bean curator	1.00
Total	1.15

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BP01	*Phaseolus* Conservation	15	34	49	15	34	49
	Total	**15**	**34**	**49**	**15**	**34**	**49**

Project BP02: *Phaseolus* Genetic Structure

Purpose: Characterize the genome of common bean

Output and activities:

- A better understanding of the genetic structure of cultivated and wild gene pools of *P. vulgaris*
  - Characterize the bean genome, using a combination of morphoagronomic and molecular techniques.
  - Map RFLP and RAPD probes from diverse laboratories on a common population, and develop molecular markers linked to resistance genes or other physiological traits associated with yield and adaptation.

Senior staff:

Germplasm specialist	0.40
Andean breeder	0.10
Mesoamerican breeder	0.10
Pathologist	0.10
Entomologist	0.10
Virologist	0.20
Molecular geneticist	0.30
Total	1.30

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BP02	*Phaseolus* Genetic Structure	80	176	256	80	176	256
	Total	**80**	**176**	**256**	**80**	**176**	**256**

Project BP03: Wild and Cultivated *Phaseolus* Species

Purpose: To use genes from other *Phaseolus* species to improve common bean

Output and activities:

- Information on the genetic value and potential of other wild and cultivated species
  - Determine the potential for using *P. coccineus, P. polyanthus*, and *P. acutifolius* to diversify the common bean genome for resistance to specific constraints.

Senior staff:

Germplasm specialist	0.25
Mesoamerican breeder	0.10
Total	0.35

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
BP03	Wild and Cultivated *Phaseolus* Species	35	80	115	35	80	115
	Total	**35**	**80**	**115**	**35**	**80**	**115**

Project BP04: Bean Utilization

Purpose: To study and improve biological utilization of beans as food

Output and activities:

- Techniques to improve biological utilization of beans as food
  - Determine the digestibility and inheritance of protein variants of *P. vulgaris*, *P. coccineus*, and *P. acutifolius*.
  - Compare diverse bean genotypes for starch digestibility.
  - Evaluate bean germplasm for its potential as a source of minerals and vitamins.
  - Investigate the nutritional implications and genetics of the "hard-to-cook" phenomenon.

Senior staff: Germplasm specialist 0.20

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
BP04	Bean Utilization	20	45	65	20	45	65
	Total	**20**	**45**	**65**	**20**	**45**	**65**

Project Area: *Phaseolus* Diversity

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
Core		150	335	485	150	335	485
Complementary		-	-	-	-	-	-
Total		**150**	**335**	**485**	**150**	**335**	**485**

Bean Project Area BY: Bean Yield Stability

Purpose: To stabilize bean yields by developing gene pools with pest and disease resistance, tolerance to abiotic stresses, and enhanced yield potential

Rationale: Because beans are grown in a wide range of agroecologies, they are subject to numerous biotic and abiotic constraints. They must also possess a great diversity of morphological and cooking qualities to suit the many different practices related to bean consumption.

Diseases and insect pests are major constraints of bean production. In addition to reducing yields, they lower pod and seed quality, raise the cost of production, and compel farmers to use ever greater quantities of pesticides, often creating serious health and environmental hazards. To alleviate biotic constraints is therefore a central objective of our research.

Soil fertility is declining in many bean-based systems, because farmers are expanding production onto marginal soils and shortening fallow periods and because fertilizers are increasingly expensive or not readily available. P deficiency is the single most important nutrient constraint on bean production, resulting from low soil P content or P fixation in weathered soils. There is much scope for overcoming this problem and for improving biological nitrogen fixation.

In rainfed areas moisture stress is the most important cause of unstable bean production. Germplasm with tolerance to water deficit is critical for semiarid tropical regions in northeastern Brazil, north central Mexico, and much of sub-Saharan Africa.

Common bean yields considerably less than other grain legumes, such as soybean and groundnut. Our strategy to increase yield potential is to acquire a thorough knowledge of the genetic and environmental factors affecting yield and then to recombine and select within inter-gene-pool crosses to accumulate genes that maximize yield.

We will also identify the physiological mechanisms of tolerance to low P and drought, which will enable researchers in many developing countries to select more effectively for these traits. These scientists will also be able to target bean lines to specific agroecologies, based on a better understanding of photoperiod and temperature interactions and crop response.

Benefits: Bean farmers and consumers will derive substantial benefits from this research. Specifically, we expect that breeding lines with resistance to bean golden mosaic virus, *Apion* pod borers, and anthracnose will significantly reduce yield losses in Central America. New IPM systems should greatly reduce pesticide use in areas of Latin America where whitefly and leafminers are the major cause of pesticide abuse. Yield potential of major Andean and Mesoamerican cultivars is likely to increase markedly as a result of selected use of inter-gene-pool and interracial crosses that broaden the genetic base of the crop and pyramid important resistance traits.

Research Partners: Bean/Cowpea CRSP, IDRC, various national research institutes, universities, and NGOs

Project BY01: Biotic Stress Resistance

Purpose: To identify, characterize, and incorporate new sources of resistance to biotic stress in common bean and increase resistance stability

Output and activities:

- A broader genetic base of resistance or tolerance to major biotic stresses, which better enables the crop to overcome pathogen variability
  - Identify new sources of disease and insect resistance, determine the mechanisms and inheritance of resistance, and incorporate resistance genes into major bean gene pools.
  - Characterize the genetic diversity of major pathogens and their evolution with bean gene pools.
  - Develop integrated pest and pathogen management practices, using pilot IPM projects to train national scientists and farmers.

Senior staff:

Pathologist	0.60
Entomologist	0.40
Andean breeder	0.20
Mesoamerican breeder	0.20
Virologist	0.30
Total	1.70

Complementary subproject BY51: IPM for small-scale bean farmers

Purpose: To reduce insecticide use by 60-70% through development and transfer of systems for environmentally sound pest management

Research partners: ICA and the Agricultural Secretariat of Antioquia (Colombia), INIAP (Ecuador), INIAA (Peru)

Donor: IDRC

Time frame: 1991-1994

Complementary subproject BY52: Host plant resistance to the major storage pest, *Acanthoscelides obtutus*

Purpose: To reduce bean losses to this pest by identifying resistance factors and devising biochemically based assays that will facilitate the development of resistant varieties

Research partners: NRI (UK)

Donor: ODA holdback

Time frame: 1992-1994

Complementary subproject BY53: Genetics and biochemistry of bean seed protein in relation to bruchids

Purpose: Characterize the arcelin protein and initiate bean transformation using ballistic procedures

Research partners: University of Ghent (Belgium)

Donor: AGCD

Time frame: 1992-1994

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BY01	Biotic Stress Resistance	140	289	429	140	289	429
	Complementary:						
BY51	IPM for Small-Scale Bean Farmers	-	57	57	-	-	-
BY52	Host Plant Resistance to the Major Storage Pest, *Acanthoscelides obtutus*	-	31	31	-	-	-
BY53	Genetics and Biochemistry of Bean Seed Protein in Relation to Bruchids	-	8	8	-	-	-
	Total	**140**	**385**	**525**	**140**	**289**	**429**

Project BY02: Abiotic Stress Tolerance

Purpose: To improve bean tolerance and increase adaptation to abiotic stresses

Output and activities:

- Bean gene pools that are better adapted to soils with low phosphorus, low nitrogen, and high acidity; use water more efficiently; and are tolerant to temperature related stresses
  - Develop genotypes that adapt to low soil P through improved acquisition, greater P-use efficiency, and symbiosis with vesicular-arbuscular mycorrhizal fungi (VAM).
  - Improve biological nitrogen fixation by developing genotypes with better fixing capacity and N-use efficiency, improved *Rhizobium* strains, and simple systems for distributing inoculant.
  - Develop genotypes tolerant to acid soils and/or calcium deficiency.
  - Improve water-use efficiency and adaptation to water deficits.
  - Improve tolerance to high and low temperatures in selected gene pools, such as snap beans, Andean climbers, and Mesoamerican bush types.

Senior staff:

Plant nutritionist	0.60
Physiologist	0.40
Andean breeder	0.20
Mesoamerican breeder	0.20
Total	1.40

Complementary subproject BY54: Effect of phosphorus availability on the efficiency of nitrogen fixation in bean

Purpose: To identify traits responsible for improved nitrogen fixation in low P soils

Research partners: INRA (France)

Donor: INRA

Time frame: 1992-1995

Complementary subproject BY55: Competition and survival of Rhizobium strains and VAM in relation to an improved root system and mineral nutrition in *Phaseolus*

Purpose: To improve bean performance under low nitrogen by identifying competitive Rhizobium strains, making Rhizobium and VAM inocula available, and characterizing the root systems of bean cultivars after inoculation

Research partners: Phillips Universität (Germany)

Source of funds: BMZ

Time frame: 1992-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
BY02	Abiotic Stress Tolerance	140	273	413	140	273	413
	Complementary:						
BY54	Effect of Phosphorus Availability on the Efficiency of Nitrogen Fixation in Bean	-	61	61	-	-	-
BY55	Competition and Survival of Rhizobium Strains and VAM in Relation to an Improved Root Systems and Mineral Nutrition in *Phaseolus*	-	15	15	-	4	4
	Total	**140**	**349**	**489**	**140**	**277**	**417**

Purpose: Increase yield potential and adaptation in common bean

Output and activities:

- Gene pools with improved yield potential, yield stability, and adaptation
  - Identify the physiological and morphological factors that control yield potential in Andean and Mesoamerican gene pools, and develop gene recombination and selection strategies to increase yields.
  - Determine the influence of photoperiod and temperature on yield stability across and within environments to better target genotypes.

Senior staff:

Physiologist	0.40
Andean breeder	0.20
Mesoamerican breeder	0.20
Agronomist (GXE)	0.15
Total	0.95

Complementary subproject BY56: Improvement of cranberry, red Mexican, and great northern common bean cultivars adapted to higher latitudes in Iran, phase 2

Purpose: To improve bean production and strengthen local research capacity through germplasm development and training

Research partners: Iranian bean scientists

Donor: Government of Iran

Time frame: 1991-1994

Complementary subproject BY57: Improving common bean seedling establishment, nitrogen fixation, and yield

Purpose: To evaluate the effect of vitamin compounds on nitrogen fixation by legumes in Latin America

Research partners: La Roche

Donor: F. Hoffman - La Roche Ltd.

Time frame: 1990-1994

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BY03	Improved Yield Potential	95	201	296	95	201	296
	Complementary:						
BY56	Improvement of Cranberry, Red Mexican, and Great Northern Common Bean Cultivars Adapted to Higher Latitudes in Iran	-	35	35	-	-	-
BY57	Improving Common Bean Seedling Establishment, Nitrogen Fixation, and Yield	-	25	25	-	-	-
	Total	**95**	**261**	**356**	**95**	**201**	**296**

Project Area: Bean Yield Stability

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
Core		375	763	1,138	375	763	1,138
Complementary		-	232	232	-	4	4
Total		**375**	**995**	**1,370**	**375**	**767**	**1,142**

Bean Project Area BL: Sustaining Bean Productivity in Latin America and the Caribbean

Purpose: To improve and sustain bean productivity in Latin America by deploying gene pools that help solve major production constraints and by supporting networks for applied research

Rationale: Latin America produces 45% of the world's bean supply and is the leading consumer of this important commodity. The region also contains the crop's two centers of genetic diversity. In tropical America beans are the fourth most important source of protein in the human diet and the sixth most important source of calories. Total demand for the crop appears to be increasing in Latin America at about the same rate as population.

At CIAT we tailor bean gene pools to the requirements of Latin America by developing resistance to the predominant diseases, insects, and edaphic and climatic stresses.

The Center has helped establish networks in Latin America to strengthen national programs through training and other means and to promote the adoption of new technology. As the networks develop, national programs assume increasing responsibility for coordination and training. CIAT continues to support the networks through strategic and applied research.

Benefits: The immediate beneficiaries of this project are national programs in Latin America. The networks provide them with an efficient way to jointly develop, test, and promote new technology and organize training. This greatly increases the payoff of research to farmers. For example, high-yielding bean gene pools with multiple disease and insect resistance will contribute to a significant increase in bean production. Artisan seed production systems will improve farmers' supplies of new varieties. And improved crop management practices, erosion control measures, and IPM systems can make production more stable and sustainable.

Research Partners: Bean/Cowpea CRSP, various national research institutes, universities, and NGOs

Project BL01: Germplasm Improvement (Latin America)

Purpose: To provide improved bean germplasm to the national programs for variety development

Output and activities:

- Improved germplasm for bean variety development in national programs.
  - Characterize bean growing environments, using climatic, edaphic, and biological data, and group the environments according to uniformity of bean genotype response to permit more precise targeting of improved germplasm.
  - Distribute Mesoamerican and Andean germplasm with resistance or tolerance to major constraints among national programs and form regional nurseries for dissemination of elite materials among network partners.

Senior staff:

Agronomist	0.20
Mesoamerican breeder	0.10
Andean breeder	0.10
Total	0.40

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
BL01	Germplasm Improvement	40	165	205	40	165	205
	Total	**40**	**165**	**205**	**40**	**165**	**205**

Purpose: To provide technical support to bean regional networks in Latin America

Output and activities:

- Strong regional networks and activities, with technical support from CIAT
  - Establish ways for network members to assume responsibility for project management through participatory planning, which involves researchers as well as other people working in bean production (e.g., seed specialists, extension agents, and farmers).
  - Participate in network training events, monitoring tours, conferences, and workshops, and design collaborative research projects with national programs.

Senior staff:

Agronomist	0.50
Entomologist	0.20
Pathologist	0.20
Plant nutritionist	0.10
Physiologist	0.10
Total	1.10

Complementary subproject BL51: Proyecto regional de frijol, zona Andina (PROFRIZA)

Purpose: To strengthen national research capacity, increase regional cooperation, and improve common bean productivity

Research partners: National research programs throughout the region

Donor: SDC

Time frame: 1994-1996

Senior scientist:
Breeder/Agronomist 1.00

Complementary subproject BL52: Projecto regional de frijol para Centro América, México y el Caribe (PROFRIJOL)

Purpose: To strengthen national research capacity, increase regional cooperation, and increase common bean productivity

Research partners: National programs throughout the region

Donor: SDC

Time frame: 1993-1996

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BL02	Network Development	110	226	336	110	226	336
	Complementary:						
BL51	Proyecto Regional del Frijol, Zona Andina	100	200	300	100	240	340
BL52	Proyecto Regional de Frijol para Centro-américa Mexico y el Caribe (PROFRIJOL)	-	55	55	-	55	55
	Total	**210**	**481**	**691**	**210**	**521**	**731**

Project BL03: Integrated Bean Production Systems (Latin America)

Purpose: To collaborate in the development of integrated bean production systems in Latin America

Output activities:

- Integrated bean production systems for major agroecologies, including hillsides; forest margins; savannas; the semiarid plains of northeastern Brazil, north central Mexico, and Chile; and the subhumid subtropical lowlands of southern Brazil and northwestern Argentina
  - In collaboration with national institutions, develop, test, and promote sustainable crop management practices, including no-till cropping, erosion control barriers, green and organic manures, intercropping, and IPM sytems.
  - Develop novel methods for seed multiplication and distribution to speed testing and adoption of new bean varieties.

Senior staff:

Agronomist	0.15
Plant nutritionist	0.20
Entomologist	0.20
Soil scientist (Brazil) 0.25	
GIS specialist	0.20
Economist (impact)	0.30
Total	1.30

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BL03	Integrated Bean Production Systems	55	162	217	55	162	217
	Total	**55**	**162**	**217**	**55**	**162**	**217**

Project Area: Sustaining Bean Productivity in Latin America and the Caribbean

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
Core		205	553	758	205	553	758
Complementary		100	255	355	100	295	395
Total		**305**	**808**	**1,113**	**305**	**848**	**1,153**

Bean Project Area BA: Sustaining Bean Productivity in Sub-Saharan Africa

Purpose: To improve and sustain bean productivity by deploying gene pools that help solve major production constraints and by supporting networks for applied research

Rationale: In eastern and southern Africa, beans rank second as a source of protein and third as a source of calories. Total demand for this commodity is increasing at a rate of about 3% per year.

From the mid-1960s through the 1970s, bean production grew mainly as a result of increasing area planted. But as land becomes scarce, farmers will be strongly inclined to adopt technologies that increase yield. The gap between bean production and demand in Africa currently stands at about 700,000 t and continues to widen.

At CIAT headquarters and in Africa, we tailor bean gene pools to the requirements of eastern and southern Africa by developing resistance to the predominant diseases, insects, and edaphic and climatic stresses.

The Center has also helped establish regional research networks to strengthen national institutions through training and other means and to encourage coordination and mutual assistance. The bean networks are financed almost entirely with special project funds. Their activities are based on regional needs, ascertained by steering committees composed of national program leaders and regional coordinators.

Benefits: The immediate effect of this project is to strengthen the research capacity of national programs and gradually place the management of the regional networks in their hands. The networks offer African bean producers a number of concrete benefits. For example, by introducing bean germplasm from Latin America, the network is helping broaden the genetic diversity of beans in Africa, making production more resilient and creating new options for farmers. IPM components, including green manuring, crop management practices, and resistant varieties, should reduce production losses to beanfly and root rots. Further benefits will accrue from varieties resistant to necrotic strains of BCMV.

In addition, the project is contributing to good collaboration with other international centers in the development of sustainable cropping systems for the Eastern African Highlands.

Research Partners: Various national research institutes, universities, and NGOs; International centers; Bean/Cowpea CRSP

Project BA01: Germplasm Development (Sub-Saharan Africa)

Purpose: To make available improved bean germplasm to national programs in Africa

Output and activities:

- Improved germplasm for variety development in national programs
  - Characterize bean growing environments, using climatic, edaphic, and biological data, and group the environments according to uniformity of bean genotype response to permit more precise targeting of improved germplasm.
  - Distribute Andean and Mesoamerican germplasm with resistance or tolerance to major constraints among national programs and other organizations for testing.
  - Distribute pan-Africa breeding nurseries and trials (containing superior lines and germplasm developed or evaluated in Africa) to network participants.

Senior staff:

Andean breeder	0.20
Mesoamerican breeder	0.10
Total	0.30

Complementary subproject BA54: Bean improvement in Malawi

Purpose: Strengthen the national bean program and increase bean productivity in Malawi

Research partners: Malawi DAR National Bean Program, Bunda College

Donor: ODA

Time frame: 1994-1998

Senior staff: Plant breeder 1.0

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
BA01	Germplasm Development	30	71	101	30	71	101
	Complementary:						
BA54	Bean Improvement in Malawi	100	210	310	100	210	310
	Total	**130**	**281**	**411**	**130**	**281**	**411**

Project BA02: Network Development (Sub-Saharan Africa)

Purpose: To provide technical and management support to regional bean networks in Africa

Output and activities:

- Effective networks for developing improved germplasm and cropping practices that contribute to sustainable bean production
  - Establish ways for network members to take greater responsibility for managing projects and implementing strategies defined by steering committees and researchers in periodic, regional planning meetings.
  - Participate in network training events, monitoring tours, conferences, and workshops, and design collaborative research projects with national programs to solve important production constraints in the region.
  - Develop IPM components and strategies to reduce losses caused by pests and diseases in major production systems.
  - Develop management practices that combine green manures, erosion control, selective intercropping, and tolerant varieties to overcome constraints associated with low soil fertility.

Senior staff:

Plant nutritionist	0.10
Physiologist	0.10
Entomologist	0.10
Pathologist	0.10
Total	0.40

Subproject BA12/BA51: Collaborative bean research network for the eastern Africa region (EABRN), phase 3

Purpose: To strengthen national research capacity, increase regional cooperation, and improve common bean productivity

Research partners: ARC (Sudan), FOFIFA (Madagascar), IAR (Ethiopia), KARI (Kenya), MSIRI (Mauritius), Ugandan Ministry of Agriculture

Donor: CIDA, USAID

Time frame: 1991-1996

Senior staff:

Pan-Africa coordinator (restr. core)	0.33
Breeder (restr. core)	1.00
Entomologist (restr. core)	0.33
Agronomist (restr. core)	0.50
Pathologist	0.50
Total	2.66

Complementary subproject BA52: Southern Africa regional bean research (SADC)

Purpose: To enhance food security by strengthening the capacity of national institutions to develop and promote improved production technology

Research partners: Various national institutes and other organizations in the SADCC countries

Donor: CIDA

Time frame: 1987-1994

Senior staff:

Pan-Africa coord. (restr. core)	0.34
Entomologist (restr. core)	0.33
Agronomist (restr. core)	0.50
Total	1.17

Subproject BA13/BA53: Great Lakes regional bean research network (RESAPAC), phase 3

Purpose: To strengthen national research capacity and improve the productivity of common beans

Research partners: ISABU (Burundi), ISAR (Rwanda), INERA and PNL (Zaire)

Donor: SDC

Time frame: 1992-1995

Senior staff:

Pan-Africa coord. (restr. core)	0.33
Breeder (complementary)	1.00
Plant pathologist (complementary)	0.50
Entomologist (restr. core)	0.34
Total	2.17

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
BA02	Network Development	40	347	387	40	347	387
BA12	Collaborative Bean Research Network for the Eastern Africa Region (EABRN)	500	790	1,290	500	790	1,290
BA13	Great Lakes Regional Bean Research Network	200	193	393	200	193	393
	Complementary:						
BA51	Collaborative Bean Research Network for the the Eastern Africa Region (EABRN)	-	-	-	-	210	210
BA52	Southern Africa Regional Bean Research	-	97	97	-	-	-
BA53	Great Lakes Regional Bean Research Network (RESACAC)	-	152	152	-	235	235
	Total	**740**	**1,579**	**2,319**	**740**	**1,775**	**2,515**

Project BA03: Seed Distribution and Farmer Participation (Sub-Saharan Africa)

Purpose: To insure to insure that seed of new varieties is distributed to farmers, and that farmers are involved in new technology testing

Output and activities:

- Novel seed distribution systems and extensive feedback from farmers to validate and increase adoption of new varieties and other technologies
  - Develop innovative seed multiplication and distribution systems to promote testing and adoption of new varieties.
  - Involve farmers early in the development of new technologies and practices through visits to experiment stations, on-farm trials, surveys, and other means.

Senior staff:

Sociologist	1.00
Economist (impact)	0.20
Total	1.20

Complementary subproject BA55: Swiss associate for the bean research program in Uganda

Purpose: To develop on-farm testing methodologies and low-cost seed storage technologies

Research partners: Uganda National Program

Donor: SDC

Time frame: 1994-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
BA03	Seed Distribution and Farmer Participation	-	-	-	-	-	-
	Complementary:						
BA55	Swiss associate for the bean research Program in Uganda	-	103	103	-	-	-
	Total	-	**103**	**103**	-	-	-

Project Area: Sustaining Bean Productivity in Sub-Saharan Africa

Code Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
	Senior	Operations	Total	Senior	Operations	Total
Core	770	1,401	2,171	770	1,401	2,171
Complementary	100	562	662	100	655	755
Total	**870**	**1,963**	**2,833**	**870**	**2,056**	**2,926**

Cassava Project Area CD: *Manihot* Genetic Diversity

Purpose: To conserve and characterize biodiversity for improving cassava quality and productivity

Rationale: Genetic diversity is essential for enabling farmers to improve cassava production and take advantage of market opportunities. A well-preserved, readily available, and thoroughly characterized global *Manihot* collection is critical for sustained improvement of gene pools for the major agroecologies of Latin America, Africa, and Asia. A better understanding of the biology, ecology, and gene flow of *Manihot* is needed to develop long-term strategies for managing and deploying genes and genotypes of cassava. In 1992, the international *Manihot* genetic resources network defined a global approach that will help national and international institutions share the work load and benefits of this work.

Benefits: Readily available germplasm of known agronomic potential, along with appropriate conservation methods, enables cassava curators and breeders to meet the requirements of crop improvement more efficiently. This work benefits cassava producers, processors, and consumers through the development of improved cassava gene pools and varieties containing *Manihot* genetic diversity.

Safe, long-term conservation of this germplasm (and dissemination of information on its special features) provides a broad genetic base for the development of sustainable cassava production systems.

CIAT maintains the world collection in collaboration with national germplasm curators and users. Institutions located in the centers of diversity of *Manihot* (South and Central America) should be particularly active in developing and implementing conservation strategies. Programs in Africa and Asia can also participate in and benefit from germplasm management.

Research Partners: IITA, IPGRI, ORSTOM, University of Georgia, Washington University, national programs in Brazil, Thailand and other countries

Project CD01: Conservation and Characterization of Manihot Genetic Resources

Purpose: To ensure safe conservation of cassava genetic resources and enhance their value through characterization and documentation

Outputs and activities:

- Safe conservation of *Manihot* germplasm
  - Maintain the world *Manihot* collection in vitro and in the field.
  - Acquire and distribute germplasm.
  - Ensure the health and safety of the collection.
  - Improve conservation methods (seed biology, rooting, and cryopreservation).
  - Train staff of national institutions in germplasm management.
  - Document the world collection.

- Characterization and documentation of *Manihot* germplasm
  - Conduct morphological characterization.
  - Identify and eliminate duplicates.
  - Characterize subsets of core, elite, and wild species at the molecular level.
  - Improve characterization methods (molecular map, taxonomic descriptors, and new screening methods).
  - Document the collection, develop a global database, and publish a germplasm catalog.
  - Consolidate the global *Manihot* genetic resources network.
  - Train national program personnel in characterization and documentation.

Research partners: EMBRAPA, FCRI, IITA, IPGRI, University of Georgia, Washington University

Senior staff:

Cassava geneticist	0.24
Virologist	0.08
Tissue culture specialist	0.10
Molecular geneticist	0.10
GIS specialist	0.10
Total	0.62

Complementary subproject CD01/51: Development of a cassava molecular map

Purpose: To construct a molecular map of cassava to improve breeding efficiency

Donor: Rockefeller Foundation

Research partners: CIF and University of Georgia

Time frame: 1992-1994

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CD01	Conservation and characterization of *Manihot* Genetic Resources	24	130	154	24	130	154
	Complementary						
CD51	Development of a Cassava Molecular Map	-	71	71	-	-	-
	Total	**24**	**201**	**225**	**24**	**130**	**154**

Project CD02: Defining Desirable Characteristics of Cassava Germplasm for More Efficient Gene Pool Development

Purpose: To understand the mechanisms and genetic control of variation for useful characteristics and to make this information available for gene pool improvement

Outputs and activities:

- Definition of desirable characteristics in the *Manihot* germplasm.
  - Characterize mechanisms of variation in resistance (CBB, root rot pathogens, whitefly, chinch bug, and mites) and physiological (photosynthetic rate and water and nutrient use efficiency) and quality traits (starch quality, cyanogenesis and postharvest deterioration).
  - Produce and evaluate special stocks for enhancement and study of genetic control of useful variation.
  - Study the structure of genetic variability in *Manihot*.
  - Characterize ecogeographically the provenant sites of germplasm origin.

Research partners: CIRAD, DANIDA, EMBRAPA, NRI, ORSTOM, Universidad Nacional de Colombia, University of Florida, University of Newcastle

Senior staff:

Geneticist	0.56
Breeder	0.20
Physiologist	0.30
Pathologist	0.10
Entomologist	0.10
Processing specialist	0.10
Virologist	0.02
Molecular biochemist	0.30
Total	1.68

Complementary subproject CD02/52: Investigation of metabolites implicated in cassava root postharvest deterioration

Purpose: To develop a biochemical assay for postharvest physiological deterioration in cassava roots and to identify key metabolites whose genetic manipulation may successfully inhibit and/or block such deterioration

Research partners: NRI

Donors: DGIS, NRI

Time frame: 1994-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CD02	Defining Desirable Characteristics of Cassava Germplasm for more Efficient Gene Pool Development	136	297	433	136	297	433
	Complementary						
CD52	Investigation of Metabolites Implicated in Cassava Root Post Harvest Deterioration	-	41	41	-	-	-
	Total	**136**	**338**	**474**	**136**	**297**	**433**

Project Area: *Manihot* Genetic Diversity

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	160	427	587	160	427	587
	Complementary	-	112	112	-	-	-
	Total	**160**	**539**	**699**	**160**	**427**	**587**

Cassava Project Area CG: Improved Cassava Gene Pools

Purpose: To develop cassava gene pools for improved yield, quality, and resistance to or tolerance of major pests, diseases, and abiotic stresses

Rationale: Cassava varieties derive from improved gene pools targeted at specific ecosystems. These gene pools are developed by scientists of different disciplines who integrate desirable traits for general adaptation from the available genetic base into a group of selected genotypes. National program scientists then select for adaptation to specific agroecosystems and promote successful genotypes among farmers. The creation of new and useful genetic combinations, therefore, depends on a sound knowledge of cassava's response to biotic and abiotic stresses, the crop's inherent qualities, and the development of appropriate and effective methodologies for breeding and varietal diffusion.

Benefits: This work is expected to improve the socioeconomic conditions and nutrition of small farmers in targeted, marginal ecosystems, small-scale processors, and poor urban consumers. Such improvements will occur through enhanced cassava production levels, improved production stability, more efficient processing, and better quality cassava products. The interaction between CIAT and national programs is expected to be mutually beneficial: national programs will strengthen their research capabilities, and CIAT will receive important feedback for focusing its cassava research on the needs of developing countries. Such an integrated approach is expected to shorten the time for generating and diffusing improved cassava varieties.

Research Partners: IITA and national programs in Latin America and Asia

Project CG01: Cassava Germplasm Development for the Semiarid Tropics

Purpose: To develop improved populations and support national programs in adaptative selection and diffusion of new varieties for the specific growing conditions, biotic and abiotic constraints, and market demands of subregions within the semiarid ecosystem and CIAT's Hillsides and Tropical Lowlands Programs

Outputs and activities:

- Segregating populations and adapted germplasm for semiarid ecosystems
  - Evaluate, select, and recombine elite germplasm based on agronomic and quality traits.
  - Incorporate sources of resistance to water stress and improved biomass accumulation.
  - Incorporate sources of resistance to mites and whiteflies and develop improved screening techniques.
  - Incorporate sources of resistance to witches' broom disease and develop improving screening techniques.
  - Train and network with national personnel for effective dissemination and deployment of genetic material.

    Evaluate the socioeconomic impact of variety adoption.

Research partners: IITA and national programs in Latin America and Asia.

Senior staff:

Breeder (HQ)	0.20
Physiologist	0.20
Entomologist	0.10
Economist	0.04
Breeder (Asia)	0.30
Breeder (Africa)	0.20
Total	1.04

Complementary subproject CG51: Cassava germplasm development for the drier tropics of Africa, Asia, and Latin America

Purpose: To develop improved populations, and select and diffuse elite genotypes with high yield potential, resistance to major local pests and diseases, good root quality, and adaptation to the edaphic and climatic conditions of semiarid ecosystems.

Research partners: CPATSA, EBDA, EMBRAPA/CENARGEN, EMBRAPA/CNPMF, EPACE, IPA

Donor: IFAD

Time frame: 1990 to 1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CG01	Cassava Germplasm Development for the Semiarid Tropics	104	207	311	104	207	311
	Complementary						
CG51	Cassava Germplasm Development for the Drier Tropics of Africa, Asia, and Latin America	-	16	16	-	12	12
	Total	**104**	**223**	**327**	**104**	**219**	**323**

Project CG02: Cassava Germplasm Development for the Subhumid Tropics

Purpose: To develop improved populations, and select and diffuse elite genotypes with high potential and stability for root yield and quality, resistance to major pests and diseases, and adaptation to the predominant agroclimatic conditions of the subhumid tropics

Outputs and activities:

- Segregating populations and adapted germplasm for subhumid tropics ecosystems
  - Evaluate, select, and recombine elite germplasm based on agronomic and quality traits.
  - Incorporate sources of resistance to mealybugs and thrips and develop improved screening techniques.
  - Incorporate sources of resistance to bacterial blight, superelongation, anthracnose, root rots, and CLVM disease and develop improved screening techniques.
  - Train and network with national personnel for effective dissemination and deployment of genetic material.
  - Evaluate the socioeconomic impact of variety adoption.

Research partners: IITA and national programs in Latin America and Asia

Senior staff:

Breeder (HQ)	0.20
Physiologist	0.10
Pathologist	0.10
Entomologist	0.20
Economist	0.04
Breeder (Asia)	0.30
Breeder (Africa)	0.15
Virologist	0.10
Total	1.19

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CG02	Cassava germplasm development for the subhumid tropics	109	259	368	109	259	368
	Total	**109**	**259**	**368**	**109**	**259**	**368**

Project CG03: Cassava Germplasm Development for the Humid Tropics

Purpose: To broaden the genetic base (for yield potential in short-cycle crops, nutrient use efficiency, resistance to root rots and other pathogens of local importance, and root quality for processing and nutrition) for the future development and diffusion of varieties specific to the humid tropics

Outputs and activities:

- Segregating populations and adapted germplasm for humid tropics ecosystems.
  - Evaluate, select, and recombine elite germplasm based on agronomic and quality traits.
  - Incorporate sources of resistance to root rots and frogskin and develop improved

screening techniques.
- Train and network with national personnel for effective dissemination and deployment of genetic material.
- Evaluate the socioeconomic impact of varietal adoption.

Research partners: IITA, national programs in Latin America and Asia, and CIAT Tropical Lowlands Program

Senior staff:

Breeder (HQ)	0.08
Pathologist	0.10
Economist	0.04
Breeder (Asia)	0.25
Breeder (Africa)	0.15
Virologist	0.10
Total	0.72

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CG03	Cassava Germplasm Development for the Humid Tropics	62	165	227	62	165	227
	Total	**62**	**165**	**227**	**62**	**165**	**227**

Project CG04: Cassava Germplasm Development for the Highlands

Purpose: To develop improved populations, and select and diffuse elite genotypes with high yield potential, earliness, early ground cover, good and stable root quality for processing and human consumption, resistance to major pathogens and pests, and adaptation to the predominant agroclimatic conditions of the highlands

Outputs and activities:
- Segregating populations and adapted germplasm for highland tropics ecosystems
  - Evaluate, select, and recombine elite germplasm based on agronomic and quality traits.
  - Incorporate sources of resistance to bacterial blight and leaf ring spot disease and develop screening techniques.
  - Train and network with national personnel for effective dissemination and deployment of genetic material.
  - Evaluate the socioeconomic impact of varietal adoption.

Research partners: IITA, national programs in Latin America, and CIAT Hillsides Program

Senior staff:

Breeder (HQ)	0.12
Pathologist	0.05
Entomologist	0.10
Economist	0.04
Breeder (Africa)	0.20
Virologist	0.05
Total	0.56

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CG04	Cassava Germplasm Development for the Highlands	51	92	143	51	92	143
	Total	**51**	**92**	**143**	**51**	**92**	**143**

Project CG05: Cassava Germplasm Development for the Subtropics

Purpose: To develop improved populations, and assist national programs to select and disseminate new varieties for the specific growing conditions, biotic and abiotic stresses, and market demands of subregions within the subtropics

Outputs and activities:

- Segregating populations and adapted germplasm for subtropic ecosystems
  - Evaluate, select, and recombine elite germplasm based on agronomic and quality traits.
  - Incorporate sources of resistance to to subterranean mealybug and develop screening techniques.
  - Incorporate sources of resistance to bacterial blight and develop screening techniques.
  - Train and network with national personnel for effective dissemination and deployment of genetic material.
  - Evaluate the socioeconomic impact of varietal adoption.

Research partners: IITA and national programs in Latin America and Asia

Senior staff:

Breeder (HQ)	0.08
Pathologist	0.05
Entomologist	0.10
Economist	0.04
Breeder (Asia)	0.15
Total	0.42

Complementary subproject CG52: Cassava germplasm development for the subtropics of Africa, Asia, and Latin America

Purpose: To develop improved populations, and select and diffuse elite genotypes with high yield potential, resistance to major local pests and diseases, good root quality, and adaptation to the predominant agroclimatic conditions of the subtropics

Research partners: EPAGRI, IAC, IPAGRO, IAPAR

Donor: IFAD

Time frame: 1990-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CG05	Cassava Germplasm Development for the Subtropics	42	74	116	42	74	116
	Complementary						
CG52	Cassava Germplasm Development for the Subtropics of Africa, Asia, and Latin America	-	38	38	-	12	12
	Total	**42**	**112**	**154**	**42**	**86**	**128**

Project CG06: Tools and Methodologies for Gene Pool Development

Purpose: To increase the efficiency with which improved cassava varieties are generated and diffused by developing nonconventional tools and methodologies for genetic modification, index selection, optimization of sites for evaluation, characterization of major agroecosystems, incorporation of cropping system effects, and farmer participatory research in varietal selection

Outputs and activities:

- Improved breeding methodologies, including genetic transformation for interspecific gene transfer
  - Develop appropriate breeding methodologies for more efficient gene pool enhancement, including farmer participatory research in varietal selection.
  - Develop nonconventional methods for genetic modification of cassava, including genetic transformation for interspecific gene transfer.

Research partners: Asian Cassava Breeders Network, CAMBIA, ILTAB, Ohio State University, Pan-American Cassava Breeders Network, Purdue University, University of Wageningen

Senior staff:

Breeder (HQ)	0.12
Geneticist	0.20
Tissue culture specialist	0.10
Total	0.42

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CG06	Tools and Methodologies for Gene Pool Development	32	65	97	32	65	97
	Total	**32**	**65**	**97**	**32**	**65**	**97**

Project Area: Improved Cassava Gene Pools

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	400	862	1,262	400	862	1,262
	Complementary	-	54	54	-	24	24
	Total	**400**	**916**	**1,316**	**400**	**886**	**1,286**

Cassava Project Area CI: Cassava Integrated Crop Management

Purpose: To promote sustainable cassava production in major agroecosystems of Latin America and Asia by developing principles of and component technologies for integrated crop management

Rationale: Cassava's growth cycle varies from 7 to 24 months, depending on the ecosystem. Agrochemicals are seldom used for controlling pests and diseases or for maintaining soil fertility. To realize cassava's true production potential, adapted germplasm must be used, but integrated with cultural and biological management practices that enhance the crop's biotic and abiotic environment, thus reducing erosion, maintaining soil fertility, and avoiding use of pesticides.

Benefits: Small-scale farmers should obtain higher productivity, lower costs, and a safer working environment. Off-farm benefits to society would include reduced soil erosion and smaller sediment loads in rivers.

National programs will benefit from research conducted at representative sites in several ecosystems; from close collaboration with regional, national, and international partners; from new research techniques of participatory diagnosis, validation, adaptation, and on-farm testing of generated technologies to ensure adoption and thus more sustainable production; and from feedback to ensure orientation of research toward users' needs.

Research Partners: National programs in Latin America and Asia, including EMBRAPA (Brazil), DOAE (Thailand), MARIF (Indonesia), SCATC (China); IITA; research institutions in developed countries

Project CI01: Integrated Pest and Disease Management

Purpose: To develop environmentally sound and economically viable genetic, biological, and cultural control technology and implementation strategies for major cassava pests and diseases

Outputs and activities:

- Appropriate integrated pest management practices for sustainable cassava-based production systems
  - Identify and quantify pest and disease complexes in selected cassava agroecosystems.
  - Develop biological, botanical and cultural practices for controlling major cassava pests and diseases.
  - Develop IPM implementation strategies through pilot projects in selected agroecosystems.
  - Train natural program scientists and extension personnel in the design, development, adaptation, and implementation of effective IPM strategies.
  - Conduct ex-post analysis of the impact of adoption of IPM technologies.

Research partners: National programs of Brazil, Colombia, Cuba, Ecuador, and Panama; IITA; Texas A&M University; University of Florida

Senior staff:

Pathologist	0.60
Entomologist	0.40
Economist	0.10
Virologist	0.25
Total	1.35

Subproject CI11: Ecologically sustainable cassava plant protection in South America and Africa

Purpose: To develop and implement sustainable forms of plant protection for small-scale cassava producers to increase yields and reduce pesticide use

Research partners: IITA; EMBRAPA/CNPDA, EMBRAPA/CNPMF, and governmental organizations of Bahia, Ceará, and Pernambuco states (Brazil)

Donor: UNDP

Time frame: 1993-1996

Senior staff:

IPM specialist	1.00
Biological control specialist	1.00
Total	2.00

Complementary subproject CI01/51: Importance of *Neoseiulus ideaus* and *Typhlodromalus limonicus* as natural enemies of cassava green mites

Purpose: To qualify and quantify the predatory behavior of selected phytoseiid species as biological control agents of the cassava green mite

Research partners: University of Göttingen

Donor: BMZ

Time frame: 1992 to 1994

Complementary subproject CI52: Control of the cassava pest *Cyrtomenus bergi*

Purpose: To increase the knowledge base on the burrowing bug *Cyrtomenus bergi* for the premonitory application of successful control

Research partners: Danish Royal Veterinary and Agricultural University

Donor: DANIDA

Time frame: 1993-1996

Complementary subproject CI53: Diversified cassava agroecosystems—chemically mediated orientation

Purpose: To determine how cassava plant volatiles affect the host location process of larval parasitoides that attack the cassava hornworn and cassava mealybug

Research partners: ETH

Donor: SDC

Time frame: 1994-1996

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CI01	Integrated Pest and Disease Management	110	210	320	110	210	320
CI11	Ecologically Sustainable Cassava Plant Protection in South America and Africa	200	210	410	200	210	410
	Complementary						
CI51	Importance of *Neoseiulus idaeus* and *typhlodromalus limonicus* as Natural Enemies of Cassava Green Mites	-	13	13	-	-	-
CI52	Control of the Cassava Pest *Cyrtomenus bergi*	-	70	70	-	75	75
CI53	Diversified Cassava Agroecosystems: Chemically Mediated Orientation	-	50	50	-	100	100
	Total	**310**	**553**	**863**	**310**	**595**	**905**

Project CI02: Integrated Soil Crop Management

Purpose: To develop integrated crop management components and principles for sustainable cassava production in Latin American and Asian agroecosystems

Outputs and activities:

- Appropriate crop/soil management practices for sustainable cassava-based production systems

- Generate technical knowledge on new technology components and quantification of soil degradation in cassava-based systems.
- Develop interinstitutional farmer participatory techniques for validating, adopting and selecting component technologies.
- Develop and evaluate soil fertility maintenance and erosion control practices for specific ecosystems.
- Train national program scientists and extension personnel and the development of intercountry networks.
- Conduct *ex post* analysis of the impact of adoption of integrated crop/soil management practices.

Research partners: National programs of Brazil, Colombia, and Ecuador; IITA

Senior staff:

Physiologist	0.40
Economist	0.10
Agronomist (Africa)	0.30
Total	0.80

Subproject CI12/CI56: Improving agricultural sustainability in Asia—integrated crop-soil management for cassava-based production systems

Purpose: To develop appropriate integrated crop-soil management practices for sustainable cassava-based production systems in Asia

Donor: Sasakawa Foundation

Research partners: National programs of China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand, Vietnam

Time frame: 1993-1998

Senior staff:
Soil scientist 1.00

Complementary subproject CI55: Soil conservation in smallholder hillside farming on the Andean Inceptisols through cassava-forage legume intercropping

Purpose: To generate basic knowledge on soil degradation and erosion of Andean Inceptisols and develop cropping systems that conserve the soil

Research partners: CETEC, CVC, FEDECAFE, FUNDAEC, INCORA,

University of Hohenheim

Donor: BMZ

Time frame: 1993-1996

Senior staff: Agronomist 1.00

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CI02	Integrated Soil Crop Management	80	134	214	80	134	214
CI12	Improving Agricultural Sustainability in Asia: Integrated Crop-Soil Management for Cassava-Based Production Systems	100	140	240	100	140	240
	Complementary						
CI55	Soil Conservation in Smallholder Hillside Farming on the Andean Inceptisols Through Cassava-Forage Legume Intercropping	-	137	137	-	125	125
CI56	Improving Agricultural Sustainability in Asia: Integrated Crop-Soil Management for Cassava-Based Production Systems	-	70	70	-	31	31
	Total	**180**	**481**	**661**	**180**	**430**	**610**

Project Area: Cassava Integrated Crop Management

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	490	694	1,184	490	694	1,184
	Complementary	-	340	340	-	331	331
	Total	**490**	**1,034**	**1,524**	**490**	**1,025**	**1,515**

Cassava Project Area CM: Cassava Markets

Purpose: To strengthen links between farmers and markets, and obtain orientation for cassava gene pool development through research on processing, product development, and markets

Rationale: Cassava is a multipurpose root crop. To maximize its true potential as a source of additional income for small- to medium-scale farmers in tropical agroecosystems requires integrating farm production with marketing opportunities for processed products. The correct identification of existing markets and potential new end uses is key to the crop's development. Rural cassava-based agroindustries provide a link between farmers and markets, generate added value, and ensure that technology development benefits the rural poor.

Benefits: The ultimate beneficiaries will be cassava producers and processors: the development of small- to medium-scale cassava transformation processes, suitable for operation in rural areas, would create income and employment opportunities, thus enhancing the quality of life in cassava-growing regions. Stable prices and markets would motivate farmers to increase production and adopt productivity-increasing, resource-conserving technologies.

Research in national programs will also benefit from an integrated, interinstitutional approach to product, processing, and market development. Not only would the national programs analyze consumption patterns, markets, and demand trends to identify product opportunities and quality requirements, but also receive feedback essential for introducing genetically controlled quality traits for specific end uses.

Research Partners: CIRAD-CA, CIRAD-SAR, IITA, IRAT, NRI, ORSTOM, UBA, UNESP, UNESP-CERAT, UNIVALLE, national programs in Latin America and Asia

Project CM01: Cassava Product, Processing, and Market Development

Purpose: To develop cost-competitive, consumer-acceptable cassava products through integrating research on marketing, consumption, processing, and quality

Outputs and activities:

- Improved cassava product quality
  - Study the effects of gene x process interaction on cassava flour and starch quality.
  - Modify the physicochemical and functional properties of cassava products.
  - Characterize raw material properties for producing different cassava-based products.

- Economically sustainable processes for small- to medium-scale flour production and starch extraction
  - Conduct market studies in selected cassava-growing regions in Latin America and Asia.

- Develop processes for producing high quality cassava flour.
- Improve traditional equipment for cassava starch extraction, and develop processes for treating waste water.
- Evaluate processes and products at pilot-plant and semicommercial levels in selected countries.
- Monitor the commercialization of processes and products.

- Prototype novel cassava products and processes for local manufacture
  - Determine the potential for new cassava-based products.
  - Bioconvert cassava flours and starches.
  - Develop processes for treating and recuperating waste products.

- Strategies, networks, and trained national personnel for sustainable, economically viable, integrated enterprises in cassava production, processing, and marketing
  - Provide in-service and short-course training for national program scientists and extension leaders.
  - Form and consolidate national and regional integrated project and utilization networks.
  - Conduct model pilot of production, processing, and marketing projects in selected countries.

- Feedback on the socioeconomic impact of processing and marketing innovations will help focus research priorities
  - Perform *ex ante* studies for constraint and opportunity analysis and research planning.
  - Conduct adoption and impact studies in selected pilot projects.

Research partners: CIRAD-SAR, NRI, national programs in Latin America and Asia, IITA

Senior staff:

Economist	0.40
Processing specialist	0.20
Molecular biochemist	0.10
Total	0.70

Complementary subproject CM51: Production and marketing of cassava flour in Colombia

Purpose: To create, in high-priority regions of rural Colombia, a small-scale, but commercially viable, cassava-flour agroindustry that integrates production, processing, and marketing functions

Research partners: DRI and FUNDIAGRO

Donor: IDRC

Time frame: 1992-1994

Complementary subproject CM52: Field testing and implementing improved flour-processing technologies

Purpose: To improve the technical and economic efficiency of small-scale production of high-quality cassava flour for processed foods

Research partners: CARITAS, FUNDIAGRO, IDRC, NRI

Donor: NRI

Time frame: 1993-1995

Complementary subproject CM53: Improving small-scale cassava-starch extraction

Purpose: To improve the technical and economic efficiency of processes for small-scale cassava-starch extraction, and improve product quality

Research partners: CIRAD; UNIVALLE and Universidad Autonoma (Colombia)

Donors: CIRAD and French Ministry of Foreign Affairs

Time frame: 1989-1994

Senior staff:
Food technologist 1.00

Complementary subproject CM54: Adding value to the products and by productsof small- and medium-scale cassava-processsing industries in Latin America

Purpose: To develop economically viable, environmentally sound, and replicable cassava-processing systems by strengthening existing markets and creating new product opportunities

Research partners: CIRAD-CA, CIRAD-SAR, NRI, ORSTOM, UBA, UNESP-CERAT, and UNIVALLE

Donor: EU

Time frame: 1993-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CM01	Cassava Product, Processing, and Market Development	60	158	218	60	158	218
	Complementary						
CM51	Production and Marketing of Cassava Flour in Colombia	-	37	37	-	-	-
CM52	Field Testing and Implementing Improved Flour-Processing Technologies	-	26	26	-	7	7
CM53	Improving of Small-Scale Cassava-Starch Extraction	-	45	45	-	45	45
CM54	Adding Value to the Products and Byproducts of Small- and -Medium-Scale Cassava-Processing Industries in Latin America	-	64	64	-	64	64
	Total	**60**	**330**	**390**	**60**	**274**	**334**

Project Area: Cassava Markets

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	60	158	218	60	158	218
	Complementary	-	172	172	-	116	116
	Total	**60**	**330**	**390**	**60**	**274**	**334**

Cassava Project Area CC: Institutional Development

Purpose: To increase the effectiveness of national, regional, and global research and development systems for cassava

Rationale: The CIAT Cassava Program forms part of a global system of individuals and institutions in developed and developing countries who are involved in cassava research and development (R&D). Effective use of R&D resources depends on strong links existing among these players so that information, resources, and products flow efficiently and freely among them.

CIAT's international nature and 20-year experience in cassava research justify the Cassava Program's leading role in convening and catalyzing collaborative, interinstitutional endeavors at national, regional, and international levels. These endeavors help identify research topics and their priority, and promote horizontal collaboration between countries and institutions.

Benefits: Those who will directly benefit are: 1) national programs of developing countries, both private and public, that are associated with cassava R&D,
2) international and regional institutions with R&D responsibilities, 3) institutions of developed countries that dedicate resources to basic and applied cassava research and to technical cooperation in developing countries, and 4) donors who finance bilateral and multilateral cassava R&D activities.

The human and financial resources of national cassava systems are more effectively and efficiently used when information exchange is promoted, results shared, and research and development issues related to cassava prioritized. Strong national programs, in turn, means that cassava farmers, processors, and consumers benefit, in a significantly shorter time, from new knowledge, research tools and methodologies, and technology components.

Research Partners: National programs in Latin America, Africa and Asia, IITA, advanced labs in developed countries

Project CC01: Research Planning, Information Exchange, Project Design, and Networking

Purpose: To increase the effectiveness of national, regional, and global cassava R&D systems

Outputs and activities:

- Mechanism for continued adjustments of research priorities for cassava R&D
  - Conduct *ex ante* studies on technology impact.
  - Conduct *ex post* analysis of adoption and impact.
  - Conduct "bench mark" and "need assessment" studies at different levels in the cassava market for identifying constraints and opportunities in selected countries.
  - Develop agronomic and socioeconomic cassava databases.

- Trained cadres of national program personnel
  - Develop human resources in training trainers, diagnostic skills, and integrated cassava projects.

- Regional and global cassava R&D and networks
  - Consolidate existing, and create new, collaborative regional and global research and information networks.
  - Exchange information through *Cassava Newsletter*, *Cassava Biotechnology Network Newsletter*, and regional conferences and seminars.

Research partners: IITA, national programs in Latin America and Asia, research institutions in developed countries

Senior staff:

Program leader	0.70
Economist	0.20
Total	0.90

Complementary subproject CC51: Cassava Biotechnology Network

Purpose: To foster collaborative biotechnology research on high priority topics that would enhance food security and the development value of cassava

Research partners: DGIS and IITA

The Network's Steering Committee comprises one regional representative each from Latin America, Asia, and Africa; three institutional representatives; three disciplinary representatives; and the coordinator.

Donor: DGIS

Time frame: 1992-1997

Senior staff:
Biotechnologist 1.00

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
CC01	Research Planning, Information Exchange, Project Design, and Networking	90	251	341	90	251	341
	Complementary						
CC51	Cassava Biotechnology Network	100	250	350	100	218	318
	Total	**190**	**501**	**691**	**190**	**469**	**659**

Project Area: Institutional Development

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	90	251	341	90	251	341
	Complementary	100	250	350	100	218	318
	Total	**190**	**501**	**691**	**190**	**469**	**659**

Rice Project Area RL: Lowland Rice Improvement

Purpose: To strengthen lowland rice national programs and jointly contribute to sustainable increases in production from the dominant agroecosystem for rice in Latin America and the Caribbean (LAC). This, in turn, would lower rice prices for the region's poor.

Rationale: Rice is the most important food grain in most of tropical America, and lowland rice accounts for 70% of the region's total rice production.

Several important new traits are being developed for the crop, but many have genetic backgrounds that are not sufficiently well adapted to LAC farming conditions to be used effectively as parents or released as varieties. We are therefore "pooling" the total set of traits into backgrounds that are well adapted to the region's lowlands.

To ensure that resulting benefits reach users, we are actively involved in training and networking. We also function as a regional clearing-house for information on lowland rice improvement. Tropical LAC national programs receive special attention because of their countries' greater poverty, lesser self-sufficiency in rice, and weaker research and development systems. The region's private sector is being asked to contribute funding for projects in this Project Area.

Benefits: Improved rice varieties particularly benefit the poor, who spend about 7% of their total income on rice. Improved lowland germplasm has been key to the 40% decline in the price of rice over the past 25 years. An annual US$135 million worth of benefits are estimated to flow to LAC society from CIAT's rice effort (Sanint, 1992). Of the 239 new varieties released over the period, 38% came directly from CIAT germplasm, including 65% over the last 2 years. CIAT's training and networking activities have contributed significantly to many other releases by enhancing the skills of national scientists. Our economic surplus models estimate that promoting the adoption of new rice germplasm technology by just one year yields about US$58 million in additional benefits to the region.

Research Partners: The LAC national rice programs, IRRI, and CIRAD-CA.

Purpose: In close collaboration with national programs, to increase the quantity and efficiency of rice production by developing lowland rice germplasm that is higher yielding, agronomically improved, and pest-and-stress resistant. The use of such germplasm would subsequently translate into greater food security and lower rice prices for LAC consumers.

Output and activities:

- Lines and populations that possess important traits for increasing and stabilizing rice production. These traits include higher yield potential, more diverse genetic base, new plant type for direct seeding, ability to enhance weed control, more durable resistance to blast, new resistance sources against *Tagosodes* and "hoja blanca," and better grain type. Other potential traits are novel sheath blight resistance, hybrid vigor, and the apomixis character.
  - From diverse sources, obtain potential parental lines expressing useful traits.
  - Intercross promising parental lines with adapted lines and advance through segregating generations, using both pedigree and population improvement methods.
  - Diversify the genetic base through plant-type studies, recurrent selection, and molecular fingerprinting techniques.
  - Use anther culture to accelerate generation advance and facilitate wide crosses.
  - Apply selection pressure, using relevant sites or techniques, for traits such as plant type and agronomic characters; environmental adaptation; resistance to blast, *Tagosodes*, and hoja blanca; and grain quality.
  - Strengthen the skills of national program scientists by working closely with them at test sites, and help ensure that they use gene pools effectively.
  - Distribute elite lines and populations to national programs and others.

Senior staff:

Breeder	0.75
Pathologist	0.25
Biotechnology specialist	0.50
Total	1.50

Complementary subproject RL51: Lowland rice gene pools for recurrent selection

Purposes: To diversify the genetic base of lowland rice and reduce the risks involved in genetic uniformity, to increase the chances of obtaining useful novel recombinants, and to ensure continuing progress from selection.

Donor and partner: CIRAD-CA

Time frame: Ongoing partnership

Complementary subproject RL52: Anther culture training for national programs

Purpose: To train national program scientists to use the promising new techniques of anther culture for enhancing breeding.

Donor: Rockefeller Foundation

Time frame: 1993-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
RL01	Improved Lowland Rice Gene Pools	100	289	389	100	289	389
	Complementary:						
RL51	Lowland Rice Gene Pools for Recurrent Selection	-	10	10	-	-	-
RL52	Anther Culture Training for National Programs	-	50	50	-	-	-
	Total	**100**	**349**	**449**	**100**	**289**	**389**

Project RLO2: Information and Technology Sharing

Purpose: To assume the responsibilities, called for by CIAT's ecoregional mandate, of being the LAC regional rice research convenor, networker, and information clearing-house. These tasks will help guide the research agenda.

Outputs and activities:

- Regional clearing-house for the collection, analysis, and dissemination of information related to regional rice research and development.
  - Convene meetings, workshops, conferences, and seminars, and publish proceedings.
  - Collect and store regional economic, technical, commercial, institutional, and other relevant rice data in databases.
  - Collate, organize, and disseminate these data in print, electronic, and other useful forms for national programs, IRRI, FAO, and other interested parties.

- Coordinate and participate in regional rice research and development (R&D) networks.
  - International Network for Genetic Evaluation of Rice for Latin America (INGER-Latin America): coordinate the region's network for rice germplasm exchange and testing, in collaboration with IRRI.

- Caribbean Rice Improvement Network (CRIN): use an integrated rice development approach targeted to LAC's poorest countries and weakest national programs.
- Networks to gather and disseminate socioeconomics data on the Andean and other regions.

- Priority-setting for CIAT and regional rice R&D partners.
  - Analyze information and data gathered in above outputs to understand trends, spot R&D needs and opportunities, and assess impact.
  - Apply these analyses to priority-setting mechanisms and models, tempered by experience, to set research objectives.
  - Publish, discuss, and otherwise disseminate these findings to regional agricultural research programs, donors, and other interested parties, to enhance the quality of research planning and outcomes.

Senior staff:

Program Leader	0.25
Plant breeder	0.50
Total	0.75

Complementary subproject RL53: International Network for Genetic Evaluation of Rice for Latin America (INGER-Latin America)

Purpose: To exchange the region's, and the world's, elite rice germplasm among LAC national programs and train them in its effective use.

Donor and partner: IRRI

Time frame: 1994-1999

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
RL02	Information and Technology Sharing	75	142	217	50	142	192
	Complementary:						
RL53	International Network for Genetic Evaluation of Rice for Latin America	-	85	85	-	85	85
	Total	**75**	**227**	**302**	**50**	**227**	**277**

Project Area: Lowland Rice Improvement

Code	Name of Project	Working budget 1 9 9 4 Senior	Operations	Total	Estimated 1 9 9 5 Senior	Operations	Total
	Core	175	431	606	150	431	581
	Complementary	-	145	145	-	85	85
Total		**175**	**576**	**751**	**150**	**516**	**666**

Rice Project Area RU: Upland Rice Improvement

Purpose: To develop upland rice types for sustainable agriculture, where they can act as "nurse" crops to protect the soil and enhance the establishment of perennials such as forages in the tropical savannas and hillsides and under tree crops in forest margins and hillsides.

Rationale: Upland rice is the only grain crop that tolerates soil acidity, which is widespread in tropical Latin America and the Caribbean (LAC). Because of its high seeding rate and rapid canopy formation, upland rice quickly creates a dense ground cover that protects soil from erosion and provides a favorable microenvironment for establishing soil-rejuvenating perennials such as forages and trees. Income from the rice pays the cost of establishing the perennials. Farmers readily adopt upland rice because of its low input and management requirements, and easy marketability. Historically, upland rice improvement has received much less research attention than has lowland rice, but if this crop is to fulfil its promising role in sustainable agriculture, varieties must be improved to fit these emerging systems.

Because breeding for this agroecosystem is relatively new, much effort goes into developing linkages with national and international groups, exchanging germplasm and methodologies, training, and collaborative research. This ensures complementarity, relevance, and impact.

Benefits: The new upland rices will provide farmers and governments with a technology to help reverse soil-exhaustive practices, regenerate degraded pastures, hillsides, and forest margins, and adopt improved pasture and tree species. This will start an upward spiral of increasing soil quality and productivity, sustainability, and enhanced production in CIAT's mandate agroecosystems. Increased and more sustainable agricultural production in the tropical savannas will help protect the Amazon rain forests by enabling countries to meet their basic food production and economic development objectives without having to enter these more sensitive environments.

Many people living in these isolated and environmentally sensitive forest margins and hillsides are poverty-stricken smallholders who depend heavily on upland rice to feed their families. The new upland rices will enhance their production and nutrition.

Research Partners: LAC national rice programs, CIRAD-CA, IRRI, and WARDA.

Purpose: To help national programs develop a genetically diverse, improved germplasm for upland rice by pooling traits for higher yielding ability; good agronomic characteristics; compatibility with intercropped perennials; tolerance of acid, low-nutrient soils; responsiveness to inputs; resistance to blast, grain discoloration, and other pests; and grain type that meet market standards set by lowland rice.

Outputs and activities:

- Pooling of desirable upland rice traits into combined genetic backgrounds that are well adapted to LAC farming conditions, and can be used as parents in national breeding programs, or even released directly after local testing.
  - Identify potential parents by screening diverse sources for useful traits and for broadening the genetic base.
  - Cross parents with existing elite material and merge the new germplasm into population improvement and line development processes.
  - Diversify the genetic base by using recurrent selection.

- Identification of gene sources with better adaptation to acid, nutrient-poor soils.
  - Improve basic understanding of prevalent nutrient stresses and plant response mechanisms.
  - Target specific physiological traits to be improved, and develop screening methods.
  - Screen for higher nutrient efficiency and/or tolerance traits, and use superior lines in crosses.

- Close collaboration with national programs and other partners to strengthen skills and benefit from synergies in this relatively new area of rice improvement, so leading to more rapid release of varieties, adoption, and impact.
  - Conduct collaborative breeding and exchange of germplasm at both CIAT and national program sites.
  - Hold meetings and workshops, make site visits, and provide backup.
  - Provide courses on specialized techniques, prepare didactic materials, and perform other formal training activities.

Senior staff:

Breeder	0.75
Pathologist	0.25
Physiologist	0.25
Breeder (CIRAD)	0.50
Physiologist (JIRCAS)	0.75
Total	2.50

Complementary subproject RU51: Upland rice gene pools for recurrent selection

Purposes: To diversify the genetic base of upland rice to reduce the risks involved in genetic uniformity, to increase the chances of obtaining useful novel recombinants, and to ensure continuing progress from selection.

Donor and partner: CIRAD-CA

Time frame: Ongoing partnership

Complementary subproject RU52: Physiological mechanisms of acid-soil tolerance

Purposes: To understand how rice genotypes are affected by nutrient stresses characteristic of acid upland soils (e.g., aluminum toxicity and low calcium, magnesium, silicon), to develop practical screening methods, and to identify superior genotypes.

Donor and partner: JIRCAS

Time frame: Ongoing partnership

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
RU01	Improved Upland Rice Gene Pools	125	366	491	100	366	466
	Complementary:						
RU51	Upland Rice Gene Pools for Recurrent Selection	-	20	20	-	20	20
RU52	Physiological Mechanisms of Acid-Soil Tolerance	-	18	18	-	-	-
	Total	**125**	**404**	**529**	**100**	**386**	**486**

Project Area: Upland Rice Improvement

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	125	366	491	100	366	466
	Complementary	-	38	38	-	20	20
Total		**125**	**404**	**529**	**100**	**386**	**486**

Rice Project Area RP : Reducing Losses to Rice Pests

Purpose: To work jointly with national programs to help stabilize rice yields and quality, reduce pesticide use and production costs, and close the gap between farm and station yields.

Rationale: Pests reduce rice yields in Latin America and the Caribbean (LAC) by an estimated average of 22% annually (weeds: 11%; diseases, 7%; and insects, 4%). This average masks the destabilizing effect of epidemics, which induce farmers to use excessive amounts of pesticides as a preventive measure. Chemical control is costly: about US$483 million are spent each year on pesticide applications on LAC rice, with herbicides accounting for 45%, fungicides 35%, and insecticides, 20% of the expenditures. Pesticides are also hazardous to the applicator and the environment. Genetic resistances and integrated control practices can greatly reduce pesticide use while stabilizing yields at levels closer to their potential, and increasing farmers' incomes.

High levels of resistance to the blast fungus (*Pyricularia grisea*) are known in rice, but they rapidly break down once a new variety is grown on a large scale. Innovative approaches pioneered by CIAT and collaborators at Purdue University are raising new hopes that durable resistance can be achieved soon. The powerful techniques involved need to be refined and diffused to many countries.

Weeds cause more yield loss over larger areas than any other rice pest, and cost more to control. Some rice traits can enhance the effects of current weed management practices, thus reducing herbicide use. Other promising control methods are more competitive rice varieties, allelopathy (where chemical exudates from rice roots inhibit weeds), and adaptation to water-seeding systems.

The rice "hoja blanca" virus (RHBV) causes severe recurrent epidemics in poorer tropical LAC. Its vector, the whitebacked planthopper *Tagosodes oryzicola* is endemic to LAC and also causes mechanical damage to the crop. The unpredictability of RHBV epidemics induces farmers to spray regardless, as "insurance." Although CIAT has incorporated a single resistance source against each of the virus and vector into elite gene pools, additional sources are needed to safeguard against possible breakdown of these resistances.

In addition to using genetically resistant rice, farmers can control pests through "integrated management" of pests (IPM) and crops (ICM). Integrated management is not widely adopted in developing countries because it requires knowledgeable and skilful farmers and a well-developed technology transfer process. But new information technologies, such as expert systems and electronic communications, promise to alleviate this constraint: CIAT and others have accumulated considerable information on the biology and agroecology of major LAC rice pests over the last 25 years.

Benefits: Increased genetic resistances and adaptive characters against blast, weeds, and the hoja blanca/*Tagosodes* complex would substantially reduce rice production costs. History shows that most of these savings are eventually passed on to consumers as lower rice prices. Less pesticide use would also reduce farmers' exposure to toxic chemicals and lessen the risks of contaminating the environment, particularly the aquatic ecosystems and river drainage systems associated with lowland rice.

Research Partners: The LAC national rice programs, IRRI, CIRAD-CA, Purdue University, Institut Jaques Monod, IFDC, WARDA, USDA.

Project RP01: Durable Blast Resistance

Purpose: To increase and stabilize rice yields through reliable, durable resistance to blast, the most serious disease of tropical LAC's most important food grain crop, and help reduce the costs and hazards of fungicide use against this pest.

Outputs and activities:

- Conclusive proof of the "lineage exclusion hypothesis," which proposes a strategy for achieving broad-spectrum, durable blast resistance in rice.
  - Characterize the evolutionary relationships (using DNA fingerprinting) and virulence spectrum of blast isolates collected in major rice-production areas.
  - Identify resistance genes in rice that act against entire families or "lineages" of blast, rather than just against individual races.
  - Pyramid these genes in crosses, and verify whether the progeny exhibit the expected broad range of resistance against the respective range of lineages.
  - Tag lineage resistance genes, and establish marker-assisted selection when laboratory robotics become economical.
  - Provide in-country training for national program scientists to apply these techniques against their own blast lineages.

- Increased efficiency and scale of the resistance gene pyramiding process through developing practical methodologies that national programs can use.
  - Make crosses with rice lines containing resistance genes to Colombian blast lineages.
  - Test recurrent selection for its efficiency and effectiveness in pyramiding diverse resistance sources.
  - Test the durability of pyramided resistances, in field plantings over time and space.
  - Develop training materials and collaborative links to extend the recurrent selection methodology and products to national programs.

Senior staff:

Pathologist	0.50
Breeder	0.25
Outside biotechnologist	0.25
Total	1.00

Subproject RP11: Application of biotechnology to characterize blast and blast resistance

Purpose: To test promising techniques such as MGR-DNA fingerprinting, RFLP gene tagging and mapping, and marker-assisted selection in the characterization of rice blast, and in resistance breeding.

Research partner: IRRI, Cornell and Purdue Universities

Donor: Rockefeller Foundation, core

Time frame: 1993-1998

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
RP01	Durable Blast Resistance	75	192	267	75	192	267
RP11	Application of Biotechnology to Characterize Blast and Blast Resistance	-	88	88	-	88	88
	Total	**75**	**280**	**355**	**75**	**280**	**355**

Project RP02: Rice Traits to Enhance Weed Control

Purpose: To reduce rice yield losses from weeds, and reduce production costs and hazards associated with herbicide use, contributing to lower rice prices for consumers.

Outputs and activities:

- High-yielding germplasm that is more competitive against weeds.
  - Re-examine the assumption that competitive ability is always antagonistic to yield potential by assessing the possibility of breaking the association between early season competitiveness, which controls weeds, and late season competitiveness, which can reduce yield.
  - In upland agropastoral systems, identify rice traits that suppress pasture competition but do not endanger pasture establishment, thereby maximizing rice yield and overall system performance.

- Develop practical screening techniques for these desirable competitive traits, and identify promising parents.

- Germplasm that expresses allelopathy against weeds.
  - Test rice materials identified by the USDA as allelopathic, as well as CIAT germplasm, for allelopathy against major LAC weeds of lowland rice.
  - If allelopathy is confirmed, develop linkages and strategies to identify the mechanisms and genes involved, and practical screening methods.
  - Identify promising parents for crossing.

- Germplasm that tolerates water seeding and submergence.
  - Test germplasm reported by IRRI to have marked tolerance, and test CIAT and other materials.
  - If tolerance is confirmed, identify the most useful parents for crossing.
  - Adapt or develop rapid, practical screening techniques.

Senior staff:

Weed scientist	0.25
Breeder	0.25
Breeder (CIRAD)	0.25
Total	0.75

Complementary subproject RP52: Integrating rice improvement within agropastoral systems

Purpose: To identify traits that will let rice compete with pasture grasses without endangering pasture establishment. For use in rice-pasture systems in Colombia and Brazil.

Research partner: EMBRAPA-CNPAF

Donor: ODA holdback facility

Time frame: 1994-1996

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
RP02	Rice Traits to Enhance Weed Control	50	140	190	25	140	165
	Complementary:						
RP52	Integrating Rice Improvement within Agropastoral Systems	-	45	45	-	45	45
	Total	**50**	**185**	**235**	**25**	**185**	**210**

Purpose: To help poorer, tropical rice-growing countries overcome these pests by diversifying the resistance genes deployed against them, thus protecting against resistance breakdown, stabilizing yields, and reducing insecticide use.

Outputs and activities:

- Identification of additional, distinct, and complementary sources of genetic resistance against both *Tagosodes* and RHBV, for use in lowland gene pooling.
  - Screen diverse germplasm collections for resistance.
  - Do genetic analyses to confirm whether different resistance sources are, in fact, genetically distinct.
  - Tag resistance genes by using RFLP markers.
  - Characterize the mechanisms of resistance, so that complementary mechanisms can be pyramided.

- Creation of two entirely novel sources of RHBV resistance.
  - Characterize the molecular genetics and DNA sequence of the RHBV genome.
  - Assemble gene constructs for transformation of rice with viral coat protein and antisense RNA genes that could inhibit viral replication in the rice plant and virus transmission.
  - Adapt rice genetic transformation systems to LAC rice germplasm.
  - Apply the transformation systems and genes to transform rice for these novel resistance mechanisms.

Senior staff:

Virologist	0.40
Breeder	0.25
Total	0.65

Subproject RP13: Genetic transformation of rice with viral genes for novel resistance against RHBV

Purposes: To create entirely new resistance sources against RHBV, thereby forestalling possible breakdown through genetic uniformity; and to help build up rice biotechnological skills in LAC.

Research partner: Institut Jacques Monod

Donor: Rockefeller Foundation

Time frame: 1993-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
RP03	Diversified *Tagosodes*/Hoja Blanca Resistance	-	183	183	-	183	183
RP13	Genetic Transformation of Rice with Viral Genes for Novel Resistance Against RHBV	-	52	52	-	52	52
	Total	-	**235**	**235**	-	**235**	**235**

Project RP04: Integrated Pest and Crop Management

Purpose: To reduce pesticide use and production costs, increase production efficiency, and narrow the "yield gap" in LAC.

Outputs and activities:

- Collection and analysis of information, and convening of regional discussions on the costs of inefficient, unsustainable, and costly production practices and of excessive, environmentally harmful pesticide use.
  - Collect information on production inputs, practices, and constraints across LAC, and analyze trends and opportunities related to ICM and IPM.
  - Raise awareness by convening regional discussions through workshops and conferences, and publishing.

- Improved national program capacity to formulate location-specific rice IPM and ICM projects and seek funding.
  - Acquaint donors with high-impact opportunities, and connect them to relevant national agencies.
  - Help national programs prepare proposals according to donor protocols.
  - Include scientific input from CIAT where appropriate.

- Increase, consolidation, and sharing of knowledge on the biology and ecology of major rice pests in LAC.
  - Carry out strategic research on the biology, ecology, and epidemiology of weeds, blast, the *Tagosodes*/hoja blanca complex, and other serious pests.
  - Consolidate and publish existing, scattered information.
  - Adopt innovative information-management techniques such as expert systems to deliver complex information packages in a user-friendly form.

Senior staff:

Weed scientist	0.20
Program Leader	0.25
Physiologist (JIRCAS)	0.25
Total	0.70

Complementary subproject RP54: Workshop on rice IPM in LAC

Purpose: To convene, under FAO auspices, a workshop with key regional national programs to discuss the successful Indonesian rice IPM experience, examine LAC's own needs and opportunities, and develop a project for complementary funding.

Donor: FAO

Time frame: September 1994

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
RP04	Integrated Pest and Crop Management	45	122	167	20	122	142
	Complementary:						
RP54	Workshop on Rice IPM in LAC	-	12	12	-	-	-
	Total	**45**	**134**	**179**	**20**	**122**	**142**

Project Area: Reducing Losses to Rice Pests

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	170	777	947	120	777	897
	Complementary	-	57	57	-	45	45
Total		**170**	**834**	**1,004**	**120**	**822**	**942**

Tropical Forages Project Area FD: Forage Diversity

Purpose: To acquire, assess, conserve, and deploy diverse genetic resources of forages for use as feed and other purposes in sustainable production systems in the humid and subhumid tropics and subtropics

Rationale: Exploiting the genetic diversity among and within wild species by acquisition, characterization, evaluation, and conservation of a diverse germplasm collection of those wild legume and grass species with forage and soil improvement potential continues to be the basis for forage improvement in tropical areas of the world.

The Tropical Forages Program (TFP) will continue to acquire and screen species for the acid infertile soils of the tropical lowlands and mid-altitude hillsides of the humid and subhumid tropics for use as forages and for soil improvement. Acquisition, conservation, and evaluation will focus on key genera and species that show forage and/or soil improvement potential. The key forage genera are:

Grasses—*Andropogon, Brachiaria, Panicum*, and *Paspalum*
Herbaceous legumes—*Arachis, Calopogonium, Centrosema, Chamaecrista, Desmodium, Pueraria*, and *Stylosanthes*
MPTS—*Calliandra, Cratylia, Gliricidia, Leucaena*, and *Sesbania.*

Genera will be added as their potential becomes apparent.

The genetic diversity held in *ex situ* collections will be compared with that occurring *in situ* to determine that sufficient genetic diversity is held *ex situ* to overcome constraints that may appear as forage species or ecotypes are deployed and utilized.

Effective rhizobia and mycorrhizae will be collected and maintained for germplasm accessions held *ex situ* to ensure that strains are available for distribution and research. There is a need to investigate the long-term viability of applied rhizobia in different farming systems.

New forage germplasm can be effectively deployed only if there is some knowledge about tolerance to diseases and pests in specific climatic and edaphic environments. The germplasm must also be well characterized and documented. Initial evaluation for environmental adaptation will be carried out and an information system developed to relate plant adaptation characteristics to GIS land use databases to facilitate deployment of the germplasm.

Benefits: This research will benefit farmers and consumers by documenting and making available characterized forage germplasm for use by researchers in national programs for evaluation in production systems for soil improvement and animal feed. Forage geneticists will have access to a wider range of gene pools for incorporation of desired traits into commercially important species.

Research Partners: CATIE, CENARGEN/EMBRAPA (Brazil), CSIRO, ICRAF, ICRISAT, ILRI, Kew (UK), OFI, Missouri State University (USA), Universidad Nacional at Palmira and Universidad del Valle at Cali (Colombia), USDA

Purpose: To acquire, characterize, conserve, document, and distribute forage germplasm for subsequent evaluation for environmental adaptation on acid infertile soils of the humid and subhumid tropics

Outputs and activities:

- New forage germplasm accessions
  - Collect *Arachis* germplasm.
  - Collect *Cratylia* germplasm.
  - Acquire *Paspalum* germplasm by exchange.
  - Acquire germplasm of *Calliandra, Gliricidia, Leucaena, Neonotonia*, and *Sesbania*.

  - Germplasm multiplied for conservation, distribution, and duplicate deposit
  - Meet phytosanitary requirements for entry and distribution.
  - Multiply new germplasm and place in short- and long-term storage.
  - Regenerate existing germplasm for long-term storage.
  - Ensure duplicate deposit of germplasm in other gene banks.
  - Distribute forage germplasm.

- Characterization and identification of forage germplasm
  - Morphologically characterize new germplasm accessions.
  - Morphologically characterize previously acquired accessions.
  - Conduct isoenzyme characterization of forage *Arachis, Cratylia, Stylosanthes guianensis*, and *Brachiaria* accessions.
  - Determine taxonomy of unidentified accessions at the species level.
  - Maintain herbarium.

- Documentation of forage germplasm accessions
  - Maintain forage genetic resources database.
  - Revise and enter passport data.
  - Enter characterization data.
  - Publish germplasm catalogs.

- Improved knowledge for conservation of forage germplasm
  - Research the reproductive biology of key species.
  - Study practices to improve seed quality.
  - Investigate in-vitro culture of *Arachis glabrata.*
  - Study the genetic diversity and geographical distribution of *Arachis* and *Brachiaria.*
  - Conduct taxonomic research.

- Effective rhizobia and mycorrhizae available for forages
  - Maintain rhizobia and mycorrhizae strains.
  - Produce rhizobia and mycorrhizal cultures.
  - Select effective rhizobia strains for new legumes.
  - Identify and evaluate the value of rhizobia with antifungal properties.
  - Study the persistence of applied rhizobia.
  - Investigate the role of mycorrhizae in crop associations.

Senior staff:

Germplasm specialist	0.30
G x E specialist	0.20
Forage agronomist (Brazil)	0.30
Pathologist	0.10
Geneticist	0.10
Soil nitrogen specialist	0.10
Virologist	0.20
Total	1.30

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
FD01	Enhanced Genetic Resources of Tropical Forages	110	203	313	110	203	313
	Total	**110**	**203**	**313**	**110**	**203**	**313**

Project FD02: Forage Ecotypes with Known Environmental Adaptation

Purpose: To identify forage ecotypes adapted to climate, soil, pests, and diseases of the subhumid and humid tropics, with persistence, high-quality feed value, and potential for improving the soil.

Outputs and activities:

- Forages for crop-pasture systems in the acid-soil savannas
  - Identify forages for low-input permanent pasture systems.
  - Identify forages for intensive medium-term pastures on soils of medium fertility.

- Forages for mid-altitude hillsides
  - Identify forage species for use as pasture, fodder, fallow improvement, erosion barriers, and soil cover.
  - Assess farmer involvement in initial selection of forages.

- Forages for lowland humid tropics
  - Identify forages that are adapted to humid environments and persist under competition from weeds.

- Forages of high feed value
  - Assess feed value of environmentally adapted germplasm and acceptability to cattle.

- Seed available for regional evaluation
  - Multiply seed of promising accessions.

- Information system on adaptation of forages to climate, soil, and biotic factors.

- Develop a system to match plant attributes with abiotic and biotic factors linked to a GIS database system.

Senior staff:

Germplasm specialist	0.40
Forage quality specialist	0.20
Forage agronomist (Brazil)	0.10
Forage agronomist (MCAC)	0.20
G x E specialist	0.10
Pathologist	0.20
GIS specialist/geographer	0.10
Biometrician	0.20
Total	1.40

Subproject FD12: Forages for smallholders in Southeast Asia, phase 1

(30% funds directed to FD02)

Purpose: To identify new forages for different farming systems in Southeast Asia

Donor: AIDAB

Time frame: 1991-1994

Senior staff:
Forge agronomist 0.30

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
FD02	Forage Ecotypes with Known Environmental Adaptation	120	208	328	120	208	328
FD12	Forages for Smallholders in Southeast Asia	30	27	57	30	27	57
	Complementary:						
FD51	Forages for Smallholders in Southeast Asia	-	20	20	-	-	-
	Total	**150**	**255**	**405**	**150**	**235**	**385**

Project Area: Forage Diversity

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	260	438	698	260	438	698
	Complementary	-	20	20	-	-	-
Total		**260**	**458**	**718**	**260**	**438**	**698**

Tropical Forages Project Area FI: Forage Improvement

Purpose: To improve the utility of commercially important tropical forage genera by enhancing diversity through acquisition and genetic manipulation

Rationale: The adaptation of certain key species (e.g., *Arachis pintoi*) can be enhanced through the identification and deployment of genetic diversity. With other species, it has not been possible to identify all the desirable characteristics within one genotype. In those cases recombination and selection are needed to overcome specific constraints, such as spittlebug in *Brachiaria*, anthracnose in *Stylosanthes*, and foliar blight in *Centrosema*.

Brachiaria species have been planted over approximately 50 million hectares in tropical America, the majority to *B. decumbens*. This species is well adapted to acid, infertile soils, but productivity is severely reduced by spittlebug attack. A gene pool development program will utilize new techniques for exploiting apomixis to create synthetic gene pools with resistance to spittlebug and leaf cutter ant, high feed quality, and good persistence in acid, low fertility soils. Research on mapping the apomixis gene will be extended to locate and clone the gene for use in other crops.

A. pintoi is the first herbaceous legume to show high productivity and long-term persistence with vigorous stoloniferous grasses in the humid tropics. The same is true for *A. glabrata* in subhumid areas. There is a need to acquire additional accessions to extend the range of adaptation and ensure the availability of genes for resistance to future disease and insect outbreaks.

Stylosanthes species have been the most successful commercial tropical legumes worldwide. In tropical America severe anthracnose and poor persistence in pastures have limited the use of *Stylosanthes* species. There is known resistance to anthracnose and variability in seed yield and plant vigor. The nature of host-pathogen relationships will be analyzed and genotypes with high seed production and seedling vigor identified for gene pool improvement.

Centrosema contains several species with demonstrated high feed value and an ability to grow in association with tropical grasses. But their use is limited by foliar blight, low seed set under grazing, and difficulties in seed production. Overcoming these limitations will increase the range of legumes available for different production systems.

This research emphasizes legume improvement, because fewer legumes are available commercially than grasses and because legumes can have considerable impact on soil improvement when used as pastures or cover crops.

Benefits: This research will benefit farmers using diverse production systems by improving the availability of new forage grasses and legumes that are adapted to a range of soil and climatic conditions and have durable disease resistance.

Research Partners: CENARGEN, CNPAB, CPAC and CNPGC/EMBRAPA (Brazil); CORPOICA, CENICAFE, Fondo Ganadero, Universidad Nacional at Palmira (Colombia); CSIRO; ILRI, ICRISAT, IPGRI

Project FI01: Genetic Enhancement of *Brachiaria*

Purpose: To improve the utility and productivity of *Brachiaria* forage grasses through the utilization of natural genetic resources complemented by plant breeding

Outputs and activities:

- Completed evaluation of the 1984-85 *Brachiaria* germplasm collection
  - Conduct agronomic trials at major screening sites in MCAC, Colombia, and Brazil.
  - Complete spittlebug bioassay.
  - Assemble and analyze data.
  - Identify accessions as potential new cultivars or sources of key attributes.
  - Multiply and distribute seed for local testing by national programs.

- Gene pools with resistance to spittlebug and edaphic adaptation/persistence
  - Hybridize apomictic accessions possessing desired attributes with tetraploid sexual.
  - Evaluate in the field and select for desired character combinations and recombine.
  - Conduct multilocational testing of promising recombinants in diverse environments.

- Apomixis gene tightly marked for manipulation in breeding populations
  - Screen RAPD primers (bulk segregant analysis) on segregating hybrid progeny of 4x sexual X 4x apomictic cross, phenotyped by embryo sac analysis.
  - Identify primers producing cosegregating bands.
  - Conduct fine mapping of apomixis gene.
  - Confirm in sexual x apomictic hybrid progenies and breeding populations.
  - Develop SCARS for the linked RAPD markers.

- Improved screening methods for spittlebug resistance
  - Study environmental factors affecting insect populations.
  - Study nongenetic sources of variation in host reaction.

- Improve precision and capacity of screening by effective field infestation and other means.
- Correlate biochemical and morphological attributes with host antibiotic resistance.
- Identify key factors conferring resistance.
- Develop rapid screening procedures based on mechanisms of resistance.

- Genetic diversity in genus *Brachiaria* assessed through biochemical and molecular markers
  - Characterize patterns of genetic diversity in the genus.
  - Assess deficiencies in existing collections.
  - Assess geographical sources of useful new diversity.
  - Assess potential for gene exchange within the genus.
  - Assess potential to exploit heterosis.

- Description and quantification of genetic control of key attributes
  - Study spittlebug resistance in segregating biparental hybrid progenies.
  - Conduct quantitative genetic studies in breeding populations for yield, quality, and adaptation.

- Quantification of edaphic adaptation to acid infertile soils and associated nitrogen fixation
  - Quantify variation in associated N fixation.
  - Identify plant attributes for edaphic adaptation and relation to associated N fixation.
  - Develop screening procedures for associative N fixation and edaphic adaptation.
  - Develop N efficient genotypes.

- *Brachiaria* gene pools with resistance to foliar blight disease caused by *Rhizoctonia solani*
  - Screen advanced lines from the spittlebug improvement program.

- Improved screening procedures for virus
  - Implement a screening procedure for advanced lines and promising accessions.

- Methods to overcome seed dormancy and improved understanding of its mechanisms
  - Study biochemical control of dormancy and site(s) of expression within the seed.
  - Develop method(s) to overcome dormancy by hormonal treatment or embryo rescue.

- Knowledge of the role of endophytic fungi in tropical grasses
  - Identify fungal endophytes in tropical grasses.
  - Determine the role of endophytes in disease and pest control and N fixation
  - Determine the potential toxicity of endophyte-infected grasses to cattle.

Senior staff:

Geneticist	0.60
Germplasm specialist	0.10
Pathologist	0.10
Plant nutrition specialist	0.10
Molecular biologist	0.10
Molecular geneticist	0.20
Virologist	0.10
Total	1.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
FI01	Genetic Enhancement of *Brachiaria*	90	267	357	90	267	357
	Total	**90**	**267**	**357**	**90**	**267**	**357**

Project FI02: Improved Forage *Arachis* Gene Pools

Purpose: To extend the range of adaptation of forage *Arachis* species by broadening the available genetic base through collection and evaluation, to ensure conservation through population biology studies, and to improve utility through more rapid and reliable establishment practices

Outputs and activities:

- Augmented germplasm base
  - Collect new *Arachis* accessions.
  - Carry out morphological and isoenzyme characterization of new accessions.
  - Increase seed of new accessions.

- Accessions available for a wide range of environmental conditions
  - Study adaptation of a "core set" of germplasm through multilocational trials.

- Rapid and reliable establishment of forage *Arachis*
  - Study agronomy of establishment.
  - Assess germplasm accessions for variation in seedling vigor.
  - Study effect of associated soil microorganisms.

- Improved *Arachis* seed quality and storage conditions
  - Study effect of harvest and processing procedures on *Arachis* seed quality.
  - Study effect of conditions of seed storage on seed longevity.

- Knowledge on distribution of wild *Arachis* species and on the population biology of key species, with germplasm characterized by morphological, biochemical, and molecular markers
  - Develop GIS-based maps of distribution and genetic diversity of *Arachis* linked to soil and climatic and other biophysical data.
  - Study population dynamics of key species of wild *Arachis*.
  - Study morphological, isozyme, and RAPD/RFLP polymorphisms.
    Develop a strategy for *ex situ* and *in situ* conservation of key species of wild *Arachis*.

- Basic information on reproductive behavior, hybridization techniques, and species compatibility
  - Identify biochemical and/or molecular genetic markers to study inheritance.

- Study rate of natural outcrossing and susceptibility to environmental factors.
- Study efficient hybridization techniques for wild *Arachis*.

Senior staff:

G x E specialist	0.20
Forage agronomist (Brazil	0.30
Forage agronomist (MCAC)	0.10
Germplasm specialist	0.10
Geneticist	0.10
Pathologist	0.10
Plant nutrition specialist	0.10
Virologist	0.10
Biometrician	0.05
Total	1.15

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
FI02	Improved Forage *Arachis* Gene Pools	100	180	280	100	180	280
	Total	**100**	**180**	**280**	**100**	**180**	**280**

Project FI03: *Stylosanthes* Cultivars with Anthracnose Resistance and Good Persistence

Purpose: To develop gene pools of *Stylosanthes guianensis* and *S. capitata* with durable resistance to anthracnose, using the knowledge base of regional and temporal pathogenic variation and incorporate high persistence under grazing

Outputs and activities:

- A fully characterized collection of *S. guianensis* and *S. capitata*
  - Evaluate *S.guianensis* at Carimagua, where there is maximum known virulence to anthracnose.
  - Evaluate *S. capitata* at Campo Grande in cooperation with CNPGC-EMBRAPA.

- New gene pools widely evaluated for anthracnose resistance and agronomic performance
  - Evaluate advanced breeding lines in a multilocational trial.

- Germplasm with broad based resistance to anthracnose
  - Collect and maintain representative isolates of *C. gloeosporioides.*
  - Screen, select, and assemble a set of *Stylosanthes* genotypes for use as differentials.
  - Differentiate and classify isolates of the pathogen into races based on their pathogenic phenotypes on the differentials.

- Characterize the "races" at the molecular level.
- Identify sources of resistance to the various races of the pathogen for combining the genes in a breeding program.

- Foreign genes displaying antibiotic production transferred to *Stylosanthes* and evaluated
  - Clone and characterize bacterial genes.
  - Carry out gene construction for plant transformation.
  - Transform and regenerate plants.
  - Conduct a pathogenicity test.
  - Carry out genetic characterization and inheritance studies.

- Known variability of seedling vigor and yield and persistence under defoliation
  - Test the seedling vigor of a range of accessions.
  - Assess the effect of associated grass and nutrient levels on seedling vigor.
  - Estimate seed production of selected lines under varying defoliation pressure.
  - Assess seedling regeneration from soil seed reserves.

Senior scientists:

Pathologist	0.50
G x E specialist	0.10
Germplasm specialist	0.10
Geneticist	0.10
Molecular biologist	0.10
Total	0.90

Complementary subproject FI51: Development of *Stylosanthes* cultivars with stable resistance to anthracnose

Purpose: To classify *Colletotrichum gloeosporioides* isolates against host differentials and characterize races of *C. gloeosporioides* at the molecular level

Donor: ACIAR

Time frame: 1994-1995

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
FI03	*Stylosanthes* Cultivars with Anthracnose Resistance and Good Persistence	80	145	225	80	145	225
	Complementary:						
FI51	Development of *Stylosanthes* Cultivars with Stable Resistance to Anthracnose	-	9	9	-	9	9
	Total	**80**	**154**	**234**	**80**	**154**	**234**

Project FI04: Development of *Centrosema* Gene Pools with Resistance to Foliar Blight

Purpose: To develop *C. brasilianum* lines with resistance to foliar blight while maintaining high seed yield and other desirable agronomic characteristics

Outputs and activities:

- An improved inoculation method for evaluation of foliar blight resistance
  - Validate inoculation method, using material from crosses between susceptible and resistant lines.

- Sources of resistance identified in *Centrosema* germplasm
  - Screen species compatible with *C. brasilianum* for sources of resistance.

- Resistance incorporated with desirable agronomic traits
  - Hybridize, recombine, select.
  - Conduct field evaluation, select desired characteristics, and recombine.
  - Carry out multilocational evaluation.

Senior staff:

Geneticist	0.10
Pathologist	0.10
Total	0.20

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
FI04	Development of *Centrosema* Gene Pools with Resistance to Foliar Blight	20	37	57	20	37	57
	Total	**20**	**37**	**57**	**20**	**37**	**57**

Project Area: Forage Improvement

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	290	629	919	290	629	919
	Complementary	-	9	9	-	9	9
Total		**290**	**638**	**928**	**290**	**638**	**928**

Tropical Forages Project Area FS: Forages for Acid Soils

Purpose: To develop reliable procedures for identifying forages with high feed quality and acid soil adaptation, to develop forage components for production systems, and to enhance their delivery to farmers through participatory research, skill acquisition and institutional development

Rationale: Forages are used in a wide range of environments and production systems. An understanding of quality constraints, factors affecting persistence, tolerance to low soil fertility, and germplasm x environment interactions will enable better predictions of the adaptation of particular species to specific niches in production systems.

Some legumes with good adaptation to acid soils have limited forage value because of high tannin and alkaloid contents. Low nutrient supply is the major limitation to forage adaptation and productivity in the humid tropics, and thus widespread adoption of forages depends on their being efficient at extracting and utilizing nutrients. Other forage species have good adaptation to climatic and edaphic constraints and high feed value but persist poorly when grown in associations under heavy grazing.

Associated projects on forage diversity and forage improvement will provide species and ecotypes with potential for use in production systems. But these need to be evaluated and developed as components of production systems. Farmer participation is essential for validating the utility of such components. There will be strong emphasis on the use of forages in contributing to sustainable resource management. Particular attention needs to be directed to *Arachis pintoi*, because *Arachis* has demonstrated potential for contributing to sustainable productivity in tropical pastures and serving as a cover crop in perennial tree crops.

Seed production technology and forage delivery systems must be developed to increase adoption of new forage species and cultivars. Effective communication needs to be maintained with national programs, along with training in forage technology and on-farm research and development. In turn, it is expected that the national programs will reciprocate through their contributions to collaborative research.

Benefits: This research will develop new forage components for production systems in the tropical lowlands and hillsides and facilitate their delivery to farmers through national programs.

Research Partners: CORPOICA, CENICAFE, Fondo Ganadero, Universidad Nacional at Palmira, Universidad del Valle at Cali (Colombia); University of Hohenheim; University of Vienna; Massey University; Kansas State University; CSIRO; CIMMYT, ILRI, ICRAF, CATIE

Project FS01: Forage Ecotypes with High Feed Quality

Purpose: To assess the quality and feed value of forage genetic resources for infertile acid soils in the humid and subhumid tropics

Outputs and activities:

- Screening procedures for forage quality based on polyphenol analysis
  - Determine the effect of the nature of polyphenols on digestibility.
  - Determine in sacco protein and fiber degradation of legumes differing in quality.
  - Determine in vivo intake, protein, and fiber degradation of legumes differing in quality.
  - Use this information to develop a screening procedure.

- Knowledge about the influence of environment on forage quality
  - Assemble a core collection of *D. ovalifolium*, based on origin, growth habit, flowering, and quality.
  - Evaluate agronomic performance, quality, and palatability of the core collection at four contrasting sites in Colombia.

- Forage ecotypes with improved quality
  - Conduct a grazing experiment to measure forage quality, liveweight gain, and milk yield of new *P. maximum* cultivars sown with and without legume.
  - Conduct a grazing experiment to measure forage quality and milk yield in new cultivars of *S. guianensis*-grass associations.
  - On-farm grazing experiments to measure productivity and persistence of *P. maximum* and *S. guianensis* pastures in agropastoral systems in the Llanos.
  - Evaluate the effect of shrub legumes on utilization of low-quality grass and crop by-products.
  - Evaluate the effect of shrub legume supplementation on milk yield.

- Relation established between plant nutrient supply and forage quality
  - Identify grass species and ecotypes with differences in N uptake and forage quality.
  - Identify grass species and ecotypes with differences in Ca uptake and forage quality.
  - Test relationships between plant N fractions and Ca partitioning and quality parameters of cell wall fraction and digestibility.
  - Develop a rapid screening procedure to selection grasses for forage quality in relation to nutrient acquisition and utilization.

Senior staff:

Forage quality specialist	0.50
Plant nutrition specialist	0.10
Biometrician	0.10
Total	0.70

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
FS01	Forage Ecotypes with High Feed Quality	60	135	195	60	135	195
	Total	**60**	**135**	**195**	**60**	**135**	**195**

Project FS02: Adaptive Attributes of Forages to Acid Soils

Purpose: To identify plant attributes that confer tolerance to low fertility acid soils and contribute to efficient acquisition and utilization of nutrients to develop reliable screening procedures and effectively deploy forages in different ecosystems

Outputs and activities:

- Known adaptive attributes of *Brachiaria* species and ecotypes to acid infertile soils
  - Study the relationship between plant growth characteristics and forage quality attributes as influenced by nutrient supply.
  - Identify biochemical and molecular mechanisms of tolerance to aluminum and low fertility.

- Known adaptive attributes of *Arachis, Stylosanthes*, and *Centrosema* species to acid infertile soils
  - Study ecotypic differences in root and shoot growth characteristics as influenced by nutrient supply.
  - Identify biochemical and molecular mechanisms of tolerance to aluminum and low nutrient stress.

- Ecotypic differences in acquisition and utilization of N, P and Ca in *Brachiaria* species
  - Study differences in acquisition and utilization of nitrogen, phosphorus, and calcium.
  - Study differences in internal cycling of nitrogen, phosphorus, and calcium.

- Ecotypic differences in acquisition and utilization of nutrients in *Arachis, Stylosanthes*, and *Centrosema* species for growth and nitrogen fixation
  - Study differences in acquisition and utilization of phosphorus and calcium.
  - Study differences in internal cycling of nitrogen, phosphorus, and calcium.
  - Examine the role of root exudation in the acquisition of phosphorus and calcium.
  - Determine the role of these and other nutrients in nitrogen fixation by legumes in infertile acid soils.

- Screening procedures for genotypes that are adapted to acid soils and use nutrients efficiently
  - Determine the usefulness of plant attributes as screening indices.

Senior staff:

Plant nutrition specialist	0.50
G x E specialist	0.10
Soil nitrogen specialist	0.10
Plant biochemist	0.10
Total	0.80

Complementary subproject FS51: Phosphorus dynamics in the rhizosphere of tropical grasses and legumes

Purpose: To improve the knowledge of phosphorus acquisition by tropical forages

Donor: BMZ

Time frame: 1992-1994

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
FS02	Adaptive Attributes of Forages to Acid Soils	70	131	201	70	131	201
	Complementary:						
FS51	Phosphorus Dynamics in the Rhizosphere of Tropical Grasses and Legumes	-	5	5	-	-	-
	Total	**70**	**136**	**206**	**70**	**131**	**201**

Project FS03: Forage Components of Known Performance in Production Systems

Purpose: To develop and evaluate the productivity and environmental and socioeconomic impact of forage components for different production systems

Outputs and activities:

- Shrub legumes for acid infertile soils in the hillsides
  - Evaluate the contribution of shrub legume fodder banks to milk production.
  - Develop appropriate agronomic systems for introduction of shrub legumes in the hillsides with farmer participation.
  - Evaluate the feed system using shrub legumes in conjunction with other forage systems.

- Fallow improvement in the hillsides
  - Conduct a taxonomic and ecological study of native vegetation in fallow land.
  - Evaluate legume and grass mixtures in fallow.
  - Develop an agronomic system for introduction of legumes and grasses into fallows.
  - Assess the impact of improved fallows on livestock and crop production and soil properties.
  - Carry out a socioecomic study of adoption of improved fallows.
  - Evaluate the contribution of introduced forages to soil fertility.

- Stable grass-legume associations for pastures in the savannas, forest margins, and hillsides
  - Study the effects of nutrients, legume density at planting, preferential grazing, vigor of associated grass, longevity of legume plants, ability to regenerate, strips, mixtures, and grazing management.
  - Evaluate establishment under crops in pastures at various stages of degradation.

- Grass-legume associations for short term crop-pasture rotations
  - Evaluate adapted legumes and grasses under varying soil fertility conditions and crops.
  - Study the relative importance of crop and weed competition on establishment.
  - Study the effect of early grazing management on establishment.
  - Evaluate the effect of forages on soil improvement.

- Forages for smallholder systems in Southeast Asia
  - Evaluate forages as components of mixed farming systems for livestock feed and soil improvement through participatory research in sloping uplands, rainfed rice, plantations, forest lands, and open grasslands.

- Forages for soil cover, green manure, and erosion control
  - Evalute the utility of adapted legumes for soil covers in tree crops.
  - Evaluate the role of green manures in smallholder cropping systems in Central America.
  - Evaluate the use of forages for erosion barriers in hillside cropping systems .
  - Measure the impact of introduced legumes and grasses on the sustainability of the systems.

- Seed supply systems for commercial cultivars
  - Develop seed production technology for new cultivars.
  - Develop seed systems for small farmer associations.
  - Evaluate the economic advantage of seed production with an intercrop.
  - Liase with national programs and commercial producers to improve seed delivery.

- Information on forage adaptation and adoption by farmers
  - Conduct surveys of demand for and adoption of forages.
  - Involve farmers in adapting forage systems.
  - Determine reasons for slow adoption of legumes in farming systems.
  - Study policy and trends in livestock production.

Senior staff:

Forage quality specialist	0.30
Forage agronomist (Brazil)	0.20
Forage agronomist (MCAC)	0.50
G x E specialist	0.20
Plant nutrition specialist	0.20
Soil nitrogen specialist	0.10
Biometrician	0.10
Economist (impact)	0.20
Total	1.80

Subproject FS13: Forages for smallholders in Southeast Asia, phase 1 (40% funds directed to FD02)

Purpose: To develop forage components for different farming systems in Southeast Asia

Donor: AIDAB

Time frame: 1991-1994

Senior staff:
Forage agronomist 0.40

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
FS03	Forage Components with Known Performance in Production Systems	140	280	420	140	280	420
FS13	Forages for Smallholders in Southeast Asia	40	36	76	40	36	76
	Complementary:						
FS52	Forages for Smallholders in Southeast Asia	-	27	27	-	-	-
FS53	Legume Selectivity by Grazing Animal	-	49	49	-	-	-
	Total	**180**	**392**	**572**	**180**	**316**	**496**

Project FS04: Institutional Support and Skill Acquisition for Delivery of Forage Systems

Purpose: To facilitate interaction between national organizations involved in forage research and development within a region; develop recognized channels for dessiminating information, new forage species, and forage technologies; and arrange or provide for nondegree training

Outputs and activities:

- A forage research and development network in MCAC for dissemination of new forage germplasm and technology, training, and a vehicle for regional projects
  - Facilitate communication and networking within countries.
  - Make new forage germplasm and forage component technology available.
  - Provide training in farmer participatory research and seed system development.
  - Organize regional meetings of the RIEPT-MCAC in association with the PCCA.
  - Seek project funding for the regional network.
  - Produce and distribute a regular newletter.
  - Provide database support for the evaluation network.

- A forage research and development network for tropical South America for communication of information on new forages and forage technology
  - Produce and distribute a regular newsletter.
  - Determine the form that a network should take to meet current needs.
  - Faciliate the funding and formation of a RIEPT-South America.
  - Make new forage germplasm and forage component technology available.
  - Provide training in farmer participatory research and seed system development.
  - Provide database support for the evaluation network.

- A feed resources network for Southeast Asia to promote effective communication and collaboration in the region
  - Produce and distribute a regional newsletter.
  - Make new forage germplasm and forage component technology available.
  - Seek funding and organize regular regional meetings.
  - Facilitate nondegree training in forage technology and technology transfer.

- Research journal and occassional publications on forage-based systems for sustainable agriculture
  - Supervise the publication of a scientific journal.
  - Produce bibliographic reviews on forage research and development.

Senior staff:

G x E specialist	0.10
Forage agronomist (Brazil)	0.10
Forage agronomist (MCAC)	0.20
Total	0.40

Subproject FS14: Forages for smallholders in Southeast Asia, phase 1

(30% funds directed to FS04)

Purpose: To develop the capacity of national programs to transfer new forage components into different farming systems in Southeast Asia

Donor: AIDAB

Time frame: 1991-1994

Senior staff:
Forage agronomist 0.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
FS04	Institutional Support and Skill Adquisition for Delivery of Forage Systems	40	105	145	40	105	145
FS14	Forages for Smallholders in Southeast Asia	30	27	57	30	27	57
	Complementary:						
FS54	Forages for Smallholders in Southeast Asia	-	20	20	-	-	-
	Total	**70**	**152**	**222**	**70**	**132**	**202**

Project Area: Forage for Acid Soils

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	380	714	1,094	380	714	1,094
	Complementary	-	101	101	-	-	-
Total		**380**	**815**	**1,195**	**380**	**714**	**1,094**

Hillsides Project Area HA: Andean Hillsides

Purpose: To develop knowledge about how to combine conservation and production technologies in ways that sustain and regenerate the natural resource base and are also economically viable and acceptable to farmers

Rationale: On the hillsides, where most poor farmers in the Andean zone reside, the depletion of soils and forests exceeds renewal rates. Mining the natural resource base gives farmers short-term subsistence without a secure livelihood. And yet few of them have adopted conservation technology. Existing conservation practices often involve production trade-offs that are unaceptable to farmers. We need a better understanding of how to combine conservation with production in ways that are attractive to hillside farmers.

Benefits: The long-term beneficiaries are resource-poor hillside families, who, by adopting improved technologies in new systems of land use, will be able to maintain and improve food security, productivity of labor, and incomes without further land degradation.

The immediate beneficiaries are the research and extension personnel of national research institutues, public sector agencies for natural resource management, NGOs, local government municipalities, and producer organizations that participate in project activities and receive training in the use of methods, models, and decision-support systems to assist land use planning and technology choice.

Research Partners: CIPASLA (a consortium of Colombian institutions), Federación de Cafeteros and CENICAFE (Colombia), University of Florida (USA), CSIRO Institute of Natural Resources and Environment

Hillsides Project HA01: Effects of Soil Degradation and Practices for Soil Conservation and Regeneration on the Potential Productivity of Cultivated Hillsides

Purpose: To define and quantify the effects of accelerated soil quality degradation and of practices for soil regeneration and conservation on soil properties and their true costs

Outputs and activities:

- Criteria to stratify and map experimental sites
  - Stratify different types of hillside environments within the Río Ovejas watershed (Colombia) and select experimental sites using this stratification.
  - Conduct geostatistical spatial analysis of soil chemical properties across different types of hillside environments.

- Estimates of loss of yield potential
  - Conduct maximum yield trials (MYT) to obtain response curves for representative indicator crops—e.g., shallow rooted (beans), medium rooted (maize), deep rooted (shrubs and trees), and roots and tubers (cassava)—in at least 4-10 locations.
  - Determine indicators for properties of "healthy" and "degraded" soil systems.

- Criteria to evaluate soil improvement practices
  - Study nutrient cycling, organic matter formation, and soil physical properties under representative soil improvement practices.
  - Study changes in soil properties under different types of soil improvement practices in multisite experiments.
  - Determine the relative importance of different types of soil improvement practices for representative environments.

- Prioritized soil properties correlated with soil degradation and regeneration and changes in productivity
  - Study soil biology and organic matter effects and N-flux effects in maximum yield trials and practices trials.

- Acceptability to farmers and management requirements determined
  - Quantify factor requirements of the most important conservation practices. Determine criteria for acceptability to farmers.

- Economic value of environmental effects estimated
  - Value in economic terms the effects of the most important soil improvement practices.

Senior staff:

Soil scientist	0.50
Plant nutritionist	0.20
Soil scientist	0.10
Soil scientist	0.30
Economist	0.20
Total	1.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
HA01	Effects of Soil Degradation and practices of soil conservation and regeneration on the potential productivity of cultivated hillsides	90	179	269	90	179	269
	Total	**90**	**179**	**269**	**90**	**179**	**269**

Project HA02: Decision Support Systems for Land Use Planning and Technology Design

Purpose: To process information from strategic research in the form of decision-support systems that can be continuously updated to assist consensus-building among stakeholders in the formulation of plans for agricultural land use and protection of ecologically fragile areas.

Outputs:

- A prototype, interactive, computer-based decision-support system for hillsides
- Methodology for incorporating stakeholders' values into optional changes.
- Guidelines for defining minimum data needs.
- Priority areas in the Andean hillsides identified

Activities:

- Construct multiobjective analytical models, with input from results of subprojects, and develop knowledge-based models of the relationship between land characteristics and land use in the Río Ovejas watershed, using farm typologies, expert knowledge, and farmer-created maps of land use.
- Evaluate and adapt software for presentation of scenarios in interaction with stakeholders:
  - Parameterize WEPP soil erosion model.
  - Evaluate water balance models to estimate the effects of land use on partitioning, regulation, and quality of water in hillside catchments.

- Evaluate soil and water course physical, chemical, and biological properties in the Río Ovejas watershed, and simulate environmental x production tradeoffs.
- Estimate the true value of production at the plot, farm, and landscape units of analysis, including environmental costs.
- Assess the economic environmental x production tradeoffs in farm and landscape models.
- Test the decision-support system with stakeholders and document changes in their preferred scenarios before and after use and effects on the degree of consensus obtained.
- Publish the results in refereed journals.
- Assess the usefulness of this approach and the potential for extending it to other case study areas with national programs.
- For the Andean hillside agroecology, digitize GIS coverages of major river systems and other geographic features relevant for prioritizing potential research areas.
- Digitize GIS agricultural land use maps for the Andean hillside agroecology.
  Value the effects of sedimentation and agrochemical polution from different land uses in selected case study watersheds, including the Río Ovejas.
- Develop diagnostic simulation models for the hillsides agroecology and apply them to selected case study watersheds, including the Río Ovejas.

Senior staff:

Soil scientist	0.30
GIS specialist	0.50
Systems specialist	0.10
Economist (impact)	0.10
Total	1.00

Complementary subproject HA51: Improving agricultural sustainability and livelihoods in the tropical American hillsides

Purpose: To develop sustainable systems of land use with a working model of community-based, participatory research and development that will improve the productivity of hillside agriculture at experimental sites in the Andes

Donors: IDRC, USDA, DRI

Time frame: 1993-1995

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
HA02	Decision Support System for Land Use Planning and Technology Design	30	151	181	30	151	181
	Complementary:						
HA51	Improving Agricultural Sustainability and Livelihoods in the Tropical American Hillsisdes	-	210	210	-	151	151
	Total	**30**	**361**	**391**	**30**	**302**	**332**

Project HA03: Prototype Systems for Ecologically Sound Intensification of Production in the Hillsides

Purpose: To develop agrosilvopastoral systems that improve soil quality, water management, and the efficiency and productivity of labor

Outputs:
- Sustainable agrosilvopastoral systems
- Stable or improved soil quality
- Improved water management in hillsides
- Improved labor productivity and efficiency

Activities:
- Test best-bet prototype systems in pilot projects.
- Develop mechanisms for sustainable grass/legume establishment in hillsides.
- Examine animal production in pasture systems with and without trees.
- Evaluate crop/tree associations.
- Evaluate on-farm elite cassava germplasm already selected at the main site.

- Identify bean germplasm low-P tolerance and improved N_2 fixation.
- Identify the most promising grasses and legumes.
- Monitor disease/pest complexes in different crop regimes.
- Introduce processing technologies.
- Identify marketing opportunities.
- Identify ways to generate additional income from the animal component.
- Introduce alternative crops and crop management to improve seasonal occupation of labor.
- Introduce small-scale mechanization.

Senior staff:

Soil scientist	0.20
Soil scientist	0.20
Soil scientist	0.10
Total	0.50

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
HA03	Prototype Systems for Ecologically Sound Intensification of Production in the Hillsides	40	104	144	40	104	144
	Total	**40**	**104**	**144**	**40**	**104**	**144**

Project Area: Andean Hillsides

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	160	434	594	160	434	594
	Complementary	-	210	210	-	151	151
Total		**160**	**644**	**804**	**160**	**585**	**745**

Hillsides Project Area HC: Central American Hillsides

Purpose: To develop knowledge about how to combine conservation and production technologies in ways that sustain and regenerate the natural resource base and are also economically viable and acceptable to farmers

Rationale: On the hillsides, where most poor farmers in Central America reside, the depletion of soils and forests exceeds renewal rates. Mining the natural resource base gives farmers short-term subsistence without a secure livelihood. And yet few of them have adopted conservation technology. Existing conservation practices often involve production trade-offs that are unaceptable to farmers. We need a better understanding of how to combine conservation with production in ways that are attractive to hillside farmers.

Benefits: The long-term beneficiaries are resource-poor hillside families, who, by adopting improved technologies in new systems of land use, will be able to maintain and improve food security, productivity of labor, and incomes without further land degradation.

The immediate beneficiaries are the research and extension personnel of national institutions, public sector agencies for natural resource management, NGOs, local government municipalities, and producer organizations that participate in project activities and receive training in the use of methods, models, and decision-support systems to assist land use planning and technology choice.

Research Partners: CATIE, CIMMYT, CURLA (Honduras), IFPRI, IICA, INTA (Nicaragua); SRN (Honduras), UNA (Nicaragua), Zamorano (Honduras)

Project HC01/HC11: Improving Agricultural Sustainability and Livelihoods in the Central American Hillsides

Purpose: To help develop more productive and sustainable land use in the hillsides of Central America through research on system components and their interactions, development of policy guidelines, and dissemination of research results

Outputs and activities:

- Information on sustainable agriculture for the hillsides of Central America.
  - Review and analyze the available information on hillsides agriculture with particular emphasis on Central America.
  - Analyze successes and failures of different projects on soil conservation practices in Central America.

- Selection of research priorities
  - Select at least three research sites for each country based on the available information and data generated by the CAHP.
  - Develop a set of useful criteria for selecting hillside areas for agricultural research in future projects.

- Selection of representative experimental sites.
  - In participatory planning workshops, narrow the research possibilities to a few key topics that are vital for Central America and are within the budgetary and operational capabilities of the CAHP.

- A complete long-term research plan for the project and for specific study areas
  - Based on the results of participatory workshops, prepare a general working plan for the CAHP, including both socioeconomic and ecological aspects of the research, as well as a more detailed workplan for each study area.

- Implementation of field activities at each selected experimental site
  - Conduct field experiments on which there is clear agreement, dealing with topics already discussed in the first consultative workshop held in Nicaragua, and begin other field activities, such as participatory research.
  - Identify and test in the field prototype combinations of system components (e.g., soil conservation practices, leguminous species for soil improvement, multipurpose forage germplasm, and agroforestry components).

Senior staff:
Production systems specialist 1.00

Complementary subproject HC51: Improving agricultural sustainability and livelihoods in the Central American hillsides

Purpose: To help develop more productive and sustainable land use in the hillsides of Central America through research on system components and their interactions, development of policy guidelines, and dissemination of research results

Donor: SDC

Time frame: 1994-1995

Senior staff:
Economist 1.00
Soil scientist 1.00
Total 2.00

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
HC01	Improving Agricultural Sustainability and Livelihoods in the Central American Hillsides	100	71	171	100	71	171
HC11	Improving Agricultural Sustainability and Livelihoods in the Central American Hillsides	200	300	500	200	300	500
	Total	**300**	**371**	**671**	**300**	**371**	**671**

Project Area: Central America Hillsides

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	300	371	671	300	371	671
	Complementary	-	-	-	-	-	-
Total		**300**	**371**	**671**	**300**	**371**	**671**

Hillsides Project Area HP: Participatory Research

Purpose: To develop methodologies for a community-based, participatory approach to evaluating the productive performance, ecological impact, and acceptability to farmers of technologies with potential for improving land use in the hillsides of tropical America.

Rationale: Hillside agroecosystems are a mosaic of diverse micro-edapho-climatic regimes, user circumstances, and cultures. In any one area the results of technological innovation will be location-specific. An essential task is to develop a replicable approach to innovation, based on a strategic understanding of how to establish ecologically sound and ecologically viable alternatives that are acceptable to users (both on-site and off-site).

Testing technology with a model for community-based, participatory research and development is an innovative approach to determing the reasons that some technology options are more acceptable to farmers than others and the trade-off between production and conservation objectives. In order for hillside farmers to transform land use, it will frequently be necesary for innovation to be managed collectively across household, community, and supra-community scales of social organization. Similarly, technology testing needs to encompass different scales of analysis: field, farm system, and landscape. Participatory methods for technology assessment, hitherto applied at the individual, field, and plot level, need to be further tested and adapted to encompass the collective and landscape scales of analysis.

Benefits: This work will give us a better understanding of principles and criteria by which farmers select or adapt "best-bet" technologies for hillside agroecosystems. Partner institutions will incorporate these criteria into their technical recommendations. "Best-bet" technologies will be selected with farmer participation, and farmers will test these in community-managed participatory system trials. The project will also develop a method to determine how farmers value natural resources and incorporate into techniques for participatory assessment at the collective and individual levels of analysis. Project staff will publish training handbooks on this method.

In at least three pilot locations, the project will institutionalize self-sustaining mechanisms for continuing the work of local consortia. Staff will prepare refereed journal publications and manuals on the organizational model and participatory method.

Research Partners: Various national programs, universities, and NGOs in Bolivia, Costa Rica, Colombia, Ecuador, Guatemala, Honduras, Nicaragua, and Peru

Project HP01: Improving Agricultural Sustainability and Livelihoods in the Tropical American Hillsides

Purpose: To implement innovative organizational arrangements for managing prototype systems of sustainable land use, together with pilot incentive schemes designed and implemented with local people

Outputs:
- Prototype technology assessed for acceptability to farmers
- Adapted participatory methods
- Community-based organizations developed for research and development
- Trained people

Activities:
- Form watershed consortia and land users' councils and analyze farmer decision making.
- Review the literature and conduct a diagnostic study of institutions.
- Assess prototype technology with farmers and monitor sustainability indicators.
- Develop recommendations on institutional innovations needed to improve systems of land use.
- Test models for participatory technology development, produce training materials, and conduct training with national programs.

Senior staff:
Sociologist 0.30

Complementary subproject HP51: Improving agricultural sustainability and livelihoods in the tropical American hillsides

Purpose: To implement innovative organizational arrangements for managing prototype systems of sustainable land use, together with pilot incentive schemes designed and implemented with local people

Donors: IDRC, DANIDA

Time frame: 1993-1995

Complementary subproject HP52: Institutionalizing local leadership for farmer participation in agricultural technology generation and transfer in rural communities

Purpose: To improve the welfare of small-scale farmers in poor rural communities by institutionalizing their active participation in generating appropriate agricultural technology and establishing committees of experimenting farmers that will use participatory methods

Donor: Kellogg Foundation

Time frame: 1990-1994

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
HP01	Improving Agricultural Sustainability and Livelihoods in the Tropical America Hillisdes	100	156	256	100	156	256
	Complementary:						
HP51	Improving Agricultural Sustainability and Livelihoods in the Tropical American Hillisdes	-	87	87	-	87	87
HP52	Institutionalizing Local Leadership for Farmer Participation in Agricultural Technology Generation and Transfer in Rural Communities	-	132	132	-	132	132
	Total	**100**	**375**	**475**	**100**	**375**	**475**

Project Area: Participatory Research

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	100	156	256	100	156	256
	Complementary	-	219	219	-	219	219
Total		**100**	**375**	**475**	**100**	**375**	**475**

Tropical Lowlands Project Area TC: Brazilian Cerrados

Purpose: To generate technologies, land management strategies, and policy options for sustainable agricultural development

Background: In the last three decades, the Cerrados of Brazil, covering about 205 million hectares, have contributed importantly to the country's crop and livestock production. More intensive use of this area, particularly through monocropping and pasture development, has given rise to forms of land use that are neither environmentally nor economically sustainable.

CIAT and EMBRAPA have carried out pioneering studies to characterize the Cerrados according to major agroecological classes. After jointly prioritizing these classes, the Center, CPAC/EMBRAPA, and the Federal University of Uberlandia initiated on-farm and watershed-based studies in the area around Uberlandia (which is highly representative of about half the Cerrados) to develop land management options for sustainable development.

Benefits: The prototype technologies, land management strategies, and research methods developed by this project will be widely applicable throughout the Cerrados and possibly to intrusions of this environment in the Santa Cruz Department of Bolivia.

Research Partners: EMBRAPA/CPAC, EMBRAPA/CNPAF, Universidad Federal de Uberlandia (Brazil); Bayreuth University; IFDC; CIMMYT

Project TC01: Prototype Sustainable Cropping Systems for the Brazilian Cerrados

Purpose: To generate technologies, land management strategies, and policy options for sustainable agricultural development in the Brazilian Cerrados

Outputs and activities:

- Prototype technologies that allow lasting improvement in the efficiency of resource use and that control soil and water degradation
  - Conduct long-term experiments on agropastoral systems, sequential crop rotations, and practices for managing native vegetation (at experiment stations and on-farm with farmer participation) to determine input/output ratios and effects on soil parameters.
  - Conduct on-farm studies of farmers' allocation of resources to different production alternatives.
  - Monitor alternative land uses on-farm to quantify input/output ratios.
  - Conduct microeconomic evaluations of alternative prototypes.

Senior staff:

Cropping systems specialist	0.20
Cropping systems specialist	0.60
Production systems specialist	0.30
Total	1.10

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
TC01	Prototype Sustainable Cropping Systems for the Brazilian Cerrados	110	199	309	110	199	309
	Total	**110**	**199**	**309**	**110**	**199**	**309**

Project TC02: A Mechanistic Understanding and Models of Soil Chemical, Physical, and Biological Processes in Agropastoral and Sequential Crop Production Systems

Purpose: To develop conceptual models of soil chemical, physical, and biological processes in agropastoral and crop production systems

Outputs and activities:

- Data on soil organic matter, P, K, Mg, and Ca acquisition and cycling in relation to prototype cropping and agropastoral systems; a conceptual model of soil physical processes in different land uses; and an understanding of how these processes relate to soil biological activity
  - In a small number of long-term experiments conducted on-station, study contrasting systems (crops, crops-pastures, and native and sown pastures) to characterize nutrient cycling in response to a wide range of organic and inorganic nutrient inputs.
  - Conduct short-term "satellite" experiments in the field and greenhouse.
  - Refine and adapt soil analysis methods for specific parameters, such as organic P characterization.
  - Survey important soil fauna groups.
  - Study population dynamics of native vegetation and soil fauna and biological activity.

Senior staff:

N cycling specialist	0.20
Soil microbiologist	0.30
Soil microbiologist	0.60
Total	1.10

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
TC02	A Mechanistic Understanding and Models of Soil Chemical, Physical, and Biological Processes in Agropastoral and Sequential Crop Production Systems	110	98	208	110	98	208
	Total	**110**	**98**	**208**	**110**	**98**	**208**

Purpose: To develop databases on the spatial/temporal dynamics of land use, including socioeconomic aspects

Outputs and activities:

- Georeferenaced databases on the spatial and temporal dynamics of land use, a typology of land use classes that will help identify domains of extrapolation and relevant experimental sites, and hypotheses related to the characteristics of economically efficient and sustainable farming systems in different land classes
  - Collect, digitize, and georeference soils, slopes, vegetation, economic surveys, maps, and miscellaneous data to land use and farming systems of the Cerrados in the form of a GIS database.
  - Develop user-friendly interfaces for the database.
  - Develop GIS-based land use models.
  - Monitor a wide range of different farming systems to quantify land use forms, inputs, and outputs and to assess farmers' decisions about land use and choice of technology.

Senior staff:

Economist	0.20
Cropping systems specialist	0.10
Total	0.30

Complementary subproject TC51: Soil indicators of sustainable agropastoral systems

Purpose: To generate basic knowledge on soil physical degradation and enhancement and develop effective cropping systems for savanna oxisols

Donor: GTZ

Time frame: 1994-1996

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
TC03	Dynamics of Land Use	30	139	169	30	139	169
	Complementary:						
TC51	Soil Indicators of Sustainable Agropastoral Systems	-	79	79	-	94	94
	Total	**30**	**218**	**248**	**30**	**233**	**263**

Project Area: Brazilian Cerrados

Code	Name of Project	Working budget 1 9 9 4 Senior	Operations	Total	Estimated 1 9 9 5 Senior	Operations	Total
	Core	250	436	686	250	436	686
	Complementary	-	79	79	-	94	94
Total		**250**	**515**	**765**	**250**	**530**	**780**

Tropical Lowlands Project Area TL: Colombian Llanos

Purpose: To generate technologies, land management strategies, and policy options for sustainable agricultural development

Background: The Colombian Llanos have traditionally been dedicated to extensive cattle ranching. But this environment is changing rapidly as farming is intensified through the introduction of annual crops and new cattle-based systems. Studies involving remote sensing and ground-truthing indicate that large areas of the Llanos have been damaged as a result of more intense use of native vegetation by cattle. There are increasing signs of laminar erosion, loss of native species, and other forms of environmental degradation. Studies conducted by Colombian institutions in the the piedmont area have shown that contamination of rivers by biocides used in intensive crop production reduced fish species and resulted in high concentrations of some pesticides in fish consumed by people.

There is an urgent need for land management strategies that can reconcile more intensive agricultural production with conservation and enhancement of natural resources. Such strategies must be tailored to diverse conditions throughout the Llanos.

Benefits: The prototype technologies, land management strategies, and research methods developed by this project will be widely applicable throughout the Colombian and Venezuelan Llanos.

Research Partners: CORPOICA, IGAC, Ministry of Agriculture, Universidad Nacional, Universidad Tecnológica del Llano (Colombia); Ministry of Environment and Natural Resources, Universidad Experimental de los Llanos Exequiel Zamora (Venezuela); CIMMYT

Project TL01: Prototype Sustainable Cropping Systems for the Llanos

Purpose: To generate technologies that allow lasting increases in the efficiency of resource use and that control soil and water degradation

Outputs and activities:

- Prototype agropastoral, sequential crop rotations, and native vegetation management practices
  - Characterize farmers' decision making in relation to resource allocation.
  - Make quantitative estimates of biopyhsical and economic tradeoffs between alternative prototypes.
  - Establish a network of researchers active in the development of sustainable agropastoral systems.
  - Conduct long-term experiments on agropastoral systems, sequential crop rotations and practices for managing native vegetation (at experiment stations and on-farm with farmer participation) to determine input/output ratios and effects on soil parameters.
  - Conduct on-farm studies of farmers' allocation of resources to different production alternatives.
  - Monitor alternative land uses on-farm to quantify input/output ratios.
  - Conduct microeconomic evaluations of alternative prototypes.

Senior staff:

Range ecologist	0.20
Cropping systems specialist	0.20
Production systems specialist	0.20
Total	0.60

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
TL01	Prototype Sustainable Cropping Systems for the Llanos	40	137	177	40	137	177
	Total	**40**	**137**	**177**	**40**	**137**	**177**

Project TL02: A Mechanistic Understanding and Models of Soil Chemical, Physical, and Biological Processes in Agropastoral and Sequential Crop Production Systems

Purpose: To develop, by using models, a mechanistic understanding of soil chemical, physical, and biological processes in agropastoral and sequential cropping systems

Outputs and activities:

- Data on soil organic matter, P, K, Mg, and Ca acquisition and cycling in relation to prototype cropping and agropastoral systems; a conceptual model of soil physical processes in different land uses; and an understanding of how these processes relate to soil biological activity
  - In a small number of long-term experiments conducted on-station, study contrasting systems (crops, crops-pastures, and native and sown pastures) to to characterize nutrient cycling in response to a wide range of organic and inorganic nutrient inputs.

- Conduct short-term "satellite" experiments in the field and greenhouse.
- Refine and adapt soil analysis methods for specific parameters, such as organic P characterization.
- Survey important soil fauna groups.
- Study population dynamics of native vegetation and soil fauna and biological activity.

Senior staff:

Soil scientist	0.40
Range ecologist	0.10
N cycling specialist	0.40
Cropping systems specialist	0.20
Total	1.10

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
TL02	A Mechanistic Understanding and Models of Soil Chemical, Physical, and Biological Processes in Agropastoral and Sequential Crop Production Systems	60	136	196	60	136	196
	Total	**60**	**136**	**196**	**60**	**136**	**196**

Project TL03: Dynamics of Land Use

Purpose: To develop databases on the spatial and temporal dynamics of land use, including socioeconomic aspects

Outputs and activities:

- Georeferenced databases on the spatial and temporal dynamics of land use, a typology of land use classes that will help identify domains of extrapolation and relevant experimental sites, and hypotheses related to the characteristics of economically efficient and sustainable farming systems in different land classes
  - Collect, digitize, and georeference soils, slopes, vegetation, economic surveys, maps, and miscellaneous data to land use and farming systems of the Llanos in the form of a GIS database.
  - Develop user-friendly interfaces for the database.
  - Develop GIS-based land use models.
  - Monitor a wide range of different farming systems to quantify land use forms, inputs, and outputs and to assess farmers' decisions about land use and choice of technology.

Senior staff:

Range ecologist	0.30
Cropping systems specialist	0.20
Production systems specialist	0.20
Total	0.70

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
TL03	Dynamics of Land Use	40	202	242	40	202	242
	Complementary:						
TL51	Research for Improving Native Grasslands	-	81	81	-	47	47
	Total	**40**	**283**	**323**	**40**	**249**	**289**

Project Area: Colombian Llanos

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	140	475	615	140	475	615
	Complementary	-	81	81	-	47	47
Total		**140**	**556**	**696**	**140**	**522**	**662**

Tropical Lowlands Project Area TA: Forest Margins

Purpose: To develop technological options for arresting soil nutrient depletion as well as policy options for promoting stabilization of shifting cultivation

Background: The Amazon Basin contains an estimated minimum of 45 million hectares of accessible forest margins. Without exception, CIAT's mandate commodities, along with maize, are major staples throughout this area. The Center's crop programs have gathered a wealth of information on germplasm performance and to a lesser extent on predominant farming systems. Moreover, the Global Alternatives to Slash and Burn Project, financed by GEF and coordinated by ICRAF, has designated CIAT its ecoregional coordinator.

Benefits: This project will benefit farmers in forest margins by helping stabilize shifting cultivation in the short term and identifying technologies and policies that contribute to sustainable development.

Research partners: EMBRAPA/CPAC and PESACRE (Brazil), ICRAF

Project TA01: Prototype Sustainable Cropping Systems for Forest Margins

Purpose: To develop technological options for arresting soil nutrient depletion as well as policy options for promoting stabilization of shifting cultivation

Outputs and activities:

- Prototype technologies that allow lasting improvement in the efficiency of resource use and that control soil and water degradataion
  - Conduct long-term experiments on agropastoral systems, sequential crop rotations and practices for managing native vegetation (at experiment stations and on-farm, with farmer participation) to determine input/output ratios and effects on soil parameters.
  - Conduct on-farm studies of farmers' allocation of resources to different production alternatives.
  - Monitor alternative land uses on-farm to quantify input/output ratios.
  - Conduct microeconomic evaluations of alternative prototypes.

Senior staff:

Weed ecologist	0.30
Soil scientist	0.20
Cropping systems specialist	0.30
Cropping systems specialist	1.00
Total	1.80

Complementary subproject TA51: Alternatives to slash and burn

Purpose: To design sustainable agrosilvopastoral systems for deforested areas of the Amazon Basin

Donor: GEP

Research partners: EMBRAPA, ICRAF

Time frame: 1994

Senior staff:

Agronomist	1.00

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
TA01	Prototype Sustainable Cropping Systems for Forest Margins	180	199	379	180	199	379
	Complementary:						
TA51	Alternatives to Slash and Burn	100	86	186	100	100	200
	Total	**280**	**285**	**565**	**280**	**299**	**579**

Project TA02: Dynamics of Land Use

Purpose: To develop technological options for arresting soil nutrient depletion as well as policy options for promoting stabilization of shifting cultivation

Outputs and activities:

- Georeferenced databases on the spatial and temporal dynamics of land use, a typology of land use classes that will help identify domains of extrapolation and relevant experimental sites, and hypotheses related to the characteristics of economically efficient and sustainable farming systems in different land classes
  - Collect, digitize, and georeference soils, slopes, vegetation, economic surveys, maps, and miscellaneous data to land use and farming systems of the forest margins in the form of a GIS database.
  - Develop user-friendly interfaces for the database.
  - Develop GIS-based land use models.
  - Monitor a wide range of different farming systems to quantify land use forms, inputs, and outputs and to assess farmers' decisions about land use and choice of technology.

Senior staff:

N cycling specialist	0.10
Production systems specialist	0.50
Economist	0.10
Total	0.70

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
TA02	Dynamics of Land Use	70	111	181	70	111	181
	Total	**70**	**111**	**181**	**70**	**111**	**181**

Project Area: Forest Margins

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	250	310	560	250	310	560
	Complementary	100	86	186	100	100	200
Total		**350**	**396**	**746**	**350**	**410**	**760**

Projects TI01 and 02: Joint Activities with Other Programs

The Tropical Lowlands Program has set aside resources for joint research activities with the Hillsides Program and Tropical Forages Program. These joint activities are being defined and will be assigned to the respective projects when available.

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core						
TI01	Hillsides Program	-	121	121	-	121	121
TI02	Tropical Forages Program	-	43	43	-	43	43
	Total	**-**	**164**	**164**	**-**	**164**	**164**

Project Area: Interprograms

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	-	164	164	-	164	164
	Complementary	-	-	-	-	-	-
Total		-	**164**	**164**	-	**164**	**164**

Biotechnology Project Area IM: Molecular Characterization and Analysis of Genetic Diversity

Purpose: To design strategies, with the aid of molecular markers, for conserving and assessing genetic diversity, collecting new germplasm, understanding its genetic structure, and using this diversity more efficiently.

Rationale: Molecular markers are extremely useful tools for examining plant genomes. Genetic maps based on RFLPs and RAPDs provide genome-wide markers to monitor introgression of useful traits from exotic germplasm into adapted gentypes, to estimate the variability and heterozygosity within and between gene pools, to understand the evolutionary relationships between various species of *Phaseolus* and *Manihot*, and to tag important agronomic traits (simply or quantitatively inherited).

Benefits: In various ways this work increases the efficiency of crop breeding programs, thus facilitating the development of germplasm with pest resistance and other traits important to farmers.

Project IM01: Construction of a Molecular Map of Cassava

Purpose: To improve the efficiency of cassava germplasm conservation and breeding by constructing a detailed molecular map of cassava

Outputs:
- A better understanding of cassava genetics
- A framework molecular map
- Markers for gene tagging and DNA fingerprinting
- A better understanding of species relationships, based on molecular data
- Molecular characterization of gene pools

Activities:
- Construct and screen cassava genomic libraries.
- Generate mapping populations and evaluate them for agronomic traits.
- Conduct linkage analysis of RAPD and RFLP data.
- Implement nonradioactive labelling.
- Screen the cassava core collection, using molecular markers.

Research partners: IITA, University of Georgia (see cassava subproject 1B)

Donor: Rockefeller Foundation, core

Time frame: 1993-1996

Senior staff:

Geneticist	0.10
Cassava geneticist	0.10
Total	0.20

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
IM01	Construction of a Molecular Map of Cassava	20	10	30	20	10	30
	Complementary:						
IM51	Construction of Cassava Molecular Map	-	28	28	-	28	28
	Total	**20**	**38**	**58**	**20**	**38**	**58**

Project IM02: Construction of a Molecular Map of Tepary Bean

Purpose: To speed the development of common beans resistant to common bacterial blight (CBB) by gaining a better understanding of the relationship between this species and tepary bean, identifying sources of CBB resistance in tepary bean, and developing molecular markers to facilitate the introgression of this resistance into common bean

Outputs:
- Comparative mapping between the tepary bean and common bean
- Markers linked to CBB resistance genes to facilitate their introgression into common bean
- Publications

Activities:
- Screen tepary genotypes with clones from the common bean map.
- Develop recombinant inbred lines from an intragene pool tepary cross.

- Conduct linkage analysis to detect possible inversion or translocation.
- Screen recombinant inbred lines for CBB resistance and tag resistance gene(s).

Research partners: National programs in Latin America

Donor: AGCD, core

Time frame: 1993-1997

Senior staff:

Geneticist	0.15
Germplasm specialist	0.05
Total	0.20

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
IM02	Construction of a Molecular Map of Tepary Bean	30	27	57	30	27	57
	Complementary:						
IM52	Construction of a Molecular Map of Tepary Bean	-	36	36	-	36	36
	Total	**30**	**63**	**93**	**30**	**63**	**93**

Project IM03: Identification, Isolation, and Characterization of Minisatellite and Microsatellite Sequences

Purpose: To isolate and characterize minisatelllites in *Phaseolus* for studies on genetic diversity, to determine the presence of microsatellites in common bean, and to assess their potential as markers in mapping and tagging simple and complex traits

Outputs:

- A better understanding of the *Phaseolus* genome and its evolution and of the genetic structure of the Mesoamerican and Andean gene pools of *P. vulgaris* as a basis for establishing the degree of relatedness among bred lines
- Recovery of the recurrent parent genotype in backcrossing experiments
- Primers for analyzing crosses from intragene pools in studies of population gene flow
- Increased saturation of the molecular map and PCR-based markers for gene tagging and marker-assisted selection of QTLs

Activities:
- Generate genomic libraries from *P. vulgaris* and *P. acutifolius* genotypes and isolate fragments through hybridization with three different probes: Jeffrey's probes 33.15 and 33.6 and a fragment of gene III from M13.
- Characterize selected minisatellites and design oligonucleotides to generate PCR-based markers.
- Construct a random bean genomic library, select fragments of less than 500 bp, and screen the library with synthetic oligonucleotides.
- Purify the selected clones, sequence them, and design specific PCR primers flanking the microsatellites for use as new molecular markers in bean mapping.

Donor: AGCD, core

Time frame: 1993-1996

Senior staff:
Geneticist 0.15

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
IM03	Identification, Isolation, and Characterization of Minisatellite and Microsatellite Sequences	30	24	54	30	24	54
	Complementary:						
IM53	Identification, Isolation, and Characterization of Minisatellite and Microsatellite Sequences	-	26	26	-	26	26
	Total	**30**	**50**	**80**	**30**	**50**	**80**

Project IM04: Formation and Molecular Characterization of a Common Bean Core Collection

Purpose: To study the genetic structure of wild *P. vulgaris*, assess the extent of the founder effect, and determine gene flow within and between wild and cultivated gene pools, with the aim of developing a model for in situ and ex situ conservation and utilization of genetic diversity in breeding

Outputs:
- Characterization of the genetic structure of wild and cultivated *P. vulgaris*

- Specific molecular markers for gene flow studies
- Databases integrating GIS and molecular markers

Activities:
- Select and characterize the agronomic features of the wild and cultivated core collection.
- Characterize the collections for phaseolins and establish genetic stock for each variant.
- Evaluate core collections with RFLP, RAPD, and mtDNA probes.
- Conduct training.

Research partners: National programs in Latin America

Senior staff:

Geneticist	0.10
Bean Germplasm Specialist	0.10
GIS Germplasm specialist	0.05
Total	0.25

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
IM04	Formation and Molecular Characterization of a Common Bean Core Collection	20	65	85	20	65	85
	Total	**20**	**65**	**85**	**20**	**65**	**85**

Project Area: Molecular Characterization and Analysis of Genetic Diversity

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	100	126	226	100	126	226
	Complementary	-	90	90	-	90	90
Total		**100**	**216**	**316**	**100**	**216**	**316**

Biotechnology Project Area IB: Biochemical and Molecular Characterization of Plant Adaptation to the Environment

Purpose: To elucidate the mechanisms of resistance to selected biotic and abiotic stresses

Rationale: Biochemical and molecular approaches can help us identify factors involved in the interactions between plants and biotic and abiotic stresses. This in turn facilitates germplasm improvement (e.g., through screening techniques and gene cloning) and the development of plant-of improved strategies for managing pests and soil.

Benefits: This work benefits farmers by facilitating the development of germplasm with pest resistance and tolerance of abiotic stress.

Research partners: Laboratorium voor Genetika, Rijksuniversiteit Ghent; SAR-CIRAD; University of Vienna; NRI; CAMBIA

Project IB01: Biochemical Basis of Bean Weevil Resistance

Purpose: To identify natural factor(s) of resistance to the bean weevil in wild beans for eventual cloning of the corresponding genes, to develop a screening assay for more efficient selection of this trait, and to identify alternative approaches for developing resistance

Outputs:
- Natural resistance factors identified in wild common and tepary beans
- Resistance genes identified
- An assay for resistance screening
- Novel resistance mechanisms identified

Activities:
- Isolate proteinaceous fractions for *in vivo* testing of antibiotic activities.
- Isolate differentially expressed genes in resistant and susceptible accessions.
- Determine the in vivo effects of avidin and cystatin on the insect
- Determine the role of amylase and protease inhibitors in resistance.

Donor: AGCD, core

Time frame: 1992-1997

Senior staff

Biochemist	0.15
Bean entomologist	0.10
Total	0.25

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
IB01	Biochemical Basis of Bean Weevil Resistance	38	16	54	38	16	54
	Complementary:						
IB51	Biochemical Basis of Bean Weevil Resistance	-	50	50	-	50	50
	Total	**38**	**66**	**104**	**38**	**66**	**104**

Project IB02: Biochemical and Genetic Basis of Tolerance of Aluminum and Low Nutrient Stress in *Brachiaria* Species

Purpose: To understand the mechanisms by which *Brachiaria* spp. adapt to acid soils, to develop selection tools for tolerance breeding, and to understand the mechanisms of pasture degradation

Outputs:
- Preliminary data on mechanisms of adaptation in pastures to acid soils
- Preliminary data on causes of pasture degradation

Activities:
- Develop a nutrient solution culture to simulate acid soil stress.
- Determine organic/phenolic acids in roots, leaves, and root exudates of plants grown under simulated acid soil conditions.
- Analyze localization of aluminum and histology of roots grown under simulated acid soil conditions.
- Differentially screen genes induced by simulated acid soil stress.
- Establish *Brachiaria* cell suspension cultures for gene induction studies.

Donor: Austrian government, core

Time frame: 1993-1996

Senior staff:

Biochemist	0.10
Plant nutritionist	0.10
Total	0.20

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
IB02	Biochemical and Genetic Basis of Tolerance of Aluminum and Low Nutrient Stress in *Brachiaria* Species	25	21	46	25	21	46
	Complementary:						
IB52	Biochemical and Genetic Basis of Tolerance of Aluminum and Low Nutrient Stress in *Brachiaria* Species	-	40	40	-	40	40
	Total	**25**	**61**	**86**	**25**	**61**	**86**

Project IB03: Molecular Mechanisms of CO_2 Assimilation in Cassava

Purpose: To develop cassava germplasm with improved photosynthetic rates under drought and high temperatures

Outputs:
- An understanding of the molecular mechanisms that allow some cassava varieties to carry out photosynthesis and accumulate biomass more efficiently under drought and high temperatures
- Screening assays to select for this trait in cassava breeding
- Molecular techniques that are applicable to different problems and crops

Activities:
- Isolate and characterize the genes involved in photosynthesis in cassava.
- Bring about in situ hybridization on histological sections, using nonradioactively labelled RNA and immunofluorescence, to understand the subcellular compartmentalization of photosynthetic enzymes.
- Characterize enzymatic activities involved in photosynthesis in cassava.
- Isolate photosynthetic enzymes in cassava.

Time frame: 1993-1998

Senior staff:

Biochemist	0.15
Cassava physiologist	0.10
Total	0.25

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
IB03	Molecular Mechanisms of CO_2 Assimilation in Cassava	37	40	77	37	40	77
	Total	**37**	**40**	**77**	**37**	**40**	**77**

Project Area: Biochemical and Molecular Characterization of Plant Adaptation to the Environment

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	100	77	177	100	77	177
	Complementary	-	90	90	-	90	90
Total		**100**	**167**	**267**	**100**	**167**	**267**

Biotechnology Project Area IG: Gene Transfer and Conservation of Genetic Diversity

Purpose: To develop novel sexual and nonsexual gene transfer strategies, using hybridization, tissue culture, and genetic transformation technologies and to devise new approaches to in vitro germplasm conservation

Rationale: Resistance to biotic constraints is a key prerequisite for sustainable bean production in the tropics and subtropics. Currently, resistance to bacterial blight, BGMV, *Empoasca*, and bruchids is low or nil in common bean, leaving farmers no choice but to control these diseases pests with chemical applications. Wild relatives of common bean (*P. acutifolius* and *P. coccineus*) contain high levels of resistance. But to take advantage of this interspecies genetic variability in *Phaseolus* requires that we overcome barriers to crossing by achieving hybrid embryo rescue, and growing hybrids in vitro, and monitoring gene introgression with the aid of molecular markers.

Transformation offers a means of broadening the genetic base of crops through nonsexual transfer of genes from any source. This approach circumvents the incompatibility barriers that are typical of conventional sexual gene transfer. Transformation is particularly useful for incorporating characters (e.g., starch quality) that do not exist in the genetic

resources of the crop and for enhancing or reducing regulation of their expression in different tissues or organs or at specific developmental stages of the plant (e.g., cyanogenesis in cassava and virus resistance and insect resistance in beans).

Cassava genetic resources are conserved both in the field and as in vitro cultures under slow growth conditions. These methods are adequate to maintain germplasm in short-term active collections. But they are not suitable for long-term conservation because of the high labor and other costs, the large amount of space required, and the risk of losses resulting pest or disease attack in the field collection or by damage from natural disasters or other causes to the in vitro collection.

Research Partners: CIAT programs, IPGRI, Ghent University, University of Bath, ILTAB, University of Wageningen, University of Hannover

Project IG01: Embryo Culture and Molecular Marker-Aided *Phaseolus* Hybridization to Develop Interspecific Gene Pools

Purpose: To develop interspecific *Phaseolus* hybrid populations expressing desirable traits

Outputs:
- In vitro culture methods for obtaining fertile *P. vulgaris* x *P. acutifolius* and x *P. coccineus* hybrids
- Molecular markers for monitoring and facilitating gene introgression in *Phaseolus*

Activities:
- Use single and medium-copy markers to form common bean and tepary bean molecular maps.
- Identify minisatellite probes for the same purpose.
- Use embryo rescue and molecular markers to expedite the introgression of genes into common bean.
- Develop a similar approach for *P. vulgaris* x *P. coccineus* crosses.
- Distribute interspecific hybrids for evaluation and population enhancement.

Donor: AGCD, core

Time frame: 1993-1997

Senior staff:

Biotechnology specialist	0.10
Bean geneticist	0.10
Total	0.20

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
IG01	Embryo Culture and Molecular Marker-Aided *Phaseolus* Hybridization to Develop Interspecific Gene Pools	25	42	67	25	42	67
	Complementary:						
IG51	Embryo Culture and Molecular Marker-Aided *Phaseolus* Hybridization to Develop Interspecific Gene Pools	-	6	6	-	6	6
	Total	**25**	**48**	**73**	**25**	**48**	**73**

Project IG02: *Agrobacterium*-Mediated and Particle Bombardment Mediated GeneticTransformation of Cassava, Beans, and *Stylosanthes*

Purpose: To develop methods for transferring genes to cassava and beans, using *Agrobacterium tumefaciens* vectors and particle bombardment, including transformation and regeneration of transformed plants as well as the development of expression cassettes for genes altering starch quality in cassava

Outputs:

- Expression cassettes for the starch branching enzyme and starch bound synthase enzyme in cassava
- Methods for transferring genes to cassava, using *A. tumefaciens* vectors (short term) and particle acceleration (long term)
- Transgenic cassava plants expressing marker genes and eventually variable amylpase amylopectin ratios
- Methods for transferring genes to beans through particle acceleration and regeneration of transformed plants expressing markers genes

Activities:

- Clone genes for starch quality into expression cassettes for transformation.
- Transform somatic embryos of cassava, using marker genes and the starch branching enzyme, using *A. tumefaciens* vectors and particle bombardment.
- Conduct molecular and biological tests of gene integration/expression.
- Use genes controlling the biosynthesis of cyanogenic glucoside and HCN production in cassava for transformation.
- Transform common bean through particle bombardment, using the available marker genes, and test for gene integration and expression.

Research partners: University of Bath, ILTAB, University of Wageningen, University of Hannover

Donor: GTZ, Italian government, core

Time frame: 1992-1997

Senior staff:
Biotechnology specialist 0.15

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
IG02	*Agrobacterium*-Mediated and Particle Bombardment-Mediated Genetic Transformation of Cassava, Beans, and *Stylosanthes*	30	58	88	30	58	88
	Complementary:						
IG52	*Agrobacterium*-Mediated and Particle Bombardment-Mediated Genetic Transformation of Cassava, Beans, and *Stylosanthes*	-	96	96	-	96	96
	Total	**30**	**154**	**184**	**30**	**154**	**184**

Project IG03: Transgenic Rice Resistant to Rhizoctonia

Purpose: To use currently available rice transformation protocols for introducing the rip gene in rice as a potential defense mechanism against *Rhizoctonia solani*

Outputs:
- Rice plants expressing antifungal activity for evaluation under *Rhizoctonia solani* infection
- Effective methods for genetic transformation of Latin American Indica genotypes

Activities:
- Bombard immature embryos of the Indica rice varieties BR-IRGA 409, INTI, and CICA 8, using the rip construct (which contains the CaMV 35 promoter with the hygromicin resistance gene) and the GUS gene as markers.
- Regenerate plants from transformed calli.
- Evaluate integration of the marker genes at early stages of plant growth.
- Evaluate integration and expression of the rip gene in the greenhouse with proper biosafety precautions.

Donor: Rockefeller Foundation, core

Time frame: 1993-1998

Senior staff:
Biotechnology specialist 0.10

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
IG03	Transgenic Rice Resistant to *Rhizoctonia*	25	31	56	25	31	56
	Total	**25**	**31**	**56**	**25**	**31**	**56**

Project IG04: Cryopreservation of *Manihot* Genetic Diversity in Liquid Nitrogen

Purpose: To develop simple, low-cost, reproducible technology for long-term conservation of *Manihot* genetic diversity

Outputs:
- Methods for freezing and preserving *Manihot* genetic resources in the form of shoot-apical tips
- Technology and logistical support for a base *Manihot* gene bank under cryopreservation

Activities:
- Based on progress already made at CIAT, standardize the cryopreservation technique to cover a wide range of cassava genotypes.
- Simplify the current protocol both in terms of time required to introduce samples into liquid nitrogen and of the overall costs of the operation.
- Examine the operational and logistical aspects of running a base gene bank under cryopreservation.
- Place the cassava genetic resources held at CIAT under cryopreservation.

Time frame: 1994-1998

Senior staff:
Biotechnology specialist 0.10

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
IG04	Cryopreservation of *Manihot* Genetic Diversity in Liquid Nitrogen	20	52	72	20	52	72
	Total	**20**	**52**	**72**	**20**	**52**	**72**

Project Area: Gene Transfer and Conservation of Genetic Diversity

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	100	183	283	100	183	283
	Complementary	-	102	102	-	102	102
Total		**100**	**285**	**385**	**100**	**285**	**385**

Genetic Resources Project Area UG: Genetic Diversity

Purpose: To assemble, conserve, and characterize all critical genetic resources of *Phaseolus*, *Manihot*, and several genera of tropical forages, and to conduct research on these collections

Rationale: Successful crop improvement depends on ready access to the world's diverse genetic resources. They are particularly vital for developing genotypes that are adapted to marginal environments, such as those characterized by infertile, acid soils).
Traditional cultivars of important crops are at considerable risk. Many landraces are being lost in farmers' fields, as they are displaced by modern cultivars or destroyed by natural disaster or human activity. Wild ancestors and relatives of crops, which offer unique sources of important traits, are also disappearing at an alarming rate as their natural habitats are destroyed.

Given the difficulty of finding germplasm in farmers' fields and natural environments, gene banks are an essential source of genetic sources. CIAT established its Genetic Resources Unit (GRU) in 1976 to ensure proper conservation of germplasm of three important groups of species: *Phaseolus* beans, key tropical forage species (including legume and grass species from several genera), and cassava and its wild relatives of the genus *Manihot.*

Beans are a traditional staple of the poor in Latin America, some Caribbean countries, eastern Africa, and parts of the Middle East. Continued progress in bean improvement

depends on a broad genetic base. CIAT's *Phaseolus* germplasm collection, the largest in the world, offers unique opportunities for assessing the available genetic variability of the crop. National collections contain valuable genetic resources as well but are widely dispersed and somewhat vulnerable. For that reason and because of ex-situ and in situ genetic erosion, it is urgent that we continue to assemble collect, conserve, characterize, and freely distribute *Phaseolus* germplasm.

The tropics and subtropics have enormous agricultural potential but also present serious obstacles to productive, sustainable farming. The tropical American savannas, for example (occupying about 250 million hectares), receive abundant solar radiation and adequate rainfall, and their soil physical properties are generally favorable. But virtually all of this agroecology is characterized by infertile, acid soils. Parts of the forest margins and hillsides in Latin America also have high agricultural potential but are extremely vulnerable to resource degradation under continuous cultivation. One way CIAT contributes to the development of sustainable production systems for these and other environments is to conserve and disseminate germplasm of tropical forages for a wide range of edaphic, climatic, and biotic conditions. For this purpose the Center maintains a worldwide collection of both legumes and grasses. This germplasm offers unique opportunities to broaden the genetic base of agriculture.

Cassava is an important staple of the poor in South America, Africa, and Asia. A well-characterized global collection of *Manihot* germplasm (including wild and cultivated species) provides the genetic basis for continued improvement of this crop. CIAT's *Manihot* collection, the largest in the world, offers unique opportunities for assessing the genetic variability of cassava. There are few national collections of this crop, and they contain virtually no accessions of wild species. For that reason it is particularly important that CIAT conserve and document this germplasm.

Benefits: These projects preserve the genetic variability of three important groups of species, which are essential for food security and are at risk of genetic erosion. The projects also support the work of national genetic resources and breeding programs by providing germplasm and related information.

Research Partners: Various national programs and universities in Latin America, Africa, and Asia; IPGRI

Project UG01: Conservation of the Agrobiodiversity of *Phaseolus* Beans

Purpose: To assemble, conserve, and characterize the *Phaseolus* bean germplasm collection through established and new management techniques

Outputs and activities:

- A *Phaseolus* collection, including germplasm of the five cultivated species and their wild relatives
  - Organize collecting expeditions to fill genetic and geographical gaps.
  - Acquire additional variability through germplasm exchange.

- Gather genetic stocks (including biochemical and morphological mutants) that are important for strategic research.
- Establish a network to assemble a wild *Phaeolus* collection.
- Process the germplasm backlog (4,000 accessions).

- Optimal seed quality and quantity for short- and long-term conservation
  - Maintain the germplasm collection in short-and long-term storage.
  - Multiply germplasm of the five domesticated species to meet demand for storage and distribution.
  - Monitor seed quality, using established techniques.
  - Duplicate the collection in at least two other countries.
  - Acquire new techniques for avoiding genetic erosion.
  - Carry out in situ conservation of wild *Phaseolus* species.
  - Support regional cooperation in ex-situ conservation and molecular characterization of the agrobiodiversity of *Phaseolus* in Mesoamerica and the Andean zone.

- A thoroughly characterized and evaluated collection of the cultivated species of *Phaseolus* and a better understanding of their genetic variability
  - Characterize the germplasm in the field for important morphological descriptors.
  - Acquire knowledge on molecular and biochemical characterization.
  - Acquire knowledge on seed image characterization and establish a bank of images.
  - Gain a better understanding of the genetic variability available, using molecular markers, biochemical methods, and DNA fingerprinting with RAPDs.
  - Establish core collections for *P. vulgaris, P. coccineus,* and *P. acutifolius.*

- Proper documentation of the *Phaseolus* collection to improve data management and analysis
  - Complete passport data for all cultivated species, including primary and secondary centers of diversity.
  - Develop a computer database for the entire germplasm management process.
  - Publish catalogs, in printed and electronic form, of the cultivated species.
  - Investigate pattern analysis packages to improve data use.

- Improved availability of the germplasm to scientists in national and international institutions
  - "Clean" the core collection of *P. vulgaris* for international distribution.
  - Establish protocols for international germplasm distribution (under an ICA-CIAT agreement).
  - Distribute seeds and information to national and international organizations.

Senior staff:
Agronomist 0.35

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
UG01	Conservation of the Agrobiodiversity of *Phaseolus* Beans	-	280	280	40	291	331
	Total	**-**	**280**	**280**	**40**	**291**	**331**

Project UG02: Conservation of the Agrobiodiversity of Tropical Forages

Purpose: To assemble, conserve, assess, and deploy genetic resources of forages (using established and new management techniques) for sustainable production systems in the humid and subhumid tropics

Outputs and activities:

- Increased genetic variability and geographic representation in the collection
  - Exchange germplasm with other international centers and national programs.
  - Organize collecting expeditions to fill genetic or geographical gaps in the collection.

- Sufficient quality and quantity of seed for long- and short-term storage
  - Take post-entry phytosanitary measures under an ICA-CIAT agreement
  - Monitor seed quality (physical, sanitary, physiological, and genetic).
  - Multiply clean seed to ensure that enough is available for conservation and distribution.
  - Maintain seed quality seed in short- and long-term storage.
  - Investigate reproductive biology.
  - Investigate seed quality and physiology.

- Measurements of genetic variability
  - Describe morphological characters and identify key descriptors.
  - Carry out biochemical characterization of key species.
  - Determine the taxonomy of accessions.
  - Conduct specialized taxonomy studies on key germplasm.
  - Conduct studies on genetic variability.

- Improved data management for more efficient germplasm use
  - Complete passport documentation.
  - Computerize germplasm management.
  - Publish plant descriptor booklets on key genera.
  - Publish germplasm catalogs containing characterization and passport data.
  - Study the geographic distribution of species and/or genera.
  - Establish a genetic resources network for tropical forages.

- Improved availability of germplasm to researchers
  - Assure that the germplasm meets sanitary standards under an ICA-CIAT agreement.

- Update the mailing list.
- Distribute catalogs.
- Obtain feedback.

Senior staff:
Agronomist 0.35

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
UG02	Conservation of the Agrobiodiversity of Tropical Forages	-	256	256	30	264	294
	Total	-	**256**	**256**	**30**	**264**	**294**

Project UG03: Conservation of the Agrobiodiversity of Cassava Species

Purpose: To assemble, conserve, and characterize the in vitro and field collections of *Manihot* germplasm through established and new management techniques

Outputs:

- A *Manihot* collection, comprising cultivated and wild species
  - Organize collecting expeditions to fill genetic and geographical gaps in the germplasm of cultivated species.
  - Organize expeditions in the primary centers of diversification to collect wild species.
  - Incorporate germplasm from countries not yet represented in the collection.

- Optimal in vitro and field management for short- and long-term conservation
  - Maintain the in vitro collection of cultivated and wild species.
  - Maintain the field collection of cultivated species.
  - Duplicate the core collection in vitro in two countries.
  - Investigate methods for conserving wild species.
  - Monitor the genetic stability of the in vitro collection.
  - Develop cryopreservation techniques for long-term storage.
  - Help develop a global network for ex situ conservation of domesticated species.

- Well-characterized and evaluated germplasm and a good understanding of the genetic variability available
  - Carry out biochemical and molecular characterization of cultivated species.
  - Identify duplicates of cultivated species by means of DNA fingerprinting.
  - Study the genetic variability of cultivated and wild species.
  - Characterize the core collection at the molecular level according to geographic diversity.

- Proper documentation of the *Manihot* collection to improve data management and analysis
  - Develop a global database for cultivated and wild species.
  - Complete passport data for cultivated and wild species.
  - Publish catalogs, in printed and electronic form, of the cultivated species.

- Improved availability of the germplasm to national and international institutions
  - Develop improved methods to "clean" the germplasm for international distribution.
  - Establish protocols for safe international exchange (under an ICA-CIAT agreement).
  - Disseminate information through catalogs and a computer database.

Senior staff:
Agronomist 0.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
UG03	Conservation of theAgrobiodiversity of Cassava Species	-	221	221	30	229	259
	Total	**-**	**221**	**221**	**30**	**229**	**259**

Project Area: Genetic Diversity

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	-	757	757	100	784	884
	Complementary	-	-	-	-	-	-
Total		**-**	**757**	**757**	**100**	**784**	**884**

Virology Research Project Area VC: Characterization of Plant Viruses

Purpose: To facilitate the collection, maintenance, and utilization of plant genetic resources of CIAT's mandate crops by characterizing viruses of economic and quarantine significance

Background: Regardless of the degree of symptom expression, most plant viruses cause significant economic losses, affecting the yield and quality of food and forage crops as well as their reproductive capacity. Viruses are also the main subject of quarantine regulations, since they are the most difficult pathogens to detect in reproductive material. The introduction of exotic plant viruses in a virus-free agroecosystem threatens, not only the plant species in which a virus is introduced, but other cultivated plants as well.

Benefits: Characterization of viruses facilitates the exchange and utilization of plant genetic resources and is critical for implementing suitable plant disease control strategies that reduce or eliminate the need for pesticides.

Well-equipped virology facilities are rare or nonexistent in most developing countries. Most collaborating national programs in Latin America, Africa, and Asia benefit from the distribution of diagnostic materials or from a diagnostic center that can identify the viral pathogens attacking their crops. To prevent the introduction of exotic plant viruses, most developing countries rely on the seed health services of the international centers to ensure safe exchange of plant genetic resources.

Research Partners: Advanced virology laboratories in developed countries, including France, the UK, The Netherlands, and the USA, as well as some in developing countries, including Costa Rica, Brazil, and Guatemala

Project VC01: Genetic Interaction Between *Phaseolus vulgaris* L. and Economically Important Bean Viruses

Purpose: To identify virus resistance mechanisms and implement suitable bean improvement strategies

Outputs:
- Genes for resistance to bean viruses
- Improved procedures for screening bean germplasm
- Suitable breeding strategies

Activities:
- Conduct genetic studies on the interaction of bean genotypes with selected viruses.
- Develop reliable inoculation procedures.
- Select homozygous, virus-resistant bean genotypes.

Donor: Italian government, core

Time frame: 1994-1995

Senior staff: Virologist 0.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VC01	Genetic Interaction between *Phaseolus vulgaris* L. and Economically Important Bean Viruses	30	36	66	30	36	66
	Total	**30**	**36**	**66**	**30**	**36**	**66**

Project VC02: Characterization of Viruses Infecting *Manihot esculenta*

Purpose: To identify viruses that affect cassava production in the American tropics

Outputs:
- Reliable cassava virus detection techniques
- Virus-free cassava germplasm
- Safe international exchange of cassava germplasm

Activities:
- Isolate and characterize cassava viruses.
- Index cassava germplasm, using sensitive virus-detection techniques.
- Produce virus-free reproductive material.

Donor: UNDP, core

Time frame: 1993-1997

Senior staff: Virologist 0.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VC02	Characterization of Viruses Infecting *Manihot esculenta*	30	59	89	30	59	89
	Total	**30**	**59**	**89**	**30**	**59**	**89**

Project VC03: Molecular Characterization of Rice Hoja Blanca Virus (RHBV)

Purpose: To produce RHBV-resistant rice cultivars

Outputs:
- A genetic map of RHV
- c-DNA probes for diagnostic purposes and studies on virus ecology (IPM)
- Improved germplasm screening methodologies
- Rice genotypes bred for RHBV-resistance

Activities:
- Carry out molecular characterization of RHBV genomic components.
- Clone and sequence RHBV's genome.
- Use improved diagnostic tools to select RHBV resistant rice germplasm.
- Select RHBV-resistant parental genotypes and resulting lines.

Senior staff:
Virologist 0.10

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VC03	Molecular Characterization of Rice Hoja Blanca Virus (RHBV)	10	31	41	10	31	41
	Total	**10**	**31**	**41**	**10**	**31**	**41**

Project VC04: Characterization of Viruses Affecting Tropical Forages

Purpose: To characterize viruses that affect the collection, exchange, and use of tropical forage germplasm

Outputs:
- Improved virus detection techniques
- Virus-free forage germplasm
- Safe international exchange of germplasm
- Virus-resistant forage germplasm

Activities:
- Isolate and characterize tropical forage viruses.
- Index tropical forages for presence of viruses.
- Testing vegetative reproductive material and seed of tropical forage species.
- Evaluate forage germplasm collections.

Senior staff:
Virologist 0.40

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VC04	Characterization of Viruses Affecting Tropical Forages	40	73	113	40	73	113
	Total	**40**	**73**	**113**	**40**	**73**	**113**

Project Area: Characterization of Plan Viruses

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	110	199	309	110	199	309
	Complementary	-	-	-	-	-	-
	Total	**110**	**199**	**309**	**110**	**199**	**309**

Virology Research Project Area VP: Control of Plant Viruses Affecting CIAT's Mandate Commodities

Purpose: To help control plant viruses and their insect vectors by selecting virus-resistant plant germplasm and implementing integrated pest management practices

Background: Plant viruses affect the yield and quality of plant products and restrict the utilization of plant genetic resources.

Benefits: Identifying sources of genetic resistance and transferring this resistance to cultivated plants is the most effective way to reduce pesticide use on food crops. Virus-resistant cultivars are a key componet of integraged pest management practices.

Most national programs in developing countries lack the capacity to screen for viruses in support of plant improvement. It is therefore essential that CIAT develop improved cultivars by identifying sources of virus resistance in germplasm banks and applying efficient disease screening methods and that it certify superior plant germplasm with resistance to plant viruses.

Research Partners: National plant breeding institutions around the world and agricultural research institutes interested in integrated pest and disease management

Project VP01: Screening for Viral Disease Resistance in *Phaseolus vulgaris* L.

Purpose: To produce virus-resistant bean genotypes possessing yield stability

Outputs:
- Genetic sources of virus-resistance
- Virus-resistant lines
- Improved bean cultivars possessing resistance to economically important viruses

Activities:
- Evaluate bean germplasm accessions.

- Select lines possessing resistance to bean viruses.
- Recombine mechanisms of resistance in high-yielding bean cultivars.

Donor: Italian government, core

Time frame: 1994-1995

Senior staff: Virologist 0.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VP01	Screening for Viral Disease Resistance in *Phaseolus vulgaris* L.	30	58	88	30	58	88
	Total	**30**	**58**	**88**	**30**	**58**	**88**

Project VP02: Integrated Control of Cassava Viruses

Purpose: To control the spread and reduce the economic impact of the main viruses affecting cassava in the American tropics

Outputs:
- An epidemiological model for cassava vein mosaic virus
- Virus-free cassava germplasm
- Action thresholds

Activities:
- Identify virus vectors.
- Develop rapid diagnostic tools.
- Carry out disease loss assessments.

Donor: UNDP, core

Time frame: 1993-1997

Senior staff:
Virologist 0.30

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VP02	Integrated Control of Cassava Viruses	30	35	65	30	35	65
	Total	**30**	**35**	**65**	**30**	**35**	**65**

Project VP03: Genetic Transformation of Rice Plants for Resistance to the Rice Hoja Blanca Virus (RHBV)

Purpose: To produce plants with durable resistance to RHBV, using nonconventional breeding methods

Outputs:
- Transgenic RHBV-resistant rice plants
- A genomic map for RHBV

Activities:
- Transform rice plants with virus-derived genomic components.
- Clone and sequence RHBV.

Donor: Rockefeller Foundation, core

Time frame: 1993-1995

Senior staff: Virologist 0.30

Subproject VP03: Genetic Transformation of Rice Plants for Resistance to the Rice Hoja Blanca Virus

(See rice complementary subproject RP53.)

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
VP03	Molecular Characterization of Rice Hoja Blanca Virus	30	41	71	30	41	71
VP13	Genetic Transformation of Rice Plants for Resistance to the Rice Hoja Blanca Virus	-	10	10	-	10	10
	Total	**30**	**51**	**81**	**30**	**51**	**81**

Project Area: Control of Plant Viruses Affecting CIAT's Mandate Commodities

Code	Name of Project	Working budget 1994			Estimated 1995		
		Senior	Operations	Total	Senior	Operations	Total
	Core	90	144	234	90	144	234
	Complementary	-	-	-	-	-	-
	Total	**90**	**144**	**234**	**90**	**144**	**234**

Land Management Project Area UT: Research Support Services and Coordination

Purpose: To provide CIAT programs and partners with the tools and information needed to plan research on commodities and research management

Rationale: In the CGIAR system, CIAT is the recognized leader in GIS, which is an invaluable specialized resource for virtually every area of the Center's work.

CIAT is also a recognized leader in the development of large spatial databases for agricultural and ecosystem analysis. These databases take a long time to develop and require constant maintenance.

Over the last 16 years, for example, the Center has produced, if not the best, one of the best, climate databases for the tropics. It is used by almost every program and project in CIAT. It is also widely distributed to other CGIAR centers and to major institutions throughout the world. Data from some 18,000 stations are now held in the files.

Benefits: CIAT's GIS capabilities and databases are vital for ensuring that the Center's research planning is based on accurate information about our mandate crops and the conditions under which they are grown and about our mandate agroecologies and resource management within them.

Project UT01: Maintenance of the GIS Facility

Purpose: To maintain an effective GIS unit to handle the GIS needs of CIAT in the day-to-day conduct of its business

Outputs and activities:

- Mapping and satellite imagery
  - Provide facilities for map database preparation, including hand digitizing and scanning.
  - Perform remote sensing/image analysis as required.
  - Provide facilities for the integration of scientific, natural resource, and socioeconomic data in a relational database and link it to the map database mentioned above.
  - Provide ground survey facilities, including global positioning satellite surveys, to support program activities.
  - Provide suitable software and programming facilities for data analysis, modelling, and interpretation.
  - Provide map output facilities.

Senior staff:
GIS management specialist 0.70

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
UT01	Maintenance of the GIS Facility	70	193	263	70	193	263
	Total	**70**	**193**	**263**	**70**	**193**	**263**

Project UT02: Background GIS/Database Activities Needed to Maintain Credibility and Flexibility in Handling Spatially Referenced Data

Purpose: To maintain current databases and develop new ones that make data readily available for CIAT initiatives

Outputs and activities:

- Databases that facilitate research planning
  - Translate current databases to the UNIX system and Oracle database.
  - Provide staff training in new technologies (such as satellite image analysis, scanning, and radar interpretation) to ensure that databases are prepared efficiently.
  - Convert existing GIS coverages to ARC/INFO.
  - Secure socioeconomic data and crop distribution and cropping system data for areas where CIAT has major projects.
  - Maintain the legally protected areas dataset.
  - Update the map database.

Senior staff:
GIS management specialist 0.30

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
UT02	Background GIS/Database Activities Needed to Maintain Credibility and Data Flexibility in Handling Spatially Referenced	30	81	111	30	81	111
	Total	**30**	**81**	**111**	**30**	**81**	**111**

Project UT03: CIAT Climate Database for the Tropical World

Purpose: To maintain and update the database and conduct innovative research on new methods of applying the data

Outputs and activities:

- An up-to-date climate database and new applications for it
  - Translate the database from the IBM VM/CMS system to create a new user environment under UNIX.
  - Add new data and correct errors as these are found or reported.
  - Distribute and/or sell copies of the database or subsets of the data.
  - Develop and update interpolated climate surfaces from the point data held in the interactive database.
  - Develop new interpolation techniques for incorporating stochastic effects for the analysis of climatic risk.
  - Develop a CIAT CD-ROM based on the data, the interpolated surfaces, and the markov models.

Senior staff:
Geographer 1.00

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
UT03	CIAT Climate Database for the Tropical World	100	169	269	100	169	269
	Total	**100**	**169**	**269**	**100**	**169**	**269**

Project UT04: Diagnostic Surveys and Research Planning for the Brazilian Amazon and Lowland Savannas of South America

Purpose: To provide a sound basis for developing technologies and policies that contribute to sustainable agriculture by studying the dynamic processes underlying patterns of land use

Outputs and activities: See complementary subprojects below.

Complementary subproject UT51: A diagnostic study of agricultural land use in the southwest Brazilian Amazon

Purpose: To analyze the social, cultural, economic, political, and ecological factors that shape the development of land use patterns in colonized areas of the states of Acre and Rondonia

Outputs:
- A systematic framework for the dynamics of land use
- A diagnostic of current land use
- A report of the study's findings

Donor: IDB

Research partners: EMBRAPA, PESACRE

Time frame: 1994-1995

Senior staff: Anthropologist 0.50

Complementary subproject UT52: Strategies for sustainable agricultural land use in the lowland savannas of South America, a planning study

Purpose: To complete a planning study for a detailed research proposal on sustainable agricultural development in the lowland savannas of Bolivia, Brazil, Colombia, and Venezuela

Outputs:
- Committed national partners
- Position papers on national priorities
- Comparative analyses
- A detailed proposal

Donor: DGIS

Research partners: National programs, NGOs, and private institutions in Bolivia, Brazil, Colombia, and Venezuela; the Research Institute for Agrobiology and Soil Fertility (AB-DLO)

Time frame: 1994

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
UT04	Diagnostic Surveys and Research Planning for the Brazilian Amazon and Lowlands Savannas of South America	300	465	765	300	465	765
	Complementary:						
UT51	A Diagnostic Study of Agricultural Land Use in the Southwest Brazilian Amazon	-	400	400	-	-	-
UT52	Strategies for Sustainable Agricultural Land Use in the Lowland Savannas of South America	-	75	75	-	-	-
	Total	**300**	**940**	**1,240**	**300**	**465**	**765**

Project Area: Research Support Services an Coordination

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	500	908	1,408	500	908	1,408
	Complementary	-	475	475	-	-	-
Total		**500**	**1,383**	**1,883**	**500**	**908**	**1,408**

Impact Assessment Project Area UI: Research Impact

Purpose: To generate information that helps guide the allocation of CIAT resources, improve the quality of Center's outputs, and indicate the returns to stakeholders' investments

Rationale: No CGIAR center has ever made a fully quantitative estimate of potential impact, based on multiple decision criteria, at the project level. At best most models use "indicators" of the underlying variables that need to be measured. These indicators are misleading and difficult to use in comparisons.

Little work has been done on research impact at the level of agroecologies, particularly with respect to off-farm and other sustainability impacts. Nor has much been done on the impact

of methods (e.g., biotechnology) or of genetic resources conservation and related work. The CG system has yet to disaggregate the benefits of research by country or subregion.

Benefits: CIAT management can use an assessment of the socioeconomic returns to research investments in deciding about resource allocation. Information on the acceptability and adoption of CIAT's outputs serves two purposes. It provides feedback for improving the generation and delivery of outputs, and it gives stakeholders a measure of the returns to their investments in CIAT.

Project UI01: Ex Ante Analysis of Returns to Research

Purpose: To estimate the expected contribution of CIAT project outputs to economic growth (efficiency), equity (poverty alleviation), and sustainability of the natural resource base.

Outputs:

- Aggregate continental-scale models of the economic growth and equity benefits of germplasm improvement or commodity research
- Disaggregated ecosystem-scale models of the benefits of commodity research
- Agroecosystem-scale models of the benefits of resource management research
- National- or regional-scale models of the benefits of commodity and resource management research

Senior staff:
Economist 0.60

Complementary subproject UI51: The impact of public intervention and technical changes

Purpose: To measure the welfare impact of technical change and public intervention in agriculture in Brazil, Colombia, Mexico, and Peru.

Research partner: University of Georgia

Donor: Italian government

Time frame: 1994-1995

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
UI01	*Ex ante* Analysis of Returns to Research	60	112	172	60	112	172
	Complementary:						
UI51	The Impact of Public Intervention and Technical Changes	-	60	60	-	-	-
	Total	**60**	**172**	**232**	**60**	**112**	**172**

Project UI02: Monitoring the Acceptability, Adoption, and Impact of CIAT Outputs

Purpose: To document the acceptability and adoption of CIAT outputs.

Outputs:

- Review of the literature to document historic adoption and impact of CIAT outputs
- Feedback on the acceptability of new forages and of integrated pest management for beans in Colombia
- Feedback on the acceptability and adoption of new agropastoral systems in Brazil and of new legume forage species and bean varieties in Central America.
- Studies on the adoption and impact of integrated pest management and bean varieties in Ecuador and Peru.

Senior staff:
Economist 0.40

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
UI02	Monitoring the Acceptability, Adoption and Impact of CIAT Outputs	40	170	210	40	170	210
	Total	**40**	**170**	**210**	**40**	**170**	**210**

Project Area: Impact Research

Code	Name of Project	Working budget 1 9 9 4			Estimated 1 9 9 5		
		Senior	Operations	Total	Senior	Operations	Total
	Core	100	282	382	100	282	382
	Complementary	-	60	60	-	-	-
Total		**100**	**342**	**442**	**100**	**282**	**382**

Institutional Relations and Development Support

All CIAT managers and scientists participate in institutional relations and development (IRD), collaborating, in varying degrees, with partners, donors, and the scientific and agricultural community in general. The goal is to develop and enhance agricultural research and development (R&D) in tropical countries.

But certain activities at CIAT, such as library services, communications, and training, are gathered into the division of Institutional Relations and Development Support (IRDS) to give centralized and specialized support to IRD activities. Integrated, CIAT-wide strategies and economies of scale can therefore be established.

Goals

The IRDS pursues two goals:

- *Effective and efficient agricultural R&D,* in accordance with CIAT's mandated responsibilities; and
- *An appropriately funded and effectively operational CIAT, collaborating with partners of targeted countries.*

Effective and efficient agricultural R&D

The IRDS follows three strategies to support and increase the effectiveness and efficiency of agricultural R&D:

- To help scientists be well informed;
- To assist scientists in performing effectively; and
- To facilitate the dissemination of appropriate technology, and research methods and management.

Well-informed scientists. The Information and Documentation Unit provides rapid access to current worldwide bibliographic information for scientists at CIAT and at relevant R&D institutions in targeted countries.

The Unit keeps abreast of the rapidly advancing information technology and links CIAT to worldwide networks to provide efficient but cost-effective services to its users. In round figures, the Unit also annually subscribes to 2,000 journals, acquires 2,200 books and other information products, undertakes 3,000 database searches, answers 5,000 reference questions, lends 6,000 publications, and supplies 20,000 photocopied documents.

The Communications Unit informs the scientific community of CIAT's R&D activities and results. Information on problem analysis and diagnosis, on-going research, methods, consolidated results, interinstitutional collaboration, scientific meetings, and impact assessment is packaged in formats such as bulletins, monographs, reports, manuals, proceedings, catalogs, newsletters, and in visual and electronic media.

Because CIAT's media production is bilingual—English and Spanish—the heavy demand for translations is met by machine-aided translation for English to Spanish and by native English-speaking writers and editors for Spanish to English.

Publications are produced in-house, in judicious combination with outside production services to optimize cost-effectiveness and timeliness of output. Annual production is about 20 scientific publications; and distribution invovles 25,000 to 30,000 books, 4,000 study guides, and several hundred audiotutorials.

Overall output, including public awareness materials (see below) is over 3.5 million printed pages; over 2,000 pages of camera-ready text, about 73,000 slides, and over 10,000 black-and-white and color photographic prints.

Trained scientists. Training is a powerful mechanism for enabling scientists in relevant R&D institutions in targeted countries to better perform their jobs. For training in germplasm development, CIAT offers specialized training to experienced scientists in highly customized programs. This precisely focused and labor-intensive approach to human capital development involves about one hundred trainees yearly.

CIAT has always provided opportunities for training through research programs leading to higher degree theses (M.S. and Ph.D.). The number of higher degree trainees is expected to increase, whereas that for trainees for introductory courses will be reduced.

CIAT has just begun offering training in resource management research. At first, broadly based, group training may be necessary, as had been the case for training in germplasm research. The new responsibilities will probably be tackled as an interinstitutional endeavor in which CIAT and partners would address needs and opportunities, and seek financial resources to meet them, on an ad hoc basis.

For scientists to be more productive, research increasingly must be a collaborative undertaking, whether as multidisciplinary teams, consortia, networks, or other interinstitutional arrangement. CIAT has a strong record of successful networking and interinstitutional cooperation. The IRDS supports its interinstitutional efforts through partner

identification, project design, and facilitating effective interinstitutional linkages—all crucial to CIAT's research strategy, which depends heavily on interinstitutional collaboration and complementarity.

Intermediaries of technology and methodology extension. Although CIAT has no comparative advantage for training extensionists for technologies or methodologies, it does have an advantage for developing the capacities of national and subregional programs to train intermediaries. That is, CIAT trains national or subregional teams of trainers, who operate as bodies with recognized authority to train, create their own modern training materials, and are integrated in a properly designed and funded project that will give them continuity for 3 to 5 years.

Eight training bodies have been successfully established, for bean production in Central America; cassava production in the Southern Cone (Paraguay, southern Brazil, and Northeast Argentina); rice production in Ecuador, Colombia, Venezuela, and Dominican Republic; research management in Latin America (in collaboration with ISNAR); and training municipal extension agents in office administration (in collaboration with the Colombian Ministry of Agriculture). Plans are being made to develop training bodies for farmer participatory research.

CIAT's activity in developing training capacities is financially self-sustained because its services are contracted out at full cost to customers, who include CIAT projects, other IARCs (e.g., ISNAR), and other institutions (e.g., Colombian Ministry of Agriculture).

Appropriately funded and effectively operational CIAT

Fund-raising and collaboration with partners are coordinated by Management and implemented with the participation of all senior scientists. The IRDS provides support through media development and distribution, and project development.

Well-informed audiences. CIAT is accountable to its shareholders and stakeholders.

Donors and their constituents must perceive CIAT as an institution in which investments are well made. Similarly, decision-makers and their constituents in targeted countries must perceive CIAT as a valuable partner and worthy of political support. The Center must therefore not only have the required qualities, but also be seen as having them.

Both accountability and the need to be seen as worthy oblige CIAT to keep donors, national decision-makers, and their constituents, well informed of the Center's objectives, activities, use of resources, outputs, and impact.

Personal and media communications, coordinated by CIAT's Management, are a means to this end. The IRDS advises on, and implements, media communications, following a two-pronged approach. Certain media for broad distribution are targeted at the constituents of donors and national decision-makers. Other media are more narrowly targeted to the donors and decision-makers themselves. Still other media are directed to both audiences.

Publications include CIAT's *Annual Report*; press releases (about two per month); *CIAT On-Line*, a two-page bulletin with 5-6 research highlights, issued four times yearly; videos; posters; brochures; and ad hoc publications.

Projects for partnership and financial support. Projects are the basic organizational arrangement for collaborative research. They harness financial resources for specified ends and facilitate processes of accountability of partners and to donors.

The IRDS supports participatory project planning with partners, helps prepare project proposals with high technical quality and communication effectiveness, and submits them opportunely to appropriate donors.

Conferences and visitors support. Bringing people together in conferences and receiving visitors are two important mechanisms that link CIAT with partners and donors, and with members of local and other communities. The provision of specialized support for conferences and visitors contributes to the IRDS' two overall goals and also serves the more general communication needs of CIAT's scientists. These activities are combined into a section of their own within the IRDS.

Conferences help serve strategic and operational planning; networking; exchange of scientific information and discussion of research issues; linkage with farmers; and miscellaneous matters. Visitors come to interact with CIAT staff and management, and for information on CIAT.

Specialized support for conferences includes maintenance and development of conference facilities; conference design; and pre-conference and conference logistics. Visitors are helped to plan their visits and, during visits, to make contacts with CIAT staff and find housing and transport, and ensure their well-being.

Funding Strategies

The services and products provided by the IDRS are funded in various ways: with core resources; by subcontracting services; by customers; with ad hoc projects; and from indirect cost recovery.

Core funding. Core resources are used to fund permanent basic services such as CIAT's bibliographic information bank, the public awareness services to maintain favorable attitudes among shareholders and stakeholders, and a skeleton support staff for attending pre-event and event logistics of Training and Conferences. The conferences

and training events themselves, however, are funded by third parties, such as CIAT programs and units, external customers, and donors, or by ad hoc projects.

Subcontracting services. Some services, for which only minimal core funding is given such as training trainers, are subcontracted to CIAT or external customers.

Services paid for by customers. Other services are charged to customers, on a partial or full cost basis. Partial cost recovery usually covers operational but not personnel costs, for example, certain library services, graphic arts services, and training. These services will gradually shift to full-cost recovery rates to all customers. For CIAT customers, this shift will be facilitated by the new system of budgeting by project: *all projects must now budget for IRDS services and products.*

For external customers, some subsidies will still be available, lest partners from poorer nations be cut off from vital information and training services.

Ad hoc projects. Ad hoc projects fund the production of specific outputs, such as a book or CD-ROM; specific training events, such as a course, set of training fellowships for a given purpose, or conference; and a trial activity or service, such as a new information service. When an ad hoc activity needs to become a permanent service, then other funding mechanisms must be used, such as long-term core funding or cost recovery charges to customers.

Indirect cost recovery. The IRDS' project development capacity is funded completely from indirect cost recovery.

		Working budget 1 9 9 4			**Estimated 1 9 9 5**		
Code	**Name of Project**	Senior	Operations	Total	Senior	Operations	Total
NL	Linkages	100	195	295	100	195	295
NT	Training and Conferences	-	807	807	-	807	807
NT12	Training trainers	-	170	170	-	170	170
NI	Information and Documentation	100	526	626	100	526	626
NP	Publications	100	312	412	100	312	412
NB	Bussisness Development	100	217	317	100	217	317
ND	Project Development	-	-	-			
	Total	**400**	**2,227**	**2,627**	**400**	**2,227**	**2,627**
	Complementary:						
NT	Training and Conferences	-	293	293	-	463	463
	Total	**-**	**293**	**293**	**-**	**463**	**463**

Research Services

Laboratory Services

Purpose: To provide centralized research services such as advanced research equipment, facilities, and laboratories, and their maintenance, for all CIAT programs, projects, and units.

Activities/Services:

- Provide mass spectrophotometry and mycorrhizae laboratories.
- Provide equipment and technical support for soil and plant analyses.
- Provide basic inputs for laboratory processes, such as specialized microscopic and microphotographic services of high quality, small animals (mice, rabbits, hamsters), water of quality for chemical and microbiological processes, germplasm, inocula and evaluations pertinent to mycorrhizae and rhizobia, adequate site for work with radioisotopes, and analyses of stable isotopes.
- Provide preventive and corrective maintenance for all equipment used in research.
- Assign spaces for and provide plant growth facilities (screenhouses, greenhouses, growth rooms, and growth chambers).
- Provide storehouses and worktables.
- Store and prepare soils: provide sheds and paved yards, and steam treatment.
- Incinerate organic and chemical wastes.
- Provide technical consultancy on the design and climatic characterization of installations.

Biometry Unit

Background: As a science-based institution, CIAT relies heavily on statistical and mathematical sciences and tools for research design and analysis of research results.

Purpose: To provide advisory and methodological support in statistical and mathematical sciences to CIAT researchers.

Activities/Services:

- Provide statistical and mathematical advice in experimental design, data analysis methodology, and interpretation of results, together with their forecasting ability and final presentation.
- Conduct collaborative methodological studies and specific data analysis projects with CIAT scientists, aimed at responding to relevant research questions.
  - Evaluate and recommend appropriate experimental designs for a given research.

- Identify and quantify sources of variation affecting specific response variables to support research planning.
- Evaluate the efficiency, accuracy, and applicability of different statistical analysis methodologies for a given research problem and accordingly recommend appropriate ones.

- Develop "MACROS," that is, software programs for users to implement specific statistical analysis methodologies.

- Train personnel from CIAT research programs and selected groups from national programs in basic biometrical methods and research data analysis techniques.

- Assist CIAT to define centerwide standards for statistical and mathematical software. Current standards include SAS/BASICS, SAS/STATS, SAS/ETS, SAS/IML, SAS/GRAPH, SAS/OR, GENSTAT, MSTAT, GLMM, and AGROBASE/4.

Field Operations

Purpose: To provide machinery and irrigation services for research and crop production activities at the Palmira, Quilichao, Popayán, Santa Rosa, and Carimagua CIAT stations and at off-station experiment sites.

Activities/Services for All CIAT Experiment Fields:
- Build and maintain roads, fencing, and irrigation and drainage structures.

- Maintain, repair, and operate farm machinery.

- Manage commercial production of crops, seed plants at Palmira, Quilichao, and Popayán, and the cattle herds at Quilichao and Carimagua.

Information Management Unit

Background: To develop its information functions, CIAT has a central group of specialists to coordinate information management and analysis. Information is grouped in "domains" that reflect CIAT's new research strategy. These domains are Geographic Information System; Socioeconomics; Germplasm Development; Soil and Plants; Bibliography and Documentation; Institutional Development; and Financial and Administrative.

CIAT was recently accepted as member of INTERNET. Electronic information flow to and from CIAT is now technically feasible.

Purpose: To efficiently manage CIAT's information resources by providing a centralized policy, coordinating activities, services, and resources, and giving technical advice and support to all CIAT research programs and units.

Overall Activities/Services:

- Develop long-term policies and strategies for information management within CIAT and between CIAT and its partner institutions.

- Develop decentralized hardware and software components and standards for various information domains.

- Develop CIAT policy on hardware and software acquisition, maintenance, and growth.

- Maintain the central LAN communications equipment and servers.

Activities/Services for Databases and Information Systems Development at CIAT:

- For each information domain, create a "database team" with expertise specific to that domain. Team members are (a) the systems analyst, or software expert, (b) the researcher(s), and (c) the biometrician.
  - The team will conceptualize, design, implement, and maintain the databases or information systems required for that domain, developing procedures for information input, processing, storage, and analysis.

- Create a Databases/Information Systems Development group who will:
  - Develop standards for database management software for micros, and LAN environments, and methodology for applications development.
  - Support the different domains in database development.
  - Design, implement, and maintain institutional research and research-related databases in close collaboration with CIAT research programs and units.
  - Train users to operate existing databases.

Management and Administration

Board of Trustees

Background: The Board of Trustees consists of 17 members, four of whom are ex officio (the CIAT Director General, the Colombian Minister of Agriculture, the Director of CORPOICA of Colombia, and the President of the Colombian National University). Standing committees are the Program Committee, the Executive Committee, and the Audit and Operations Review Committee.

Activities/Services:

- Board meetings may take place several times a year. On the average, a Board member invests about 15 work days per year in Board activities.
- A small Board secretariat is maintained at headquarters.

Office of the Director General

Background: The Director General is the chief executive officer of the institution.

Activities/Services:
- Report to the Board of Trustees.
- Oversee the Offices of the Deputies Director General (Research and Finance & Administration), the Associate Director for Institutional Relations, and the Internal Auditor.
- Organize reviews of CIAT programs by external reviewers.

Internal Audit

Purpose: To assist the Board and Management to discharge their responsibilities with respect to financial reporting and internal controls. It also assists Management to evaluate the efficiency and effectiveness of operations and monitor compliance with management policies.

Activities/Services:
- Review and evaluate internal controls of administrative, operative, and accounting areas by periodically testing transactions considered to be high risk.
- Verify the execution of the CGIAR accounting policies and "reporting practices" manual.
- Continue verifying the fulfilment of agreements with donors and third parties, and adherence to the Colombian labor code.
- Assist Management to verify the accomplishment of cost reduction measures and rationalization of resources for supplies and services.
- Define controls during the analysis of new computerized systems and important modifications to existing systems to guarantee their implementation for users, fulfilment of management requirements, and their auditability.
- Ensure follow-up of implementation of internal and external audit recommendations.

Office of the Deputy Director General for Finance and Administration

Purpose: Coordinate the financial, budgetary, administrative, and general operations services.

Activities/Services:
- Oversee the Offices of the Controller, Executive Officer, Head of Field Operations, Head of the Information Management Unit and networking services, and Head of International Personnel Administration.

- Mobilize resources and interact with donors and other external entities.

- Attend administrative needs of international personnel.

Office of the Executive Administrator

Purpose: To lead, coordinate, and control the administrative and central services to help create a suitable environment for CIAT's activities.

To fulfil its objectives, the Office of the Executive Administrator works with the Legal Advisory Office, Administrative Support (for outposted activities), CIAT Bogotá Office, and CIAT Villavicencio Office.

Activities/Services:

- Coordinate linkages with governments and national institutions of Colombia and other countries where CIAT carries out activities. Follow up commitments made between CIAT and these institutions.

- Administer CIAT's relationships with entities such as public and private enterprises, universities, institutions, and municipalities. Administer relationships of CIAT and its international staff with the Colombian Ministry of Foreign Affairs and other governmental departments.

- Support international staff on their arrival in Colombia in carrying out the procedures required by the Ministry of Foreign Affairs.

- Direct the Central Services Units: Supplies, Human Resources, Maintenance, and Food and Housing.

Office of the Controller

Purpose: Plan, establish, and maintain an integral plan to control CIAT's financial operations, and create an opportune economic information system to facilitate decision-making.

Activities/Services:

- Manage cash inflow and outflow and foreign exchange hedging operations, invest short-term surplus funds, and maintain relationships with commercial banks, other financial institutions, and legal counsel.

- Coordinate the budget formulation and execution process, carry out cost analysis, and calculate reimbursable services rates.

- Manage accounting operations, including general accounting, accounts payable, accounts receivable, and fixed assets control.

- Prepare financial reports for Management, Board of Trustees, external auditors, and donors.

- Administer international and local payroll systems.
- Conduct financial analyses of research project proposals, and coordinate financial and technical reports of projects to their donors.
- Coordinate all financial matters with outposted stations in Latin America, Africa, and Asia.
- Oversee all automated financial systems and manual procedures, and introduce required changes.

Administrative Systems

Background: Although financial and administrative information is a "domain" properly belonging to the Information Management Unit (p. 3), it differs from the other domains by being administrative in nature rather than of research. It is therefore controlled by Administrative Systems.

Purpose: To administer the information resources (software and hardware), and elaborate and maintain procedures to ensure the opportunity and confidence of the information produced by Finance and Administration.

Activities/Services:
- Maintain and fit current automatic information systems to organizational changes.
- Analyze and design applications for the development of new information systems.
- Advise on the design of norms and procedures for Finance and Administration.
- Assist, through training and problem-solving, in the management of hardware and software that concern financial and administrative applications.
- Administer resources for the IBM AS/400 system.
- Coordinate contracting for the development or purchase of new applications for Finance and Administration.

Central Services

The CIAT headquarters is located at Kilómetro 17, in the countryside, on the road between Cali and Palmira. The Center occupies 525 hectares, of which 58,800 m^2 are built over and 26,000 m^2 comprise roads and parking lots.

Because of the Center's distance from either city, Colombian law requires that CIAT supplies, while observing environmental protection regulations, some of its own utilities such as potable water, sewerage treatment through oxidation lagoons, emergency electricity plants, telephone service by microwaves, secure and comfortable on-campus housing for visiting researchers, catering services, transport for employees, industrial security, and first aid facilities.

The Center has five other rural stations, located in different regions of the country, which must also provide similar services.

Different sections of Central Services are described below:

Supplies

Purpose: To supply CIAT programs, units, and projects with materials, equipment, and services for research in different stations and work sites.

Activities/Services:

- Make local purchases, import goods, contract services, store and control merchandise; and dispatch and deliver merchandise to users in programs, units, and stations.
- Import and export international staff's household goods.
- Export seed samples and materials such as printed materials, tools, equipment.
- Manage, including modify, spaces in offices and warehouses; manage CIAT motor fleet; reassign and sell goods.
- Coordinate national and international mail services; and provide a messenger service within CIAT and from CIAT to Cali and Palmira.
- Coordinate CIAT's air services.

Human Resources

Purpose: To help guarantee that CIAT personnel are committed to the Center's mission and strategies by designing, performing, and evaluating personnel administrative processes.

Activities/Services:

- Ensure compliance with CIAT norms, regulations, and policies, and perform procedures required by governmental entities.
- Apply the Colombian Labor Code, administer salary policies and benefits, organize activities to promote the Center's social well-being, conduct relationships with the labor union; administer the labor pool.
- Recruit personnel, develop induction plans, perform evaluations, relocate and/or promote personnel, provide training, provide counselling for improved work relationships, and provide recreative and sporting activities.
- Interact with the Social Security Institute and family welfare organizations ("Cajas de Compensación Familiar"), and ensure industrial health.

Maintenance

Purpose: To maintain equipment, infrastructure, and available space in excellent condition at minimal cost.

Activities/Services:

- Operate and maintain CIAT's infrastructure: utilities for electricity, water, and sewerage and sewerage treatment; telecommunications; air conditioning; and steam and hot water supplies.
- Transport personnel and supply vehicles and drivers for transport of goods. Supply fuel (propane gas and diesel).
- Maintain buildings, roads, vehicles, and equipment by providing industrial and automotobile mechanical services, instrumentation, telecommunications, painting, carpentry, masonry, and plumbing.
- Advise on and supervise building remodelling and construction of equipment for research.
- Advise on the physicochemical treatment of water used for research.

Food and Housing

Purpose: To provide CIAT with catering and housing services, security, and cleaning services. The security section oversees the security of personnel, materials, equipment, and installations. The cleaning services section is responsible for maintaining the Center in a state of optimal cleanliness.

Activities/Services:

- Provide reception services for the Center's visitors.
- Housekeeping services for on-campus housing and laundry.
- Swimming-pool and sporting services.
- Rent furniture to international staff.
- Provide telephone exchange services for the Center.
- Provide a "Duty Officer" on a 24-hour basis to attend emergencies.
- Provide breakfast, lunch, and dinner for personnel and on-campus residents. Catering services include cafeterias, snack-bar, and main dining-room.
- Provide a 24-hour vigilance service with radio for all installations, control CIAT's principal entrance, and patrol the grounds.
- Maintain the cleanliness of the installations.

Appendix 1: CIAT's Areas of Competence

Scientific Resource Groups

To deliver research outputs effectively through its current program/project structure, CIAT requires a critical mass of scientific, sociological, and technical talent. These disciplinary-based talents are also essential to the future development of the Center's research on commodities and agroecologies.

Because of continuing budget constraints, now and in the future, it will not be possible for each project area to have an adequate internal critical mass. In addition, CIAT must have the capacity to develop strategic research capacity, which not only cuts across the Center's programs and projects but also strengthens and distinguishes our ability to contribute to joint intiatives with our national partners and other CG centers.

The scientific resource groups (SRGs) have been established to encourage innovation within the various disciplines that contribute to CIAT's mission. Each SRG will also be anchored to a particular research unit. The five groups, their overall objectives, and the associated research units are:

1. ***Genetic Diversity***
   Collect, conserve, analyze, evaluate, and distribute genetic diversity within and among selected species to support germplasm development and help other institutions in Latin America characterize, conserve, and monitor a wide range of plant genetic diversity.

   Associated unit: Genetic Resources Unit

2. ***Germplasm Development***
   Identify sources of useful genetic variability, assemble and recombine this variability into pools and complexes for variety development (using both conventional and biotechnology approaches), devise efficient selection techniques for rapid enrichment with desirable genes, and promote networks for disseminating improved germplasm.

   Associated unit: Biotechnology Research Unit

3. ***Disease and Pest Management***
   Provide tools for detecting and monitoring pests and pathogens, gene complexes that can provide durable resistance, biological control agents, and new knowledge about resistance mechanisms and the dynamic relationships between pests, diseases, natural enemies, and their plant hosts.
   Associated unit: Virology Research Unit

4. ***Production Systems and Soil Management***
   Develop sustainable systems that combine plant species in such a way as to increase productivity, maintain adequate soil cover, cycle nutrients efficiently, and increase soil organic matter.

   Associated unit: Soils Research Unit

5. ***Land Management***
   Analyze current patterns of land use and develop tools for designing sustainable land management strategies, with a strong emphasis on community action and government policy.

   Associated unit: Geographic Information Systems

Because they are new, the SRGs will need to evolve in response to needs and challenges. It is also possible that new SRGs may be developed as a result of increased disciplinary demands (e.g., in economics and sociology).

Each of our principal and senior staff will be a member of a specific SRG. A few staff may belong to more than one SRG. Staff assignments are currently being made in consultation with SRG and program leaders.

Institutional Affairs

To deploy its research capacity effectively, CIAT performs a range of essential support functions referred to as institutional affairs. These are divided into four groups:

1. ***Research and development linkages***: Strengthens our ties with others through global information systems, library and documentation services, and collaboration with national systems and international centers in training and technical advice.

2. ***Institutional sustainability***: Mobilizes additional financial resources, diversifying the funding base, through targeted communication and public awareness.

3. ***Operations management***: Administers financial, physical, and human resources and manages legal matters and government relations.

4. ***Center management***: Includes functions and resources provided by the offices of the director general and deputy and associate directors.

Genetic Diversity

In genetic resources research we have considerable capacity for analysis of intraspecific genetic variability and of diversity between species and for *ex situ* conservation of selected species.

This means that we collect, conserve in safe storage facilities, characterize and evaluate (using both conventional approaches and DNA-based marker analysis), and distribute genetic resources freely. To meet phytosanitary standards for the international movement of germplasm under our trusteeship, we ensure the health of seed and other planting material. In performing these activities, CIAT concentrates on the following:

- Food crops and their relatives—*Manihot and Phaseolus*
- Forage legumes—*Arachis, Calopogonium, Centrosema, Chamaecrista, Desmodium, Pueria, and Stylosanthes*
- Grasses—*Andropogon, Brachiaria, Panicum, Paspalum, and Urochloa.*
- Soil biota—Rhizobium and mycorrhizae.

In the past we employed our capacity in this area primarily to support germplasm development. In view of widespread concern about diminishing species diversity, we have begun to broaden our horizon at all levels of biodiversity for those species under CIAT's responsibility. This includes the analysis of genetic diversity within species, diversity among related species, and biodiversity in relation to edaphic and ecological variation.

For example, the Center can support *in situ* conservation by employing molecular techniques in the study of the population dynamics of relevant species and genera in their natural settings within their center of origin. Similarly, we are applying molecular genetics to help develop strategies to establish core collections.

The methods and knowledge we will develop and apply for CIAT crops will be broadly applicable. We plan to provide training opportunities and research facilities for other institutions in Latin America and elswhere to characterize, conserve, and monitor a much wider range of plant biodiversity in keeping with the Biodiversity Convention, which emerged from the Earth Summit.

Expertise Needed

Core Competence	Complementary Competence	Project Area
Genetics		Genetic resource management
Genetics		Diversity - Phaseolus
Genetics		Diversity - Manihot
Genetics		Diversity - tropical forages
Biotechnology		Diversity conservation
Biotechnology	Cassava biotech network	
Molecular biology	Diversity - cassava	
Molecular genetics		Diversity - beans/rice
Molecular biology	Diversity - beans	
Agronomy		Diversity - use of trop. forages

Competence Descriptors

Genetics:

- Acquisition, collection, and exchange of plant genetic resources of mandated crop species and their wild relatives.
- Genetic systems of sexually and asexually reproducing species.
- Description of diversity at the morphological and genetic levels.
- Conservation strategies to maximize genetic diversity in core collections.

Biotechnology:

- In vitro methods of genetic conservation.
- Wide hybridization for alien gene transfer.
- Transformation techniques to introduce foreign genes.
- Diagnostics and protocols to ensure dissemination of clean planting material.

Molecular biology:

- DNA isolation, characterization, and sequence analysis.
- Recombinant DNA technology.
- Molecular probes and markers to analyze DNA sequence variation and develop molecular maps.

Agronomy:

- Procedures for the evaluation of diversity in tropical legumes and grasses for use in agro/silvo/pastoral systems.

Training

- Training and workshops on conservation, description, handling, and dissemination of genetic resources.
- Molecular technologies to analyze species diversity for designing conservation strategies.

Germplasm Development

CIAT applies its strong capacity for genetic improvement of plants strictly to its mandate commodities. In this research we have traditionally concentrated on improving the adaptation of higher yielding germplasm to a broad range of environments, particularly in Latin America, Africa, and Asia. This is a four-stage process.

First, we identify sources of genetic variability to overcome constraints on production imposed by plant pests and diseases and by abiotic stresses, to enhance yield, to improve nutritional or processing quality, and to sustain crop productivity.

Then we assemble and recombine useful genetic variability into gene pools and complexes for variety development. This includes conventional crossing and recombination, novel wide hybridization for interspecific and intergeneric gene transfer, and molecular technology for introduction of defined alien genes and associated regulatory sequences.

The third major component is development of efficient selection strategies for rapid accumulation of desirable genes and gene complexes into adapted genotypes and populations. Conventional selection techniques are now being complemented by biochemical and molecular marker-based selection technologies to speed up the process of selection.

Finally, we foster and promote appropriate networks for effective dissemination of improved germplasm to national plant breeding and variety development programs.

Increasingly, we are taking into account the effects of our mandated crops and their management on the resource base. In so doing our aim is to improve, or at least maintain, production within the context of sustainable agricultural development. This objective will be supported by research aimed at identifying gene complexes associated with efficient use of soil nutrients, water, solar radiation, and which improve soil quality and are compatible with integrated cropping systems in keeping with our agroecological approach to resource management and sustainability.

In addition, we will employ our capacity in plant genetics and improvement to modify the quality traits of the mandated commodities to improve nutritional value and to enable others in developing countries to readily add value through postharvest processing and product development.

Across this whole range of activities, we will extend our pioneering efforts to employ molecular biology to make conventional germplasm development more efficient and diverse.

Expertise Needed

Core Competence	Complementary Competence	Project Area
Genetics/Breeding		Beans - Andean
Genetics/Breeding		Beans - Mesoamerica
Breeding		Beans - East SSA
	Breeding/Agronomy	Beans - South SSA
	Breeding/Agronomy	Beans - Central SSA
Breeding		Cassava
Breeding		Cassava - Asia
Breeding/Agronomy		Cassava - SSA
Breeding		Tropical forages
Breeding	Rice - Upland	
Breeding	Rice - Lowland	
	Breeding	Rice - Upland/lowland
	Biochemistry	Various crops
	Biotechnology	Cassava
	Biotechnology	Rice
	Biotechnology	Beans
Agronomy (GxE)		Tropical forages
Agronomy (GxE)		Beans - LA
	Agronomy	Beans - LA
	Agronomy	Tropical forages - Asia
Physiology (plant)		Cassava - LA
Physiology (crop)		Rice
	Physiology (roots)	Rice
Physiology		Beans
Product processing		Cassava
	Product processing	Cassava
	Product processing	Cassava
	Product processing	Cassava
Economics		Cassava

Competence Descriptors

Genetics:

- Inheritance of agronomically useful traits at the monogenic and polygenic levels.
- Protocols to maximize phenoypic expression of useful genetic variability.
- Mating systems, reproductive biology, and polyploidy.
- Application of biochemical and molecular technologies to identify and isolate useful genetic variability.

Breeding:

- Identification and assembly of genes and gene complexes carrying useful genetic variability.
- Novel hybridization and recombination protocols.
- Selection design, protocols, and their implementation.
- Statistically robust evaluation of breeding material at differing stages of development.

Biochemistry/physiology

- Physiological basis of stress response.
- Biochemical basis of gene action for defined useful traits.
- Development of biochemical selection protocols.

Biotechnology:

- DNA markers and molecular maps for gene identification.
- DNA-based protocols for rapid and efficient selection and to pyramid gene complexes.
- Tissue culture and micropropagation.
- Embryo culture to rescue interspecific hybrids.
- Development of genetic transformation protocols.

Agronomy:

- Field evaluation and validation trials with NARS of gene pools and advanced breeding material.
- Genotype x environment interaction in major target areas.
- Adaptation of forages to various farming systems.
- Determination of factors influencing relations among plants and changes associated with soil and crop/pasture management.

Product processing:

- Postharvest intermediate stage processing of crops.
- Prototype development of low-cost conventional and novel products.
- Identification of genetically controlled postharvest quality traits.

Economics:

- Economic assessment and impact of changes in varieties, production, and postharvest processing.

Networks:

- Foster and promote germplasm exchange, research coordination, training and information transfer in Latin America, Africa, and Asia for mandated crops.
- Assist national programs in matching gene pools with farming systems to increase sustainable productivity.
- Integrate with resource management research to achieve sustainable productivity in agroecologies where CIAT works.

Disease and Pest Management

This area of competence in CIAT has expanded beyond its original role of supporting plant improvement. The key features of this area are to generate:

- Simple and inexpensive high-tech diagnostic tools that research institutions in developing countries can employ to detect and monitor the presence of causal agents of major biotic stress.
- Gene complexes which provide durable resistance, pyramided by molecular biology techniques.
- Biological control agents, which can serve as alternatives to the use of hazardous chemicals.
- New knowledge about the evolutionary dynamics of relations between pests, diseases, their natural enemies, and their plant hosts.
- New knowledge about mechanisms that govern the reaction of host plants to pests and pathogens.

In this area of competence, we are able to supply basic information in support of biopesticide development. However, other organizations will have to generate marketable products, possibly as a result of research collaboration with CIAT.

Overall, this expertise provides a strong foundation for collaboration with other institutions to find more effective methods to manage and control the impact of pests, diseases, and weeds, particularly IPM. IPM contributes to increased production, maintenance of biodiversity, and conservation of the natural resource base, while minimizing human health risks associated with chemical pest control.

Expertise Needed

Core Competence	Complementary Competence	Project Area
Pathology		Rice
Pathology		Cassava
Pathology		Beans
	Pathology	Beans - SSA
Pathology/Molecular biology		Forages
Entomology		Beans/Rice
Entomology		Beans - SSA
Entomology		Cassava
	Entomology/IPM	Cassava - Brazil
Entomology		Rice/forages
Virology		Beans/forages
Virology/Molecular biology		Cassava/rice
Weed science		Various crops

Competence Descriptors

Pathology:

- Identification and assessment of genes for durable disease resistance.
- Epidemiology of pathogen diversity and prediction of virulence change.
- Development of screening protocols for pathogen resistance.
- Development of diagnostics for monitoring disease incidence thresholds.

Virology:

- Virus identification and epidemiology of viral diseases, mode of transmission, and prediction of virulence change.
- Development of screening procedures for host plant resistence and monitoring disease incidence.
- Development and implementation of virus detection methods, including serology and DNA-based techniques.

- Application of molecular biology to develop transgenic virus resistant plants.
- Viral screening methods to produce clean planting material.

Entomology:

- Identification and assessment of host plant resistance.
- Assessment of biotype diversity in insect pests.
- Identification, collection, rearing, and dissemination of natural enemies of pests, diseases, and weeds of mandated crops.

IPM:

- Integrated participatory assessment for problem diagnosis and development of control strategies.
- Integration of adapted varieties resistant to pests and diseases as key components to IPM.
- Development and pilot scale implementation of biocontrol methods and strategies.
- Development of prototype integrated pest control systems, including agronomic practices.
- Development of action thresholds to minimize pesticide use, reduce contamination, and human health problems and encourage natural biological control.
- Monitoring protocols to sustain use and modification of IPM strategies.
- Collaboration and training involving national programs to assemble components and implement strategies for integrated control.

Production Systems and Soil Management

By combining complementary plant species according to sound ecological principles production systems must increase productivity, maintain a soil cover, cycle nutrients efficiently, and increase soil organic matter.

To identify promising technological alternatives, we must have the capacity to evaluate prototype systems in terms of their productivity and effects on the resource base. We also need to understand why some options fulfill the requirements of sound resource management and others do not (and under what conditions). This in turn requires that we have sufficient competence in soil science to examine the processes that contribute to soil degradation (such as erosion and nutrient depletion) and those that improve the soil (such as crop rotation and proper residue management). Mathematical models are powerful tools for elucidating soil-plant dynamics and predicting the effects of alternative systems and production-conservation tradeoffs.

for elucidating soil-plant dynamics and predicting the effects of alternative systems and production-conservation tradeoffs.

CIAT is committed to working with a wide range of cooperating institutions to gather the necessary data and analyze underlying relationships for:

- Assessing the economic and ecological sustainability of existing production systems.
- Generating alternative prototype systems.
- Anticipating the tradeoffs between crop productivity and soil and water quality under alternative production systems.
- Relating indicators of soil degradation to changes in crop productivity and in the agricultural environment.
- Understanding dynamic soil processes and their effects on soil and water quality.

This competence area should also include the capacity to develop methodologies for participatory design and evaluation of alternative production systems.

Expertise Needed

Core Competence	Complementary Competence	Project Area
Soil nutrient management:		
Soil chemistry		P cycling
Soil chemistry		Analytical lab
Soil physics*		Erosion/compaction
	Soil physics	Erosion
Soil microbiology		N cycling
	Soil biochemistry	Organic matter
	Agronomy	Soil management
	Agronomy	Soil/crop-Cassava Asia
Plant nutrition		Lowland crops
Soil biology*		Soil biota/crop
Production systems:		
Soils/agronomy		Segmental cropping

Core Competence	Complementary Competence	Project Area
Soils/agronomy		Fallow systems - HS
Soils/agronomy		Agropastoral - Sav
Agronomy		Crop systems - HSCA
	Agronomy	Native pastures
Physiology (weeds)		Lowland crops
Agronomy		Farm systems-SSA/beans
Agronomy		Farm systems-SSA/beans
Production systems		Crop/livestock
Animal nutrition		Pasture management
Agricultural economics		Farm economics
	Agricultural economics	Farm economics - HSCA
Sociology		Participatory research

* Suggested new positions under review.

Competence Descriptors

Soil chemistry:

- Application of chemical methods for acid soil analysis.
- Analysis of nutrient (P) cycling and use efficiency in prototype crop and pasture systems in acid soils.
- Development of crop and cropping systems models that represent crop growth, phenology, and nutrient cycling.
- Modelling crop and pasture growth and production in agropastoral systems.

Soil physics:

- Analysis of land use systems and soil physical conditions to control erosion and compaction of acid soils.
- Conceptual and mathematical models that simulate soil physical trends under contrasting land uses.

Soil microbiology:

- N cycling in tropical low-fertility soils, where fertilizer inputs are restricted;
- Determination of the efficiency of N fixation, use, and transfer in alternative cropping systems.
- Development of models of N and organic matter cycling.

Soil biology:

- Identification and quantification of soil biota under relevant vegetation covers.
- Study of the dynamics of soil biota under prevailing production systems, estimating their effect on soil quality.

Soils/agronomy:

- Development and evaluation of alternative cropping/pasture systems for the corresponding ecosystems.
- Understanding compatibility in multispecies systems to develop a mechanistic model of soil and plant processes.

Agronomy:

- Analysis of the contribution of selected crops and pastures to performance of alternative prototype farming systems.
- Validation of alternative cropping/production systems compatible with natural resource protection.
- Quantification of soil processes in agropastoral systems.

Animal nutrition:

- Analysis and quantification of forage/animal interactions.
- Identification of nutritional and antinutritional factors in plants grown on acid soils of low fertility.
- Grazing patterns in agropastoral systems.

Physiology/weed ecology:

- Physiological traits to increase yield.
- Physiological approaches to overcome abiotic constraints, particularly in low-fertility, acid soils.
- Development of efficient screening/selection protocols for higher yield and adaptation to environmental stress.
- Effect of weed competition on land degradation in lowland agroecosystems.

Plant nutrition:

- Identification of soil fertility constraints on crop yield.
- Novel selection protocols for efficient nutrient uptake.
- Improved symbiosis with soil microorganisms.
- Nutrient accumulation and nutritional value of crops for human consumption.
- Assessment of gene-controlled quality traits in postharvest processing.

Agricultural economics:

- Assessment of the economic benefits and impact of alternative agricultural technologies at the farm level.
- Evaluation of the impact of external factors, such as prices and other policies, on on-farm land use strategies.

Sociology:

- Development of participatory research methods to evaluate alternative technologies at farm and community levels.
- Analysis of farming systems in the decision making process at the farm and rural community levels.
- Analysis of on-farm testing of alternative production systems.

Land Management

A central feature of CIAT's strategic plan is that it broadens the scope of our research to encompass the management of agricultural land. To gain a sufficient grasp of this complex issue requires analysis of potential impact of existing land use patterns on the environment, identifying main determinants, and suggesting alternatives to foster or change prevailing trends. Alternatives can then be designed by operating simultaneously at the micro level of community action and at the macro level of policy-making, combining the "bottom up" with the "top down" approaches to sustainable agricultural development. Research on these issues requires that we have the capacity to:

- Analyze current trends in economic production and environmental degradation under the prevailing land use patterns.
- Assess the effects on these patterns of existing policies and institutional structures.
- Design alternative patterns and evaluate their potential impact on the private and social benefits/costs.

In addition, we must have the expertise needed to develop the following tools for sustainable land use:

- Institutional mechanisms for community assessment of changes in production systems and in other aspects of the rural landscape.
- Decision-support systems that help rural communities examine alternative production systems.
- Models that rural communities and government policy makers can employ for participatory land-use planning.
- Information systems that help farmers and policy makers design land management strategies that are economically viable, environmentally sound, and socially acceptable.

Expertise Needed

Core Competence	Complementary Competence	Project Area
Agronomy		Land use patterns
Geography		GIS
Systems analysis		Cross-scale linkage
Tropical ecology		Landscape impact
Resource economics		Land use economics
	Anthropology	Farm decision support
	Sociology	Farm socioeconomics-SSA beans
Ag economics*		Policy/decision making

* Suggested new positions under review.

Competence Descriptors

Agronomy:

- Patterns of land use and their relation to agricultural technology and socioeconomic trends.
- Development of regional and country databases and models, including biophysical and socioeconomic variables.

Geography:

- Development of GIS databases integrating biophysical, economic, and social variables.
- Integration of land use analysis from the watershed to the continental scale.
- Development of effective computer networking.

Systems analysis:

- Modelling and mathematical simulation of agroecological systems at contrasting levels of aggregation.
- Development of watershed, regional, and continental models of land use.

Tropical ecology:

- Assessing the ecological impact of agriculture, other technologies, and policy on land use pattern at the regional and ecosystem levels in the tropics.
- Identification of limitations and opportunities in developing ecologically sound agriculture in the tropics.

Resource economics:

- Economic analysis of land use patterns at the watershed, community, and regional levels.
- Assessment of social costs of resource degradation and social benefits of resource preservation and enhancement.
- Evaluation of the impact of regional, national, and international policies on land use trends and patterns.
- Modelling the impact of contrasting policy and technological scenarios in differing national and international market situations.

Agricultural economics:

- Study the effects of policy instruments on land use patterns and agricultural technologies.
- Appraise the effect of alternative policy scenarios on alnd use patterns.
- Understand the policy making and implementation processes.

Institutional Affairs

To deploy its research capacity effectively, CIAT must perform a series of support functions, which we refer to as institutional affairs. These are divided into four groups: (1) research and development linkages, (2) institutional sustainability, (3) operations management, and (4) Center management.

Research and Development Linkages

Our research activities are linked with the global information system in science and technology through direct access to the world's important data networks. In addition to direct access to the system by the scientists, the link with international information systems is mediated and facilitated through CIAT's library and documentation services. Beyond electronic access to the world's information systems, CIAT also contributes to the body of scientific and technical knowledge through diverse media ranging from print to video.

CIAT's works in a complementary fashion with national, regional, and international institutions, both in the public and private sectors and in the developing and developed worlds. Such collaboration is supported in numerous ways, including the convening of the groups concerned; joint, participatory planning, execution, and evaluation of projects; provision of training and technical advice; and conflict resolution.

CIAT participates in institution building through projects aimed at developing specific capacities and through linking isolated efforts into inter-institutional efforts.

In addition to strengthening and expanding its current institutional linkages, CIAT must set up new ones, particularly with policy makers. This is essential for helping create a policy environment that is conducive to sustainable development. We can contribute to that end by: (a) using research sites as showcases for bringing key issues to the attention of decision makers; (b) establishing direct contacts between these people and Center staff; (c) organizing conferences; and (d) informing decision makers through print and audiovisual media.

Institutional Sustainability

CIAT's ability to weather the storm of the 1990s will depend heavily on our success in mobilizing financial resources and in securing the patronage of decision makers and other influential people in the countries we serve. We must have their support to work effectively with national institutions and to maintain our good standing with the international donor community.

CIAT must diversify its financial base by attracting additional funds from the environmental "windows" of traditional donors and by identifying other donors. Since it will take at least a year or two to establish these new relationships, we must act now and allocate sufficient staff time and money if we hope to stabilize the financial base by 1995. Our principal means of accomplishing these ends will be to match projects with donors. In

most cases we will seek funds from different donors for different projects or project components. While drawing mainly on CIAT's own expertise for resource mobilization, we must also be prepared to supplement it by hiring consultants.

CIAT's funding strategy must be supported by strong efforts to create a favorable image of the Center in the eyes of donors, their constituencies, other influential people, and the general public. To achieve this effect, CIAT is taking a two-pronged approach, consisting of targetted communication with key individuals and more general dissemination of information through print and electronic media.

Operations Management

In addition to overall administration of physical, financial, and human resources, operations management includes all of the centralized function through which the Center maintains its physical infrastructure and provides support service.

Specifically, operations management refers to (a) financial administration (accounting, treasury, budgeting, and control of fixed assets); (b) administration of human resources (international and national staff, including temporary staff and consultants); (c) development and upkeep of the physical infrastructure (buildings, machinery, and equipment); and (d) central services (e.g., the provision of services required in legal matters, in maintaining the Center's relations with the local and national governments, purchasing and warehousing operations, field operations, motor pool, transportation, and administrative systems development).

Center Management

Center management includes functions and resources used in support of the overall administration of the Center. Included are the Office of the Director General, the Research Directors, Impact Assessment, and Internal Audit.

Expertise Needed

Core Competence	Complementary Competence	Project Area
Research and development linkages:		
R&D Linkages (SS)		Coordination of linkages
Library and documentation (SS)		Mediate the linkage between CIAT and global information systems
Training Administration (GAS)		Admissions office & logistics support
	Training	Development of training materials and methods
Technical Publishing (SS)		Development of printed technical publications:
Institutional sustainability:		
Project Design and Funding (SS)*		Maintenance of donor information; project design; and matching of projects with funding sources.
Public Awareness (SS)		Production and dissemination of public information materials in support of funding strategy
Operations management:		
Coordination (SS)		Overall coordination of financial, administrative and CIAT-wide services
Financial Administration (SS)		Administration of accounting, budgeting, and treasury services
Budgeting (GAS)		Development and administration of budgets
Business Administration (SS)		Coordination of central and CIAT- wide services
Project Administration (GAS)*		Coordination of administrative aspects and reporting requirements of special projects
Experimental Field Operations (SS)		Coordination of field operation services
Human Resources Administration (GAS)		Administration and development of support staff
Electronic Information Management (GAS)		Coordination of hardware, software, and netware; and coordination of development
Laboratory Analysis (GAS)		Coordination of laboratory and other specialized research services
Biometrics (Assoc. Scientist)		Coordination of biometrics services

Core Competence	Complementary Competence	Project Area
Maintenance of Physical (GAS)		Coordination of preventive Infrastructure (GAS) and corrective maintenance of physical infrastructure of the center
Materials Acquisition (GAS)		Coordination and supervision of purchasing, warehousing and importation services
Graphic Arts Production (GAS)		Supervision of production of graphic arts and printing services
Center management		
Director General (SS)		Chief Executive Officer of the Center
Research Direction (2 SS)		Coordination of the implementation of the Center's research strategies; and fund raising
Impact Assessment (SS)		Coordination of ex-ante and ex post impact assessment for priority setting and accountability.
Internal Audit (GAS)		Review and audit of financial processes

* Paid from overhead charges on special projects.

Appendix 2: Financial Tables

Table 1. Funding requirements by Programs and Units: Amounts for core activities in 1992, 1993, 1994, and Budget Request 1995. (SYs = Senior Staff years; thousands of current US dollars).

	Actual 1992		Actual 1993		1994 Budget				1995 Budget request		Changes over 1994 estimate	
					Approved		Estimate					
	SYs	Amount	SYs	Amount	SYs*	Amount	SYs	Amount	SYs	Amount	$'000	%
1. Operations												
Research Programs												
Beans	15	4,038	14	4,033	14	3,945	15	4,552	15	4,552	-	-
Cassava	10	2,909	10	2,660	11	3,275	12	3,592	12	3,592	-	-
Rice	6	1,724	6	1,735	6	1,818	4.7	2,044	3.7	1,944	(100)	(5)
Tropical Forages	9.5	2,827	9.5	2,936	9.5	2,862	9.3	2,711	9.3	2,711	-	-
Forest Margins	1	144	3	218	4	744	-	-	-	-	-	-
Hillsides	2	180	3	591	4	873	5.6	1,521	5.6	1,521	-	-
Savannas/Tropical Lowlands	5.5	1,258	5.5	1,481	5.5	1,685	6.4	2,025	6.4	2,025	-	-
Research Units												
Biotechnology	3	526	3	574	3	591	3	686	3	686	-	-
Virology	2	410	2	438	2	457	2	543	2	543	-	-
Genetic resources	1	624	1	676	1	825	-	757	1	857	100	13
Land Use	2	472	4	850	5	1,346	5	1,408	5	1,408	-	-
Impact assessment	-	-	1	92	1	216	1	382	1	382	-	-
Research Management												
Research management	2	428	2	438	2	536	2	426	2	426	-	-
Strategic research initiatives	-	19	-	178	-	666	-	107	-	107	-	-
Scientific resources groups	-	-	-	-	-	-	-	112	-	112		
Total research	**59.0**	**15,559**	**64.0**	**16,900**	**68.0**	**19,839**	**66**	**20,866**	**66.0**	**20,866**	**-**	**-**
Research Support												
Research services	-	381	-	495	-	530	-	97	-	97	-	-
Field operations	1	984	1	1,027	1	1,184	1	184	1	184	-	-
Canmagua	-	447	-	539	-	512	-	366	-	366	-	-
Information management	-	323	-	605	-	561	-	218	-	218	-	-
Biometry support	-	254	-	187	-	183	-	-	-	-	-	-
Visiting scientists and postdoctorals	-	131	-	99	-	584	-	56	-	56	-	-
Total research support	**1**	**2,520**	**1**	**2,952**	**1**	**3,554**	**1**	**921**	**1**	**921**	**-**	**-**
Institutional Development Support												
Linkages and conferences	1	295	1	382	1	539	1	607	1	607	-	-
Professional development	-	362		315	-	548	-	623	-	623	-	-
Information and documentation	1	586	1	586	1	630	1	621	1	621	-	-
Communication/Public affairs	2	994	2	1,071	2	1,178	2	776	2	776	-	-
Seed supply	-	247	-	-	-	-	-	-	-	-	-	-
Project design **	1	-	1	-	1	-	1	-	1	-	-	-
Total institutional development	**5**	**2,486**	**5**	**2,354**	**5**	**2,895**	**5**	**2,627**	**5**	**2,627**	**-**	**-**
Management and administration												
Board of Trustees	-	189	-	164	-	208	-	258	-	258	-	-
Central administration	5	1,997	5	2,146	5	2,363	4	2,078	4	2,078	-	-
Central services	-	3,843		4,037	-	3,990	-	1,500	-	1,500	-	-
Total management and administration	**5**	**6,029**	**5**	**6,347**	**5**	**6,561**	**4**	**3,836**	**4**	**3,836**	**-**	**-**
Contingencies	-	-	-	-	-	312	-	-	-	-	-	-
Total operations	**70**	**26,594**	**75**	**28,553**	**79**	**33,161**	**76**	**28,250**	**76**	**28,250**	**-**	**-**
Price increase	-	-	-	-	-	-	-	-	-	1,650	1,650	-
Total operations	**70**	**26,594**	**75**	**28,553**	**79**	**33,161**	**76**	**28,250**	**76**	**29,900**	**1,650**	**6**
Additional operating funds	-	1,517	-	(1,019)	-	-	-	-	-	-	-	-
Total operating requirements	**70**	**28,111**	**75**	**27,534**	**79**	**33,161**	**76**	**28,250**	**76**	**29,900**	**1,650**	**6**
Self-generated income												
Investments	-	1,060	-	2,251	-	300	-	650	-	650	-	-
Other (sales, etc.)	-	129	-	21	-	100	-	100	-	100	-	-
Total self-generated income	**-**	**1,189**	**-**	**2,272**	**-**	**400**	**-**	**750**	**-**	**750**	**-**	**-**
Total operating funds required	**70**	**26,922**	**75**	**25,262**	**79**	**32,761**	**76**	**27,500**	**76**	**29,150**	**1,650**	**6**
2. Total capital	-	-	-	-	-	-	-	-	-	-	-	-
3. Total funding requirements	**70**	**26,922**	**75**	**25,262**	**79**	**32,761**	**76**	**27,500**	**76**	**29,150**	**1,650**	**6**

* Positions are shown for the full year although, for budgetary purposes, a fill ratio of 96 % is assumed.

** Paid from indirect cost recovery.

Table 2. Funding requirements by Programs and Units: Amounts for complementary activities in 1992, 1993, 1994, and Budget Request 1995. (SYs= Senior Staff years; thousands of current US dollars).

	Actual 1992		Actual 1993		1994 Budget				1995 Budget request		Changes over 1994 estimate	
			Actual		Approved		Estimate					
	SYs	Amount	SYs	Amount	SYs	Amount	SYs	Amount	SYs	Amount	$'000	%
1. Operations												
Research Program												
Beans	8	2,691	5	2,144	9	2,908	2	1,249	2	1,154	(95)	(8)
Cassava	2	1,002	4	1,305	3	1,882	1	1,028	1	789	(239)	(23)
Rice	1	264	-	227	2	1,010	-	240	-	150	(90)	(38)
Tropical Forages	-	257	1	152	4	985	-	130	-	9	(121)	(93)
Forest Margins	-	-	-	24	3	675	-	-	-	-	-	-
Hillsides	-	40	-	158	4	1,190	-	429	-	370	(59)	(14)
Savannas/Tropical Lowlands	1	58	1	68	2	215	1	346	1	341	(5)	(1)
Research Units												
Biotechnology	-	22	-	-	1	215	-	282	-	282	-	-
Virology	-	-	-	-	-	-	-	-	-	-		
Genetic resources	-	-	-	10	-	50	-	-	-	-	-	-
Land Management	-	-	-	-	-	-	-	475	-	-	(475)	(100)
Impact Assessment	-	-	-	-	-	-	-	60	-	-	(60)	(100)
Total research	**12**	**4,334**	**11**	**4,088**	**28**	**9,130**	**4**	**4,239**	**4**	**3,095**	**(1,144)**	**(27)**
Institutional Development Support												
Professional development	-	813		398	-	300	-	293	-	463	170	58
Conferences	-	-		-	-	300	-	-	-	-	-	-
Total institutional development	**-**	**813**	**-**	**398**	**-**	**600**	**-**	**293**	**-**	**463**	**170**	**58**
Research Support												
Farmer participatory research	1	159	1	77	-	-	-	-	-	-	-	-
Total research support	**1**	**159**	**1**	**77**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Contingencies	-	-	-	-	-	33	-	-	-	-	-	-
Total operations	**13**	**5,306**	**12**	**4,563**	**28**	**9,763**	**4**	**4,532**	**4**	**3,558**	**(974)**	**(21)**
Additional operating funds	-	-	-	-	-	-	-	-	-	-	-	-
Total operations	**13**	**5,306**	**12**	**4,563**	**28**	**9,763**	**4**	**4,532**	**4**	**3,558**	**(974)**	**(21)**
2. Capital	-	236	-	225	-	300	-	-	-	-	-	-
3. Total funding requirements	**13**	**5,542**	**12**	**4,788**	**28**	**10,063**	**4**	**4,532**	**4**	**3,558**	**(974)**	**(21)**

Table 3. Funding requirements by Programs and Activity: Amounts for core activities in 1992, 1993, 1994, and Budget Request 1995. (SYs = Senior Staff years; thousands of current US dollars).

	Actual 1992		Actual 1993		1994 Budget				1995 Budget request		Changes over 1994 estimate	
					Approved		Estimate					
	SYs	Amount	SYs	Amount	SYs	Amount	SYs	Amount	SYs	Amount	$'000	%
1. Operations program												
A. Research Activities												
1. Conservation and management of natural resources												
1.1 Ecosystem conservation and management	8.3	2,346	12.0	3,370	16.6	5,301	14.3	4,713	14.3	4,713	-	-
1.2 Germplasm collection, conservation, characterization and evaluation	5.1	1,444	5.1	1,444	2.7	853	4.0	1,317	4.0	1,317	-	-
Total activity 1	13.4	3,790	17.1	4,814	19.3	6,154	18.3	6,030	18.3	6,030	-	-
2. Germplasm enhancement and breeding												
2.0 Generic			-	-	0.6	184	-	-	-	-	-	-
2.1 Crops												
2.1.1 Beans	7.9	2,220	7.5	2,137	7.6	2,420	6.1	2,031	6.1	2,031	-	-
2.1.2 Cassava	5.4	1,534	5.7	1,617	5.9	1,890	4.9	1,600	4.9	1,600	-	-
2.1.3 Rice	3.8	1,083	4.1	1,155	4.3	1,384	4.4	1,460	4.4	1,460	-	-
2.1.4 Tropical forages	4.3	1,209	4.4	1,252	-	-	-	-	-	-	-	-
Total sub-activity 2.1	21.4	6,046	21.7	6,161	17.8	5,694	15.4	5,091	15.4	5,091	-	-
Total activity 2	21.4	6,046	21.7	6,161	18.4	5,878	15.4	5,091	15.4	5,091	-	-
3. Production systems development and management												
3.1 Crops systems												
3.1.1 Beans	2.6	740	2.6	732	3.7	1,175	4.0	1,316	4.0	1,316	-	-
3.1.2 Cassava	2.4	686	2.0	578	4.5	1,452	5.0	1,668	5.0	1,668	-	-
3.1.3 Rice	1.8	505	1.7	481	2.0	645	1.7	564	1.7	564	-	-
3.1.4 Tropical forages	2.8	776	2.5	712	-	-	1.4	441	1.4	441	-	-
Total sub-activity 3.1	9.6	2,707	8.8	2,503	10.2	3,272	12.1	3,988	12.1	3,988	-	-
3.2 Livestock systems	1.0	270	1.0	289	8.0	2,558	7.6	2,518	7.6	2,518	-	-
Total activity 3	10.6	2,977	9.8	2,792	18.2	5,830	19.7	6,507	19.7	6,507	-	-
4. Socioeconomic, public policy and public management research												
4.1 Economic and social analysis	4.2	1,173	5.4	1,540	3.3	1,060	3.0	1,024	3.0	1,024	-	-
4.2 Policy analysis	1.3	360	1.7	481	0.6	207	-	-	-	-	-	-
4.3 Governance and management of public systems	0.3	90	0.7	193	-	-	-	-	-	-	-	-
Total activity 4	5.8	1,623	7.8	2,214	3.9	1,267	3.0	1,024	3.0	1,024	-	-
Total research activities	51.2	14,436	56.4	15,981	59.8	19,129	56.4	16,652	56.4	16,652	-	-
5. Institution building												
5.1 Training and conferences	4.5	1,263	3.4	963	4.9	1,590	4.8	1,600	4.8	1,600	-	-
5.2 Documentation, publication and dissemination of information	6.7	1,895	6.8	1,925	5.4	1,728	5.2	1,721	5.2	1,721	-	-
5.3 Organizations and management consulting	-	-	-	-	-	-	0.4	106	0.4	106	-	-
5.4 Networks	1.6	451	1.4	385	1.9	599	4.3	1,414	4.3	1,414	-	-
Total institution building activities	12.8	3,609	11.6	3,273	12.2	3,917	14.7	4,841	14.7	4,841	-	-
B. Research Support	1	2,520	1	2,952	1	3,554	1	921	1	921	-	-
C. Administration/Operations												
1. Management and administration	5	2,186	5	2,310	5	2,571	4	2,336	4	2,336	-	-
2. Central services	-	3,843	-	4,037	-	3,990	-	1,500	-	1,500	-	-
Total administration/operations	5	6,029	5	6,347	5	6,561	4	3,836	4	3,836	-	-
Subtotal operations program	70	26,594	74	28,553	78	33,161	76	28,250	76	28,250	-	-
D. Inflation	-	-	-	-	-	-	-	-	-	1,650	1,650	-
Total operations program	70	26,594	74	28,553	78	33,161	76	28,250	76	29,900	1,650	6
2. Additional operating funds	-	1,517	-	(1,019)	-	-	-	-	-	-	-	-
Total operating requirements	70	28,111	74	27,534	78	33,161	76	28,250	76	29,900	1,650	6
3. Self-generated income												
1. Investment	-	1,060	-	2,251	-	300	-	650	-	650	-	-
2. Other (sales, etc)	-	129	-	21	-	100	-	100	-	100	-	-
Total self-generated income	-	1,189	-	2,272	-	400	-	750	-	750	-	-
Total operating funds required	70	26,922	74	25,262	78	32,761	76	27,500	76	29,150	1,650	6
4. Capital program	-	-	-	-	-	-	-	-	-	-	-	-
Total funding required	70	26,922	74	25,262	78	32,761	76	27,500	76	29,150	1,650	6

Table 4. Funding requirements by Programs and Activity: Amounts for complementary activities in 1992, 1993, 1994, and Budget Request 1995. (SYs = Senior Staff years; thousands of current US dollars).

	Actual 1992		Actual 1993		1994 Budget				1995 Budget request		Changes over 1994 estimate	
					Approved		Estimate					
	SYs	Amount	SYs	Amount	SYs	Amount	SYs	Amount	SYs	Amount	$'000	%
1. Operations program												
A. Research Activities												
1. Conservation and management of natural resources												
1.1 Ecosystem conservation and management	0.3	113	0.8	313	5.5	1,923	1.1	1,222	0.7	666	(556)	(45)
1.2 Germplasm collection, conservation, characterization and evaluation	0.8	321	0.6	246	1.0	342	0.1	161	0.1	91	(70)	(43)
Total activity 1	**1.1**	**434**	**1.4**	**559**	**6.5**	**2,265**	**1.2**	**1,383**	**0.8**	**757**	**(626)**	**(45)**
2. Germplasm enhancement and breeding												
2.0 Generic	-	-	-	-	1.5	517	-	-	-	-	-	-
2.1 Crops												
2.1.1 Beans	3.2	1,278	2.2	894	3.4	1,181	0.2	275	0.2	207	(68)	(25)
2.1.2 Cassava	1.9	736	2.0	830	1.1	391	0.3	306	0.3	239	(67)	(22)
2.1.3 Rice	0.4	162	0.7	299	0.2	78	0.1	63	-	37	(26)	(41)
2.1.3 Tropical forages	0.5	212	0.4	179	-	-	-	10	-	-	(10)	(100)
Total sub-activity 2.1	**6.0**	**2,388**	**5.3**	**2,202**	**4.7**	**1,650**	**0.6**	**654**	**0.5**	**483**	**(171)**	**(26)**
Total activity 2	**6.0**	**2,388**	**5.3**	**2,202**	**6.2**	**2,167**	**0.6**	**654.6**	**0.5**	**483**	**(171)**	**(26)**
3. Production systems development and management												
3.1 Crops systems												
3.1.1 Beans	0.9	363	0.7	282	3.5	1,220	0.4	442	0.4	376	(66)	(15)
3.1.2 Cassava	0.7	270	0.7	286	3.0	1,035	0.4	418	0.4	369	(49)	(12)
3.1.3 Rice	0.2	65	0.3	121	1.3	459	-	54	0.1	54	-	-
3.1.3 Tropical forages	0.3	112	0.2	94	-	-	-	50	-	-	(50)	(100)
Total sub-activity 3.1	**2.1**	**810**	**1.9**	**783**	**7.8**	**2,714**	**0.8**	**964**	**0.9**	**799**	**(165)**	**(17)**
3.2 Livestock systems	0.1	47	0.1	45	2.5	879	0.1	103	0.1	49	(54)	(52)
Total activity 3	**2.2**	**857**	**2.0**	**828**	**10.3**	**3,593**	**0.9**	**1,067**	**1.0**	**848**	**(219)**	**(21)**
4. Socioeconomic, public policy and public management research												
4.1 Economic and social analysis	0.9	369	1.0	416	-	10	0.1	119	0.1	71	(48)	(40)
4.2 Policy analysis	0.2	91	0.2	98	0.2	59	0.1	60	-	-	(60)	(100)
4.3 Governance and management of public systems	-	4	-	18	-	-	-	-	-	-	-	-
Total activity 4	**1.1**	**464**	**1.2**	**532**	**0.2**	**69**	**0.2**	**179**	**0.1**	**71**	**(108)**	**(60)**
Total research activities	**10.4**	**4,143**	**9.9**	**4,121**	**23.2**	**8,094**	**3**	**3,283**	**2**	**2,159**	**(1,124)**	**(34)**
5. Institution building												
5.1 Training and conferences	1.0	813	0.5	206	2.6	908	0.5	538	0.8	681	143	27
5.2 Documentation, publication and dissemination of information	-	-	-	-	0.6	205	0.1	74	0.1	72	(2)	(3)
5.3 Organization and management counselling	-	-	-	-	-	-	0.2	178	0.2	185	7	4
5.4 Networks	0.5	191	0.4	143	1.6	556	0.3	459	0.5	461	2	-
Total institution building activities	**1.5**	**1,004**	**0.9**	**349**	**4.8**	**1,669**	**1.1**	**1,249**	**1.6**	**1,399**	**150**	**12**
B. Research Support	**1**	**159**	**1**	**77**	-	-	-	-	-	-	-	-
Total operations program	**13**	**5,306**	**12**	**4,563**	**28**	**9,763**	**4**	**4,532**	**4**	**3,558**	**(974)**	**(21)**
2. Additional operating funds	-	-	-	-	-	-	-	-	-	-	-	-
Total operating funds required	**13**	**5,306**	**12**	**4,563**	**28**	**9,763**	**4**	**4,532**	**4**	**3,558**	**(974)**	**(21)**
4. Capital program	-	236	-	225	-	300	-	-	-	-	-	-
Total funding required	**13**	**5,542**	**12**	**4,788**	**28**	**10,063**	**4**	**4,532**	**4**	**3,558**	**(974)**	**(21)**

Table 5. Research and research-related activity requirements: Amounts for core activities in 1992, 1993, 1994, and Budget Request 1995. (thousands of current US dollars; percent share).

Activities	Actual 1992		Actual 1993		1994 Budget Approved		1994 Budget Estimate		1995 Budget request		Change over 1994 estimate	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	$'000	%
1. Conservation and management of natural resources												
1.1 Ecosystem conservation and management	3,505	13.0	4,997	17.5	7,627	23.0	5,678	20.1	6,010	20.1	332	6
1.2 Germplasm collection, conservation, characterization and evaluation	2,157	8.0	2,141	7.5	1,227	3.7	1,582	5.6	1,674	5.6	92	6
Total activity 1	**5,662**	**21.0**	**7,138**	**25.0**	**8,854**	**26.7**	**7,260**	**25.7**	**7,684**	**25.7**	**424**	**6**
2. Germplasm enhancement and breeding												
2.0 Generic			-	-	265	0.8	-	-	-	-	-	-
2.1 Crops												
2.1.1 Beans	3,316	12.3	3,169	11.1	3,482	10.5	2,430	8.6	2,571	8.6	142	6
2.1.2 Cassava	2,292	8.5	2,398	8.4	2,719	8.2	1,921	6.8	2,033	6.8	112	6
2.1.3 Rice	1,618	6.0	1,713	6.0	1,990	6.0	1,780	6.3	1,884	6.3	104	6
2.1.4 Tropical forages	1,806	6.7	1,856	6.5	-	-	-	-	-	-	-	-
Total sub-activity 2.1	**9,032**	**33.5**	**9,137**	**32.0**	**8,191**	**24.7**	**6,130**	**21.7**	**6,488**	**21.7**	**358**	**6**
Total activity 2	**9,032**	**33.5**	**9,137**	**32.0**	**8,456**	**25.5**	**6,130**	**21.7**	**6,488**	**21.7**	**358**	**6**
3. Production systems development and management												
3.1 Cropping systems												
3.1.1 Beans	1,105	4.1	1,085	3.8	1,691	5.1	1,582	5.6	1,674	5.6	92	6
3.1.2 Cassava	1,024	3.8	857	3.0	2,089	6.3	2,006	7.1	2,123	7.1	117	6
3.1.3 Rice	755	2.8	714	2.5	929	2.8	678	2.4	718	2.4	40	6
3.1.4 Tropical forages	1,160	4.3	1,056	3.7	-	-	537	1.9	568	1.9	31	6
Total sub-activity 3.1	**4,044**	**15.0**	**3,712**	**13.0**	**4,709**	**14.2**	**4,803**	**17.0**	**5,083**	**17.0**	**280**	**6**
3.2 Livestock systems	404	1.5	428	1.5	3,681	11.1	3,023	10.7	3,199	10.7	177	6
Total activity 3	**4,448**	**16.5**	**4,140**	**14.5**	**8,390**	**25.3**	**7,825**	**27.7**	**8,282**	**27.7**	**457**	**6**
4. Socioeconomic, public policy and public management research												
4.1 Economic and social analysis	1,752	6.5	2,284	8.0	1,525	4.6	1,243	4.4	1,316	4.4	73	6
4.2 Policy analysis	539	2.0	714	2.5	298	0.9	-	-	-	-	-	-
4.3 Governance and management of public systems	135	0.5	286	1.0	-	-	-	-	-	-	-	-
Total activity 4	**2,426**	**9.0**	**3,284**	**11.5**	**1,824**	**5.5**	**1,243**	**4.4**	**1,316**	**4.4**	**73**	**6**
5. Institution building												
5.1 Training and conferences	1,887	7.0	1,428	5.0	2,288	6.9	1,921	6.8	2,033	6.8	112	6
5.2 Documentation, publication and dissemination of information	2,831	10.5	2,855	10.0	2,487	7.5	2,062	7.3	2,183	7.3	120	6
5.3 Organization and management counselling	-	-	-	-	-	-	113	0.4	120	0.4	7	6
5.4 Networks	674	2.5	571	2.0	862	2.6	1,695	6.0	1,794	6.0	99	6
Total activity 5	**5,392**	**20.0**	**4,854**	**17.0**	**5,637**	**17.0**	**5,791**	**20.5**	**6,130**	**20.5**	**338**	**6**
Total research and research-related activities	**26,960**	**100.0**	**28,553**	**100.0**	**33,161**	**100.0**	**28,250**	**100.0**	**29,900**	**100.0**	**1,650**	**6**

Table 6. Research and research-related activity requirements: Amounts for complementary activities in 1992, 1993, 1994, and Budget Request 1995. (thousands of current US dollars; percent share).

Activities	Actual 1992		Actual 1993		1994 Budget				1995 Budget request		Change over 1994 estimate	
					Approved		Estimate					
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	$'000	%
1. Conservation and management of natural resources												
1.1 Ecosystem conservation and management	116	2.2	319	7.0	1,923	19.7	1,224	27.0	669	18.8	(555)	(45)
1.2 Germplasm collection, conservation, characterization and evaluation	331	6.2	251	5.5	342	3.5	163	3.6	89	2.5	(74)	(45)
Total activity 1	**447**	**8.4**	**570**	**12.5**	**2,265**	**23.2**	**1,387**	**30.6**	**758**	**21.3**	**(629)**	**(45)**
2. Germplasm enhancement and breeding												
2.0 Generic	-	-	-	-	517	5.3	-	-	-	-	-	-
2.1 Crops												
2.1.1 Beans	1,317	24.8	913	20.0	1,181	12.1	272	6.0	210	5.9	(62)	(23)
2.1.2 Cassava	758	14.3	849	18.6	391	4.0	304	6.7	242	6.8	(62)	(20)
2.1.3 Rice	167	3.1	306	6.7	78	0.8	63	1.4	32	0.9	(31)	(50)
2.1.4 Tropical Forages	220	4.1	183	4.0	-	-	14	0.3	-	-	(14)	(100)
Total sub-activity 2.1	**2,462**	**46.3**	**2,250**	**49.3**	**1,650**	**16.9**	**653**	**14.4**	**484**	**13.6**	**(169)**	**(26)**
Total activity 2	**2,462**	**46.3**	**2,250**	**49.3**	**2,167**	**22.2**	**653**	**14.4**	**484**	**13.6**	**(169)**	**(26)**
3. Production systems development and management												
3.1 Cropping systems												
3.1.1 Beans	374	7.0	287	6.3	1,220	12.5	440	9.7	377	10.6	(62)	(14)
3.1.2 Cassava	280	5.3	292	6.4	1,035	10.6	417	9.2	370	10.4	(47)	(11)
3.1.3 Rice	67	1.3	123	2.7	459	4.7	54	1.2	53	1.5	(1)	(2)
3.1.4 Tropical Forages	115	2.2	96	2.1	-	-	54	1.2	-	-	(54)	(100)
Total subactivity 3.1	**836**	**15.8**	**799**	**17.5**	**2,714**	**27.8**	**965**	**21.3**	**801**	**22.5**	**(165)**	**(17)**
3.2 Livestock systems	48	0.9	46	1.0	879	9.0	100	2.2	46	1.3	(53)	(54)
Total activity 3	**884**	**16.7**	**844**	**18.5**	**3,593**	**36.8**	**1,065**	**23.5**	**847**	**23.8**	**(218)**	**(20)**
4. Socioeconomic, public policy and public management research												
4.1 Economic and social analysis	380	7.2	424	9.3	10	0.1	118	2.6	71	2.0	(47)	(40)
4.2 Policy analysis	94	1.8	100	2.2	59	0.6	59	1.3	-	-	(59)	(100)
4.3 Governance and management of public system	4	0.1	18	0.4	-	-	-	-	-	-	-	-
Total activity 4	**478**	**9.1**	**543**	**11.9**	**68**	**0.7**	**177**	**3.9**	**71**	**2.0**	**(106)**	**(60)**
5. Institution building												
5.1 Training and conferences	838	15.8	210	4.6	908	9.3	539	11.9	680	19.1	140	26
5.2 Documentation, publication and dissemination of information	-	-	-	-	205	2	73	1.6	71	2.0	-	-
5.3 Organization and management counselling	-	-	-	-	-	-	181	4.0	185	5.2	-	-
5.4 Networks	197	3.7	146	3.2	556	5.7	458	10.1	463	13.0	5	1
Total Activity 5	**1,035**	**19.5**	**356**	**7.8**	**1,669**	**17.1**	**1,251**	**27.6**	**1,398**	**39.3**	**145**	**12**
Total research and research-related activities	**5,306**	**100.0**	**4,563**	**100.0**	**9,763**	**100.0**	**4,532**	**100.0**	**3,558**	**100.0**	**(974)**	**(21)**

Table 7. Regional distribution of research and, research-related activity requirements: Allocation resources in 1992, 1993, 1994, and 1995. (percent share).[1]

Activities	SSA (%)				Asia (%)				LAC (%)			
	92	93	94	95	92	93	94	95	92	93	94	95
Core activities:												
1. Conservation and management of natural resources												
1.1 Ecosystem conservation and management	-	-	-	-	-	-	0.3	0.3	13.0	17.5	19.6	19.6
1.2 Germplasm collection, conservation, characterization, and evaluation	2.0	2.0	1.1	1.1	1.5	1.5	0.6	0.6	4.5	4.0	3.8	3.8
2. Germplasm enhancement and breeding	8.5	8.0	4.3	4.3	5.0	5.0	0.6	0.6	20.0	19.0	16.3	16.3
3. Production systems development and management	4.0	3.0	6.4	6.4	2.5	2.5	3.8	3.8	10.0	9.0	17.5	17.5
4. Socioeconomic, public policy, and public management research	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	7.5	10.0	4.3	4.3
5. Institution building												
5.1 Training and conferences	2.0	1.5	2.2	2.2	0.5	0.5	0.4	0.4	4.5	3.0	4.1	4.1
5.2 Documentation, publicationn and dissemination of information	3.0	3.0	1.8	1.8	1.0	1.0	0.3	0.3	6.5	6.0	5.2	5.2
5.3 Organization and management conselling	-	-	0.5	0.5	-	-	-	-			-	-
5.4 Networks	0.5	0.5	2.7	2.7	0.5	0.5	0.4	0.4	1.5	1.0	2.8	2.8
Total core activities	**21.0**	**19.0**	**19.5**	**19.5**	**11.5**	**11.5**	**6.9**	**6.9**	**67.5**	**69.5**	**73.6**	**73.6**
Complementary activities:												
1. Conservation and management of natural resources												
1.1 Ecosystem conservation and management	-	-	-	-	-	-	0.5	0.3	13.0	17.5	26.5	18.5
1.2 Germplasm collection, conservation, characterization, and evaluation	2.0	2.0	0.7	0.3	1.5	1.5	0.2	0.2	4.5	4.0	2.5	2.0
2. Germplasm enhancement and breeding	8.5	8.0	4.4	5.6	5.0	5.0	1.8	1.8	20.0	19.0	8.2	6.3
3. Production systems development and management	4.0	3.0	6.3	8.9	2.5	2.5	3.3	0.8	10.0	9.0	13.9	14.2
4. Socioeconomic, public policy, and public management research	1.0	1.0	0.8	0.2	0.5	0.5	-	-	7.5	10.0	3.1	1.8
5. Institution building												
5.1 Training and conferences	2.0	1.5	3.5	5.0	0.5	0.5	0.3	0.7	4.5	3.0	8.1	13.5
5.2 Documentation, publicationn and dissemination of information	3.0	3.0	1.2	1.3	1.0	1.0	-	-	6.5	6.0	0.6	0.7
5.3 Organization and management conselling	-	-	2.3	3.0	-	-	-	-			1.5	2.2
5.4 Networks	0.5	0.5	3.6	5.9	0.5	0.5	0.8	0.7	1.5	1.0	5.9	6.1
Total complementary activities	**21.0**	**19.0**	**22.8**	**30.2**	**11.5**	**11.5**	**6.9**	**4.5**	**67.5**	**69.5**	**70.3**	**66.3**

[1] LAC = Latin America and Caribbean; SSA = Sub-Saharan Africa.

Table 8. Funding requirements by categories of expenditures: Amounts for core and complementary activities in 1992, 1993, 1994, and Budget Request 1995. (thousands of current US dollars).

Expenses by categories	Actual 1992	Actual 1993	1994 Budget Approved	1994 Budget Estimate	1995 Budget request	Changes over 1994 estimate $'000	Changes over 1994 estimate %
Core							
Personnel	18,047	19,648	22,052	18,930	18,930	-	-
Supplies and services	5,734	5,286	6,916	6,077	6,077	-	-
Travel	1,271	1,810	1,801	1,643	1,643	-	-
Depreciation expense	1,542	1,809	2,080	1,600	1,600	-	-
Contingency	-	-	312	-	-	-	-
Subtotal	**26,594**	**28,553**	**33,161**	**28,250**	**28,250**	**-**	**-**
Capital	-	-	-	-	-	-	-
Additional operating funds	1,517	(1,019)	-	-	-	-	-
Price increase	-	-	-	-	1,650	1,650	-
Total core	**28,111**	**27,534**	**33,161**	**28,250**	**29,900**	**1,650**	**6**
Complementary							
Personnel	2,126	3,352	3,688	2,973	2,348	(625)	-
Supplies and services	1,848	902	3,464	1,108	854	(254)	-
Travel	1,332	309	2,578	451	356	(95)	-
Contingency	-	-	33	-	-	-	-
Subtotal	**5,306**	**4,563**	**9,763**	**4,532**	**3,558**	**(974)**	**(21)**
Capital	236	225	300	-	-	-	-
Additional operating funds	-	-	-	-	-	-	-
Total complementary	**5,542**	**4,788**	**10,063**	**4,532**	**3,558**	**(974)**	**(21)**
Total							
Personnel	20,173	23,000	25,740	21,903	21,278	(625)	-
Supplies and services	7,582	6,188	10,380	7,185	6,931	(254)	-
Travel	2,603	2,119	4,379	2,094	1,999	(95)	-
Depreciation expense	1,542	1,809	2,080	1,600	1,600	-	-
Contingency	-	-	345	-	-	-	-
Subtotal	**31,900**	**33,116**	**42,924**	**32,782**	**31,808**	**(974)**	**(3)**
Capital	236	225	300	-	-	-	-
Additional operating funds	1,517	(1,019)	-	-	-	-	-
Price increase	-	-	-	-	1,650	1,650	-
Grand total	**33,653**	**32,322**	**43,224**	**32,782**	**33,458**	**676**	**2**

Table 9. Staffing pattern: approved positions for 1992, 1993, 1994, and Estimated 1995.

	Actual 1992	Actual 1993	1994 Budget Approved	1994 Budget Estimate	1995 Budget request	Changes over 1994 estimate No.	Changes over 1994 estimate %
Core programs:							
I. International staff positions			*	*	*		
Research	59	64	67	66	66	-	-
Research support	1	1	2	1	1	-	-
Institution building	5	5	5	5	5	-	-
Management and administration	5	5	5	4	4	-	-
Total	**70**	**75**	**79**	**76**	**76**	**-**	**-**
II. Supervisory staff							
Research	155	161	167	147	147	-	-
Research support	29	28	29	31	31	-	-
Institution building	28	22	23	29	29	-	-
Management and administration	71	64	64	66	66	-	-
Total	**283**	**275**	**283**	**273**	**273**	**-**	**-**
III. Support staff	984	875	987	776	776	-	-
Total core staff	**1,337**	**1,225**	**1,349**	**1,125**	**1,125**	**-**	**-**
Complementary programs:							
I. International staff positions							
Research	12	11	28	4	4	-	-
Research support	1	1	-	-	-	-	-
Institution building	-	-	-	-	-	-	-
Management and administration	-	-	-	-	-	-	-
Total	**13**	**12**	**28**	**4**	**4**	**-**	**-**
II. Supervisory staff							
Research	40	26	63	24	11	(13)	(54)
Research support	2	2	2	2	2	-	-
Institution building	-	-	-	-	-	-	-
Management and administration	-	-	-	-	-	-	-
Total	**42**	**28**	**65**	**26**	**13**	**(13)**	**(50)**
III. Support staff	83	65	130	76	68	(8)	(11)
Total core staff	**138**	**105**	**223**	**106**	**85**	**(21)**	**(20)**

*** Positions are shown for the full year although for budgetary purposes a fill ratio of 96 % is assumed.**

Table 10. Funding requirements for capital expenditures and assets: Amounts for core, complementary activities in 1992, 1993, 1994, and Budget Request 1995. (thousands of current US dollars).

	Actual	Actual	1994 Budget		1995 Budget	Changes over 1994 estimate	
	1992	1993	Approved	Estimate	request	$'000	%
New core capital expenditures							
Research equipment	-	-	-	-	-	-	-
Operating equipment	-	-	-	-	-	-	-
Furnishing and office equipment	-	-	-	-	-	-	-
Vehicles	-	-	-	-	-	-	-
Buildings and leasehold improvements	-	-	-	-	-	-	-
Computer equipment	-	-	-	-	-	-	-
Total new core capital	-	-	-	-	-	-	-
Complementary capital expenditures							
Research equipment	124	115	180	-	-	-	-
Operating equipment	6	14	50	-	-	-	-
Furnishing and office equipment	24	28	20	-	-	-	-
Vehicles	41	50	20	-	-	-	-
Buildings and leasehold improvements	22	18	-	-	-	-	-
Computer equipment	19	-	30	-	-	-	-
Total complementary capital	**236**	**225**	**300**	-	-	-	-
Total capital	**236**	**225**	**300**	-	-	-	-
Capital stock							
Fixed assets (beginning of year)	20,413	18,889	20,089	19,707	21,307	1,600	8
Acquisitions	739	3,543	2,700	3,900	2,700	(1,200)	(31)
Disposal	(721)	(916)	(800)	(700)	(800)	(100)	14
Depreciation for the year	(1,542)	(1,809)	(2,000)	(1,600)	(1,600)	-	-
Fixed assets (at year end)	**18,889**	**19,707**	**19,989**	**21,307**	**21,607**	**300**	**1**

Table 11. Budget request: Price assumptions. Amounts for core complementary activities (in percentages)

Expenses by categories	1993/1994	1994/1995					
	Net change	Currency	Budget amount ($'000)	% of total	Inflation rate in currency	Change in exchange rate	Net price adjustment
Personnel costs							
	--	US$	7,112	25.2	3.0	-	3.0
	13.8	Col$	11,141	39.5	23.0	13.0	8.8
Supplies and services							
	2.6	US$	3,781	13.4	3.0	-	3.0
	12.5	Col$	4,348	15.4	21.0	13.0	7.1
Operational travel							
	2.6	US$	1,080	3.8	3.0	-	3.0
	5.5	Col$	738	2.7	19.0	13.0	5.3
Total	**8.1**		**26,200**	**100.0**	-	-	**6.0**

Table 12. Funding requirements: Sources and application of funds (thousands of current US dollars).

	Donor	Actual 1992	Actual 1993	1994 Budget Approved	1994 Budget Estimate	1995 Budget Request	Change over 1993 estimate $'000	Change over 1993 estimate %
Sources of funds								
1. Grants								
a. Core								
	Australia	152	146	142	367	367	-	-
	Belgium	182	111	189	113	113	-	-
	Brazil	-	-	-	35	35	-	-
	Canada	1,530	1,330	1,285	2,094	2,094	-	-
	Colombia	-	-	-	1,200	1,200	-	-
	China	20	10	20	10	10	-	-
	EEC	2,305	2,133	2,268	2,143	2,143	-	-
	Ford Foundation	100	400	400	400	400	-	-
	France	185	157	180	156	156	-	-
	Germany	1,183	1,176	1,170	1,107	1,107	-	-
	IDB	2,000	2,253	2,550	2,120	2,120	-	-
	Italy	340	-	332	-	-	-	-
	Japan	3,078	3,608	3,061	3,625	3,625	-	-
	Mexico	20	-	20	-	-	-	-
	Netherlands	286	272	274	260	260	-	-
	Norway	684	516	519	431	431	-	-
	Rockefeller Foundation	-	-	-	150	150	-	-
	Sasakawa Foundation	-	-	-	240	240	-	-
	Spain	90	90	90	90	90	-	-
	Sweden	368	283	290	262	262	-	-
	Switzerland	2,151	1,672	1,528	1,918	1,918	-	-
	United Kingdom	893	725	776	714	714	-	-
	UNDP	-	-	-	410	410	-	-
	USAID	5,064	4,580	4,440	3,675	3,675	-	-
	World Bank	6,291	5,800	6,630	5,000	5,000	-	-
	Other	-	-	6,577	980	2,630	1,650	168
Subtotal core		**26,922**	**25,262**	**32,761**	**27,500**	**29,150**	**1,650**	**168**
b. Complementary								
	Australia	109	160	257	67	67	-	-
	Belgium	68	172	200	234	234	-	-
	CIDA	1,789	992	1,500	210	210	-	-
	Colombia	50	-	-	-	-	-	-
	France	97	138	104	172	172	-	-
	FUNDAGRO	83	72	85	22	-	(22)	(100)
	GEF	-	-	-	200	200	-	-
	BMZ/GTZ (Germany)	144	249	433	538	538	-	-
	IDB	702	300	300	130	130	-	-
	IDRC	282	182	193	269	269	-	-
	IFAD	162	12	200	16	-	(16)	(100)
	Iran	24	44	30	30	30	-	-
	Italy	55	80	100	60	60	-	-
	Japan	45	222	65	65	65	-	-
	Kellogg Foundation	356	183	220	70	70	-	-
	Netherlands	147	222	350	350	350	-	-
	Rockefeller	268	338	252	116	116	-	-
	Switzerland	983	666	637	1,374	974	(400)	(29)
	UNDP	35	305	400	-	-	-	-
	Other	143	451	4,737	609	73	(536)	(88)
Subtotal complementary		**5,542**	**4,788**	**10,063**	**4,532**	**3,558**	**(974)**	**(21)**
Total grants		**32,464**	**30,050**	**42,824**	**32,032**	**32,708**	**676**	**2**
2. Self-generated income								
Investment		1,060	2,251	300	650	650	-	-
Other		129	21	100	100	100	-	-
Total self-generated income		**1,189**	**2,272**	**400**	**750**	**750**	**-**	**-**
Total sources		**33,653**	**32,322**	**43,224**	**32,782**	**33,458**	**676**	**2**

Table 12. Funding requirements: Sources and application of funds (thousands of curre...

	Donor	Actual 1992	Actual 1993	1994 Budget Approved	1994 Budget Estimate	1995 Budget Request	Change ove 1993 estima $'000	
Application of funds								
1. Operations program								
Core		26,594	28,553	33,161	28,250	29,900	1,650	
Complementary		5,306	4,563	9,763	4,532	3,558	(974)	
2. Capital program								
Core		-	-	-	-	-	-	
Complementary		236	225	300	-	-	-	
3. Additional operating funds and reserves								
Core		1,517	(1,019)	-	-	-	-	
Complementary		-	-	-	-	-	-	
Total applications		**33,653**	**32,322**	**43,224**	**32,782**	**33,458**	**676**	
Memo items								
Operating fund at year end		3,946	2,872	2,872	1,372	1,372	-	
Reserves at year end		3,188	2,677	2,500	2,692	2,500	(192)	

Table 12. Funding requirements: Sources and application of funds (thousands of current US dollars).

	Donor	Actual 1992	Actual 1993	1994 Budget Approved	1994 Budget Estimate	1995 Budget Request	Change over 1993 estimate $'000	Change over 1993 estimate %
Application of funds								
1. Operations program								
Core		26,594	28,553	33,161	28,250	29,900	1,650	6
Complementary		5,306	4,563	9,763	4,532	3,558	(974)	(21)
2. Capital program								
Core		-	-	-	-	-	-	-
Complementary		236	225	300	-	-	-	-
3. Additional operating funds and reserves								
Core		1,517	(1,019)	-	-	-	-	-
Complementary		-	-	-	-	-	-	-
Total applications		**33,653**	**32,322**	**43,224**	**32,782**	**33,458**	**676**	**2**
Memo items								
Operating fund at year end		3,946	2,872	2,872	1,372	1,372	-	-
Reserves at year end		3,188	2,877	2,500	2,692	2,500	(192)	(7)

Table 13. Funding requirements: Balance sheet. Amounts for core, and complementary activities in 1992, 1993, 1994, and Projection 1995. (thousands of current US dollars

	Actual		Estimate	Projection
	1992	1993	1994	for 1995
Assets				
Cash and bank balances	15,338	18,495	16,745	15,382
Accounts receivable				
Donors	6,597	2,305	4,182	4,910
Employees	242	365	380	409
Other	1,859	3,199	1,200	1,500
Inventories	1,297	1,572	1,100	930
Other current assets	246	242	450	404
Total current assets	**25,579**	**26,178**	**24,057**	**23,535**
Fixed assets				
Property, plant, and equipment	33,880	35,845	39,045	40,545
Less: accumulated depreciation	(14,991)	(16,138)	(17,738)	(18,938)
Total fixed assets	**18,889**	**19,707**	**21,307**	**21,607**
Total assets	**44,468**	**45,885**	**45,364**	**45,142**
Liabilities and fund balances				
Liabilities				
Bank indebtedness	1,676	5,420	5,600	6,400
Accounts payable				
Donors	8,891	5,161	6,200	6,693
Employees	1,073	934	1,180	980
Others	2,021	4,155	3,000	2,200
In-trust accounts	-	169	180	210
Accruals and provisions	1,373	2,001	1,800	1,200
Staff reserves	3,192	2,876	2,500	2,500
Total liabilities	**18,226**	**20,716**	**20,460**	**20,183**
Fund balances				
Capital invested in fixed assets				
Core	13,789	14,382	15,982	16,307
Complementary	5,100	5,325	5,325	5,300
Capital fund	2,982	2,536	2,225	1,980
Operating fund	3,946	2,926	1,372	1,372
Infrastructure fund	425	-	-	-
Total fund balances	**26,242**	**25,169**	**24,904**	**24,959**
Total liabilities and fund balances	**44,468**	**45,885**	**45,364**	**45,142**