CIAT is a nonprofit agricultural research organization devoted to the goal of increasing sustainable food production in tropical developing regions. CIAT is one of 13 international agricultural research centers under the auspices of the Consultative Group on International Agricultural Research (CGIAR). The government of Colombia provides support as a host country for CIAT and furnishes a 522-hectare site near Cali for CIAT's headquarters. In addition, the Colombian Foundation for Higher Education (FES) makes available to CIAT a 184-hectare substation in Quilichao and a 73-hectare substation near Popayán; the Colombian Rice Federacion (FEDEARROZ) also makes available to CIAT a 30-hectare farm—Santa Rosa sub-station—near Villavicencio. CIAT comanages with the Colombian Agricultural Institute (ICA) the 22,000-hectare Carimagua Research Center on the Colombian eastern plains and carries out collaborative work on several other ICA experimental stations in Colombia; similar work is done with national agricultural agencies in Latin American, African and Asian countries.

CIAT is financed by a number of donors, most of which are represented in CGIAR. During 1986 these CIAT donors include the governments of Australia, Belgium, Canada, France, the Federal Republic of Germany, Italy, Japan, Mexico, the Netherlands, Norway, the People's Republic of China, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America. Organizations that are CIAT donors in 1986 include the European Economic Community (EEC), the Ford Foundation, the Inter-American Development Bank (IDB), the International Bank for Reconstruction and Development (IBRD), the International Development Research Centre (IDRC), the International Fund for Agricultural Development (IFAD), the Rockefeller Foundation, the United Nations Development Programme (UNDP), and the W. K. Kellogg Foundation.

Information and conclusions reported herein do not necessarily reflect the position of any of the aforementioned entities.

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1987
PROGRAM AND BUDGET

CIAT Centro Internacional de Agricultura Tropical

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FOREWORD

The Program and Budget of CIAT for 1987 was prepared by CIAT in accordance with guidelines provided by the Secretariat of the Consultative Group on International Agricultural Research (CGIAR). The program proposals as reflected in this document are based on the Long-Range Plan—a 10-year plan for the 1980s as published by CIAT in 1980 and the subsequent published refinement of this plan for the period 1986-1989 ("CIAT in the 1980s Revisited: A Medium-Term Plan for 1986-1990").

The 1987 Program and Budget as presented herewith to the CGIAR is as approved by the CIAT Board of Trustees at its Annual Meeting on 29-30 May 1986 held in Cali, Colombia. Subsequent to the meeting of the CIAT Board of Trustees, the Technical Advisory Committee (TAC) of the CGIAR, at its 41st Meeting held on 22 June - 2 July in Cali, Colombia, reviewed CIAT's Program and Budget and recommended that, if funding is available, the program as presented here be approved and funded; if funding availability to the system should be limited to an amount as projected at the time of TAC-41 (i.e., $196 million), TAC recommended that funding to CIAT be some 5 percent (i.e., $1.21 million) below the CIAT request as approved by its Board of Trustees.

MANDATE AND OBJECTIVES OF CIAT

The purpose and approach of CIAT—one of several agricultural research centers under the aegis of the Consultative Group on International Agricultural Research (CGIAR)—is given in the following statement of objectives:

> To generate and deliver, in collaboration with national and regional institutions, improved technology which will contribute to increased production, productivity, and quality of specific food commodities in the tropics—principally countries in Latin America and the Caribbean—thereby enabling producers and consumers, especially those with limited resources, to increase their purchasing power and improve their nutrition.

The CIAT strategy to accomplish these objectives is summarized by the following statements regarding resource emphasis, commodity choice, institutional role, and scope of activities.

Resource Emphasis

CIAT's strategy emphasizes enhanced production through increased resource productivity on farms with limited resources and on underutilized land areas. By contributing to the improvement of productivity on small and medium-scale farms, the Center seeks to provide for increased rural income and employment, moderate and stable food prices, and improved diets, especially of the low-income population in rural and urban areas. Technology which contributes to the expansion of agricultural production of suitable commodities on the less fertile frontier lands makes possible the release of the more fertile lands for maximum crop cultivation. Hence more efficient food and animal production is achieved by using both poor and fertile land resources.

Commodity Choice

Commodities included under CIAT's mandate are predominantly food staples. Each commodity has one or more of the following attributes: it is a relatively inexpensive source of calories; it is a relatively inexpensive source of protein; and it is an important component in the food budget of low-income consumers in the geographic region of emphasis. Commodities are selected for their potential to augment the productivity and incomes of small farmers and/or to contribute to increasing agricultural production on existing cultivated lands or in the agricultural frontier.

Institutional Role

A basic premise of CIAT's strategy is that it represents only one small segment of the agricultural research and development matrix. All Center activities, therefore, are viewed as complementary to those of other organizations. Linkage to other closely related activities is essential in developing effective research networks that capture economies of scales in research on the chosen commodities. Such activities involve such groups as national research and extension systems, advanced scientific institutions, and related international programs.

The most important interface is with national research systems. In partnership with these programs, CIAT concentrates on activities in which it has a clear

comparative advantage and in which the results have international transferability. Such activities include the assembly of germplasm banks; large-scale screening, crossing, and selection; methodology development; and information services. CIAT attempts to strengthen collaboration and to encourage horizontal technology transfer among national programs by helping to develop and strengthen research networks. Active training and conference programs serve to fortify national research systems, as well as the network activities.

Basic research institutions in both developed and developing countries are linked with CIAT activities to provide basic research inputs and specialized research services that complement and support CIAT's more problem-solving research.

The principle of complementarity also applies to other international institutions, especially sister centers within the CGIAR System. Through informal discussions and formal agreements cooperation and division of labor is defined to maximize the benefits of comparative advantage and minimize duplication.

Scope of Activities

CIAT's efforts are predominantly focused on the American tropics. Its commodities are selected for their importance in this region. Yet, within the CGIAR System the Center has been assigned broader responsibilities for given commodities. CIAT is differentiating functional responsibilities on the basis of their being either principal mandates or regional responsibilities.

Principal Mandates

For commodities for which CIAT is assigned a principal mandate, CIAT assumes the following responsibilities:

1. Assemble, maintain, and make available the world germplasm collection;
2. Conduct specialized strategic research;
3. Generate improved production technology components for, and develop cooperative activities with, national research systems in all regions in the developing world where the commodity is important and where no sister CGIAR center is assuming regional responsibilities;
4. Provide, on a global basis, in-service training for professionals in the specialized strategic areas of research;
5. Provide specialized in-service and production-oriented training for professionals from countries where no other CGIAR center has regional responsibilities;
6. Collect, process, and disseminate information on the commodity on a global basis; and
7. Supporting the activities of other institution(s), if any, with regional responsibilities for that commodity.

Regional Responsibilities

This category applies when a sister CGIAR center has global responsibilities for a commodity and, in close cooperation with that center, CIAT takes on the mandates 3 and 5. Together with national research systems, it identifies principal production constraints. In close collaboration with the center having principal responsibility, CIAT seeks to facilitate such activities as are required to overcome such constraints.

Current Mandate

In order to achieve the objectives and apply the strategy described above, and taking into account the results of socioeconomic studies and the mandates of other centers, the CIAT programs have evolved to currently encompass the following responsibilities:

Principal responsibilities for beans *(Phaseolus vulgaris* and related species) and cassava *(Manihot esculenta);*

Principal responsibilities for tropical pastures (specific responsibilities for the acid infertile soils of the American tropics); and

Regional responsibilities for rice (specific responsibilities for the American tropics).

GOVERNANCE, ORGANIZATION, AND RESEARCH SITES

The Board of Trustees

CIAT is governed by an independent Board of Trustees. The membership of the 1986-1987 Board is as follows:

Name	Country of origin
William E. Tossell (Chairman)	Canada
Nohra de Junguito (Vice-Chairwoman)	Colombia
Eduardo Casas Díaz	México
Dely P. Gapasin	Philippines
Fernando Gómez Moncayo	Colombia
Ken-ichi Hayashi	Japan
Frederick E. Hutchinson	U.S.A.
José Fernando Botero	Colombia
John L. Nickel (Director General)	U.S.A.
Josef Noesberger	Switzerland
Marco Palacios Rozo	Colombia
Erwin Reisch	Fed. Rep. of Germany
Rodrigo Tarte	Panama
Helio Tollini	Brazil
Elmar Wagner	Brazil
Fredrick Wang'ati	Kenya

The full Board meets at least once during each calendar year. It has four standing commitees: Executive Committee, Program Committee, Audit Committee, and Nominations Committee.

Organizational Structure

Organizationally, CIAT is comprised of three divisions. **Research Division I** consists of the commodity research programs for beans and cassava, as well as the Biotechnology Research Unit, the Genetic Resources Unit, Station Operations, and Research Services (except Data Services). **Research Division II** comprises the Tropical Pastures Program, the Rice Program, the Data Services Unit, the Seed Unit, and the Coordinating Office for Training and Conferences. The third division, **Finance and Administration,** is responsible for the general services and financial administration.

Research Sites

CIAT's research activities are concentrated at five locations in Colombia: the headquarters site at Palmira, near Cali; a site at Santander de Quilichao, 60 km south of Cali, and characterized by acid, infertile soils; an intermediate altitude station at Popayan, 180 km south of Cali; a substation for upland rice research in Santa Rosa, near Villavicencio (Meta); and a site at Carimagua in the Eastern Plains of Colombia. The last named station is comanaged with the Colombian Agricultural Research Institute (ICA). In addition, pasture research is also carried out in Brazil at the Agricultural Research Center for the Cerrados (CPAC) of the Brazilian agricultural research system (EMBRAPA). CIAT also maintains cooperative agreements with other national and regional institutions to help carry out regional and international testing activities at many locations. In some cases, these agreements help support outposted staff members who conduct research or support commodity networks.

SUMMARY OF ACHIEVEMENTS

Selected major achievements of the four commodity research programs and Training during the period 1985 and part of 1986 are summarized hereunder. Achievements in the areas of Genetic Resources, Biotechnology Research, Seed Technology, and Communication/Information are also described, but are listed under the respective programs.

Rice Program

In the area of rice improvement, the full incorporation of anther culture techniques is especially noteworthy. This procedure greatly increases the speed of producing fixed lines, particularly for ecologies limited to one breeding cycle per year. Despite continuing problems of bacterial contamination and albino regenerated plants, the procedure has been organized to produce several thousand lines per year. It is now a useful tool in applied rice improvement. A large number of regenerated lines is now available for field evaluation in Chile. Isolated from crosses specific to the low temperature constraint of Chile, these lines combine dwarfism (all Chilean varieties are tall), long grain, and hopefully Indica type cooking quality. Similarly, from crosses specific to Argentina (cold tolerance, long grain, dwarfism, straighthead resistance) and southern Brazil (cold tolerance, dwarfism, quality, and iron toxicity tolerance) regenerated lines have been extracted. Anther culture is also used to produce lines for the upland breeding program where tolerance to extremely acid, infertile savanna soils is the key requirement.

Iron toxicity is an increasing problem in acid, irrigated soils in Brazil, Argentina, Colombia, and Venezuela. An efficient, simple screening method capable of handling several thousand lines per year was developed. Many advanced lines are highly tolerant, allowing the International Rice Testing Program (IRTP) for Latin America to send only known tolerant materials to areas where iron is a contraint.

"Hoja blanca" virus epidemics continue to devastate tropical Latin America. Resistance to the insect vector alone does not control the disease. The key to development of an efficient field test was the production of a massive colony of insect vectors with a capacity to acquire and transmit the virus. A routine field screening technique now permits evaluation of thousands of F_1 and F_4 materials. Several advanced virus and insect resistant lines are available for evaluation in Ecuador, Venezuela, Colombia, and Peru.

Many African upland rices, notably from IITA (International Institute of Tropical Agriculture) and IRAT (Institut de Recherches Agronomiques Tropicales et de Cultives Vivriéres), combine excellent disease tolerance with tolerance to infertile soils having aluminum saturation over 80%. These materials have limited yielding capacity and poor plant types. A complex crossing program, mostly with African materials, resulted in several populations that combine excellent dwarf plant types with tolerance to adverse soils and diseases. Many of these dwarf materials also have the long, thick root system characteristic of tall, upland varieties. These new plants are being used to improve irrigated rices and are being evaluated for yield capacity and stability under upland and irrigated conditions.

In coordination with national programs and IRRI (International Rice Research Institute), CIAT simplified its procedures for sending nurseries to increase the quality of materials dispatched and to reduce the burden that multiple nurseries impose on national

programs. Beginning in 1986, only single observation nurseries are sent to cooperators, comprising distinct sets for different ecological requirements. All entries combine resistances to the major constraints operating in each cooperating country.

It is becoming increasingly clear, now that improved varieties have saturated most of the irrigated and more favored upland ecologies, that deficiencies in crop management constitute the greatest constraint to increased productivity and rice farm profitability. Increase in production costs have exceeded additional income from yield increases in recent years. Focus on cost reduction has resulted in contributing to the resolution of the following problems:

Excessive pesticide use. Many tropical countries have increased herbicide, fungicide, and insecticide use to levels of 20% or more of total farm costs. Insecticide use, in particular, is unrealistic. Studies of all major insect targets for insecticides showed that economic thresholds, field monitoring, varietal tolerance, and biological control can eliminate the need for insecticides against most pests. Prophylactic, systemic seed treatments are being developed for the few pests that cause risk during the first two weeks after seeding. Fungicide applications for the complex of fungi associated with dirty panicle, a rapidly increasing, worldwide disease were shown to be ineffective. Their elimination would contribute to reduced production costs.

Dirty panicle, widely distributed in Latin America and elsewhere and formerly considered to have a fungal etiology, was shown to be caused by a seed-transmitted, systemic bacterium. The pathogen can be erradicated with severe dry heat therapy that does not reduce seed germination. National programs are being urged to heat-treat genetic and foundation seed in order to control the disease on farms. International Centers and Latin American national programs were advised of the cause and control of dirty panicle in order to eliminate international movement of the pathogen.

Weeds. General rice weeds, including red rice, constitute the most serious problem in rice production. As most countries have effective herbicides, the reduction of the problem is focused on:

Improved land preparation and levelling, largely through more appropriate equipment, especially for smaller farms, including steel tractor wheels, small tractors and tillers;

Terrestrial sprayers to replace air applications;

The application of inexpensive general-purpose herbicides to water to eliminate weeds, red rice, and volunteer rice prior to planting; and

The establishment of zero tolerance for red rice in seed multiplication programs.

Comparative projects were established in Colombia and temperate Brazil to combine these activities into effective weed control programs. Practical solutions will reduce seed and fertilizer costs, losses from weed competition, and discounts for red rice contamination.

Cassava Program

Latin America is experiencing a new interest in cassava as a result of the shortage of credit and foreign exchange for cereal imports. This is illustrated by the continued expansion of the Colombian small-scale cassava industry that now consists of close to 40 operational plants. This industry has doubled its drying capacity in each of the last three years. Analysis of the impact of this industry indicates that it has effectively reached the smallest farmers and benefits have also accrued to landless small farmers who gain from the profits of the plants and the employment opportunities. The analysis is also indicating that certain design parameters of the plants, such as their geographical location with respect to production areas, can help ensure that most benefits accrue to the most marginal sectors of the rural population.

Such knowledge has been used by CIAT to assist the Ministry of Agriculture in Ecuador to establish a small cassava-drying industry in the semiarid coastal regions. Two small plants were operated successfully by farmers' associations in late 1985 and several new plants are being established in 1986. In Mexico cassava production for animal feed in 1986 is estimated at 30,000 metric tons. While five years ago Mexico produced virtually no cassava, at this time the annual total commercial value is on the order of one million dollars. CIAT's input has been critical in the development of the main variety, Sabanera, and in establishing effective drying systems under the humid conditions in the State of Tabasco.

The scope for production gains in Latin America is amply demonstrated by the Cuban situation. Cuban officials estimate that adoption of CIAT-developed crop management practices have increased yields on 60% of the area from 5 t/ha in 1978 to 16 t/ha in 1984. The availability of this technology has also stimulated a massive increase in area planted and total production has almost quadrupled from 100,000 tons in 1987 to 394,000 tons in 1984. These yield increases have been obtained at the same time that the level of inputs (such

as irrigation and insecticides) have been reduced sharply.

Some ten years ago, with collaboration from the Tropical Development and Research Institute (TDRI), United Kingdom, basic research began on elucidating the causes of postharvest deterioration in cassava roots. The outcome of this long-term research effort is a cassava preservation technique which is now being tested on a commercial scale in Bucaramanga, Colombia. Both farmer and consumer acceptance has been excellent and indicate that the new technology offers the possibility of converting fresh cassava from being a low-cost rural but high-cost urban staple to being a universally low-cost source of carbohydrates in the lowland tropics.

While efforts in Latin America have concentrated on postharvest aspects that integrate production, processing, and marketing, the emphasis in Asia continues to be oriented towards new varieties to increase productivity in the intensive farming systems of the region. Currently about 100,000 distinct genotypes are tested in cooperation with national programs each year. These genotypes are made from directed crosses between parents specifically adapted to Asian conditions.

The strong national program in Thailand has already released two new varieties, Rayong 2 and Rayong 3. The latter is proving particularly popular for planting in the off-season when its yield advantage over Rayong 1, the standard variety, is greatest. The relatively young Philippine program has developed a full selection program and now has many hybrids at an advanced stage of selection.

In Africa CIAT continues to cooperate with IITA with special emphasis on biological control of green spider mites and mealybugs. Some of the Phytoseiid mites (predatory mites that consume green mites) collected in Colombia by CIAT and shipped to IITA through the Commonwealth Institute of Biological Control (CIBC) in London have now been released in commercial fields in Africa. The impact of their release is still to be measured.

In terms of more basic research that could eventually increase productivity a major breakthrough was made with the discovery that cassava possesses intermediate type photosynthesis between C3 and C4. This opens the way for manipulation of the plant to increase its efficiency.

Bean Program

Bean yields in the tropics are low. The main reason for this is because the typical bean farmer is a small farmer who has only limited access to inputs to increase productivity. The Bean Program, therefore, has long embarked on a strategy to produce multiple-disease-resistant varieties in a network formed with national programs. Since the formation of this network, collaborating national programs in 21 countries have released over 90 varieties. Those releases were based in general upon superior disease resistance of newly developed lines. For example, all lines developed in CIAT since 1979 are BCMV (bean common mosaic virus)-resistant (except some highland materials). Some lines (now varieties) combine up to five disease resistances.

The CIAT Bean Program, in collaboration with national programs, has interviewed thousands of farmers and quantified some of the adoption of these varieties. In several of the 21 countries no significant adoption has taken place for such varied reasons as insufficient on-farm testing prior to release, shortcomings in seed production, or nonacceptance by consumers because of differences in seed types. Selected examples of the eleven countries in which very significant adoption has taken place are;

Costa Rica. In the most important bean production region over 50% of farmers now use "Talamanca". "Brunca" is coming up strongly. In other selected areas over 80% of the farmers grow Talamanca. Farmers like its yield and erectness. Costa Rica used to import about 50% of its bean consumption, but has now ceased to import beans.

Guatemala. This country has also become self-sufficient in beans through the adoption of new varieties and is testing new grain types for export markets in nontraditional bean-growing areas. Adoption rates were not as high as expected because of the lack of seed production. The observed yield advantage of new varieties over traditional varieties was about 40%.

Argentina. In the last two years Argentina greatly increased bean yields, production, and exports. The net benefit of new bean technology in 1985 was estimated at US$2.4 million. Over 80% of the farmers now use improved black-seeded varieties and national yields of black varieties have increased by over 50%.

Brazil. Several states show rapid adoption of new varieties. Impact studies are planned in Espirito Santo, Goias, and Rio de Janeiro. Preliminary indications are that the recently released variety EMGOPA-Ouro is spreading exceptionally quickly.

Adoption studies as described above are an exciting

way to quantify the impact on production of the bean network. Other consequences of the formation of the network by CIAT were:

Formation of strong national programs with focused research objectives;

Strong collaboration in research among countries participating in the network with a certain degree of division of research responsibilities;

Availability of a wide range of genetic variability and widening of the often narrow genetic base of local production; and

Increased attention given by farmers to their traditional crop, as shown in use of improved agronomic management and use of inputs, to accompany new, less risky varieties.

Tropical Pastures Program

The germplasm collection now includes more than 16,000 accessions of grasses and legumes. During the last several years emphasis was given to specific collections of relevance to well-defined production problems at the farm level. Recently, grasses per se have received increased and systematic attention.

Panicum maximum is a high quality grass. However known cultivars are adapted only to fertile soils. A duplicate set of the world's largest *Panicum maximum* collection, under the aegis of the French institution ORSTOM (Office de la Recherche Scientifique et Technique d'Outre-Mer), in the Ivory Coast, was obtained, which increased the number of accessions available to CIAT from 80 to more than 700. The new accessions are now being evaluated in Quilichao and Carimagua. To build up the genetic base from which to solve the problem of spittlebug in *Brachiaria* spp., a specific collection was undertaken in East Africa to obtain as much variability as possible in the genus. This resulted in an increase from the previously available 40 accessions to more than 900. Both the *Panicum* and *Brachiaria* collections are expected to yield important cultivars for the savanna as well as for the humid tropics and moderately acid soil conditions.

Desmodium ovalifolium CIAT 350, the best of the initially available 16 accessions, reached the highest evaluation level used in the program some four years ago, especially because of its compatibility with aggressive grasses such as *Brachiaria decumbens* and *Brachiaria humidicola*. Soon thereafter, however, it was severely attacked by stem gall nematode and *Synchytrium*. Immediate action was taken to obtain additional variability by collecting in the center of diversity, Southeast Asia. Another species from Southeast Asia, the highly promising legume kudzu (*Pueraria phaseoloides*), was successful in the better soils of the Llanos, but failing, however, under poorer sandier soils and dryer environments. This again called for a broader genetic base. As a result of the specific collection efforts in Southeast Asia, the collection of *D. ovalifolium* increased from 16 to 97 and that of *P. phaseoloides* increased from 20 to about 120 entries.

The endemic problem of anthracnose of *Stylosanthes* spp. has been solved through the identification of resistant *Stylosanthes* species (including *S. capitata* for the Llanos environment) and through a better understanding of the biotic and climatic factors influencing the degree of damage and buildup of this disease in *S. guianensis* in the humid tropics.

Effective and viable low-cost pasture establishment techniques have been developed for the Llanos ecosystem. The role of nitrogen-fixing legumes in increasing productivity and persistence of pastures has also been documented. At present new approaches to further reduce the cost and risk of establishment in the Llanos are being explored.

As a result of evaluating new pasture technology in farmers' fields and under the management of farmers, the Program has obtained important information on the biological and economic performance of improved pastures in the hands of producers. Highly encouraging was the fact that, in terms of animal gains and reproduction, results obtained on farms were very similar to those at Carimagua, indicating that the highly promising technology developed in Carimagua is likely to hold up its advantage in the fields of the farmers.

Studies on initial adoption of new pasture species indicate that commercial seed production of new cultivars and effective promotion by the respective national programs are important prerequisites for the adoption process to be initiated successfully. The studies showed that more than 200,000 ha of the Brazilian Cerrados are planted to *Andropogon gayanus* and that its adoption is taking place largely because of its resistance to the spittlebug and its ready response, relative to other grasses, to the first rains which reduces the effects of the dry season by up to one month. These studies also pointed to the importance of infrastructure development, socioeconomic conditions, and cost of establishment in the adoption process.

Through the formation of the International Tropical

Pastures Evaluation Network (RIEPT) in 1979, a mechanism was established for the effective cooperation with and among the national research programs. Through the RIEPT, pasture research programs, large and small, are working together and toward the development of new pasture technology that will allow development and expansion of the cattle industry in marginal and frontier lands in the regions. The advisory committee of the RIEPT recently met at CIAT to study alternative research methodologies for the network in plant nutrition, plant hygiene, soil microbiology and seed production in order to further unify criteria and define proposals for a more systematic evaluation of pastures within RIEPT. Immediately afterwards, the third meeting of the RIEPT was held to discuss results of agronomic trials corresponding to the period 1982-1985. For the first time, results of trials in which legumes and grasses selected for each subecosystem were evaluated under grazing conditions, were presented.

Training

In 1985 a total of 245 professionals were trained in the different research programs and the Seed Unit as follows: 148 Visiting Researchers received specialized graduate training at CIAT, for periods ranging from 3 to 12 months; 29 carried out degree-oriented research—11 for a Ph.D., 12 for a Master's degree, and 6 research scholars at universities around the world; and intensive multidisciplinary courses were given in rice, tropical pastures, and beans as an integral part of the "Program for Developing Scientific Capacity" in national programs. The second cassava production course for the Asian continent was held in English at CIAT for a group of outstanding participants including 6 Ph.D.s from China, Indonesia, Malaysia, Philippines, Sri Lanka, and Thailand. The Seed Unit conducted its regular course on seed technology and an advanced course on quality control and seed-transmitted diseases.

In-country courses, which are critical in assisting national programs to bridge the gap between research and extension, are playing an ever-increasing role in training as the national programs become stronger in the areas related to CIAT commodities. In a collaborative effort between five Latin American countries and the Cassava Program, nine production and specialization courses were conducted for 192 professionals. The Bean Program provided backstopping for seven courses with a total of 200 professionals in Argentina, Colombia, Costa Rica, Chile, El Salvador, Honduras, and Peru. The Rice Program assisted Panama and Nicaragua with two courses for 46 professionals from the national institutions and universities; while the Seed Unit collaborated with five courses in Colombia (2), Ecuador (1), and Guatemala (2).

A large part of the funds for financing scholarships and research costs came from special projects funded by the United Nations Development Programme (UNDP), the Swiss Government SDC (Swiss Development Cooperation), and the Ford Foundation. CIAT was able to finance 55 participants, mostly for graduate specializations, from its core budget.

A major event for Conferences was the inauguration of the new auditorium, financed by the Kellogg Foundation, in July. The W. K. Kellogg Auditorium has a capacity for 181 people and modern facilities for simultaneous interpretation. At the same time the conference rooms were completely remodeled and audiovisual equipment was updated.

THE 1987 BUDGET REQUEST[1]

The budget request of CIAT for 1987 amounts to C$23,948,000. This total includes all special projects that were transferred to the core budget of the Center.

The following table shows the budget for 1987 as compared with 1985 actual expenditures, the approved budget for 1986, and the revised budget for 1986 (C$ in thousands).

Expenditures	1985 Actual	1986 Approved	1986 Revised	1987 Request
Operations	20,630	22,794	20,904	22,995
Capital	980	552	713	1,078
Addl. working capital	—	—	—	175
Total	21,610	23,346	21,617	24,248
Income				
Funds on hand	719	515	—	—
From donors	20,556	22,210	21,400	23,948
Earned income	302	621	250	300
Subtotal	21,577	23,346	21,650	24,248
Balance carried over	33	—	(33)	—
Total	21,610	23,346	21,617	24,248

[1] In this document the term C$ refers to current United States of America dollars of the year in question.

1987 List of Program Changes

The table below presents proposed program changes for 1987 that are to be accomplished within the level of funding being requested.

	M-Y	1986 US$ in thousands
1986 operations	71	21,617
Program reductions:		
Tropical Pastures Regional Trials Agronomist	(1.0)	(157)
Pasture Development, Llanos (Carimagua)	(1.0)	(150)
		21,310
Program additions:		
Tropical Pastures Agronomist, Central America	1.0	157
Pasture Development, Cerrados (Brazil)	1.0	150
	71	21,617

Reductions

Tropical Pastures: Regional Trials Agronomist. After the very successful long-term effort on the part of the Tropical Pastures Program to set up and further develop the International Tropical Pastures Evaluation Network (RIEPT), the network itself is increasingly becoming a decentralized collaborative effort which, in future, will require more regionally specialized coordination. Accordingly, the position of Regional Trials Agronomist is planned to be outposted during 1987, from headquarters to Central America. Concurrently, four subnetworks will be formed as follows: the Central American Network; the Llanos Network (Colombia, Venezuela, and English-speaking Caribbean) coordinated by the agronomist at Carimagua; the Humid Tropics Network (Peru, Ecuador, Brazil, and Colombia) coordinated by the agronomist at Pucallpa; and the Cerrados Network (Brazil, Paraguay, and Bolivia) coordinated by the agronomist at CPAC.

Tropical Pastures: Pasture Development Specialist (Carimagua). After several years of successful research work on the development of low-cost, low-risk pasture establishment techniques for the Llanos ecosystem, this position is planned to be moved from Carimagua to CPAC in the Brazilian Cerrados to develop pasture establishment techniques that will further accelerate the rate of adoption of new CIAT technology in this ecosystem.

Additions

Tropical Pastures: Agronomist, Central America. Areas with moderately acid soils ranging in pH from 4.5 to 5.5 are scattered all across South America and in large areas of Central America. These areas, characterized by rainfall patterns ranging from subhumid to humid tropic types, support more intensive farming systems than are possible in those regions of acid infertile soils in which the Tropical Pastures Program is working at present. Available data point toward a high degree of adaptation of many pastures species to these distinct subhumid and humid, moderately acid soil environments. CIAT has good reasons to believe that the potential for short and medium-term adoption of improved materials in these areas may be higher than in the savannas. The External Program Review (EPR) recommended that CIAT initiate activities for this ecosystem. In order to make important headway in these regions, however, it will also be necessary to accompany new improved germplasm with appropriate pasture management and weed control technology. In line with projections in the CIAT Medium-Term Plan 1986-1990, the Center plans to place one regional agronomist in Central America starting in 1987 who is to coordinate the systematic screening of germplasm there and the development of management techniques for this environment. It is expected that this work will result in a gradual shifting of more of the benefits of CIAT's work to smaller dual-purpose farms.

Tropical Pastures: Soil/Pasture Development Specialist. This position was discontinued in 1982 due to Center-wide budget cuts. The position is projected to be reinstated in 1987 to engage in research in soil problems and the development of establishment techniques to eliminate constraints to the more rapid adoption of the new grass/legume technology generated in the CPAC/-CIAT project of the Cerrados savannas.

CIAT Work Program at Level of the 1987 Budget Request

The CIAT budget request for 1987 amounts to C$23,948,000. At its 41st meeting held in Cali, Colombia, TAC considered this budget request within the context of the budget requests presented by all international centers, as well as anticipated availability of funds for 1987. TAC recommended a funding level for CIAT of C$22,690,000. Nevertheless, TAC approved the complete work program of CIAT as presented here, and recommended that the balance to the full budget request (C$23,948,000) be funded if additional financial resources are available.

The table below shows the program items that are additional to the 1986 program. No particular priority is implied in the listing of the items below. If available resources are less than the full budget request, CIAT will, of course, take into consideration the views expressed by TAC as to the order of priority of the items listed below.

	C$ in thousands				
	M-Y	Operations	Working capital	Capital items	Total
1986 revised budget	65.0	20,904		713	21,617
Inflation between 1986-1987		836	70		906
Plus:					
Program capital items					
Strengthening of Genetic Res. Unit		63	5	68	
Rice Economist	1.0	135	11	19	165
Cassava Liaison Scientist, Africa	1.0	190	16	32	238
Additional funds for postdoctoral fellowships		166	14		180
Pasture Reclamation Specialist, Humid Tropics	1.0	139	12	47	198
Africa-wide Bean Coordinator	1.0	156	13	33	202
Additional funds for training materials		63	5		68
Quarantine greenhouse				153	153
Land Systems Specialist	1.0	156	13	32	201
Virologist	1.0	187	16	49	252
1987 budget	71.0	22,995	175	1,078	24,248
Offsetting items					
Income applied in year					(300)
Funds from donors					23,948

Justifications and explanations for the added items being proposed for 1987 are under the following headings:

Inflation. Inflation between 1986 and 1987 is calculated at 4.0 percent and reflects the projected price changes for CIAT's market basket.

Strengthening activities in the Genetic Resources Unit (GRU). The GRU was created in 1977 and has carried out the overall work of germplasm conservation and management in *Phaseolus* and lately in tropical pastures species. In addition, CIAT plans to transfer all conservation activities in *Manihot* to the GRU in 1987. New facilities for medium-and long-term seed storage and in vitro conservation of cassava are now in the planning stage. Construction is expected to begin in late 1986. With this expansion and upgrading of facilities come new increased responsibilities for the GRU through the work of the Seed Health Testing Laboratory which checks seed health on outgoing CIAT germplasm. CIAT proposes strengthening the work of the GRU in cassava germplasm conservation, in seed health testing, and in improved provision for postentry quarantine activities. The amount of $65,000 shown in the review list would be dedicated to the provision of increased number of support staff to handle the increased responsibilities as well as some additional operational expenses involved.

Rice Economist. The position of Economist in the Rice Program was projected for 1982 in the first version of CIAT's Long-Range Plan. It was included in the budget for that year and endorsed by TAC, but later postponed due to funding shortfalls. It was included in all subsequent Forward Lists but not implemented due to funding reasons.

The main function of the economist is to evaluate, on a country-by-country basis, potential sources of production growth to meet demand growth. This entails an assessment of the economic viability of area expansion and yield increases in different production systems under alternative yield/cost scenarios arising from existing and potential technologies and policies. The analysis will focus on the identification and economic evaluation of physical-, biological-, cultural practices-, economic and policy-related constraints to area expansion and increased productivity in the different production systems in each country. Such analyses, carried out jointly with scientists in the national programs in the respective countries and in close collaboration with other scientists in the CIAT Rice Program, will provide the necessary information to sharpen national research and production plans and better focus the CIAT Rice Program research, testing, and training priorities.

In addition, the economist, in collaboration with national program scientists, is to evaluate and document production increases as they are taking place; quantify and analyze the existing gaps between demand and production and yield; assess the nature of the technology adoption process and of existing constraints and incentives to production, including the extent to which production increases affect prices; and assess the distribution of benefits among producers and consumers at various income strata.

The existence of a large variety of production systems in Latin America and the Caribbean—ranging from irrigated to unfavorable upland; from mechanized commercial to subsistence manual—each with a different potential to contribute to increased production in the various countries, makes it imperative that these potentials be fully understood in order to focus and prioritize research and international coopération efforts.

Cassava Liaison Scientist IITA. CIAT and IITA have developed strong research collaboration with respect to cassava and this is expected to increase markedly in the future as a consequence of the increasing realization of the critical role of cassava in sub-Saharan Africa as a buffer against famine. The work of CIAT in Latin America and Asia has already been demonstrated to contribute to the IITA Program across a wide range of activities including germplasm development, biological control of insects, virology, physiology, and cassava documentation and information services. IITA, on the other hand, could make a valuable contribution to the international cassava network. CIAT has projected the need for a CIAT-IITA Cassava Liaison Scientist based at IITA who would work as an integral member of the IITA team in a particular discipline of greatest value to IITA but who would be charged with a liaison mission to ensure that stronger and more direct contacts are maintained between the two centers so that the fruits of their research can be shared for the benefit of the network as a whole. The value of such liaison positions has been demonstrated over many years at CIAT where the IRRI-CIAT liaison scientist provides direct and continuous connection between the two centers ensuring mutual support and avoidance of duplication. CIAT considers such a position in cassava at IITA would provide this linkage.

Postdoctoral and senior research fellows. The proposed 1986 budget for postdoctoral fellows was reduced by about US$173,000 (nearly 25%) due to funding shortfalls. It is proposed to restore the same amount in 1987 for an additional 3-4 fellowships for scientists from collaborating national programs to strengthen selected collaborative research programs in beans, rice, and pastures.

There is a strong demand for postdoctoral opportunities from collaborators in CIAT-sponsored commodity research networks, as well as from individual national commodity research programs that are in the process of implementing and refining research strategies aimed at the elimination of critical constraints.

Through postdoctoral fellow internships at CIAT research personnel from national programs can obtain relevant expertise in methodologies and techniques and can plan research for joint execution by CIAT and the respective national programs.

The proposed expansion of this budget will also allow CIAT to engage scientific staff on a short-term basis to address specific research topics for which special expertise is needed. Included are the areas of virology (see justification for virology position below) and of geography/land systems (see justification for land systems specialist below). Even though temporary expertise will not satisfy the need for long-term staff in these areas, they will provide an interim solution to meet the most urgent needs in these fields.

Pasture Reclamation Specialist for Humid Tropics. The position of Pasture Reclamation Specialist was proposed for 1983 in CIAT's original Long-Range Plan. It was proposed again in the revised version of the plan[1] and was endorsed by TAC for implementation in 1986 but postponed due to funding shortfalls. This position,

[1] CIAT in the 1980's revisited: A Medium-Term Plan. CIAT, October 1985.

already included in past Forward Lists, is essential to deal with the problem of pasture degradation and ecological damage in the humid tropics—a problem affecting large areas and regarded as critical by the countries of Central America, the Caribbean, and the Amazon and Orinoco basins.

The humid tropics ecosystem includes most of the acid soil regions in Central America, the Caribbean, the Amazon basin, and Orinoco basin. It has been estimated that in this ecosystem there are already 6 to 7 million hectares of pastures, of which more than two million hectares are in a stage of severe degradation, and the remainder at different stages of degradation. Degradation occurs because most pasture species presently being used are adapted only to the higher soil fertility levels which result from the burning of the forest biomass. Consequently, as fertility declines because of leaching, nutrient fixation in the soil, and nutrient extraction by fertility demanding species, the pasture species gradually disappear, the pastures are invaded by weeds, and the soil is left exposed to degradation and erosion. This process, in turn, leads to further deforestation. It has been estimated that 300,000 hectares of forest are cleared annually, mostly to compensate for the degradation of pastures planted to nonadapted species. As a counter measure, alternative new pasture species adapted to the acid, high aluminum, and low fertility characteristics of soils are urgently needed for efficient silvo-pastoral systems.

The Pasture Reclamation Specialist will be in charge of developing economically viable methods for reclamation of degraded lands through the establishment of adapted and productive grass-legume pastures (including shrub legumes and other silvo-pastoral components) with high recycling capacity. This will require a thorough understanding of the degradation process in terms of soil and native vegetation dynamics as well as the understanding of the performance of the new improved germplasm in terms of nutrient requirements, general adaptation, aggressiveness, compatibility, nutrient recycling capacity, and relative selectivity by animals. The final aim is to reduce the forest clearing pressure by replacing the presently low-quality, low-carrying capacity (0.5 heads/ha), and degraded lands with highly productive (2.0 heads/ha), high quality and economically and ecologically stable pastures. The work of this specialist will be supported by the other sections of the Tropical Pastures Program and by specialists in other disciplines from the host national program at Pucallpa, Peru.

Africa-Wide Bean Coordinator. The CIAT Long-Range Plan for the decade of the eighties projected the need for a Regional Coordinator for the Bean Program in Africa. The proposed CIAT strategy for beans in that continent was supported by the EPR in 1984 and received the endorsement of TAC in their commentary on the CIAT EPR Report. In the meantime CIAT has developed two long-term extra core-funded projects for central and eastern Africa while a third is under negotiation for the Southern African Development Coordination Conference (SADCC) countries of southern Africa. The need for CIAT involvement directly in Africa in regional programs was recommended by participants from Africa at a conference in 1980 held in Malawi under CIAT auspices. The need for close integration of these projects in Africa on a long-term basis is clear. The creation of a position of Africa-wide coordinator for bean activities would ensure that research duplication is avoided, that training programs can be developed with economies of scale, that close cooperation with other international agricultural research centers and the national programs is achieved, and that CIAT scientists in Africa maintain contact with CIAT headquarters while at the same time developing a degree of necessary independence. This position is projected within the CIAT core budget in order to allow a long-term perspective to be given to this regional coordination.

Nucleus for producing and disseminating training materials on new production technology. During the past several years CIAT has developed —with the help of special project funds—a strong capacity to design, develop, and produce didactic materials on CIAT-generated production technologies. These materials are for participants in CIAT's training program, and play a major role in regional and in-country training courses. In addition, the materials are widely distributed to and used by collaborating national institutions, including national research and development programs and universities. Recent surveys show that CIAT's training materials are in active use by more than 400 institutions in Latin America. At this time, CIAT has available audiotutorial sets on more than 100 different topics covering all of the Center's mandated crops. Now that the special project funds for training materials have run out, CIAT must endeavor to continue this effort with a judicious allocation of core funds. This will allow the Center to package new technical information as it becomes available and to modify already existing training packages in line with the changing knowledge base. The proposal is to use core financing for the skeleton of the professional staff needed for this effort, with the understanding that any additional resources to be allocated to this work will need to be special-project funded. (Such add-on special project resources have already been secured.) Thus, this item contains resources to maintain a small group of professionals

which is considered to be the minimum required size to keep the training materials effort viable and to provide a basis around which special-project resources can be organized.

Quarantine greenhouse. Of the more than 30,000 bean accessions in the CIAT germplasm bank, approximately half are not yet available for evaluation, characterization, and use in the CIAT Bean Program and elsewhere because they have not yet been cleared by the phytosanitary authorities (i.e., ICA) in Colombia. ICA has been and continues to be very cooperative and helpful with respect to quarantine arrangements presently in place. Lack of an appropriate greenhouse facility at ICA, Tibaitata, is the principal limiting factor to increasing the number of bean accessions passing through the Colombian quarantine process. The budgeted amount under this item will suffice to construct a new greenhouse facility, which will then allow an increased capacity to clear new bean accessions as well as other species when necessary. The External Program Review made a strong recommendation that something be done to speed up the phytosanitary clearing process. It is believed that the proposal under this item will be adequate to effectively respond to this recommendation. ICA authorities have been informed of this possibility and fully support the proposal.

Land Systems Specialist. This position was projected in the original Long-Range Plan for 1983, but lack of funds have prevented its implementation. The Medium-Term Plan reaffirms the importance of this position and projects it for 1987. This position is to complement the one existing senior staff position (i.e., agrometeorology) in the Agroecological Studies Unit. The purpose of this Unit is to provide for an improved understanding of the agroclimatic zones and cropping systems, and their interactions with germplasm so as to provide, within each commodity research program, reliable definitions of production regions by integrating edaphic, climatic, cropping system, and socioeconomic information. The position of Land Systems Specialist is required to accelerate the task of collecting and interpreting the land system data (soils, topography, vegetations, etc.) critical for the target area and constraint analysis in relation to the commodities in CIAT's mandate. With the addition of this position, the Agroecological Studies Unit will also be able to provide the research programs with the critical expertise needed for the edaphoclimatic analysis of data generated by the regional and international germplasm evaluation trials with respect to the various production systems to which given subsets of the data obtained can be generalized.

Virologist. CIAT is centralizing all virological research in support of the commodity programs in the Biotechnology Research Unit (BRU). Demand for strategic virological research in all CIAT commodity programs has increased both in the area of developing strategies for genetic control of viral diseases as well as in matters related to seed health and phytosanitary controls generally. The senior staff virology position presently in the Bean Program has been transferred to the BRU. Given the increasing demand for support to all programs in this area, CIAT projects the need for a second virologist position in the 1987 Review List. The position would handle research in tropical pastures and rice and provide a direct connection to the more advanced research in biotechnology already underway in the BRU.

PROJECTIONS FOR 1988

The 1988 projection uses the 1987 proposed budget to which are added the positions that are included in the Medium-Term Plan through 1988.

	M-Y	C$ in thousands
Tropical Pastures		
Regional Liaison Scientist (ILCA)[a]	1	200
Cassava		
Physiologist	1	189
Breeder	1	224
Total additions		613

a. International Livestock Center for Africa.

THE RESEARCH PROGRAMS

BEAN PROGRAM

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Program leader	1	1	1	1	1	2	2	2	2	2	4	3	3	3	3
Soil microbiology	1	1	1	1	1	3	2	2	2	2	3	7	7	7	7
Physiology	1	1	1	1	1	2	2	2	2	2	13	13	13	13	13
Breeding I	1	1	1	1	1	3	3	3	3	3	14	13	13	13	13
Breeding II	1	1	1	1	1	2	3	3	3	3	15	16	16	16	16
Breeding III	1	1	1	1	1	2	2	2	2	2	14	14	14	14	14
Entomology	1	1	1	1	1	3	3	3	3	3	11	11	11	11	11
Pathology I	1	1	1	1	1	3	4	4	4	4	12	12	12	12	12
Agronomy (prelim. trials)	1	1	1	1	1	2	2	2	2	2	10	10	10	10	10
Agronomy (cropping systems)	1	1	1	1	1	2	2	2	2	2	9	7	7	7	7
Agronomy (international trials)	1	1	1	1	1	2	2	2	2	2	17	17	17	17	17
Virology	1	1				3	2				7	7	5	5	5
Economics	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3
Total	13	13	12	12	12	32	32	30	30	30	137	133	131	131	131

Decentralized Regional Programs

Central America and Caribbean															
Reg. Coord. Virology	1	1	1	1	1										
Agronomy	1	1	1	1	1										
Breeding	1	1	1												
Brazil and Southern Cone															
Reg. Liaison/Agronomy				1	1									2	2
Southern Africa															
Africa-wide Coordinator			1	1	1								2	2	2
Total	3	3	4	4	4								2	4	4

Direct costs (1986 US$ in thousands).

	Current Budget		Proposed Buget
	Actual 1985	Revised 1986	1987
Personnel	1970	2293	2325
Supplies and services	466	391	389
Travel	254	232	246
Replacement equipment	35	29	28
Total	2725	2945	2988

Budget Changes

The senior staff virology position is transferred to the Biotechnology Research Unit. A new senior staff position for an Africa-wide bean coordinator is added (see page 20).

Program Commentary

Importance of beans

Beans (*Phaseolus vulgaris* L.) are a principal food crop for small farmers in many countries in tropical America, Africa, and the Middle East, and constitute a major source of protein in those countries, especially for the low income segments of their populations. Bean production is the main activity supporting an estimated 5 million people living on small farms in Latin America and Africa; and for a far greater number of such farmers, beans are an important part of their cropping systems and of their diet.

Beans provide 11% of total protein consumption in tropical Latin America and in many countries it is the cheapest form of high quality protein. In eastern and central Africa per capita bean consumption reaches 50 kg per person per year—the highest in the world. Here people derive more protein from beans than from all animal products combined. Because of their low price, beans play an especially critical role in the nutrition of the poor. For example, in urban Colombia, the share of beans in the total protein of the diet of the poor is twice that of high income people. Beans are of greatest importance in diets in rural areas. In rural Brazil, beans provide from one-quarter to one-third of the total protein consumption, as well as 10 to 15% of total calories.

Bean production in the tropics is principally concentrated in Latin America (the center of the crop's origin) where 4.1 million tons are produced annually. In eastern Africa nearly 2 million tons are produced annually. In Latin America, Brazil is the largest producer, followed by Mexico. In Africa, Burundi, Kenya, Rwanda, Tanzania, and Uganda are the leading producers. Because small farmers in Africa and Latin America produce beans with low levels of inputs, on poor hillside soils, with the bean crop subject to considerable disease and drought stress, and in low plant populations in associated cropping systems, yields average little more than 500 kg/ha in tropical Latin America and Africa.

Because of the high stress conditions under which they are produced, beans are a risky crop with highly variable output. For example, in Latin America production fluctuates as much as one million tons from year to year. Moreover, in most bean producing countries there has been no productivity growth in the period 1966-1981, and often yields have been falling during this period. Due primarily to area expansion, production increases have been lagging behind population growth in most countries. As a result, for the first time in history, Latin America and Africa have become net importers of beans. For some countries, however, this picture has started to change.

Problems of the crop

Potential yields of current commercial varieties used in Latin America range from 2-3 t/ha. One of the principal reasons why actual yields are low is the heavy disease pressure on the crop. Disease incidence varies from region to region. Nevertheles, some diseases are prevalent in virtually all production regions (e.g., 60 percent of bean production in Latin America is subjected to the risk of anthracnose attack). Disease transmission via the seed has undoubtedly contributed to the wide distribution of many bean diseases. Disease pressure is further increased by the poor plant type of bush beans. Plants commonly lodge at maturity and, with pods in contact with the soil, disease accumulation in seed occurs. Farmers traditionally save their seed for subsequent plantings and, thus, are further contributing to disease incidence. Climbing beans that are excessively vigorous have podloads well above the ground, but are subject to seed loss when the maize lodges. Farmers have reacted to the strong disease pressure by planting towards the end of the wet season, which increases drought stress.

In addition to diseases, insects can cause severe reductions in bean production, particularly under the dryer conditions referred to above. With beans increasingly being displaced to marginal lands, soil acidity and phosphorus fixation are becoming important. A further important problem is that beans do not fix much nitrogen under most production conditions.

The Bean Program is reasonably confident that the above summary of production problems reflects production reality. Nevertheless, additional information on production methods, production systems, and specific production constraints in given countries is continually being gathered and is used in the adjustment process to which the Program's research priorities are continually exposed.

Program objectives

The Bean Program's objective is to develop, in collaboration with national programs, improved technology that permits increased bean production and yields. The following primary activities support this objective.

Genetic improvement of bean germplasm that meets the agronomic requirements of farmers as well as consumer preferences.

Development of agronomic practices compatible with improved genotypes.

Training to strengthen the research and technology transfer and validation activities of collaborating national programs.

International cooperation at all levels for the further development of an active bean research network throughout the action area of the Program.

Program strategies

Genetic improvement to overcome production problems—rather than the use of purchased inputs—is the principal strategy of the Bean Program to increase yields. Genetic improvement activities are based on the large genetic variability encountered in beans and are facilitated by the availability of more than 35,000 bean accessions (including their wild ancestors and related species) in the bean germplasm bank housed in the Genetic Resources Unit of CIAT. The Bean Program performs several thousand hybridizations per year. The resulting progenies pass through uniform successive nurseries. The best selections are tested in international uniform nurseries from which the national programs select materials for direct use in regional or onfarm testing or, alternatively, for use in their own breeding programs. At the beginning of this decade, and following several years of systematic training of national programs personnel, the program started an intensive effort to decentralize selection. Today national program scientists are increasingly selecting locally adapted materials mostly of CIAT-generated populations. CIAT does not release or name varieties. This is entirely a national responsibility.

The bean breeding activities strive to combine the following desired variability:

Resistance to priority diseases and insects, including bean common mosaic virus (BCMV), rust, anthracnose, angular leaf spot, common bacterial blight, and leafhoppers. In addition, the Bean Program, through its decentralized breeding strategy, attempts to incorporate into improved varieties resistance to important location-specific diseases (such as bean golden mosaic virus in Central America, or the beanfly in Africa). Of major importance in selecting improved varieties is the need to meet local color and seed size requirements. These requirements vary from country to country and from region to region.

Yield potential. Increasing yield potential of a legume crop like beans is a long-term objective. In order to be able to increase yields of beans when disease resistances have been incorporated, the Program has recently started to place great emphasis on genetic improvement for increasing yield potential, first under no-stress conditions, to be followed later under diverse stress conditions.

Improvement of drought resistance. Over large areas in Africa and Latin America beans suffer from drought stress. The germplasm collection and breeding will provide lines better able to withstand drought stress.

Decreased dependence on fertilizer requirements. While all lines are being developed and evaluated under low fertilizer (and plant protection) regimes, a genetically improved bean/*Rhizobium* interaction is sought to increase the nitrogen-fixation ability of beans. The Bean Program also strives to enhance the genetic variability for adaptation to low soil phosphorus conditions which is of principal importance in Brazil and large areas in Africa.

While genetic improvement for protein content, cooking time or digestibility is not actively pursued, the Program does monitor these factors in newly developed materials to ensure that no deterioration occurs.

Since agronomic practices are largely site-specific, the Bean Program conducts little research in this area. There are indications, however, that improved varieties perform differently on the experiment station than on farmers' fields. Given that onfarm research and regional variety trials are still inadequately developed in most countries, the Program has found it necessary to devote considerable resources to validation trials. The Bean

Program has therefore developed active onfarm research and training activities with national programs to provide feedback to research and link research and extension. This program is being developed in close collaboration with other international centers, especially with the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) as beans are mostly grown in association with maize.

Achievements of the program

See bean section under SUMMARY OF ACHIEVEMENTS, p.10.

Special Projects

The Bean Program seeks to enhance the improvement of bean production in ecologically uniform production areas through special projects in the respective regions. The Program emphasizes regional collaboration on research and networking activities to improve communication among national programs. To achieve this, special projects are organized in which research and CIAT staff members are placed in the region. They are supported with training funds and means to improve communication among the network countries. Funds are also provided to national programs to execute research of regional significance. In this way not every participating program needs to cover the entire area of crop improvement, but rather is allowed to specialize in specific areas where they have a comparative advantage. The networks are formed to assure horizontal transfer of results and integration of research. CIAT's outposted staff does not manage CIAT nurseries, but rather assists and trains national program scientists so that they are in a better position to plan and execute research and to use research results from elsewhere. This model has proved very successful in Central America and is now being applied with success in Africa.

Bean Improvement for Eastern Africa

The objective of this project is to increase bean production through the propagation of improved varieties and production technologies in Kenya, Uganda, Ethiopia, and Somalia, thereby increasing the protein intake and nutritional status of local populations. Major activities are: developing national program research capacity by training of bean breeders and agronomists; introducing new germplasm and, through national breeding programs, developing highly productive varieties adapted to local conditions and consumer preferences; and improving cropping systems. Germplasm improvement emphasizes the development and distribution of multiple-disease and pest-resistant lines. Regional collaboration on research and networking activities to improve communication among national programs is also emphasized.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel (4 senior scientists)	100	476
Honoraria, stipends, and allowances	35	201
Supplies and services	15	90
Travel	30	45
Training	17	
Equip. replacement and capital	20	37
Indirect costs	30	122
Contingencies	25	81
Project review	8	59
Subtotal	280	1111

Bean Improvement for Francophone Eastern Africa

This regional bean project aims to strengthen national research in the Great Lakes region of Africa (Rwanda, Burundi, and Kivu Region of Zaire). Strategies include: incorporation of disease resistance and tolerance to climatic and edaphic constraints; onfarm cropping systems research, evaluating small farmers' production constraints and testing new bean technology components, with emphasis on the dynamics of genetic mixtures in traditional cropping systems; and training through regional and in-country courses and development of training materials in order to develop national programs' self-reliance in bean research. Funding for 1987 is not yet assured, but is assumed to continue at the 1986 level.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel (3 senior staff)	270	270
Honoraria, stipends, and allowances	45	45
Supplies and services	179	179
Travel	86	86
Equip. replacement and capital	70	70
Indirect costs	58	58
Contingencies	29	29
Subtotal	737	737

Bean Improvement for Southern Africa (SADCC Countries)

This project is designed to increase bean productivity, production, and consumption and to strengthen national agricultural research in *Phaseolus* beans in the SADCC countries of Africa. This regional networking project will develop, in collaboration with national programs of the region, new bean production technology for both traditional and innovative cropping systems and will strengthen national research capacity so as to increase national bean production to keep pace with expected demand from rapidly growing populations in the region. Although this project has not yet been funded, interim funding has been provided for finalizing the design of the SADCC program.

	Budget (1986 US$ in thousands)	
	1986 (interim funding)	1987
Personnel (4 senior staff)	60	371
Honoraria, stipends and allowances		148
Supplies and services		114
Travel	65	48
Equip. replacement and capital		82
Indirect costs	20	103
Contingencies		68
Subtotal	142	934

Interspecific Hybridization

This project is being carried out in cooperation with the University of Gembloux, Belgium. It includes: research on interspecific hybridization of *Phaseolus vulgaris* and *P. coccineus*, including a complete evaluation and characterization of the latter; characterization of the existing *P. lunatus* collection and making recommendations as to further germplasm collection activities for this species; and consultation with Belgian expertise on taxonomic problems related to the forage legume species collection at CIAT.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	45	45
Honoraria, stipends and allowances	—	—
Supplies and services	15	15
Travel	14	14
Equip. replacement and capital	7	7
Other expenses	17	17
Contingencies	10	12
Subtotal	108	110

Research on *Phaseolus* Germplasm

This special project is financed by the Italian Government. It includes collaborative research with Italian institutions on: virus diseases of *Phaseolus*, primarily Bean Yellow Mosaic Virus; creation of new variability through mutagenesis in *Phaseolus* germplasm; seed protein quality; and regeneration of *Phaseolus* from unorganized cell preparations.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	—	—
Honoraria, stipends and allowances	100	88
Supplies and services	—	—
Travel	—	—
Equip. replacement and capital	—	—
Other expenses	—	—
Contingencies	—	—
Subtotal	100	88

Beans and Rice Research Programs in Peru

This project involves collaboration with the Instituto Nacional de Investigaciones y Promoción Agraria (INIPA) on bean and rice research through the outpost-

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel (2 senior staff)	84	84
Honoraria, stipends, and allowances	46	47
Supplies and services	40	40
Travel	9	9
Equip. replacement and capital	—	—
Indirect costs	14	14
Contingencies	—	—
Subtotal	193	194

ing of two research advisers who provide technical backstopping and assist national program coordinators. They also play an active role in varietal selection trials, inservice training, and the selection of candidates for training at CIAT. They also assist in the formulation of medium and long-term research plans. Funding for 1987 is not yet assured.

Biological Nitrogen Fixation, Beans, and Pastures

See under "Special Projects" in Tropical Pastures Section, p.39.

Germplasm Collection Beans and Cassava

See under "Special Projects" in Genetic Resources Unit Section, p.42.

CASSAVA PROGRAM

Core Resources

Personnel (Positions)	Senior staff Act. 85	Senior staff Bud. 86	Senior staff Bud. 87	Senior staff Bud. 88	Senior staff Bud. 89	Scientific and supervisory Act. 85	Scientific and supervisory Bud. 86	Scientific and supervisory Bud. 87	Scientific and supervisory Bud. 88	Scientific and supervisory Bud. 89	Clerical and other Act. 85	Clerical and other Bud. 86	Clerical and other Bud. 87	Clerical and other Bud. 88	Clerical and other Bud. 89
Program leader	1	1	1	1	1	2	2	1	1	1	2	1	1	1	1
Utilization		1	1	1	1	4	4	4	4	4	8	7	7	7	7
Physiology	1			1	1	1	2	2	4	4	7	4	4	11	11
Germplasm development	1	1	1	1	1	2	2	2	2	2	27	27	27	27	27
Pathology	1	1	1	1	1	2	2	2	2	2	11	11	11	11	11
Entomology	1	1	1	1	1	3	3	3	3	3	12	12	12	12	12
Soil/plant nutrition	1	1	1	1	1	2	2	2	2	2	12	11	11	11	11
Cultural practices (Agronomy)	1	1	1	1	1	2	2	2	2	2	9	10	10	10	10
Economics	1	1	1	1	1	3	3	3	3	3	4	3	3	3	3
Media Luna						1	1	1	1	1	1	2	2	2	2
Carimagua						1	1	1	1	1	11	9	9	9	9
Virology						2	2	2	2	2	4	4	4	4	4
Breeding				1	1				2	2				11	11
Total	8	8	8	10	10	25	25	25	29	29	104	101	101	119	119

Decentralized Regional Programs

Asia															
Agronomy	1	1	1	1	1						3	3	3	3	3
SubSaharan Africa															
Liaison Scientist			1	1	1								2	2	2
Total	1	1	2	2	2						3	3	5	5	5

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	1588	1535	1657
Supplies and services	166	150	180
Travel	242	231	262
Replacement equipment	4	9	9
Total	2000	1925	2108

Budget Changes

One senior staff position for a liaison scientist to be stationed at IITA in Nigeria is added (see page 25).

Program Commentary

Importance of cassava

In 1985 world cassava production was estimated at approximately 136 million tons, produced on some 14.5 million hectares. The production is roughly divided as 41% in Africa, 37% in Asia, and 22% in the Americas. More than 60 percent of the total production is destined for use as human food—half as fresh cassava and half after some form of processing. Fourteen percent is used as animal feed within the developing countries and an increasing amount is being exported as dried pellets for animal feed in the developed countries. Estimates vary for the amount of cassava lost as waste after harvest. However, the figure is somewhere between 13% and 25%, highlighting the importance of postharvest handling. In terms of direct human consumption cassava provides from 200 to 1000 calories per day for more than 700 million people in the developing countries.

Cassava is especially important for the poor because it is among the most inexpensive of foods available. In many countries dried cassava is by far the cheapest form of obtaining calories while fresh cassava usually costs about the same as other major calorie sources, such as corn or rice. Since the crucial nutritional deficiency in low income countries is calories, cassava is particularly important because it is both inexpensive and consumed primarily by the poor who are the most vulnerable to calorie shortages.

Most cassava is produced by small farmers cultivating marginal soils, making it an important component of the diet among a major segment of the rural poor. Cassava consumption is lower in the cities than in the countryside. This is the result of a complex interaction of a variety of factors, including: the perishability of cassava, poor transportation systems, and the relatively higher prices for cassava resulting from subsidies for other foods and the slower pace of technological innovation (caused by the historical neglect of the crop in terms of research and development). New technologies which raise the yields of cassava and reduce problems of storage may be expected to reverse current trends and, when coupled with the elimination of subsidies for other foods and improvements in marketing and transportation systems, induce an increase in urban consumption of cassava.

Although cassava is relatively low in protein, it can also contribute indirectly to augmenting protein availability through its use as an animal feed. Because of the availability of unused marginal land which cannot support other crops but can produce cassava, the use of cassava as an animal feed could vastly reduce the competition for feed grains between the concentrate industry and the human food sector. Moreover, domestic production of feed grains often has been unable to meet demand, leading to imports of feed grains by many countries that can ill afford it and to upward pressure on the price of animal feeds which in turn pushes up the cost of meat and puts it out of reach for the very poor. Production of cassava with underutilized domestic resources could promote employment, alleviate the burden of costly imports, and contribute to maintaining a supply of inexpensive animal protein.

In the developing world imports of wheat are increasing dramatically. In those countries with cooler climates good possibilities exist for increasing wheat production. However, in the lowland tropical areas this possibility seems remote. Cassava flour can readily substitute for part of the wheat flour in products such as bread, pastas, and biscuits. The advantages of replacing imports with locally produced products with a high labor requirement are obvious.

Problems of the crop

The problems facing the cassava crop differ depending on the desired end use. The major problem confronting the fresh cassava market is the perishability of the crop. In many areas the producer only receives a very small percentage of the final price paid by the urban consumer. It is often thought that this is due to inefficient marketing systems—however, this is probably not true. The high marketing margin is merely a reflection of the extreme perishability and bulkiness of the crop. Recent research results suggest that the shelf life of fresh roots can be extended from 48 hours to more than two weeks through improved postharvest technology. This could result in reduced prices for the con-

sumer, increased demand, and reduced wastage, without reducing the farmgate price.

The problems facing cassava as a dried product, either for animal feed or human food, are very different. The major part of the cost of production of dried cassava is the cost of the fresh roots which can be reduced by high-yield low-input technology. Present average yields of 10 t/ha are well below potential because of poor agronomic practices, lack of varieties responsive to improved management, and diseases and insects.

A further problem in the production of dried cassava products is the dehydration process. Fresh cassava contains about 60-65% water which must be reduced to 12-14%. In areas with long dry periods natural drying techniques are now well developed. However, good natural drying technology does not exist for the wetter periods in those areas of the tropics where humidity is rarely low.

The market potential for dried cassava products appears very large if a supply of cheap roots can be obtained and if they can be effectively dried. This potential may not always be realized as government policies often favor competing products, mainly wheat, through heavy subsidies. It is suggested that the availability of new production and processing technology can be used as a powerful argument to force changes in those government policies that militate against cassava.

Program objectives

The overall goal of the cassava network is to increase small farmers' income and food supply and to improve food availability to the overall population. This goal is to be achieved by converting cassava from being mainly a traditional rural staple to a major, multiuse, carbohydrate source.

The Cassava Program has two main components or functions: firstly, that of an international center; and secondly, that of a regional center in Asia and Latin America and the Caribbean. In Asia the regional activities are closely interwoven with the ESCAP (Economic and Social Commission for Asia and the Pacific) Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots, and Tuber Crops in Humid Tropics of Asia and the Pacific (CGPRT). The Centre has comparative advantage in the socioeconomic aspects specific to Asian agriculture. In Africa IITA has a regional responsibility to serve the important needs of cassava in that continent.

The CIAT program, in its global capacity, provides the following major inputs into the overall research and development efforts of the cassava network:

Maintenance of the world cassava germplasm collection and, from this base, the provision of elite gene pools with known characteristics to regional and national programs. Coupled with this effort is the development of improved breeding methodology;

Development of the basic principles for establishing improved production and utilization systems and of the research methodology required to adapt such systems to local conditions;

Basic research directed to the better understanding of the crop and its interaction with environmental stresses;

Analysis of the future potential role of cassava in the economy of the developing world;

Operation of the world's cassava documentation and information center; and

Organization of training opportunities and meetings for cassava workers from national and regional programs.

In its function as a regional center for Latin America and the Caribbean, CIAT has set up a group to investigate and promote integration of production, utilization, and marketing of cassava. This section works closely with national programs in setting up small-scale integrated cassava pilot projects. The overall activities of the group concentrate on: projects for the macroeconomic analyses of cassava potential in given countries; planning and organization of project structure; establishment of projects and development of local adaptive research; economic analysis of the pilot projects; and policy recommendations on commercialization when solicited by governments.

A CIAT regional program is now established in Asia in order to satisfy the specific requirements of germplasm for Asia, to develop agronomic practices more appropriate to the intensive cropping systems practiced there, and assist in strengthening Asian national programs.

Program status

See cassava section under SUMMARY OF ACHIEVEMENTS, p. 9.

Expected benefits

The combination of new varieties and improved agronomic practices have been shown to greatly increase cassava productivity and reduce costs. In Latin America benefits can only be reaped from this new technology by closely linking cassava with procesing and marketing. The establishment of pilot projects in various countries will accelerate the diffusion process and large increases are expected in the use of the new storage technology for fresh cassava and for the entry of large quantities of dried cassava into the animal feed market. Both these aspects of cassava will bring benefits to both the small-scale producer and the consumer. The former will benefit from increased demand for his product, thus allowing him to reap the benefits of improved production technology; and the latter, in the case of fresh cassava, from a cheaper, higher-quality product. In the case of dried cassava for animal feed and composite flour, savings will be made in foreign exchange, an important contribution as many countries struggle to repay large foreign debts.

In Asia the major benefits will come from the new varieties that will increase production with little or no change in production costs.

At present, in Africa, production of cassava is declining due to the effects of mealybugs and mites. The use of biological control developed by cooperative activities of CIAT, IITA, and CIBC in a truly international effort should reverse this trend and alleviate, at least partially, the serious food deficits in that continent.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel (1 senior staff)	45	187
Honoraria, stipends, and allowances	—	—
Supplies and services	10	34
Travel	10	42
Equip. replacement and capital	10	18
Contract research	31	50
Indirect costs	14	47
Contingencies	—	—
Subtotal	120	378

Cassava and Rice Programs in Panama

Under a bilateral agreement, CIAT's Rice Program helps the Instituto de Investigación Agropecuaria de Panamá (IDIAP) evaluate segregating populations to obtain advanced lines and varieties under conditions in Panama and the rest of Central America. The Rice Program also carries out observation, yield, and regional trials of promising lines and selections. CIAT's Cassava Program assists in the baseline study of socioeconomic and physical and biological conditions of cassava production in Panama; development of appropriate production and processing technology; and development, at the experimental level, of cassava processing and drying technology for a future national project. Funding for 1987 is not yet assured.

Special Projects

Cassava Improvement for Asia

This project aims to increase cassava productivity and production and to improve the utilization of technologies for both human food and animal feed by establishing a network among southeast Asian countries. Priority areas include work on germplasm development, agronomy and cropping systems, postharvest handling, and economics (this last area to be done by CGPRT-ESCAP in Bogor, Indonesia). Specific activities would include the assessment of regional constraints to increased production and productivity; organization of regional workshops and conferences to coordinate research, improve communications, and prevent wasteful duplication of efforts; coordinate training programs; and develop agronomic practices suitable for local cropping systems, particularly those based on perennial crops.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	11	11
Honoraria, stipends, and allowances	—	—
Supplies and services	11	11
Travel	—	—
Equip. replacement and capital	—	—
Other expenses	2	2
Contingencies	—	—
Subtotal	24	24

Cassava Development in Colombia

This project is designed to develop means for planning and propagating integrated cassava development projects in tropical Latin America. It aims to: develop a generalized procedure for institutional assessment, coordination, and division of responsibilities in integrated cassava projects; research the development of a macro-

planning framework for integrated cassava projects; and motivate policy support by holding a conference with key policymakers on the potential of cassava within their individual countries.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	96	10
Honoraria, stipends, and allowances	7	1
Supplies and services	13	1
Travel	20	2
Equip. replacement and capital	—	—
Other expenses	—	—
Contingencies	—	—
Subtotal	136	14

Biological Control for Cassava Mites in Africa

This project is designed to survey cassava mite predators in the Americas; evaluate their efficiency; and ship them to Africa.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	66	72
Honoraria, stipends, and allowances	6	7
Supplies and services	12	11
Travel	33	40
Equip. replacement and capital	—	—
Other expenses	32	9
Subtotal	149	139

Mycorrhiza

This project is to support work to maintain and evaluate the mycorrhizal collection (300 strains); conduct field-evaluation trials with highly effective mycorrhizal fungi under different edaphoclimatic conditions using cassava as test crop; define influence of agricultural management practices on native mycorrhizal symbiosis; and assist in the development of mycorrhizal research in national programs to ensure transfer of research results to farmers.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	64	22
Honoraria, stipends, and allowances	—	—
Supplies and services	4	2
Travel	5	2
Equip. replacement and capital	—	—
Other expenses	17	6
Contingencies	—	—
Subtotal	90	32

Fresh Storage

In collaboration with the Integrated Development Program (DRI) of Colombia, this project is to demonstrate the viability of the new fresh-cassava storage technology developed at CIAT on a commercial scale; and describe quantitatively the impact of the new technology on total demand of fresh cassava and farmgate and consumer prices.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	24	51
Honoraria, stipends, and allowances	4	—
Supplies and services	2	6
Travel	4	9
Equip. replacement and capital	3	5
Indirect costs	7	14
Contingencies	1	1
Subtotal	45	86

Germplasm Collection Beans and Cassava

See "Special Projects" in Genetic Resources Unit, p. 42.

RICE PROGRAM

Core Resources

Personnel (Positions)	Senior staff Act. 85	Senior staff Bud. 86	Senior staff Bud. 87	Senior staff Bud. 88	Senior staff Bud. 89	Scientific and supervisory Act. 85	Scientific and supervisory Bud. 86	Scientific and supervisory Bud. 87	Scientific and supervisory Bud. 88	Scientific and supervisory Bud. 89	Clerical and other Ac. 85	Clerical and other Bud. 86	Clerical and other Bud. 87	Clerical and other Bud. 88	Clerical and other Bud. 89
Program leader	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Agronomy (production systems)	1	1	1	1	1	2	2	2	2	2	8	8	8	8	8
Breeding (Sta. Rosa)	1	1	1	1	1	2	2	2	2	2	12	12	12	12	12
Breeding (Palmira)	1	1	1	1	1	2	2	2	2	2	23	22	22	22	22
Pathology	1	1	1	1	1	3	3	3	3	3	11	12	12	12	12
Economics			1	1	1			2	2	2			6	6	6
Physiology (Sta. Rosa)	1	1	1	1	1	2	2	2	2	2	6	6	6	6	6
Total	6	6	7	7	7	12	12	14	14	14	61	61	67	67	67

Direct costs (1986 US$ in thousands).

	Current budget Actual 1985	Current budget Revised 1986	Proposed budget 1987
Personnel	842	889	1002
Supplies and services	121	104	111
Travel	55	61	70
Replacement equipment	8	6	7
Total	1026	1060	1190

Budget Changes

One senior staff position for an agricultural economist is added (see page 30).

Program Commentary

Annual growth rates for rice in Latin America during the past two decades have averaged 3.3, 2.3, and 1.0% for production, area, and yield, respectively. Per capita consumption of rice has been rising and is currently about 35 kg of milled rice annually. Rice provides, on the average, 9% of total calories in the Latin American diet. Countries with the highest rice contribution to total caloric intake are Panama, Dominican Republic, Cuba, Brazil, Costa Rica, Colombia, and Peru.

Until recently Latin America has been a minor net importer of rice. The largest exporters were Uruguay, Suriname, Argentina, and Guyana and the major importers being Cuba, Brazil, Mexico, and Peru.

If demand increases continue at the annual rate of about 3.5% observed during the past 20 years, production must double by the year 2000 to satisfy internal demand at current relative price levels. This indicates an increase from the current 17 million tons to over 30 million tons by the end of the century. Unless production is stimulated rapidly the countries that will face serious rice deficits are Mexico, Nicaragua, Cuba, Jamaica, Brazil, Colombia, Ecuador, Peru, and Venezuela. Land and water resources other than the Caribbean are more than ample to permit this growth. The task ahead is to identify the ecologies and areas where need is greatest and growth will predominate, and to orient and intensify research and training toward the physical and biological constraints characteristic of these areas.

The CIAT Rice Program focuses on the Western Hemisphere including Mexico, Central America, the Caribbean, and South America. It collaborates closely with IRRI's efforts in global rice research and with IITA in areas of mutual interest. Research on major regional constraints is encouraged through an active network of rice specialists cooperating in the International Rice Testing Program (IRTP) coordinated by an IRRI scientist located at CIAT.

Program accomplishments

The excellent early collaboration between the CIAT Rice Program and ICA provided a rapid impact, both in and outside of Colombia. In addition, the strength of the IRRI program is an important component of the successes achieved. From its cooperative program with CIAT, ICA has released several dwarf varieties with

high yield potential. All of these varieties are now grown internationally. CIAT breeding lines have resulted in more than thirty other dwarf varieties released by national programs in the region. A recent impact study[1] has shown that these varieties are now grown on about 2.5 million ha annually in irrigated and in more favored upland systems in the Western Hemisphere. These new varieties, together with improved cultural practices, annually produce well over an additional 3 million tons of rice with a value exceeding 800 million US$. The surge in production in countries with these farming systems has equalled or exceeded population growth. A detailed analysis of the impact of new rice technology in Colombia showed that low-income consumers have received most of the economic benefits resulting from the large production gains.

CIAT has provided professional training in production agronomy, breeding, and pathology to about 300 rice researchers from 23 countries. Consequently, an effective regional network of cooperators for exchanging information and evaluating technology is fully operational. The Program's regional activities include IRTP nurseries, monitoring tours, production courses within countries, and biennial conferences at CIAT for research workers organized jointly by CIAT and IRRI under the auspices of IRTP.

Production systems and constraints

Trends in rice production, area planted, and yield vary widely among countries and over time. The major contribution to production during 1965-1975 came from increase in area, particularly in Brazil. This was reversed in the more recent period of 1976-1982 when essentially all regional growth came from yield increases. The unfavored upland area in Brazil began to decline, but was offset by increased productivity from irrigated areas in Rio Grande do Sul and Santa Catarina.

Fourteen of the 23 more important rice-producing countries now have average yields of over 3 t/ha. The Latin American average of 2 t/ha reflects the massive impact of the national average of 1.5 t/ha in Brazil. The basic causes for this variability are found in the predominant productions system in each country.

Several distinct production systems exist in the region. Often rice production is divided, somewhat misleadingly, into two main systems, irrigated and upland. In 1983-1984 irrigated rice covered 2.4 million ha (32% of the area), averaged 4.2 t/ha, and contributed 61% of regional production. In comparison, unfavored upland rice was grown on 4.1 million ha, yielded one t/ha, and contributed 26% of regional production. The more favored upland systems covered 0.7 million ha, averaged 2.4 t/ha, and produced 11% of regional production. The rainfed and manual upland ecologies together contributed only 2% of Latin American rice.

Irrigated rice. This system receives high CIAT priority because of its major contribution to regional production and its comparative advantage in maintaining and further increasing productivity and stability of supply. It is found in all countries and predominates in southern Brazil, Colombia, the Caribbean area, Guyana, Nicaragua, Peru, Surinam, Venezuela, and the Southern Cone countries. Irrigated rice is increasing in countries that formerly were upland producers. Average national yields range from3 to over 5 t/ha. Important constraints include increasing production costs, weeds, water control, rice blast and other diseases, lodging, and, in some countries, the availability of suitable grain quality for export markets.

Favored upland rice. This system is generally confined to flat areas receiving 1500 to over 2000 mm of rainfall in eight or nine months of the year. Normally, there are no short dry periods during the rainy season. The alluvial soils are slightly to moderately acid and well drained. This system uses modern dwarf varieties and improved agronomic practices. Yields average 2.5 t/ha, but better farms can produce 4-5 t/ha. The system is found in parts of Brazil, Central America, Colombia and elsewhere in tropical America. Major constraints are grassy weeds, diseases, and general instability due to irregular precipitation in some years. CIAT assigns high priority to this system.

Unfavored upland rice. This system, found in areas having irregular and low total rainfall, has low planting densities and utilizes tall varieties producing an average yield of less than one t/ha. Yield variance is extremely high. Much of Brazil's rice is produced with this system on relatively infertile and moderately acid soils.

The main system constraint is dry periods occurring during the growing season. This stress is compounded by poor root development associated with aluminum toxicity in the subsoil. The degree of drought enhances the severity of fungal diseases, particularly blast, in this system. Phosphorus and other deficiencies are a serious overall constraint. CIAT does not conduct research directly on unfavored upland rice since the system is

[1] Muchnick de Rubinstein, E. 1984. The diffusion and economic impact of high-yielding semi-dwarf rice varieties in Latin America. CIAT, Cali, Colombia.

mainly utilized in Brazil and at the present time the Program has no comparative advantage for work in this area.

The main unfavored upland rice system areas in the region have two main environmental constraints, i.e., low and/or unreliable rainfall together with infertile arid soils. In the tropical lowlands of the Americas there are vast areas of well-watered savanna lands which have not been opened up for arable agriculture. In these areas rice does have a future potential provided the problems of adaptation to low soil fertility and soil acidity can be successfully resolved. CIAT has commenced research on these problems.

Rainfed lowland rice. This system is a transition between irrigated and upland and utilizes rainwater trapped and held by field levees. Nevertheless, water deficits and/or deep flooding are common. Dwarf varieties can be grown when water control is provided, but tall varieties predominate. Average yields are 2.5 t/ha. The crop may be transplanted or directly seeded and few purchased inputs are used. Rainfed rice is important only in coastal Ecuador, Colombia's northern coast, and in the Dominican Republic. Given that rainfed lowland rice contributes only 1% to Latin American production, CIAT does not directly research this system.

Program objectives

Specific objectives for Rice Program activities in collaboration with national institutions in the Western Hemisphere include:

Continuing to develop germplasm-based technology designed to overcome the principal constraints to increased production of irrigated rice and the more favored upland production systems;

Developing widely applicable production technology, including the introduction and evaluation of appropriate farm machinery, oriented toward weed control and other related cultural practices to reduce costs and increase stability of supply; and

Strengthening national rice research programs in the region through assistance in the preparation of national production plans, training, conferences, and technical collaboration activities, and through these mechanisms to further stimulate the highly effective regional rice research network which is now in place.

General research strategy

Since its beginning in 1967, the Rice Program's basic strategy was to improve yields and production of irrigated rice in the region. This strategy was adopted because: irrigated rice offered the greatest opportunity for rapid gains; irrigated rice technology was more easily generated and transferred than that for other production systems; and limited core resources did not permit simultaneous work on all production systems.

Varietal improvement has been the key element in CIAT's irrigated rice research strategy. Tall varieties were used throughout the area before 1968, when IR 8 was introduced. An immediate increase in productivity of 2 t/ha confirmed the decision to work exclusively on dwarf materials for this system. The research has sought varieties combining dwarfism, strong stems, insensitivity to photoperiod, long grain with clear endosperm, resistance to the *Sogatodes* leafhopper, and blast resistance. Earliness and improved adaptability to acid soils are more recent varietal objectives.

In recent years a number of fungal diseases, apart from rice blast, (dirty panicle, brown spot, leaf scald, eye spot, narrow brown leaf spot, and sheath blight) have increased in severity and now constitute yield constraints, partially as a consequence of increase in fertilizer use and of expansion of upland rice and irrigated rice on infertile soils. These problems, along with the resurgence of the "hoja blanca" virus, have intensified the need for resistance breeding for all ecologies.

Once improved dwarf lines and varieties were produced, research was extended to developing appropriate cultural practices for the high-yielding varieties. Seeding rates and methods, fertilizer practices, and timing of weed control were emphasized. Farmers learned to manage modern varieties, but severe cultural practice deficiencies remain. These include red rice and weed infestations, seed quality, land preparation, and water control, and the lack of simple appropriate equipment for small-farm operations.

The unexpected adoption of the newer dwarf varieties in recent years in the more favored upland systems allowed the Program to modify its original strategy. Entries for nurseries, especially for the more favored upland systems, were selected from the advanced irrigated breeding lines and distributed to national programs for continued local selection and evaluation. Thus, CIAT contributed directly to upland systems while focusing on irrigated varieties. In 1981 CIAT began to intensify its activities in upland rice.

In the irrigated sector the number of crosses has increased substantially in response to new disease problems, need for iron toxicity tolerance, and the specific requirements for the temperate Southern Cone. This latter activity is expanding rapidly now that dwarfs are known to be well adapted throughout the temperate production areas, and the anther culture technology permits large volume production of fixed lines for these conditions.

Breeding for the more favored upland ecologies and high-rainfall, acid soil, savanna upland has increased dramatically. Crossing is currently focused on disease tolerance, grain and plant type, earliness, and general adaptability to upland soils. Work must be undertaken on the multiple mineral nutrition stresses of upland soils with specific breeding attention to tolerances to zinc, phosphorus, iron, and manganese deficiencies along with aluminum and manganese toxicities in acid soils. It seems clear that one way to reduce fungal disease pressure in upland rice is through breeding for tolerance to problem soils.

Specific research strategies for the remainder of the decade of the eighties and beyond have been developed for the various production systems identified for priority attention.

Research strategy for irrigated rice. This system will continue to receive major attention. Enhanced tolerance to diseases (e.g., blast, other fungal diseases, "hoja blanca") and soil problems (e.g., iron toxicity and straighthead disease) would increase yields, lower production costs, and increase production stability. The approach will combine breeding directly for disease resistance with breeding for tolerance to soil stresses and emphasize weed control and lower seeding and fertilizer rates. Lowered inputs should result in decreased fungal disease severity. Additionally, breeding will focus on better lodging resistance and, simultaneously, seek modest gain in yield capacity.

Improvement in farm cultural practices is indispensable to narrow the gap between varietal yield potential and farm productivity. Research on cultural practices has lagged behind varietal development. New technology in tractor wheels will be linked to recent advances in low-volume sprayers with the goal of increasing such farm operations as seeding and applications of fertilizers, herbicides, and pesticides. This should reduce costs, increase weed control efficiency, permit reduction in seeding rates, and lessen dependence on the inefficient airplane. Work in integrated pest management shows that costly insecticide applications can be eliminated for most insects.

Many new irrigated rice areas are coming into production, principally by small producers. They lack appropriate small machinery to facilitate the transition from transplanting to direct seeding where labor is scarce. Such machines (hand seeders, boom sprayers, harvesters, and threshers) are commercially available. The Rice Program will emphasize the introduction of appropriate machinery through national programs.

Research strategy for the more favored upland systems. Selected lines from the irrigated breeding program can contribute to the varietal component for expanding this system in the region. Nevertheless, a breeding program is designed to address the peculiar stresses of upland soils, particularly moisture and mineral nutrition, and their interaction with fungal diseases in several sites reflecting a range of ecologies from moderately to highly-favored upland. Vigorous dwarf varieties tolerant to problem soils, diseases, and short dry periods should increase and stabilize yields at an average of 3 t/ha, 0.5 ton higher than existing average productivity.

Weed infestations constitute a powerful yield constraint in upland rice and are more difficult to control than in irrigated rice. Since available herbicides are relatively effective, research will focus on appropriate terrestrial delivery systems to improve timing and reduce dosages.

New production systems research strategy. The vast savanna regions of Colombia, Venezuela, and Brazil are favored by abundant well-distributed rainfall, but the soils are extremely acid and infertile. Although little upland rice is produced on these soils there is a clear need for a crop component in the pasture system being developed by the Tropical Pastures Program to facilitate and finance land preparation for pasture establishment. Upland rice could become a pioneer crop thus encouraging the economically sound development of acid, high-rainfall savannas.

A minimum-input, upland rice system, using cultivars tolerant to acid soils and diseases, appears attainable. Initial research with soil-adapted cultivars consistently gives plot yields of 3.5 to 4.0 t/ha without soil amendments or chemical protection. Thus, a 3-t commercial yield seems reasonable and economically viable. A high-volume crossing program is underway with upland materials from Africa, Brazil, Japan, and other sources. Specific breeding objectives are identified and parental sources are available. Although typical, high-yielding, irrigated germplasm is not useful for this ecology, many rices are well adapted to those infertile, acid soils having over 80% aluminum saturation. Breeding will stress tolerance to Mn and Al toxicities and P, Zn, and other

deficiencies. The ideal plant type remains unclear but intermediate grain quality, multiple fungal tolerances, "hoja blanca", sogata, and sugarcane borer resistance are the main requirements.

Research on cultural practices will concentrate on weed control, methods of seeding and applying fertilizer, and conversion into pastures after one or two rice crops.

Research sites

The research program has largely decentralized its activities from the Palmira CIAT headquarters. However, the crossing program, quality laboratory, germplasm storage, sogata and "hoja blanca" screening, and IRTP remain in Palmira.

Three locations in Panama and two in Guatemala were made available by IDIAP and ICTA (Instituto de Ciencia y Tecnologia Agricolas) within collaborative programs, for selection of segregating generations of upland and irrigated materials. In 1983 CIAT acquired the Santa Rosa experiment station near Villavicencio, in the Colombian Llanos, which now is the central breeding location for favored upland and irrigated rice. Also in 1983 ICA provided long-term use of 16 ha of acid savanna on its La Libertad station adjacent to Santa Rosa. Irrigated and upland selection and evaluation work continues in Peru under a cooperative project with INIPA. Implementation of the Caribbean Cooperative Rice Research Network will add the Juma Experiment Station in the Dominican Republic as an additional research site.

Special Projects

Caribbean Cooperative Rice Research Network

This project aims to strengthen national research and development programs through the creation of an active rice research network that will allow for horizontal transfer of production and seed technology and strengthen CIAT/IRRI collaboration with national programs in the region. Network activities will comprise: coordination of research on common problems, dividing responsibilities among national programs; testing of germplasm for relevant production constraints; reinforcement of national research and extension capabilities through in-country courses and inservice training; training in seed technology; and regional workshops and monitoring tours to improve communications and cooperation in the area. One senior staff position is being provided by IRRI through the IRTP. This special project is likely to be funded as of early 1987.

	Budget (1986 US$ in thousands)
	1987
Personnel	16
Honoraria, stipends, and allowances	60
Supplies and services	35
Travel	13
Equipment replacement and capital	42
Indirect costs	20
Contingencies	—
Total	186

Cassava and Rice Research in Panama

See under Special Projects in Cassava Section p. 28.

Beans and Rice Research in Peru

See under Special Projects in Bean Section p. 24.

TROPICAL PASTURES PROGRAM

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Program leader	1	1	1	1	1	1	1	1	1	1	3	3	3	3	3
Germplasm evaluation															
Germplasm evaluation	1	1	1	1	1	3	2	2	2	2	15	15	15	15	15
Agronomy (CMG)[a]	1	1	1	1	1	2	2	2	2	2	12	12	12	12	12
Regional Trials	1	1				2	2	2	2	2	4	4	2	2	2
Pathology	1	1	1	1	1	2	2	2	2	2	10	10	10	10	10
Entomology	1	1	1	1	1	3	3	3	3	3	9	9	9	9	9
Microbiology	1	1	1	1	1	1	1	1	1	3	11	11	11	11	11
Forage Breeding	1	1	1	1	1	3	3	3	3	3	11	11	11	11	11
Legume Breeding					1					2					7
Pasture evaluation															
Seed production	1	1	1	1	1	2	2	2	2	2	18	19	19	19	19
Soil plant nutrition	1	1	1	1	1	2	2	2	2	2	13	13	13	13	13
Pasture dev.(CMG)a	1	1				2	2	2	2	2	9	9	7	7	7
Past. quality and productivity	1	1	1	1	1	2	2	2	2	2	15	17	17	17	17
Ecophysiology	1	1	1	1	1	2	2	2	2	2	12	9	9	9	9
Pasture evaluation in farm systems															
Livestock systems	1	1	1	1	1	3	3	3	3	3	11	11	11	11	11
Economics	1	1	1	1	1	3	3	3	3	3	2	2	2	2	2
Collab. operations						1	1	1	1	1	3	3	3	3	3
Total	15	15	13	13	14	36	35	35	35	37	158	158	154	154	161
Decentralized regional programs in tropical South America															
Cerrados ecosystem[b]															
Agronomy (reg. trials)	1	1	1	1	1										
Soil Pasture Develop.			1	1	1								2	2	2
Humid tropics ecosystem															
Agronomy (regional trials)	1	1	1	1	1	1	1	1	1	1	6	6	6	6	6
Pasture Reclamation			1	1	1								4	4	4
Central Amer. and Carib.															
Agronomy (regional trials)			1	1	1								2	2	2
Africa															
Regional Liaison (ILCA)				1	1									2	2
Total	2	2	5	6	6	1	1	1	1	1	6	6	14	16	16

a. CMA: Carimagua, Llanos Orientales, Colombia.

b. Brazil, Cerrados ecosystem.

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	2439	2565	2682
Supplies and services	512	385	395
Travel	262	319	326
Replacement equipment	29	25	25
Total	3242	3294	3428

Budget Changes

As part of program changes in 1987, the position for the coordinator of regional trials is discontinued and replaced by a regional cooperation position with responsibilities for Central America and the Caribbean (see page 35). A net addition is the position for a pasture renovation specialist for the humid tropics (see page 35).

Program Commentary

Importance of the Program's products

The Tropical Pastures Program has four major products: beef, milk, conservation of tropical ecosystems, and resource base expansion. A short summary of the importance of these products follows.

Beef. Beef is one of the staple foods for people in Latin America, including the urban and rural poor. The availability of beef is one of the principal reasons why protein malnutrition is less acute in tropical America than in Africa or Asia. However, during the last 15 years the annual growth in demand for beef in tropical America (5.6%) has exceeded increases in production (3.6%). This gap is resulting in real price increases which will cause a decrease in beef consumption by families of the lower 25% income strata which presently use 8 to 16% of their total budget to buy beef. The high price and income elasticities of demand for beef also suggest that increase in beef production leading to lower real prices would have a larger impact on consumption and quality of diet than production increases of most other major staple food crops consumed by the Latin American poor. In order to accomplish this, production costs, particularly social costs, must be reduced, and this is more likely possible in the underutilized areas of acid infertile soils because of their present, low, opportunity costs.

Milk. Milk production trends in tropical America are similar to those of beef with low per capita production (one-quarter that of the U.S.) and imports of milk and dairy products tripling in the last 10 years. The program's target area survey has shown that milk production from dual-purpose cattle farms is an important source of income in many areas and that its importance increases as farm size decreases.

Conserving tropical ecosystems. The Oxisol/Ultisol savanna and Cerrado regions of tropical Latin America, covering almost 300 million ha, are no longer only "potential" areas of expansion. As new roads are built, development is taking place at an ever-increasing rate. Much of this development occurs without appropriate pasture and soil management technology, resulting in land abandonment, soil erosion, and unstable farming systems with low productivity. Extensive native pasture-based beef production is the most widespread land use in the region. Well-managed, adapted, productive, and persistent grass/legume pastures not only improve cattle productivity but also provide excellent protection against soil erosion and improve soil fertility through nitrogen fixation and nutrient recycling by plants and grazing animals. On the other hand, poorly managed nonadapted pastures can be disastrous, especially on more sloping sites.

Expanding the land resources base. In addition to its ecological implications, pasture-based beef production can serve as a catalyst for settling the Oxisol/Ultisol regions, primarily because the initial infrastructure investment required is much lower than for crop production. The development of well-managed pastures increases the value of the land. When roads provide improved access to market, it becomes more profitable to intensify the farm operation by devoting part of the land to crop production. Well-managed, well-adapted, legume-based pastures that increase nitrogen and organic matter levels in the soils may reduce the fertilizer requirements for crops in rotation with pastures, providing for a more productive and socially efficient land-use alternative. Intercropping annual or perennial crops with pastures is also a feasible and efficient alternative. Therefore, beef operations can serve as a wedge to develop this important resource base and open the way for integrated agricultural development. Furthermore, increases in beef production in Oxisol/Ultisol regions permit alternative uses of better soils located closer to markets which should be used for more intensive crop production.

Program objectives

The objective of the Tropical Pastures Program is to develop and transfer, together with national programs, improved, low-input pasture technology in the acid,

infertile lowlands of the humid and subhumid tropics, with the principal responsibility being for tropical America. The aim is to increase beef and milk production, conserve and improve soil resources of tropical ecosystems, and provide a basis for an economically and ecologically sound utilization of underexploited land resources.

Program strategies.

The Program's research team is organized into three functional groups: germplasm evaluation (including sections for germplasm, agronomy, plant pathology, entomology, and breeding); pasture evaluation (including sections for soil plant nutrition and microbiology, ecophysiology, pasture development, pasture quality and production); and pasture evaluation in production systems (including sections for seed production, farming systems, and economics). These three units coordinate their work to ensure a dynamic flow of germplasm in which characterization of germplasm screening by ecosystems, assembly of appropriate pasture production technology, and economic evaluation of new pasture technology in farm systems, constitute major research areas. While thousands of germplasm entries are worked with during the initial phases of the flow of germplasm though the Program activities, only very few highly-promising germplasm materials succeed in being selected for the assembly of pasture technologies and further evaluations.

The Program exploits the natural variability of germplasm to identify grass and legume species adapted to the various ecosystems in the region. Germplasm is assembled from a wide range of conditions throughout the acid infertile soil regions of tropical America as well as southeast Asia and Africa. At present, the CIAT germplasm bank contains some 16,000 accessions. This germplasm is screened for tolerance to high soil aluminum and acidity, low phosphorus availability, and tolerance to diseases and insects. Ecotypes which pass this first screening are characterized in terms of tolerance to drought, flooding, burning, grazing, minimum nutrient requirements, nutritive value, and compatibility in grass/legume mixtures. Subsequently, pastures based on highly-promising ecotypes are assembled, relevant establishment technology is developed, and cattle liveweight gains are measured. The most promising pasture combinations undergo long-term productivity and economic evaluation, and the respective technological packages are further adapted to the requirements of the predominant farm system in the area. Finally, the improved technology is evaluated in economic terms. This entire research process is carried out in close collaboration with national programs throughout the area of interest.

To date the main screening sites, which represent major ecosystems, are:

The Carimagua Research Station in the Eastern Plains of Colombia, jointly administered with the Colombian Agricultural Research Institute (ICA), and representing the isohyperthermic savannas, including the "Llanos" of Colombia and Venezuela and the "campos" of northern Brazil (Amapa and Roraima).

The Brazilian Agricultural Center for the Cerrados (CPAC) of EMBRAPA in the central cerrado plateau, near Brasilia. This center represents the isothermic savannas of the continent, including the "Cerrados" of Brazil and well-drained savanna areas of Bolivia and Paraguay.

The Cattle Production Research Station of the Veterinary Institute for Tropical and High-Altitude Research (IVITA), at Pucallpa, Peru, where CIAT participates in a cooperative project to develop low-input pasture technology for the reclamation of already degraded lands in the humid tropics of the continent. CIAT's partners in this project are IVITA and the Peruvian National Institute for Agricultural Research and Promotion (INIPA).

The International Tropical Pastures Evaluation Network (RIEPT) has been developed in cooperation with national programs to evaluate promising germplasm in sites which represent subecosystems in the Llanos, the Cerrados, the humid tropics, including the poorly drained savannas, and moderately acid soils. This allows the Program, in collaboration with national programs, to test germplasm throughout the area of interest and to evaluate the adaptation and productivity of promising germplasm to the different ecosystems and subecosystems in the lowlands of tropical America. The information obtained through this evaluation network is recorded in computerized data banks which allows for effective analyses of germplasm performance across locations. Periodically, participants of the network are brought together in workshops to discuss alternative methodologies for germplasm evaluation and to exchange data recorded in different regional trials. These network activities allow for a high degree of feedback which assists in moving germplasm significantly faster to more advanced stages of evaluation under grazing for eventual release by national programs.

Status of the Program

The Tropical Pastures Program is well on its way to developing, in collaboration with national programs, low-input pasture production technology that has the potential to intensify the pioneer animal production system in the vast frontier lands of tropical Latin America. Available research results confirm the soundness of the Program's strategy to develop legume-based pasture technology that rests on germplasm adapted to specific ecosystems.

The availability of alternative viable techniques is expected to contribute to the gradual recovery of several million hectares that are at present in different stages of degradation throughout the humid tropics in Latin America and the Caribbean. The Program is planning to further decentralize its research strategy to cover important areas of Central America and the Caribbean where moderately acid soils predominate. The activity is planned to be initiated in 1987.

As germplasm moves into more advanced stages of evaluation under grazing in the different countries, more frequent visits are required to assist national programs in designing, analyzing, and interpreting trial results, as well as in coordinating the required backstopping from Program specialists. This is more efficiently and cost-effectively done by outposted personnel in charge of regional network activities than by scientists stationed at headquarters. This implies further decentralization of the network activities of the Program. The plan is to gradually develop four parallel networks in: Central America and the Caribbean; the Llanos ecosystem in Colombia, Venezuela, and northern Brazil; the humid tropics ecosystem in Colombia, Ecuador, Brazil, and Peru; and the Cerrados ecosystem in Brazil, Paraguay, and Bolivia. It is envisaged that the agronomists initially responsible for screening in the respective ecosystems will assume these regional network responsibilities. This will enable the Program to significantly accelerate technology transfer and to reinforce the work of national programs. These regional networks are critical for horizontal transfer of technology among national programs operating in the respective regions and to bring about economies of scale through networking of formerly isolated efforts.

The Program has developed an inventory of land resources in the area of interest with the edaphic, topographic, and climatic characterizations of the region organized in a systematic and easily retrievable manner. The Program also has assembled a germplasm bank consisting of more than 16,000 accessions. This germplasm pool is complemented by a parallel collection of *Rhizobium*. Furthermore, the Program has progressed to the stage where several genera and species have already been identified as being well adapted to conditions of one or more of the ecosystems of interest. These genera and species include *Andropogon gayanus*, *Brachiaria* spp., *Panicum maximum*, *Arachis* spp., *Stylosanthes* spp., *Desmodium* spp., *Pueraria phaseoloides*, *Zornia* spp., and *Centrosema* spp.

The potential productivity of a large number of pasture grazing alternatives in the savanna ecosystem has been determined. Various grass/legume associations in controlled grazing, low-input experiments, have produced annual liveweight gains per animal of more than 150 kg. On a per hectare basis some associations have produced more than 300 kg per year.

As part of the regional trials network there are, at present, 170 germplasm adaptation trials in selected sites of Latin America and the Caribbean. Several germplasm sets have also been sent to requesting institutions from Asia and Africa. The most promising germplasm is already moving into grazing trials in several Central America and Andean region countries, as part of the RIEPT, with partial support from the Canadian International Development Research Centre (IDRC).

Data obtained from regional trials in the humid tropics have shown that a large number of grass and legume species selected by the Program are highly productive in this ecosystem with acid infertile soils. These are showing promise for replacing the present commercially available species which become unproductive after 4-5 years of forest clearing.

The highly promising *Andropogon gayanus* CIAT 621, released by Colombia as cv. Carimagua 1 and by Brazil as cv. Planaltina, has also been released by Venezuela as cv. Sabanero, by Peru as cv. San Martin, by Panama as cv. Veranero, and nominated for seed multiplication and farmers use in Cuba. The adoption of *A. gayanus* in the central Cerrados of Brazil is rapidly accelerating. It is estimated that more than 200,000 ha have already been planted to this species in Brazil. In Colombia, about 25,000 ha have been established. As a result of the collaboration between CIAT and IVITA in Peru, the latter has released *S. guianensis* CIAT 184 cv. Pucallpa for the Peruvian humid tropics.

Since the release of *A. gayanus* in Colombia the Program has put considerable emphasis on the development of a companion legume for this grass. This has been achieved for the Llanos with *Stylosanthes capitata* CIAT 10280, which has been released by Colombia as cv. Capica, a blend of five ecotypes. The seed of this legume is now being multiplied for commercial plantings.

Special Projects

Biological Nitrogen Fixation, Beans and Pastures

This project is a collaborative program developed by CIAT, the Boyce Thompson Institute for Plant Research, IFDC[1], and MIRCEN[2] in Brazil. It aims to stimulate research for maximization of crop production through biological nitrogen fixation (BNF) by training national program personnel in BNF; conducting limited research in Latin America on pertinent aspects of BNF technology; and holding a workshop to present results to national programs. These activities constitute the first phase of the longer-term plan to establish small-scale inoculation plants at national institutes.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel (1 senior staff)	55	47
Honoraria, stipends, and allowances	21	43
Supplies and services	8	8
Travel	—	—
Equip. replacement and capital	80	—
Indirect costs	12	
Contingencies	—	—
Subtotal	176	107

[1] IFDC: International Fertilizer Development Center.

[2] MIRCEN: UNEP (United Nations Environmental Programme)/ UNESCO (United Nations Environmental, Scientific and Cultural Organisation)/ICRO (International Cell Research Organisation) Microbiological Resource Centre.

RESEARCH SUPPORT

VISITING SCIENTISTS AND POSTDOCTORAL FELLOWS

Core Resources

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Stipends and allowances	652	531	691
	652	531	691

Budget Changes

Resources for stipends and allowances for visiting scientists and postdoctoral scientists are increased (see explanation on page 40).

Program Commentary

This section includes all funds for visiting scientists and postdoctoral fellows.

Visiting Scientists

The Center seeks to attract outstanding scientists working in research institutions in developed and developing countries to spend short (six to twelve months) periods at CIAT to contribute, in their areas of specialization, to the objectives of CIAT's research or research support programs. In a large number of cases, visiting scientists spend time at CIAT as part of a sabbatical leave arrangement whereby CIAT provides additional support as necessary.

Postdoctoral Fellows

Most postdoctoral fellows are contracted in support of research activities. Contracts are for one year and extendable to a maximum of two years. A small portion of postdoctoral fellowships is reserved for postdoctoral fellows from cooperating countries who stay at CIAT for short periods before returning to institutions in their home country.

Visiting scientist funds provide for about 7 man-years. Postdoctoral funds provide for 11 man-years.

GENETIC RESOURCES UNIT

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Head of GRU	1	1	1	1	1			1	1	1	5	6	12	12	12
Germplasm processing						3	3	3	3	3	16	15	15	1	15
Seed health						1	1	1	1	1	2	2	2	2	2
Total	1	1	1	1	1	4	4	5	5	5	23	23	29	29	29

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	260	261	313
Supplies and services	33	30	36
Travel	5	9	11
Replacement equipment	—	1	1
	298	301	361

Budget Changes

To strengthen the work of the Genetic Resources Unit in cassava germplasm conservation, seed-health testing, and postentry quarantine activities, additional resources are assigned for support staff and operational expenses (see page 41).

Program Commentary

The objective of the Genetic Resources Unit is to provide suitable germplasm for crop improvement. In the short term the most important function of the Unit is to supply germplasm to CIAT programs and to fulfill requests from agricultural researchers throughout the world. The long-term function is the maintenance of genetic variability, which is rapidly being lost on the fields of farmers, for use in the distant future.

At present, the major activities of the Unit are concentrated on *Phaseolus* beans for which CIAT has the largest collection and, more important, the most extensive distribution of germplasm in the world. The Unit also maintains the pasture seed collection and germplasm data base for the CIAT pasture program, but collecting and most of the seed multiplication of this germplasm are the responsibility of CIAT's Tropical Pastures Program. At present, the handling of cassava germplasm is outside the responsibility of the Unit, but plans have been made to transfer cassava germplasm handling, including an extended tissue culture facility, to the Unit.

The most effective storage of *Phaseolus* bean and pasture germplasm is in the form of seed, dried to a low-moisture content, and placed in cold storage. The present storage consists of three cold rooms:

One medium-term store of 150 m^3 kept a 8°C with a capacity for 42,000 samples;
One medium-term store of 35 m^3 kept at 8°C with a capacity for 20,000 samples;
One long-term store of 35 m^3 kept at -15°C with a capacity for 16,000 samples.

These cold stores are almost 10 years old and are obsolescent. New storage has been planned for installation late in 1986, with a greatly increased capacity under technically improved conditions. This should greatly reduce the need for expensive field rejuvenation, and maintain the viability of the samples.

The International Board for Plant Genetic Resources (IBPGR) has continued the funding of the collection of *Phaseolus* in Latin America, producing an unexpectedly large diversity of landraces not previously represented at CIAT. This indicates that, for some areas, interesting landraces still exist and that there is a need for further collecting. Introduction from existing collections continued, with special emphasis being placed on existing European and African collections.

A previous bottleneck in the introduction of germplasm was the need for Third Country Quarantine for African *Phaseolus*. A recent agreement with the National Vegetable Research Station in England will allow the rapid processing of many thousands of samples. This is now particularly important as Africa has become an important target area for the Bean Program and African material is needed for breeding.

An agreement with the Brazilian National Germplasm Center (CENARGEN) has been reached covering the duplication of the entire CIAT *Phaseolus* collection. This duplicate is being placed in long-term storage by CENARGEN for security and will remain CIAT property.

Data handling for *Phaseolus* was improved by the introduction of a new data management system. This will allow a closer linking of information from the Bean Program and from the Unit. Direct access to the US Department of Agriculture germplasm data base (GRIN) has been negotiated. The IBPGR World Data Base for *Phaseolus* may be made available to CIAT this year.

For pasture germplasm strong efforts are being made to arrange identification for this taxonomically difficult material. The storage of pasture seed in liquid nitrogen is now thought to be a practical proposition.

To fulfill its international obligations to distribute disease-free seed, CIAT is expanding its Seed Health Laboratory within the Unit, where a variety of tests for pathogenic fungi, bacteria, and viruses can be carried out on outgoing seed samples.

Seed distribution continued with 6723 germplasm samples of beans and 2552 samples of pasture species being distributed internationally in 1985. Much larger quantities were passed to the respective CIAT programs.

The location at CIAT of an IBPGR liaison officer for Latin America has permitted the strengthening of collaboration with IBPGR, especially in collection activities of *Phaseolus*, cassava, and tropical pastures germplasm.

A Belgian associate expert attached to the GRU is responsible for investigating interspecific crossing in *Phaseolus* and evaluating the potential of *Phaseolus coccineus/polyanthus* (in cooperation with the University of Gembloux, Belgium).

Special Projects

Germplasm Collection, Beans and Cassava

There are two objectives: the analysis of available plant genetic resources data for *Phaseolus vulgaris* cultivated and wild forms; and transformation of existing cassava collections in Brazil, Guatemala, Mexico, and Paraguay into in vitro cultures for transportation to CIAT to be stored in the cassava germplasm collection for utilization in crop improvement.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel (1 senior staff)	24	22
Honoraria, stipends, and allowances	22	2
Supplies and services	5	5
Travel	2	2
Equip. replacement and capital	1	1
Other expenses	1	1
Contingencies	—	—
Subtotal	55	33

BIOTECHNOLOGY RESEARCH UNIT

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
	Act.	Bud.	Bud.	Bud.	Bud.	Act.	Bud.	Bud.	Bud.	Bud.	Act.	Bud.	Bud.	Bud.	Bud.
Personnel (Positions)	85	86	87	88	89	85	86	87	88	89	85	86	87	88	89
Head, Biotechnology Research Unit	1	1	1	1	1	4	4	4	4	4	8	8	8	8	8
Virology			2	2	2			5	5	5			9	9	9
Total	1	1	3	3	3	4	4	9	9	9	8	8	17	17	17

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	151	164	404
Supplies and services	38	27	57
Travel	14	12	27
Replacement equipment	18	1	3
	221	204	491

Budget Changes

The Biotechnology Research Unit (BRU) was created partly in response to a recommendation by the EPR. Initially, the only senior staff position in this Unit was that of cell physiologist which was transferred from the Genetic Resources Unit. In early 1987 the virology position currently held in the Bean Program will be transferred to the Biotechnology Research Unit.

Program Commentary

The involving of CIAT in monitoring and applying some of the most promising biotechnologies was anticipated in the plans outlined in the document "CIAT in the 1980's." The Second External Review recommended that CIAT establish an interdisciplinary research structure comprising those disciplines that interface with all commodity programs. CIAT, in its response to the EPR recommendation, agreed to the establishment of a small cross-commodity research unit initially devoted to the emerging field of biotechnology.

Objectives

To act as an interface between advanced research institutions where new methodologies are becoming available and CIAT and national programs where the new technologies will be tested. The Unit deals primarily with those biotechnologies that can significantly increase the efficiency of traditional plant breeding methods or make possible certain otherwise intractable processes.

Highlights

BRU's activities during 1985-1986 included research in collaboration with CIAT programs to utilize tissue culture for clonal propagation and for the generation of variability. Special research projects were also carried out in collaboration with international institutions.

Research at CIAT. The BRU continued work with cassava tissue culture propagation, i.e., over 200 clones were cleaned from diseases, increasing to nearly 1300 the number of healthy clones recovered in the last five years. Elite clones were shipped in vitro to 10 countries in Latin America and Asia. One hundred and forty-eight clones from Peru and 118 clones from southeast Asia were introduced to CIAT, using in vitro techniques. National programs in the Philippines, China, Mexico, Panama and Costa Rica reported successful results in handling cassava clones distributed in vitro from CIAT. The amount of germplasm maintained in the in vitro gene bank increased to over 2700 clones which is 71% of the entire CIAT collection.

Similar tissue culture work was initiated with other CIAT crops, e.g., the feasibility of recovering healthy plants from rare bean germplasm and from completely infected seed was demonstrated for seven *Phaseolus* ancestral species and for three accessions infected with the bean mild mosaic virus (BMMV), respectively. Using in vitro techniques, over 400 forage grass species, mostly *Brachiaria*, were transferred from Africa to CIAT.

An important part of the BRU efforts in the past year was dedicated to develop tissue culture techniques for the generation of useful variability with CIAT crops. In cassava, an important achievement was the establishment of conditions for sustained proliferation, germination, and field handling of somatic embryos regenerated from immature leaf segments. Embryogenic cultures were maintained for over 12 months without loss of plant regeneration potential and embryo differentiation and/or proliferation could also occur in salt-stressed medium depending on salt concentration. Protoplasts were isolated from leaf mesophyll cells and shoot-tips, induced to reform cell walls, and to divide to form colonies and calluses.

In *Stylosanthes*, using techniques developed at CIAT, plants of several accessions have been regenerated from calluses and grown in the greenhouse for preliminary evaluation of variability. Up to 25% spontaneous tetraploids (4X=40), differential reaction to inoculation with anthracnose cultures, and variations in leaf and flower morphology were recorded in the regenerated plants. Seed harvested after selfing these plants has been used for evaluating variability in the field. Leaf mesophyll protoplasts were isolated, cultured, and regenerated into plants in *S. guianensis* and *S. capitata* for use in somaclonal variation and protoplast fusion. Anthracnose tolerance and sensitivity of various *S.*

guianensis genotypes was expressed in cell cultures with the view to use in vitro selection of anthracnose-tolerant cells.

Research with *Phaseolus* beans resulted in the regeneration of plants from proliferating nodular structures induced from isolated embryonic axes of four genotypes.

In 1985 the collaborative activities of the BRU with the Rice Program in rice tissue culture included: improving laboratory facilities for scaling-up the anther culture work; and improving the anther culture technique itself. Current facilities have a capacity to hold over 4000 callus induction bottles and 1800 regeneration flasks. There is a transfer room to hold six laminar flow cabinets and sterilizing/washing facilities are also being adapted. To increase the number of doubled haploids, especially in genotypes with low regenerative capacity, work on chromasome-doubling is proposed. As the straightforward anther culture technique is used by the Rice Program routinely, other potentially useful tissue culture methods, e.g., somaclonal variation, can be explored.

Collaborative research abroad. In a collaborative project with the Biotechnology Institute, Saskatoon, Canada, and the IBPGR, the feasibility of cryo-preserving cassava shoottips in liquid nitrogen was demonstrated. This work provided a basis for future research into cryo-preservation of cassava using other tissues such as somatic embryos. Material retrieved from liquid nitrogen has been planted in the field at CIAT for evaluation of genotypic stability.

A collaborative project with the University of Manitoba, Winnipeg, Canada, was initiated to develop electrophoretic techniques for characterizing cassava, bean, and forage legume germplasm accessions. Enzyme systems capable of discriminating among genotypes have been selected for initial use with cassava and beans, and work with forage legumes is progressing. This project is to be transferred to CIAT this year.

A project to develop molecular probes for detecting genetic variability in tissue culture-regenerated cassava plants is being initiated at the University of Bath, England, with CIAT's collaboration.

Future developments

As a discipline closely related to biotechnology, virological research at CIAT will be integrated with the BRU in 1987. This association allows the sharing of specialized facilities such as the electron microscope, ultracentrifuges, autoradiography. Interaction of virologists with the commodity programs will be taking place through professional support staff.

The BRU is expected to generate special projects to advance knowledge in emerging biotechnologies and their application to CIAT crops. The potential of recombinant DNA for pathogen and gene detection and mapping, and gene transfer techniques for transformation of cassava and beans are being evaluated at this time.

RESEARCH SERVICES

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
Personnel (Positions)	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Food quality and nutrition						1	1	1	1	1					
Laboratories						1	1	1	1	1	13	13	13	13	13
Greenhouses						1	1	1	1	1	3	3	3	3	3
Maintenance						1	1	1	1	1	2	2	2	2	2
Total						4	4	4	4	4	18	18	18	18	18

Direct costs (1986 US$ thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	190	189	189
Supplies and services	57	79	79
Travel	—	—	—
Replacement equipment	2	—	—
	249	268	268

Program Commentary

The Laboratory Services Unit is under the control and supervision of the Research Services Committee and provides the following services:

Routine analyses of soil, plant tissue, water, and fertilizer samples submitted by program scientists for research purposes;

Routine quality evaluation and consumer acceptance of CIAT's commodities, especially beans and cassava;

Maintenance and repair of all CIAT laboratory instruments and equipment, and coordination of the use of laboratory facilities;

Control, washing, and sterilization of glassware used by pathology and microbiology programs;

Management and maintenance of CIAT's greenhouses, screenhouses and growth rooms, including soil storage and sterilization facilities; and

Maintenance of colonies of small animals such as rabbits and mice.

These activities are supervised on a part-time basis by various senior staff members who are part of the Research Services Committee. Day-to-day management is provided by four research associates/assistants in charge of the various sections.

The excellent greenhouse facilities are presently in full use. It is foreseen that in the next few years greenhouse space will become insufficient because of the further developments of core programs and expansion of special projects. For this reason capital requirements for an additional greenhouse are included on the Forward List for 1986.

STATION OPERATIONS

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
Personnel (Positions)	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Station operations	1	1	1	1	1	1	1	1	1	1	28	27	27	27	27
Popayan						1	1	1	1	1	5	5	5	5	5
Quilichao						2	2	2	2	2	20	19	19	19	19
Sta. Rosa (Meta)						1	1	1	1	1	4	4	4	4	4
Tractor pool											3	4	4	5	5
Labor pool											23	21	21	23	23
Total	1	1	1	1	1	5	5	5	5	5	83	80	80	83	83

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	664	589	589
Supplies and services	221	186	186
Travel	7	6	6
Replacement equipment	31	1	1
	923	782	782

Program Commentary

The Station Operations Unit provides logistics support for the land use of the research programs. The Unit is in charge of agricultural machinery, land preparation, planting, irrigation, field work, and harvesting at headquarters in Palmira, and at the three substations in Quilichao, Popayan, and Santa Rosa, Villavicencio. The Unit is also in overall charge of the general upkeep and maintenance of the experimental fields, and of the continuous upgrading of the experimental sites in the four locations. In addition, the Unit is in charge of commercial seed production (rice, beans, tropical pastures) and commercial crop production (sorghum, maize, beans, and cassava) on experiment station land that is temporarily not utilized for research purposes.

CARIMAGUA STATION

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
Personnel (Positions)	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Support Unit															
Administration						3	3	3	3	3	2 4	2 4	2 4	2 4	2 4
Total						3	3	3	3	3	6	6	6	6	6

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	190	240	240
Supplies and services	212	218	218
Travel	40	53	53
Replacement equipment	54	22	22
	496	533	533

Program Commentary

The Carimagua Research Station is located 350 kilometers east of Villavicencio, near the Meta-Vichada border, at latitude 4°30'N, and longitude 71°30'W in the Eastern Plains of Colombia. Carimagua's climate, soil, vegetation, and topographic conditions are typical of one of the greatest land resources in the world that is just beginning to be exploited—the tropical American savannas, which comprise 300 million ha.

In 1969 ICA purchased 22,000 ha of land, and field work was initiated in early 1970. In February 1977 an agreement was signed between ICA and CIAT for the development of a cooperative research program in the Eastern Plains. Under the terms of the agreement, an advisory committee composed of three ICA managers and three CIAT senior staff members is responsible for coordinating and directing operations of the station.

Costs of this research station are shared equally by the Colombian Institute for Agriculture (ICA) and CIAT. The budget shown is for CIAT's share of the cost of personnel, supplies and services, and travel costs.

DATA SERVICES

Core Resources

Personnel (Positions)	Senior staff Act. 85	Senior staff Bud. 86	Senior staff Bud. 87	Senior staff Bud. 88	Senior staff Bud. 89	Scientific and supervisory Act. 85	Scientific and supervisory Bud. 86	Scientific and supervisory Bud. 87	Scientific and supervisory Bud. 88	Scientific and supervisory Bud. 89	Clerical and other Act. 85	Clerical and other Bud. 86	Clerical and other Bud. 87	Clerical and other Bud. 88	Clerical and other Bud. 89
Statistical and Computing Services	1	1	1	1	1	8	8	8	8	8	10	9	9	10	10
Total	1	1	1	1	1	8	8	8	8	8	10	9	9	10	10

Direct costs (1986 US$ in thousands).

	Current budget Actual 1985	Current budget Revised 1986	Proposed budget 1987
Personnel	305	313	313
Supplies and services	156	158	158
Travel	8	8	8
Replacement equipment	54	1	1
	523	480	480

Program Commentary

The Data Services Unit provides advice, training, and assistance in all mathematical, statistical, and computational aspects of the work of the scientific programs of CIAT. The Unit has two sections, Biometrics and Computing, whose functions and responsibilities are detailed below.

Biometrics Section

To provide statistical advice on all aspects of the work of CIAT including planning, data collection, analysis, and interpretation;

To keep abreast with current developments in statistical methodology by internal and external education, and utilize and develop such techniques for the betterment of agricultural research at CIAT;

To provide a statistical computing service;

To carry out collaborative research with other workers with the aim of producing joint scientific publications;

To provide advice and assistance and engage in collaborative research work on operational research topics, such as simulation mathematical programming and decision theory; and

To provide training in statistical methods both for staff within CIAT and for CIAT program courses.

Computing Section

To provide and maintain appropriate computer hardware for the scientific and associated programs at CIAT;

To provide and maintain appropriate computer software for the scientific and associated programs at CIAT;

To provide adequate documentation of all software and hardware;

To investigate all aspects of work at CIAT which might benefit from computerization;

To keep abreast with current developments in computing;

To carry out collaborative research;

To write suites of programs of general applicability;

To ensure sufficient training is obtained within and outside the section; and

To provide the hardware and software to build and maintain scientific data bases and ensure that these are accessible to the appropriate range of personnel within a commodity network.

An IBM 4331 Group 1 computer with one megabyte

of real memory was installed at the end of 1981. During 1983 the machine was upgraded to a Group 2 and a further megabyte of memory was added. Early in 1984 the real memory was increased to the maximum for the machine, namely four megabytes. Administrative work was moved to an IBM System 36 purchased in 1983.

During 1985 the CPU was upgraded to 4361 Group 5 and real memory increased to six megabytes. The machine currently has a mip rating of 1.3, about six times its original rating as a 4331 Group 1. At present IBM has no further upgrade path other than a potential memory of 16 megabytes. In 1986, a further disk unit was attached, faster tapes were purchased to replace the 8809's and a workstation adapter was purchased to facilitate the connection of more terminals and microcomputers.

The present configuration of the 4361 is as follows:

1 4361 Group 5 CPU with 6 megabyte real memory
4 3370 Fixed Disks Units in 2 strings with a total of 2.4 gigabytes
1 3262 Line Printer rated 650 lines per minute
1 5210 Letter Quality printer rated 60 characters per second
1 Communication Adaptor with 6 lines
1 Work Station Adaptor
1 Calcomp Model 965 Plotter with 909 Controller
2 3430 Magnetic Tape Units 1600/6250 bpi 312 kbyte per second
3 Cluster Controllers type 3276
24 Displays type 3278 including Operator Consoles
8 IBM PC Microcomputers connected as 3278's.

The machine runs under the operating system VM/CMS. Installed database software includes the products IDMS/R (Cullinet Software, Inc. Westwood Mass, USA), ISIS (IDRC Canada), and STAIRS (IBM). Statistical and Mathematical packages include SAS (SAS Institute, Raleigh, North Carolina, USA), GENSTAT, GLIM and NAG Library (Numerical Algorithm Group, Oxford, England), and MINOS (Stanford University, California, USA).

There are 80 registered users of the 4361 and the system is running at about 50% of the capacity of the upgraded CPU. IDMS database systems have been written and are currently in use in the four major CIAT programs and a collaborators Mailing List System has been provided for the Communication and Information Support Unit and Research Programs. These systems continue to be developed in the Computing Section. In spite of the increase in database activities, statistical processing by the Biometrics Section of the Unit still takes a considerable (30-35) percentage of the computing resources.

To facilitate the interchange of information the Computing Section publishes a newsletter and there is a Users Group made up of representatives of the programs and staff of the Data Services Unit.

AGROECOLOGICAL STUDIES

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
Personnel (Positions)	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Agrometeorology	1	1	1	1	1	2	2	2	2	2	4	4	4	4	4
Land systems			1	1	1			2	2	2			3	3	3
Total	1	1	2	2	2	2	2	4	4	4	4	4	7	7	7

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	128	123	249
Supplies and services	7	11	21
Travel	14	12	25
Replacement equipment	—	1	2
	149	147	297

Program Commentary

One of the most important underlying reasons for agroecological analysis is that crop and pasture improvement for less-favored areas and their wider diversity of production constraints imposes severe problems on new technology design, development, and transfer. Less-favored production zones, i.e., most nonirrigated areas in the tropics with a wide range of soil constraints and insect and disease pressures, are the main targets of CIAT research. The rate of progress in genetic improvement of any species is generally inversely proportional to the number of constraints to be overcome through new genetic variability. It is clear that accurate information on the relevant constraints in each zone is essential at all stages of increasing production and productivity of basic food commodities in the tropics. This need is even more critical in the small-farm situation since the environmental conditions on farms in this sector, particularly those in Latin America, are generally more severe and constraints are more varied than in the case of the large-farm sector. Given the great diversity of prevailing climates, soils, cropping systems, and socioeconomic conditions, the need for an inventory of production conditions in the small-farm sector is pressing.

Objectives for agroecosystems analysis

Some general areas have been identified that represent common needs across CIAT programs with respect to agroecosystem information for the areas of interest in each commodity. These needs are reflected in the following objectives:

To develop a system for environmental and socioeconomic assessment of introduction constraints in the production areas of present or future importance in each CIAT commodity. Such assessment will allow for a more **accurate definition of research priorities,** and therefore of allocation of research resources among the wide range of alternatives available for action;

To develop an agroecological information system which can be integrated with the germplasm development process. This improved process will provide for a more **cost-effective and efficient operation of the cooperative germplasm transfer and evaluation programs** with collaborating national institutions. The objective is essentially to reduce the burden on national institutions imposed by testing all germplasm in all locations;

To develop a data system which will permit the **evaluation of responses** of new genetic variability when exposed to a wide range of selected conditions in terms of meteorological, edaphic, and agronomic factors. One example would be crop/weather relations in international nurseries and in other experiments; and

To develop a data system which will provide a firm base for comparative socioeconomic studies on the wide diversity of production zones. This system will enable both **ex-ante** and **ex-post** assessments of the **impact of new technology, in particular within the small-farm sector,** so that the research process can be further focused on real needs. In addition, the data system will provide a medium in which to assess economically the development priorities for underutilized frontier lands and to analyze marketing and associated economic constraints to increased production and productivity.

Research strategy

A computer-based information system designed for the needs of four ecologically divergent commodity programs must be flexible in order that the degree of detail and scale provided is appropriate in each case. In addition, the collection of data, and its storage, retrieval, and analysis, must be at a level of definition appropriate to the resources available. In other words, CIAT could not implement a massive new survey involving a great deal of field work. Accordingly, a methodology has been developed which relies on prior surveys, census information, and local knowledge of the situation in each zone. Information is gained on an opportunistic basis by CIAT personnel during duty travel and from the large number of visiting scientists and trainees from the region who visit CIAT and on the use of rapid rural survey techniques in particular areas of interest. In this way, a cost-effective collection system has been developed which appears sufficiently accurate. Any attempt

at a more detailed approach would probably be frustrated by lack of accurate local data.

Progress of agroecosystem analysis in commodity programs

The following examples illustrate some of the work completed and planned in the various programs.

Tropical Pastures. The study on the South American lowlands[1] has enabled a classification of the major ecosystems making up the Program's area of interest. Aggregation of the land system units within each major ecosystem has permitted a quantitative assessment of the natural resources available in each ecosystem. The basic philosophy of the Program outlined in this plan revolves around this classification.

In technology evaluation and transfer, the study has provided direction for defining sites for regional experiments within the germplasm evaluation scheme of the Program. In the future, an accurate definition of the environmental constraints in each land system will provide a means for defining new technology specifications, particularly with respect to germplasm characteristics, for each zone. Economic studies on the relative advantages of different zones with respect to future development will facilitate national policy making. The studies are already in use at CIAT and in Brazil and are in the form of computer files in EMBRAPA.

Beans. The Program has been considerably aided by early studies in defining research priorities and strategies and in the location of its primary sites for the first two stages of the germplasm evaluation program. A climatic analysis of the 110 bean microregions permitted an assessment of crop/temperature conditions. It also verified that growing season temperature conditions at CIAT-Palmira and CIAT-Popayan are clearly representative of, and bracket, the major proportion of production zones (with respect to temperature) in Latin America.

With the increasing interest of the Bean Program in eastern Africa the Unit's work has been extended. Crop distribution, soils, and climate data are being compiled. In the meantime a preliminary agroecological zonation of African bean regions has been produced to aid the new efforts in the region.

Rice. Initial studies have begun to define, locate, and classify the microregions of production of upland rice in South and Central America. Census data have defined municipal level information on which to aggregate data into definable and relatively homogenous microregions. This information is vitally needed to help define more closely the research strategy for the upland sector.

Cassava. The cassava production zone or ecosystem classification provided in this plan is a preliminary one. Detailed analysis of cassava distribution is now under way. An inventory of Latin American cassava production at a scale of 1:5,000,000 has been produced and has given valuable insight into the range of environments encountered. Present projects are microregion definition and database design. As these projects are completed and the data base becomes operational, a reevaluation of a cassava agroecozone classification will be feasible.

[1] Cochrane, T. T., et al. 1985. Land in tropical America. CIAT, Cali, Colombia.

SEED UNIT

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Seed Specialists	2	2	2	2	2	6	6	6	6	6	8	8	8	8	8
Total	2	2	2	2	2	6	6	6	6	6	8	8	8	8	8

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	313	342	342
Supplies and services	90	75	75
Travel	33	31	31
Replacement equipment	70	21	21
	506	469	469

Program Commentary

The need for a Seed Unit at CIAT grew out of two different problem contexts. First, the CIAT commodity programs—beans, rice, tropical pastures, and cassava—have reached a stage of development where a centralized support service for the production, processing, and distribution of breeder and basic seed represents the most rational and obvious route for the streamlining of seed-related activities at the Center. Second, the flow of new materials emanating from CIAT's research programs was hampered by the fact that in many Latin American and Caribbean countries there was only an incipient seed industry at the national level and which needed determined and systematic assistance from the international level to accelerate development. Regarding the latter point, CIAT was an obvious choice for the location of an international input in the development of national seed programs. In addition, CIAT was concerned about a need for a stronger seed sector in Latin America and the Caribbean that is capable of delivering seed of improved materials to the producer level. The Center had available the necessary conditions for hosting a successful seed effort: physical facilities for seed production, an extensive training infrastructure, expertise on seed-related aspects, and an international mode of operation.

The first phase of the Seed Unit special project, financed by the Swiss Development Cooperation (SDC), was for the three-year period January 1979 to December 1981. The second phase was for the period January 1982 to December 1983. During the third phase, 1984-1986, the Unit continues as a restricted core activity with SDC support.

The objectives of the Seed Unit at CIAT are:

To train personnel in government and private institutions, primarily from Latin American and Caribbean countries, in various aspects of seed industry and seed program development;

To extend technical collaboration to countries in the region interested in seed program development, with the aim of expanding the production of high quality seed of improved cultivars at all levels from the breeder to the commercial stage, with emphasis on, but not restricted to, the commodities with which CIAT works;

To conduct specific research in seed technology which is relevant to CIAT commodity interests and relevant to problems that collaborators at the national level are faced with;

To provide CIAT with a single unit to cooperate with commodity programs in multiplying, processing, storing, and distributing advanced experimental materials, or Breeder and Basic Seed, to collaborating countries for further multiplication; and

To disseminate information on seed activities, advances in seed technology, and the availability of promising materials in the region.

The project includes two internationally recruited scientists with a full complement of support services, resources for consultants and visiting scientists, plus scholarship monies for postgraduate interns. Also included in the initial project were resources for the remodelling of existing buildings and for the construction of additional facilities for the operation of seed-related activities (seed processing, storage, laboratory spaces for training purposes, and office/working spaces for staff of the Seed Unit).

During the period 1979 to the present, the Unit has mainly concentrated its efforts on:

Training. A combination of intensive seed production and seed technology courses, advanced short courses, individualized in-service training, and M.Sc. thesis research opportunities are offered. In the period 1979-1985, some 437 professionals have received CIAT-based training by the Seed Unit. In addition, the Seed Unit is supporting in-country training courses in the areas of seed production and seed technology.

Workshops. The Seed Unit organizes and conducts an average of one workshop per year to provide a forum for professionals with similar interests to exchange experiences and to work together in developing plans, recommendations, and fresh approaches to help seed activities advance more rapidly.

Technical collaboration. Assistance to seed programs, industries, and associations contribute to developments at the national level. Subregional activities in Central

America and the Andean Zone have reinforced seed network developments.

Seed production and supply. The Seed Unit has supported the CIAT commodity research program—especially rice, beans, and tropical pastures—with the production, drying, conditioning, and supply of basic seed of promising materials and already released varieties.

Research. A limited research input in the area of seeds is provided by the Seed Unit primarily through M.Sc. thesis programs. The preparation and dissemination of technical publications, workshop proceedings, and audiotutorial units have spread seed technology and production information in the region. In addition, a newsletter every four months improves communications on developments in the region and contributes to the strengthening of the seed network.

Status of the Seed Unit

The emphasis by the Seed Unit on training has resulted in 15 courses of different levels and specialization at CIAT over the past seven years, involving 437 participants. Seed technology and production training provided by the Seed Unit at the subregional and in-country level has involved a further 572 people. The challenge during the next five years is to capitalize on this base of trained people.

The seed sector involves activities ranging from the crop research programs to the seed enterprises and marketing groups that sell seed to farmers. Successful national seed programs are those that develop clear goals and strategies and identify mechanisms to help all segments of the sector develop and work together. One-fourth of the former course participants in a recent survey have contributed in a special way to seed program development at the national level. In the future increased followup is needed with these people to help them, other leaders in the seed sector, and their governments, to focus more sharply on solutions that can help overcome limitations restricting the production and use of improved varieties by farmers. The Seed Unit continues to focus on ways to assist especially small farmers use better seed of improved varieties. As a result of Seed Unit activities, many national programs are directing more attention on the seed needs of small farmers.

Significant differences exist among the countries in the region with respect to development of their seed programs. The countries with the greatest need are in Central America, the Caribbean and the member countries of JUNAC (La Junta del Acuerdo de Cartagena, also known as Grupo Andino). Mechanisms are being sought to provide special assistance to these subregions through outreach programs linked to the Seed Unit to help accelerate the development of seed programs and industries in these areas.

The basic seed production activities of the Seed Unit are helping to improve the availability of seed for further multiplication. This need is felt most acutely with tropical pasture seed. Increased effort is needed on systems for cassava propagating material. At the national level better organized and functional basic seed units are needed in many countries to strengthen the link between the crop research program and the rest of the seed multiplication and supply chain. Helping this aspect of national programs to become more dynamic and effective remains a priority with the Seed Unit.

Seed production and technology research in the region is largely done in a few universities with special interest in seeds. The Seed Unit's research role mostly has been limited to the work done by a few research scholars involved in degree programs. The Unit has a comparative advantage on a few high-priority areas of special interest to the CIAT commodity programs and sister centers. Opportunities exist to assist the development of collaborative research networks in the region to solve region-wide problems. A workshop held in 1985 started joint thinking on priority areas of research for the region. The follow-up to proposals in that workshop can result in more work on high-priority areas and increased cooperation among researchers in the region.

The Seed Unit provides the mechanism for continued communication among seed programs and seed scientists in the region. The continued improvement of the newsletter, the frequent updating of the "Directory of Seed Personnel and Institutions", development of a seed science and technology data base focused on the needs of the region and subregion, and regional courses will continue this network development process.

Donor and technical assistance agencies will need to continue assisting seed programs in the region for at least another decade. Through the knowledge accumulated and country status reports, the Seed Unit is in an excellent position to work closely with these agencies in developing projects and supporting their implementation. Similarly, links with CIAT's sister international centers with program interests in the region will be strengthened. As seed units are started in other parts of the world, mechanisms are needed, and will be sought, to collaborate fully with them in their development and program implementation.

Achievements

The Seed Unit in 1985 and 1986 contributed to a strengthened seed sector and the development of improved relationships between national crop research programs and the seed sector primarily through training courses, workshops, and seminars. The basic seed production, technical collaboration, research, and information and communication have complemented these achievements.

The Seed Unit's strategy to tailor seed courses to meet needs is illustrated by the 1985 four-week Advanced Course on Seed Quality and Disease Control. The course provided an integrated approach to quality and disease control starting with production and continuing through to seed marketing. Another innovation was the Seed Enterprise Management and Marketing Course offered in two subregions: Central America and the Andean Zone.

In Colombia, a short course on handling cassava planting material and a workshop on small-farmer bean seed production represented new initiatives in 1985. The bean varietal description and basic seed production course in Guatemala in cooperation with the Central American Bean Project represented a three-way collaborative effort to assist that region's bean seed production activities. The Unit also collaborated with CIMMYT in a one-week intensive seed course for 90 scientists from Asia, Africa, the Middle East, Latin America, and the Caribbean. At CIAT the ninth, regular, nine-week intensive seed production and technology course was offered to 34 participants from the region. The tenth course of this type is underway in early 1986 in English for participants from the Caribbean and other English-speaking areas.

A survey was conducted on 297 former Seed Unit course participants and their supervisors. The results of the survey were quite positive. All course participants returned to their jobs immediately after training and 94 percent were on seed sector activities at the time of the survey. Alumni found 70 percent of the course content to be highly relevant to their present work. The professional development of course participants clearly had been affected positively.

The first Workshop on Research and Training in Seed Production and Technology brought 51 participants from 16 countries in the region including the USA and UK. The group gained information on research advances inside and outside the region and identified priority areas for future research and training. The Unit cooperated with ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), INTSORMIL (International Sorghum and Millet Program), and INIFAP (Instituto Nacional de Investigaciones Forestales y Agropecuarias, Mexico) in organizing and conducting the first workshop in the region on Sorghum Seed Production. The Unit also contributed to the Pan American Seed Seminar in Colombia and a National Seed Round Table in Bolivia.

The Unit was involved in the multiplication of 37 tons of basic seed, sold 41 tons, and conditioned 155 tons. (Seed not produced by CIAT is conditioned as a service to ICA and others near the Center.)

Investigations on bean seed quality with respect to small farmers and on disease control in rice seed production will contribute to seed technological solutions needed to increase the flow of better quality seed from crop research programs to farmers.

At the subregional level, the Seed Unit worked with the Central American Regional Technical Committee; the Regional Association of Seed Technologists for Central America, Panama, and the Caribbean (ARTES); and JUNAC to assist seed sector development primarily through joint training activities. In the Southern Cone, a collaborative agreement with the Centro de Estudos e Treinamento em Tecnologia de Sementes e Mudas (CETREISEM) in Brazil was implemented in several ways, including the completion of a joint course on Breeder and Basic Seed Production in early 1986

Through information and communication a stronger seed network was developed. The main achievements included an improved newsletter, a seed sector directory, a seed glossary, and a thesaurus of seed terms.

Throughout the year the Seed Unit contributed indirectly to seed sector and network development in regions other than Latin America and the Caribbean, including assistance to a study of the feasibility of a Seed Unit type of activity in Africa.

Special Projects

Seed Training

This special project provides for training in seed technology for the member countries of JUNAC. One course was offered in seed-quality control, and another will be held on seed enterprise management and marketing. The project also funds participants (one per country) to attend a basic seed production course and one advanced course at CIAT during these two years, as well as in service training. Funding for 1987 is not yet assured.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	—	—
Honoraria, stipends, and allowances	10	10
Supplies and services	—	—
Travel	3	4
Equip. replacement and capital	—	—
Indirect costs	6	6
Contingencies	—	—
Subtotal	19	20

INTERNATIONAL COOPERATION

TRAINING AND CONFERENCES

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Training	1	1	1	1	1	9	9	9	9	9	8	7	7	7	7
Conferences						1	1	1	1	1	2	3	3	3	3
Total	1	1	1	1	1	10	10	10	10	10	10	10	10	10	10

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	417	425	425
Stipend and allowances	726	676	676
Supplies and services	110	137	137
Travel	148	130	130
Replacement equipment	—	28	28
Total	1401	1396	1396

Program Commentary

After a period of emphasis on short-course training in all four commodities, CIAT has increasingly moved towards in-country training courses conducted in cooperation with national research programs. At the same time, continued heavy emphasis is placed on individualized specializations of national research program personnel at CIAT to help strengthen cooperating national research teams and regional commodity research networks. Doctoral and M.Sc. thesis training

continues to be given high priority although this type of activity is hampered by insufficient funds in the overall international donor community available to national programs for academic study in agriculture.

Status of Training and Conference activities

To date, CIAT has provided training to some three thousand professionals. Throughout the years, CIAT has emphasized training in research methodology and production technology as related to the commodities in the Center's mandate. Recent survey data show that 60% of CIAT's former trainees are actively working with the commodities in which they received training. An additional 15% continue to be active in agricultural research, albeit not directly related to CIAT's commodities. Nevertheless,the demand for the training of new personnel continues as national programs grow and personnel shift to other institutions, including the private sector.

CIAT training has helped national programs of numerous countries in the tropics to become stronger and to increase their capacity to engage in applied, adaptive and validative research. CIAT-trained scientists are increasingly playing major roles in the selection and release of new varieties and attendant technologies. Training has also been a key contributing factor in the establishment and development of international and regional research networks on beans, rice, tropical pastures, and cassava. These networks not only facilitate the exchange of germplasm and technical information, but also play an important role in the organization and conduct of cooperative research between CIAT and participating countries. Conferences are the principal tool for the exchange of information and the coordination and development of concerted research strategies in the networks.

In the last two years, the Training and Conferences Program has streamlined operations to focus more on concerted collaboration with national research and development programs so to interlink research efforts and move newly available technology toward producers' fields. Three sets of action programs have been put into practice:

A progressive shifting of emphasis from production courses at headquarters to in-country courses conducted by national institutions with the assistance of CIAT. Such courses are frequently coordinated with the release of new varieties and/or agronomic and plant protection practices;

The development of national training plans based on expressed medium and long-term interest of the national programs and their scientific manpower needs with regard to CIAT's commodities; and

The regionalization of courses to focus increasingly on the circumstances of specific regions.

Degree-related training continues to receive high priority, but actual increases in this type of training are difficult to realize for lack of funds for academic study.

After many years of focusing attention in training on Latin America, CIAT's growing role in Asia (cassava) and Africa (beans) has led the Center to receive an increasing number of professionals for training from developing countries outside of Latin America and to organize relevant training opportunities in the respective regions.

Through the Seed Unit, CIAT has assumed a leadership role in providing training on seed technology in Latin America and the Caribbean and contributing to the development of seed programs in the region through an active conference/workshop program.

Future plans

The table below shows the projections of training activities in terms of number of participants and person-months for each type of training for the period 1986-1987. The growth in person-months is a result of the relative increase in longer-term training internships (average 6 months), post-M.Sc. training (average 10 months) and thesis training (average 14 months). Short courses at headquarters will gradually decrease as short-term training is shifted to CIAT-assisted in-country courses. Funding for in-country short courses is expected to come mainly from interested country institutions. Regional courses will increase substantially, particularly in Africa.

Special Projects

Training in Root and Tuber Crops: Phase II

This is a collaborative project involving CIAT, CIP (Centro Internacional de la Papa), and IITA. It aims to help national programs to increase the production of root and tuber crops in the tropics by conducting research on selected crops and developing scientific manpower to cooperatively adopt, generate, and transfer technology.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	20	21
Training	130	111
Supplies and services	3	3
Travel	10	11
Equip. replacement and capital	—	—
Other	20	20
Overhead	15	12
Subtotal	198	178

Number of participants and person-months of training planned for 1986-1987.

Type of training	1986		1987	
	No.	Person-month	No.	Person-month
Individual training				
Thesis research (M.Sc. and Ph.D.)	25	350	32	448
Specialized internships	120	720	140	1040
Subtotal	145	1070	172	1488
Group training				
Multidisciplinary courses	28	42	15	22
Specialized courses	90	135	100	180
Regional courses	48	48	72	72
Subtotal	166	225	187	274
Total	311	1295	359	1762
In-country courses	600	300	680	340

Conferences.

Events	No. of Participants[a]	1986 Cost		1987 Cost		
		Core	Special Projects	Core	Special Projects	Funding
International Bean Trials	80			32,000	50,000	
Bean Breeders Wkshp. L.Am.	20	20,000	8,000	28,000		
Bean Breeders Wkshp.	20	20,000	8,000			
Snapbean Wkshp.	40			20,700	61,200	c
Onfarm Research	30				40,000	Ford Foundation

Continues

Conferences (continued).

Events	No. of Participants[a]	1986 Cost		1987 Cost		
		Core	Special Projects	Core	Special Projects	Funding
Method. of pilot project for drying cassava	20		30,000			UNDP
Process. and utilization of roots and tubers	24		33,600			UNDP
Integrated production and utilization of cassava	28			30,000		
Adv. committee RIEPT	30			21,100	21,000	IDRC
RIEPT General Meeting	120			54,000	54,000	IDRC
Centrosema Wkshp.	48				55,000	
Wkshp. for agric. communicators	25	4,000	16,625[b]			IDRC
International Rice Trials	60			30,000	30,000	IRRI

a. Based on an average of US$1000 for tickets and US$400 for food, lodging, and other expenses.
b. Canadian dollars.
c. Pending.

COMMUNICATION AND INFORMATION SUPPORT UNIT

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. .85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Editor/Writing	1	1	1	1	1	2	2	2	2	2	1	1	1	1	1
Editor/Publications	1	1	1	1	1	4	5	5	5	5	1	1	1	1	1
Training materials						1	3	4	4	4		2	4	4	4
Distribut. and marketing											3	3	3	3	3
Graphic arts prod.						4	4	4	4	4	28	25	25	26	26
Unit Head and Info.Serv.	1	1	1	1	1	9	9	9	9	9	20	19	19	19	19
Total	3	3	3	3	3	20	23	24	24	24	53	51	53	54	54

Program Commentary

Targeting CIAT's audiences

As the commodity programs decentralize, and their breeding and technology development strategies grow more complex, it has become increasingly important to develop highly specific communication strategies that define both audience and purpose for each product. These strategies result from close collaboration between the commodity programs and the Communication and Information Support Unit (CISU). Additionally, a number of studies have been implemented to determine the needs of specific audiences, their disciplinary specialization, their media preferences, and their information-seeking habits.

Areas with new research efforts, for example, East Africa, Indonesia, Malaysia, and the Philippines, receive particular attention. A consultant is conducting an in-depth study of bean research communication in East Africa, where special data collection efforts have also been instigated.

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	913	942	997
Supplies and services	450	389	394
Travel	16	29	29
Replacement equipment	9	3	3
Total	1388	1363	1423

Technical publications

Research monographs, studies of the impact of new technology, field manuals, scientific articles for publication in international journals, and other such publications are designed to provide tropical agricultural scientists with the results of continuing research at CIAT.

Training support materials

Training support materials emphasize the mastery of concepts related to specific training objectives. Depending on the objectives and course design, key topics may be presented in manuals, as handouts, or in the form of "audiotutorial units." These materials teach research methodology, develop practical skills, and foster attitudes that facilitate technology transfer.

Network publications

Annual program reports, produced within the commodity programs, provide an in-depth, yearly progress report on every area of CIAT research. The reports are working documents, written in technical language.

Network research data are made available to all the members of the commodity research networks through a series of working reports, such as the results of the International Tropical Pastures Evaluation Network (RIEPT), the International Bean Yield and Adaptation Nursery (IBYAN), and the International Rice Testing Program (IRTP).

Commodity-specific newsletters contain information on developments within the programs, new research and production technology—whether from CIAT or from other research institutions—and commodity related news from regional and national collaborators. The purpose of these newsletters is to provide workers in existing networks with regular information on developments in that commodity area.

Conference proceedings are often generated when the members of the networks convene, whether the group is commodity or discipline oriented. These proceedings compile the research developments of an entire group of collaborators under one publication.

Reporting the Center's activities

CIAT report is a full-color publication that highlights CIAT research of the previous year and communicates the Center's activities and achievements in a popular style. This report is published in Spanish and English.

CIAT International, a trimestral newsletter, is specifically devoted to keeping decision makers and other CIAT contacts informed on program developments at CIAT and national program efforts toward new production and research methodology and utilization of germplasm developed through the networks. Written in a lay style, it is published in both Spanish and English.

Other kinds of information products are also routinely needed by the Center in order to make its research available to the widest number of interested persons at an international level. These include press releases, articles on the Center and its research efforts, catalogs, brochures, flyers, and others.

Library services

A specialized library with a collection of 33,000 books, 25,000 documents, and 2700 serials provides references and bibliographic research service to the staff of CIAT and to its network collaborators. The **Content pages,** a current awareness service, is published monthly and distributed to CIAT staff and subscribers throughout the tropics. The tables of contents of over 800 journals are listed, and interested scientists can order copies of articles in their field.

Specialized information centers

In line with its global and global/restricted mandate for field beans, cassava, and tropical pastures, CIAT has built up three specialized information centers

(SIC's) in support of each of these three commodities. Each SIC seeks to collect, abstract, and systematically file scientific documents on the respective commodities, and to use this databank to provide scientific information to researchers in these commodities. Services include retrospective searches, reference and referral, current awareness service, and document delivery.

Volumes of abstracts of the scientific literature are published three times per year and distributed to CIAT staff and to subscribers in the research institutions in the tropics.

Program staff

To support the concept of integrated information, CISU is comprised of five subsections, each headed by one of a multidisciplinary team of specialists. The principal staff team includes a science writer, a publications manager, an educational materials specialist, an information specialist, and a production manager. Professional support staff have degrees in a wide range of specializations including biology, agronomy, economics, agricultural engineering, food science, languages, librarianship, and computer programming. All work together to provide CIAT and collaborating scientists with top quality communication and information support.

Measurable productivity

During 1985, CIAT staff produced 391 research documents, of which 247 were published by CIAT. Major works included two conference proceedings, six research data reports, three progress reports, three research monographs, three technical manuals, 12 newsletters, ten bibliographic volumes, and 12 sets of contents pages. A total of 70,000 publications and 45,000 training materials were distributed. Almost 20,000 documents were loaned and 2000 reference questions answered. In all, CIAT's information products reached 139 different countries.

Marketing and distribution

Increasing attention is also being given to delivery systems in order to assure that information generated in CIAT's research programs reaches the end user. A publications catalog, an audiotutorials catalog, and a complete bibliography make all of CIAT's publications available by mail or through the CIAT bookstore. The multilevel, computerized mailing list has been upgraded to serve as a data base of collaborators as well as a listing of information users. Computerized inventory control enables CISU staff to study seasonal and geographical fluctuations in demand.

Copies of new publications are sent to selected book reviewers, to agricultural data bases, and to libraries of almost 500 key institutions. CIAT is an active participant in agricultural information networks, including AGRIS, AGRINTER, AGLINET, and SNICA. Distribution agents in the U.S., Europe, Brazil, and Ecuador see that interested audiences in their areas know about CIAT's work through direct mail, displays at professional societies, and major book fairs worldwide.

Special Projects

Information Services

An IDRC-financed project is in progress. It aims to reinforce operations of the specialized information analysis centers on cassava, beans, and tropical pastures. Specific objectives are: for cassava, to strengthen the scientific component in staffing of the center, increase outreach activities in Asia and Africa, and produce state-of-the-art reviews or manuals; for beans, to improve the capacity to collect and organize relevant documents and produce state-of-the-art reviews or manuals; for pastures, upgrade the information bulletin **Pastos Tropicales** to become a medium of publication for brief research reports and to produce a state-of-the-art review; and, for all three centers, to strengthen the common services available by computerizing their data bases, improving acquisition facilities in Asia and Africa, duplicating microfiche sets, producing mini-bibliographies and improving promotion.

	Budget (1986 US$ in thousands)	
	1986	1987
Personnel	101	45
Honoraria, stipends, and allowances	49	38
Supplies and services	47	30
Travel	—	—
Equip. replacement and capital	14	1
Indirect costs	18	11
Contingencies	—	—
Subtotal	229	125

ADMINISTRATION

BOARD OF TRUSTEES

Core Resources

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Honoraria	49	51	51
Supplies and services	7	22	22
Travel	67	69	69
Total	123	142	142

Program Commentary

The CIAT Board of Trustees has 17 members. Normally the Board holds one annual meeting. Its executive committee, program committee, audit committee, and nominations committee meet at the time of the annual meeting, plus at various intervals throughout the year as deemed desirable and necessary. Budgeted here are the costs for international and national travel, honoraria, per diems, and other expenses directly associated with the meeting of the Board and its committees.

OFFICE OF THE DIRECTOR GENERAL

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
	Act.	Bud.	Bud.	Bud.	Bud.	Act.	Bud.	Bud.	Bud.	Bud.	Act.	Bud.	Bud.	Bud.	Bud.
Personnel (Positions)	85	86	87	88	89	85	86	87	88	89	85	86	87	88	89
Director General	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Assistant Director	1	1	1	1	1						1	1	1	1	1
Internal Auditor						3	3	3	3	3	1	1	1	1	1
Visitors' Office						3	3	3	3	3	2	2	2	2	2
Deputy Director General	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
Director of Finance and Administration	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total	5	5	5	5	5	10	10	10	10	10	10	10	10	10	10

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	919	865	865
Supplies and services	32	31	31
Travel	104	94	94
Replacement equipment	1	6	6
Other expenses	31	32	32
Total	1087	1028	1028

Program Commentary

Three Division Heads, the Assistant Director, and the Internal Auditor report to the Director General. The following three divisions make up the organization of CIAT.

Research Division I consists of the Bean Program, the Cassava Program, and the following research support units: Genetic Resources, Biotechnology Research, Station Operations, and Research Services (except Data Services). This division is headed by a Deputy Director General.

Research Division II comprises the Tropical Pastures Program, the Rice Program, the Data Services Unit, the Seed Unit, and the Coordinating Office for Training and Conferences. The division is headed by a Deputy Director General.

Finance and Administration is responsible for the general services and financial administration, and is headed by the Director of Finance and Administration.

The Assistant Director, in addition to being assigned staff responsibilities related to the office of the Director General and the Board of Trustees, has line responsibilities for the Communication and Information Support Unit and the Visitors Office.

The Office of the Internal Auditor is headed by a General Administrative Staff (GAS) member who also reports to the Director General.

Budgeted in the Office of the Director General are special resources for the international travel of directing staff of collaborating national institutions. These resources are used to make possible selected trips of such staff to CIAT for consultation purposes.

ADMINISTRATIVE SUPPORT

Core Resources

	Senior staff					Scientific and supervisory					Clerical and other				
Personnel (Positions)	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Controller						8	8	8	8	8	18	18	18	21	21
Executive Officer	1	1	1	1	1	4	4	4	4	4	10	10	10	10	10
Human Resources						2	2	2	2	2	13	13	13	13	13
Supplies						5	5	5	5	5	23	22	22	22	22
Systems and procedures						5	6	6	6	6	5	3	3	3	3
Total	1	1	1	1	1	24	25	25	25	25	69	66	66	69	69

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	1190	1081	1081
Supplies and services	157	181	181
Travel	32	32	32
Replacement equipment	42	1	1
Other expenses	40	48	48
Total	1461	1343	1343

Program Commentary

The responsibilities of the Administrative Support Section are to provide support to all CIAT activities in order that they can carry out the research and training activities of the Center. The section includes the many necessary housekeeping and administrative/fiscal units necessary to ensure that researchers have facilities to operate. It includes:

Functions directly responsible to the Director of Finance and Administration:

Executive Officer
Controller
Treasurer
Administrative Data Processing
Miami Office
Special Projects Office

Functions that report to the Executive Officer:

Human Resources
Purchasing/Supplies
Maintenance
Travel Office
Bogotá Office
Security
Food and Housing
Aircraft Operations
Carimagua Administration

Some of the functions reporting to the Executive Officer also appear in self-supporting activities as they are designed to provide support through general income. However, because of the nature of the service provided, they receive income from Core and Special Project sources.

An IBM System 36 computer is used exclusively for fiscal and administrative support—its use began in mid-1984. Approximately 90% of initially planned applications have been implemented.

CIAT opened its own office in Miami during 1986 in order to provide better purchasing, shipping, and importation service to CIAT in Colombia, as well as other CIAT operating sites.

GENERAL OPERATING EXPENSES

Core Resources

Personnel (Positions)	Senior staff					Scientific and supervisory					Clerical and other				
	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89	Act. 85	Bud. 86	Bud. 87	Bud. 88	Bud. 89
Physical plant maintenance						4	4	4	4	4	53	53	53	53	53
Physical plant security											40	39	39	40	40
Physical plant gardens											11	11	11	11	11
Physical plant cleaning											52	49	49	51	51
Motor pool						1	1	1	1	1	51	48	48	50	50
Total						5	5	5	5	5	207	200	200	205	205

Direct costs (1986 US$ in thousands).

	Current budget		Proposed budget
	Actual 1985	Revised 1986	1987
Personnel	1282	1149	1149
Supplies and services	1115	882	882
Travel	33	26	26
Replacement equipment	324	556	556
Other expenses	677	164	164
Gain exchange rate	(549)	(300)	(300)
Total	2882	2477	2477

Program Commentary

The Palmira installations consist of about 20 buildings or complexes of buildings, including two laboratory buildings, three office buildings, two field laboratory buildings, seed processing and storage facilities, communications and library buildings, conference facilities, food, housing and recreational facilities, six greenhouses, warehouse, a germplasm store and service building for machinery and vehicle maintenance, laundry facilities, and water treatment. The gross area of buildings is 42,000 m² of which about 50% is aircondi-

tioned. The entire complex is served by about 37 km of roads, 25,000 m^2 of circulation areas and parking spaces, and is surrounded by about 10,000 m^2 of gardens.

Other than electricity, for which only standby and emergency capacity is maintained, CIAT provides all its own services. The Physical Plant includes resources to run these services, maintain all buildings and grounds, and provide security.

CIAT operates a fleet of about 250 vehicles which includes buses, trucks, vans, pickups, jeeps, and passenger cars from various manufacturers. The Motor Pool is responsible for servicing, repairing, and maintaining these vehicles and for providing bus services to transport personnel to and from work and regular services during the day and night to Cali and Palmira for employees, training participants, and visitors.

SELF-SUPPORTING AND INCOME-GENERATING ACTIVITIES

CIAT has several self-supporting activities, which are meant to break even, and several other activities which generate income in excess of the extra costs incurred. Activities falling under the two groupings are as follows:

Self-supporting	Income-generating
Food and housing	Farm production
Aircraft operation	Cattle herds
Publications fund	Seed marketing
Seed processing and conditioning	Special project support
"PROCIAT" health service	

None of these activities appear separately in this budget document although in some cases significant amounts are charged to the core budget. Examples of this are: the food operation, which is partly supported by a subsidy which is charged as a personnel cost; and the aircraft operation, which is funded by charges to the respective individual programs' travel budgets.

CAPITAL REQUIREMENTS

The proposed capital budget of US$1,078,000 includes US$250,000 for development of the Genetic Resources Unit building and US$153,000 for the construction of a quarantine greenhouse (see page 18). The remainder of US$675,000 budget is for equipment purchase, part of which is to support new activities in the Review List (see page 15).

TABLES

I. Summary of Man-Years and Costs by Program and Activity

II. Summary of Sources and Application of Funds

III. Summary Financial Data 1984-1987

IV. Table of Positions and Manpower

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL - CIAT
SUMMARY OF MAN-YEARS AND COSTS BY PROGRAM AND ACTIVITY

TABLE I

	1984		1985		1986				1987		1988	
	M-Y SR. STAFF	ACTUAL BUDGET 84$000	M-Y SR. STAFF	ACTUAL OUTCOME 85$000	M-Y SR. STAFF	APPROVED BUDGET 86$000	M-Y SR. STAFF	REVISED BUDGET 86$000	M-Y SR. STAFF	PROPOSAL 86$000	M-Y SR. STAFF	FORECAST 86$000
I. OPERATIONS PROGRAM												
RESEARCH PROGRAMS												
Beans	14.0	4,775	14.6	2,633	16.0	3,085	16.0	2,945	16.0	2,988	16.0	2,988
Cassava	7.6	1,905	9.0	1,932	9.0	2,011	9.0	1,925	10.0	2,108	12.0	2,486
Rice	3.1	891	5.8	991	6.0	1,141	6.0	1,060	7.0	1,190	7.0	1,190
Tropical Pastures	14.9	3,233	14.6	3,133	17.0	3,468	16.5	3,294	18.0	3,428	19.0	3,611
Sub-Total	39.6	8,804	44.0	8,689	48.0	9,705	47.5	9,224	51.0	9,714	54.0	10,275
RESEARCH SUPPORT												
Visiting Scientists & Post.Doc.	-	409		630		716		531		691		691
Genetic Resources	1.0	461	0.8	288	1.0	337	1.0	301	1.0	361	1.0	361
Biotechnology Research	-	-	1.0	214	1.0	218	1.0	204	3.0	491	3.0	491
Research Services	-	301		240		335		268		268		281
Station Operations	1.0	959	1.0	892	1.0	880	1.0	782	1.0	782	1.0	813
Carimagua Station	-	667		479		524		533		533		533
Data Services	1.0	469	1.0	505	1.0	549	1.0	480	1.0	480	1.0	499
Agroecological Studies	1.0	138	1.0	144	1.0	157	1.0	147	2.0	297	2.0	297
Seed Unit	1.0	364	1.7	489	2.0	469	2.0	469	2.0	469	2.0	469
Sub-Total	5.0	3,768	6.5	3,881	7.0	4,185	7.0	3,715	10.0	4,372	10.0	4,435
TOTAL RESEARCH	44.6	12,572	50.5	12,570	55.0	13,890	54.5	12,939	61.0	14,086	64.0	14,710
INTERNATIONAL COOPERATION												
Training & Conferences	1.0	1,589	0.8	1,354	1.0	1,512	0.5	1,396	1.0	1,396	1.0	1,396
Communication & Info. Support	2.6	1,478	3.0	1,341	3.0	1,529	3.0	1,363	3.0	1,423	3.0	1,445
TOTAL INTERN. COOP.	3.6	3,067	3.8	2,695	4.0	3,041	3.5	2,759	4.0	2,819	4.0	2,841
ADMINISTRATION												
Board of Trustees	-	155		119		142		142		142		142
Director General	2.0	520	2.0	488	2.0	531	2.0	504	2.0	504	2.0	504
Directors	3.0	493	2.8	562	3.0	539	3.0	524	3.0	524	3.0	524
Administrative Support	1.0	1,851 1/	1.0	1,412	1.0	1,531	1.0	1,343	1.0	1,343	1.0	1,417
TOTAL ADMINISTRATION	6.0	3,019	5.8	2,581	6.0	2,743	6.0	2,513	6.0	2,513	6.0	2,587
GENERAL OPERATING EXPENSES												
Physical Plant		1,564		1,360		1,391		1,100		1,100		1,100
Motor Pool		701		876		939		845		845		882
General Expenses		500		548		574		532		532		564
TOTAL GENERAL EXPENSES	54.2	2,765		2,784		2,904		2,477		2,477		2,546
OTHER												
Contingency		-				216		216		216		227
Provision for Price Changes 2/										884		2,107
TOTAL OPERATIONS	54.2	21,423	60.1	20,630	65.0	22,794	64.0	20,904	71.0	22,995	74.0	25,018
TOTAL SPECIAL PROJECTS		1,250		2,282		3,183		4,055		4,150		4,253
CATEGORIES OF EXPENSES												
Personnel Costs		13,955		13,296		15,412		14,016		14,873		15,450
Honoraria, Stipends & Allow.		1,180		1,378		1,432		1,207		1,367		1,367
Supplies & Services		3,522		3,815		3,344		3,456		3,552		3,711
Travel		1,492		1,290		1,348		1,354		1,445		1,496
Equipment		848		658		679		711		714		716
Other		426		195		363		(56)		(56)		(56)
Contingency						216		216		216		227
Sub-Total		21,423		20,630		22,794		20,904		22,111		22,911
Provision for Price Changes 2/										884		2,107
TOTAL CORE		84$21,423		85$20,630		85$22,794		86$20,904		87$22,995		88$25,018

1/ Included US$220 for External Program Review

2/ Inflation between Budget Years 1986 and 1987 is calculated at 4%; and inflation between 1987 and 1988 is calculated at 5%.

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CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL
SUMMARY OF SOURCES AND APPLICATION OF FUNDS
(C US$ Thousands)

TABLE 11

	ACTUAL		1986 BUDGET		Proposed Budget	PROJECTIONS
	1984	1985	Approved Budget	Current Estimate	1987	1988
SOURCES OF FUNDS						
Core Operations						
Australia	505	457		640		
Belgium	106	126				
Brazil	400					
Canada	1,239	1,218		1,241		
China	33	33		30		
European Economic Community	1,225	1,632				
Ford Foundation	100	100				
France	31	53				
Germany (Federal Republic)	814	708		538		
Interamerican Development Bank	4,043	4,043		4,275		
International Fund for Agricultural Development	1,000	500				
Italy	289	348		541		
Japan	1,329	1,389		1,855		
Mexico	397	111				
Netherlands	244	235				
Norway	274	339		441		
OPEC Fund for International Development	300	-				
Rockefeller Foundation		46		141		
Spain	50	30		30		
Sweden	98	122		191		
Switzerland	452	439		537		
United Kingdom	447	513		623		
United States of America	5,600	5,540		5,600		
World Bank	921	376		750		
Unidentified Sources			20,228	1,419	22,475	24,701
Balance (deficit) from previous year	-15	-39		-33		
Income applied in year		302	621	250	300	300
TOTAL CORE OPERATING FUNDS	19,862	18,621	20,849	18,869	22,775	25,001
Capital						
Others	115	271				
World Bank	409	924				
Unidentified Sources			552	713	1,253	1,544
Income applied in year	375					
Balance of working funds	1,577	1,577	1,577	1,577	1,577	1,752
TOTAL CAPITAL FUNDS	2,476	2,772	2,129	2,290	2,830	3,296
Special Core Projects						
Ford Foundation	10	10		79		
International Development Research Centre (IDRC)	75	209		130		
Kellogg Foundation	266	(2)				
Switzerland	2,065	673		1,470		
U.N. Development Programme (UNDP)	249	384		356		
Unconfirmed Sources			1,430		250	17
Balance from previous period	519	758	515		-	
TOTAL SPECIAL CORE PROJECT	3,184	2,032	1,945	2,035	250	17
Special Projects						
Belgium	33	80		108		
Board of the Andean Pact	24					
Canada (CIDA)		253		250		
Ford Foundation	30	102		136		
FAO	2			10		
German Agency for Technical Cooperation (GTZ)	55	131		90		
German Foundation for International Development	-4					
IBPGR	92	22		55		
International Development Research Centre (IDRC)	240	99		376		
Government of Italy		100				
Japan	200			200		
Switzerland	485	49		759		
U.N. Development Programme (UNDP)		163		176		
U.S. Agency for International Development (AID)	68	146		124		
World Bank		282		210		
Others	2	25				
Unidentified Sources			3,141	966	3,790	3,800
Balance from previous year	525	876	442	595	400	200
TOTAL SPECIAL PROJECTS	1,757	2,328	3,583	4,055	4,190	4,000
Projects at CIAT by Sister Institutes						
International Fertilizer Development Center (IFDC)	109	49				
International Institute of Tropical Agriculture (IITA)		15		150		
International Maize and Wheat Improvement Center	88	106				
International Potato Center (CIP)		15				
International Rice Research Institute	237	192				
Intsormil	65	96				
Intsoy	10					
Unconfirmed Sources				615	153	139
Balance from previous year	-141	-38		-114		
TOTAL PROJECTS BY SISTER INST.	368	435	---	651	153	139
TOTAL FUNDS	27,662	26,188	28,506	27,900	30,198	32,453
APPLICATION OF FUNDS						
Core Operation	21,203	20,630	22,794	20,904	23,025	25,018
External Review	220					
Capital	1,361	1,251	552	713	1,018	1,201
Special Projects	844	1,748	3,183	3,655	3,990	3,800
Projects at CIAT by Sister Institutes	406	534		651	153	139
Unexpended Balances						
Unrestricted Core (deficit)	-39	-33				
Working Funds	1,577	1,577	1,577	1,577	1,752	2,095
Special Core Projects	1,220					
Special Projects	908	595	400	400	200	200
Projects at CIAT by Sister Institutes	-38	-114				
SUB-TOTAL	3,628	2,025	1,977	1,977	1,952	2,295
TOTAL APPLICATIONS	27,662	26,188	28,506	27,900	30,198	32,453
Memo :						
1. Total Core Operating Funds Required	21,423	20,630	22,794	20,904	23,025	25,018
Less unexpended balance previous year	-253	-663	-515	33		
Less earned income applied		-302	-621	-250	-300	-300
Net Core Operating Funds Required	21,170	19,665	21,658	20,687	22,725	24,718
2. Total Capital Funds Required	2,873	2,557	2,129	2,290	2,830	3,296
Less unexpended balance previous year	-251	-56				
Less balance working funds	-1,577	-1,577	-1,577	-1,577	-1,577	-1,752
Less earned income applied	-375					
Net Capital Funds Required	620	924	552	713	1,253	1,544
3. Total Funds Required from Donors	21,790	20,589	22,210	21,400	23,978	26,262
4. Total Earned Income	375	302	621	250	300	300
Applied to Core Operation		-302	-621	-250	-300	-300
Applied to Capital	-375					
Balance	-	-	-	-	-	-

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TABLE III

SUMMARY FINANCIAL DATA 1984-1987

	Actual 1984	Actual 1985	1986 Budget Approved	1986 Budget Current Estimate	Budget 1987
Current Assets					
Cash and Banks	2,841	2,804	3,500	3,500	3,500
Receivable from Donors	834	2,751	900	900	900
Receivable from Employees	168	216	300	300	300
Receivable from Others	1,975	1,213	2,000	2,000	2,000
Inventories	1,678	1,986	500	417	254
Prepaid Expenses	72	73	80	80	80
Properties for Sale	201	343	200	200	200
Total Current Assets	7,769	9,386	7,480	7,397	7,234
Long-Term Accounts Receivable and Other Assets	1,019	788	1,215	1,215	1,215
Fixed Assets					
Research Equipment	5,787	5,844			
Airplane	1,299	1,299			
Vehicles	2,796	3,422			
Furnishings & Office Equip.	2,154	2,546			
Buildings, Lands & Construction in Progress	7.766	8,189			
Total Fixed Assets	19,802	21,300	21,852	22,013	23,091
TOTAL ASSETS	28,590	31,474	30,547	30,625	31,540
Libilities					
Bank Overdrafts	125	204	100	100	100
Accounts Payable	3,851	5,046	4,183	4,100	3,962
Employee's Social Benefits	1,516	1,237	1,835	1,835	1,835
Grants Received in Advance		1,994	600	600	600
Total Liabilities	5,492	8,481	6,718	6,635	6,497
Fund Balances					
Invested in Fixed Assets	19,802	21,300	21,852	22,013	23,091
Unexpended Funds (Deficit)					
Core Unrestricted	(39)	(33)			
Working Fund Grants	1,245	1,245	1,577	1,577	1,752
Special Core Projects	1,220	-	-		
Other Special Projects	870	481	400	400	200
Total Fund Balances	23,098	22,993	23,829	23,990	25,043
TOTAL LIABILITIES AND FUND BALANCES	28,590	31,474	30,547	30,625	31,540

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CENTRO INTERNACIONAL D

TABLE OF POSITIO

	SENIOR STAFF						SCIENTIFIC AND SUPERVISORY						
	POSITIONS			MAN-YEARS			POSITIONS			MAN-YEARS			P
	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85
RESEARCH PROGRAMS													
Beans	16	16	16	14.6	16.0	16.0	32	32	30	27.8	32.0	30.0	9
Cassava	9	9	10	9.0	9.0	10.0	25	25	25	23.8	25.0	25.0	9
Rice	6	6	7	5.8	6.0	7.0	12	12	14	9.0	12.0	14.0	4
Tropical Pastures	17	17	18	14.6	16.5	18.0	37	36	36	35.2	36.0	36.0	11
SUB-TOTAL	48	48	51	44.0	47.5	51.0	106	105	105	95.8	105.0	105.0	33
RESEARCH SUPPORT													
Genetic Resources Unit	1	1	1	0.8	1.0	1.0	4	4	5	7.2	4.0	5.0	1
Biotechnology Research	1	1	3	1.0	1.0	3.0	4	4	9		4.0	9.0	1
Research Services							4	4	4	4.0	4.0	4.0	
Station Operations	1	1	1	1.0	1.0	1.0	5	5	5	4.9	5.0	5.0	2
Carimagua Station							3	3	3	2.3	3.0	3.0	4
Data Services	1	1	1	1.0	1.0	1.0	8	8	8	7.3	8.0	8.0	10
Agroecological Studies	1	1	2	1.0	1.0	2.0	2	2	4	0.8	2.0	4.0	1
Seeds	2	2	2	1.7	2.0	2.0	6	6	6	6.7	6.0	6.0	2
SUB-TOTAL	7	7	10	6.5	7.0	10.0	36	36	44	33.2	36.0	44.0	21
TOTAL RESEARCH	55	55	61	50.5	54.5	61.0	142	141	149	129.0	141.0	149.0	54
INTERNATIONAL COOPERATION													
Training & Conferences	1	1	1	0.8	0.5	1.0	10	10	10	9.5	10.0	10.0	6
Communication & Inform.	3	3	3	3.0	3.0	3.0	20	23	23	20.1	23.0	23.0	12
TOTAL INTL. COOP.	4	4	4	3.8	3.5	4.0	30	33	33	29.6	33.0	33.0	18
ADMINISTRATION													
Director General	1	1	1	2.0	2.0	2.0	7	7	7	6.7	7.0	7.0	4
Directors	4	4	4	2.8	3.0	3.0	3	3	3	2.0	3.0	3.0	3
Administrative Support	1	1	1	1.0	1.0	1.0	24	25	25	21.4	25.0	25.0	66
TOTAL ADMINISTRATION	6	6	6	5.8	6.0	6.0	34	35	35	30.1	35.0	35.0	73
GENERAL OPERATING EXPENSES													
Physical Plant							4	4	4	4.0	4.0	4.0	5
Motor Pool							1	1	1	1.0	1.0	1.0	3
TOTAL GENERAL OPERATING							5	5	5	5.0	5.0	5.0	8
SELF-SUPPORTING & INCOME GENERATING ACTIVITIES	1	1	1	1.0	1.0	1.0	10	10	10	10.0	10.0	10.0	25
GRAND TOTAL	66	66	72	61.1	65.0	72.0	221	224	232	203.7	224.0	232.0	178

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TABLE IV

SUPPORT STAFF											TOTAL STAFF					
CLERICAL					OTHER SUPPORT STAFF											
SITIONS		MAN-YEARS			POSITIONS			MAN-YEARS			POSITIONS			MAN-YEARS		
Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87	Act. 85	Rev. 86	Bud. 87
9	8	8.3	9.0	8.0	128	124	125	124.2	124.0	125.0	185	181	179	174.9	181.0	179.0
9	9	7.3	9.0	9.0	98	95	97	95.3	95.0	97.0	141	138	141	135.4	138.0	141.0
5	5	5.6	5.0	5.0	57	56	62	50.1	56.0	62.0	79	79	88	70.5	79.0	88.0
11	11	10.9	11.0	11.0	153	153	157	89.8	153.0	157.0	218	217	222	150.5	216.5	222.0
34	33	32.1	34.0	33.0	436	428	441	359.4	428.0	441.0	623	615	630	531.3	614.5	630.0
1	1	1.8	1.0	1.0	22	22	28	29.3	22.0	28.0	28	28	35	39.1	28.0	35.0
2	2		2.0	2.0	7	6	15		6.0	15.0	13	13	29	1.0	13.0	29.0
					18	18	18	16.8	18.0	18.0	22	22	22	20.8	22.0	22.0
2	2	2.2	2.0	2.0	81	78	78	80.7	78.0	78.0	89	86	86	88.8	86.0	86.0
4	4	6.3	4.0	4.0	2	2	2	1.9	2.0	2.0	9	9	9	10.5	9.0	9.0
9	9	8.3	9.0	9.0	-	-	-	1.7	-	-	19	18	18	18.3	18.0	18.0
1	1	1.0	1.0	1.0	3	3	6	2.5	3.0	6.0	7	7	13	5.3	7.0	13.0
2	2	2.7	2.0	2.0	6	6	6	6.0	6.0	6.0	16	16	16	17.1	16.0	16.0
21	21	22.3	21.0	21.0	139	135	153	138.9	135.0	153.0	203	199	228	200.9	199.0	228.0
55	54	54.4	55.0	54.0	575	563	594	498.3	563.0	594.0	826	814	858	732.2	813.5	858.0
6	6	7.9	6.0	6.0	4	4	4	5.7	4.0	4.0	21	21	21	23.9	20.5	21.0
13	13	13.4	13.0	13.0	41	38	38	39.7	38.0	38.0	76	77	77	76.2	77.0	77.0
19	19	21.3	19.0	19.0	45	42	42	45.4	42.0	42.0	97	98	98	100.1	97.5	98.0
4	4	4.3	4.0	4.0	1	1	1	2.0	1.0	1.0	13	13	13	15.0	14.0	14.0
3	3	3.2	3.0	3.0	2	2	2	0.3	2.0	2.0	12	12	12	8.3	11.0	11.0
63	63	77.5	63.0	63.0	3	3	3	5.5	3.0	3.0	94	92	92	105.4	92.0	92.0
70	70	85.0	70.0	70.0	6	6	6	7.8	6.0	6.0	119	117	117	128.7	117.0	117.0
5	5	5.5	5.0	5.0	151	147	147	151.0	147.0	147.0	160	156	156	160.5	156.0	156.0
3	3	3.5	3.0	3.0	48	45	45	46.4	45.0	45.0	52	49	49	50.9	49.0	49.0
8	8	9.0	8.0	8.0	199	192	192	197.4	192.0	192.0	212	205	205	211.4	205.0	205.0
25	25	25.0	25.0	25.0	62	62	62	62.0	62.0	62.0	98	98	98	98.0	98.0	98.0
77	176	194.7	177.0	176.0	887	865	896	810.9	865.0	896.0	1,352	1,332	1,376	1,270.4	1,331.0	1,376.0

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LIST OF ACRONYMS OF ENTITES AND PROJECTS CITED

AGLINET	Agricultural Libraries Network.
AGRINTER	Sistema Interamericano de Información para las Ciencias Agrícolas. (Also known as Inter-American Information System of Agricultural Sciences.)
AGRIS	International Information System for the Agricultural Sciences and Technology (FAO).
ARTES	Asociación Regional de Tecnólogos en Semillas (for Central America, Panama and the Caribbean region).
BRU	Biotechnology Research Unit, CIAT, Colombia.
CENARGEN	Centro Nacional de Recursos Genéticos, Brazil.
CETREISEM	Centro de Estudos e Treinamento em Tecnologia de Sementes e Mudas, Brazil.
CGIAR	Consultative Group on International Agricultural Research.
CGPRT	ESCAP Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots, and Tuber Crops in the Humid Tropics of Asia and the Pacific, Indonesia.
CIAT	Centro Internacional de Agricultura Tropical, Colombia.
CIBC	Commonwealth Institute of Biological Control, U.K.
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo, Mexico.
CIP	Centro Internacional de la Papa, Peru.
CPAC	Centro de Pesquisa Agropecuária dos Cerrados, Brazil.
DRI	Desarrollo Rural Integrado, Colombia.
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária, Brazil.
EPR	External Program Review.

ESCAP	Economic and Social Commission for Asia and the Pacific, Thailand.
GRU	Genetic Resources Unit, CIAT, Colombia.
IARC	International Agricultural Research Center.
IBPGR	International Board for Plant Genetic Resources, Italy.
IBYAN	International Bean Yield and Adaptation Nursery, CIAT, Colombia.
ICA	Instituto Colombiano Agropecuario, Colombia.
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India.
ICRO	International Cell Research Organization.
ICTA	Instituto de Ciencia y Tecnología Agrícolas, Guatemala.
IDIAP	Instituto de Investigación Agropecuaria de Panamá.
IDRC	International Development Research Centre, Canada.
IFDC	International Fertilizer Development Center, U.S.A.
IITA	International Institute of Tropical Agriculture, Nigeria.
ILCA	International Livestock Center for Africa, Ethiopia.
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias, Mexico.
INIPA	Instituto Nacional de Investigaciones y Promoción Agraria, Peru.
INTSORMIL	International Sorghum and Millet Program, U.S.A.
IRAT	Institut de Recherches Agronomiques Tropicales et de Cultives Vivriéres, France.
IRRI	International Rice Research Institute, Philippines.
IRTP	International Rice Testing Program, Philippines.
IVITA	Instituto Veterinario de Investigación Tropical y de Altura, Peru.
MIRCEN	UNEP/UNESCO/ICRO Microbiological Resource Centre, Sweden.
ORSTOM	Office de la Recherche Scientifique et Technique d'Outre-Mer, France.
RIEPT	Red Internacional de Evaluación de Pastos Tropicales, Colombia (transl. as International Tropical Pastures Evaluation Network).
SADCC	Southern African Development Coordination Conference.
SDC	Swiss Development Cooperation.
SNICA	Subsistema Nacional de Información en Ciencias Agropecuarias (Colombia)
TAC	Technical Advisory Committee of the CGIAR.
TDRI	Tropical Development and Research Institute, U.K.
UNDP	United Nations Development Programme.
UNEP	United Nations Environmental Programme.
UNESCO	United Nations Education, Scientific and Cultural Organization.

Abbreviations used in text:

BCMV	Bean common mosaic virus.
BMMV	Bean mild mosaic virus.
BNF	Biological nitrogen fixation.