# CIAT

# REPORT 1985

Centro Internacional de Agricultura Tropical

Centro Internacional de Agricultura Tropical (CIAT)
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# FOREWORD. . . .

This year's CIAT Report is different in several ways from those of past years. Our new look developed from our desire to keep our report readable and visually interesting.

We have divided our "new" Report into two distinct sections. The first, called "CIAT: A Profile," takes only a few minutes to read and presents a capsule account of CIAT's programs.

The second section, "Research Highlights," consists of summaries of some of our more exciting work done in collaboration with national agricultural research programs during 1984.

For readers who may be interested in knowing where to find more detailed information on the highlighted subjects—or on other CIAT research—**a list of CIAT's 1984 publications is included at the end of the section, along with a listing of journal articles. Detailed individual program reports are available from the Coordinators of each of CIAT's commodity programs.** Complete catalogs of CIAT's publications and audiovisual teaching units are available from the Distribution and Marketing Office. An exhaustive bibliography of the papers of CIAT's staff members is also available from the Library.

We are pleased to share CIAT REPORT 1985 with our friends and colleagues around the world.

# DIRECTOR GENERAL'S MESSAGE

Over the years, CIAT has become firmly established in the constellation of institutions involved in agricultural research and training in Latin America, and this is increasingly true in a broader sector of the tropical world. The mandate of the center—to work with national research programs in four areas (cassava, beans, rice, and tropical pastures species)—transcends national and regional boundaries. This has allowed CIAT to play a significant, supportive role in the formation of collaborative research networks.

These commodity-oriented networks have developed to meet the common need to find solutions for the diseases, pests, and other production constraints that limit tropical agricultural productivity. Through the networks, teams of CIAT and national agricultural research scientists have combined their breeding efforts and pooled their expertise to produce new technologies and improved varieties of crops that have been specifically chosen for their importance to both the subsistence farmer and the low-income urban consumer. Today, the resources of CIAT are joined with those of sister international centers across the tropics.

Training activities, many of them conducted in the national programs themselves with some CIAT support, complement our research activities. CIAT has played a role in training nearly 3000 national professionals through commodity-specific research/production courses and individualized internships. These scientists are key participants in advancing food production in ways that benefit small farmers and consumers alike.

The combined program of research and training that has been the core of CIAT's contribution to agricultural development in the region has been highly effective. Without doubt, our future contributions will be measured by the extent that we are able to successfully stimulate the further development of the commodity networks, backstop national efforts, and—ultimately, increase productivity and production gains at the national level.

John L. Nickel

# CIAT: A PROFILE

# CIAT: A PROFILE

Centro Internacional de Agricultura Tropical: A partner in tropical national agricultural research

CIAT is one of thirteen International Agricultural Research Centers funded through the Consultative Group on International Agricultural Research (CGIAR). Established in 1967 to support agricultural development in tropical America, it currently specializes in four commodities—field beans, cassava, tropical pastures for cattle production, and rice. Within the CGIAR system, CIAT has a global responsibility for tropical research on beans, cassava and pasture species, and regional responsibility for rice in the American tropics. All of CIAT's activities are viewed as complementary to those of other international and national agricultural research organizations. Producers, especially small farmers, and consumers are the primary beneficiaries of the applied research of the Center.

The Consultative Group on International Agricultural Research operates informally and by consensus. It is comprised of some 40 donor countries, several foundations and international organizations. The CGIAR is advised by a Technical Advisory Committee, which sets the direction, and in some instances, the priorities of the system. Each Center, however, has its own board of trustees.

Biologically based technology—especially plant breeding—is at the core of CIAT's work. The product is high-yielding crop varieties with stable resistance to major tropical agricultural constraints.

Just as genetic manipulation can make plants resistant or tolerant of pests and diseases, it can also improve their capacity to more efficiently use nutrients in the soil. Agriculture that is less dependent on fertilizers, as well as other agrichemicals, helps hold down the front-end cost of food production. This consideration is even more vitally important to the subsistence farmer than to the small farmer producing for the local market. The approach, called 'minimum input agriculture', is at the heart of CIAT's program to develop technology to increase productivity and production of tropical agriculture.

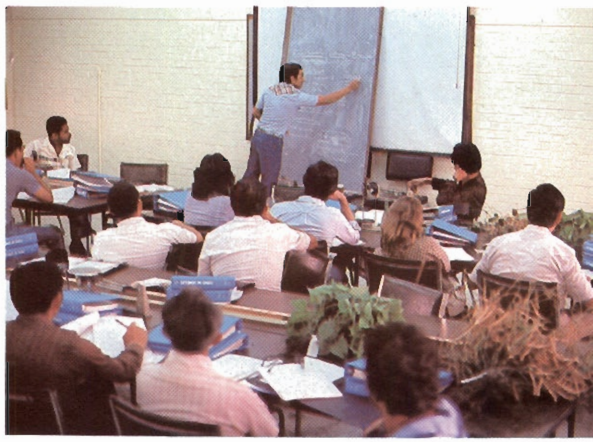
CIAT has long recognized the importance of developing production technology that requires low levels of purchased inputs. At the same time, improved production technology must have the capacity to make highly efficient use of whatever inputs are applied. The task is to develop management techniques and agricultural technology that will maximize the productivity of relatively small holdings. The producer with only limited access to purchased inputs must be assured of stable yields at acceptable levels.

## NATIONAL NURSERIES AND NETWORKS

While broad-based technology development efforts in some commodities are undertaken by CIAT, the synthesis of the technology components into a viable production system is within the domain of national research programs. This points to the important role of collaboration between national programs and CIAT in the complex tasks of tropical agricultural development.

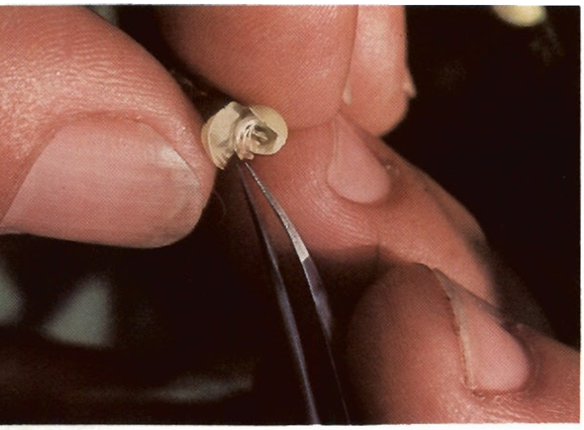
This type of collaboration has positively influenced the formation of commodity networks and created research partnerships between CIAT and many national agricultural research programs. The RIEPT (pastures research network), for in-

Classroom instruction at CIAT: Nearly 3000 professionals have received training



CIAT training: Strengthening the foundation of the international networks

Crossing beans: Breeder gives nature a helping hand



*In vitro* plant culture: Biotechnology improves breeding potential

stance, is composed of pastures scientists in 14 Latin American countries, incorporating 146 regional research sites in five principal ecological areas (Figure 1). The network helps to focus and unify the region's diversified tropical pasture research and integrates the work of many scientists.

The formidable challenge of opening up Latin America's marginal lands to agricultural development has played a formative role in the network's evolution. The size of the land mass consisting of acid and infertile soils makes high-input agricultural technology unfeasible. However, through the combined efforts of many tropical pastures specialists—breeders who can select and develop adapted grasses and legume species and other specialists to develop the technology to establish and maintain pastures on these lands with a minimum of purchased inputs—the challenge can be met. These frontiers, with the right technology, could significantly change the area's food output.

Agricultural research networks such as RIEPT pool scientific know-how, create conduits of communication, and generate mutually beneficial research. Similar networks link research and national collaboration with the bean, cassava, and rice programs. Their formation has been one of the major contributions of the International Agricultural Research Centers to the on-going process of agricultural development in the tropics.

## ON-FARM RESEARCH AND CIAT TRAINING

The small farm environment is markedly different from the experiment station, where the scientist has extensive control over many factors affecting plant growth. They include water, soil, topography and even the human factors. The small farmer is farming relatively marginal land, his holding is usually on a hillside, and he has very little control over water availability. These harsh environmental conditions demand technology developed for the small farm environment and characterized by a very high degree of adaptation to adverse production conditions. The requirement to develop technology for minimally controlled conditions puts an important additional burden on the plant breeding effort. On-farm research is the prerogative and responsibility of national programs. It is vital in order to validate the research and development process. CIAT directly collaborates with the on-farm trials in order to evaluate the technology and to help scientists understand farmers' production constraints.

New rice lines, better grasses for pastures, improved cassava and bean cultivars—all must prove themselves under typical farming conditions. The 'real world' results give breeders a truer picture of their product. This stage allows for refinements, if necessary, of genetic materials before the new varieties are released to the agricultural sector.

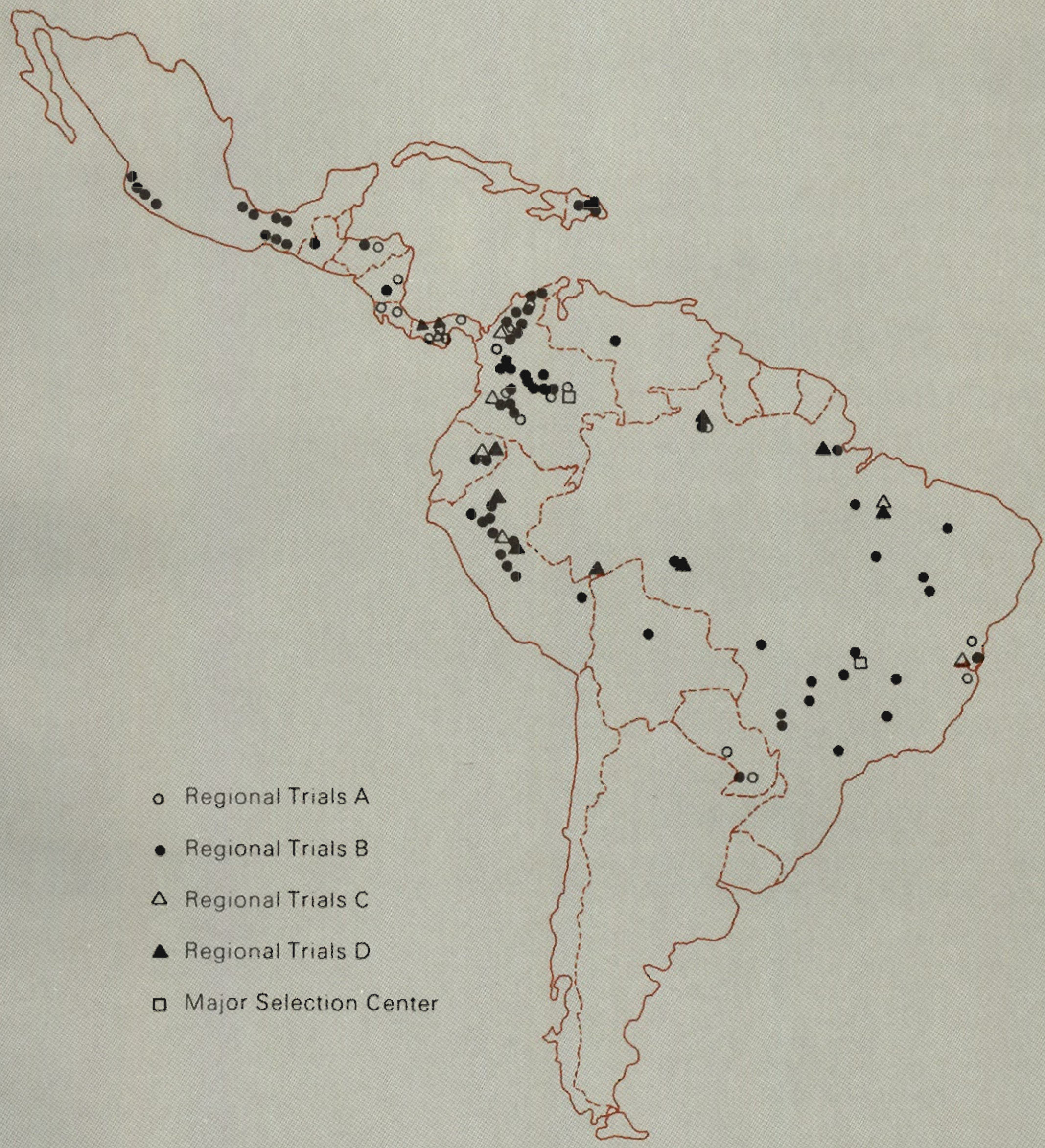
On-farm research is also receiving greater emphasis in the Center's training programs—especially methodology training. Such training is expected to contribute significantly to the ability of national programs to increasingly shift their emphasis to where it counts most: the farmers' fields. This, in turn, will further cut down the time it takes for new technology to have an impact on national production and productivity figures.

CIAT's scientific training program complements its research activities. Its main function is to transfer the networks' research methodology and new production technology to researchers in the national research programs. Over the years, CIAT's training has responded to the needs of ever-more sophisticated national programs by moving to higher levels. In recent years there has been more Ph.D. and M.S. thesis training, plus generally more training in specialized aspects of commodity-oriented research.

Since 1969, CIAT has trained more than 2700 professionals from all over Latin America, the Caribbean, Africa and Asia (Figure 2). In the past six years, in-country and regional training has increased, with CIAT-trained local staff organizing the courses and doing the instruction.

Conferences are also an important part of CIAT's program. Each year the Center is host to hundreds of professionals from throughout the world who participate in special seminars developed around themes related to the production of beans, cassava, rice and tropical pastures.

FIGURE 1. INTERNATIONAL TROPICAL PASTURES EVALUATION NETWORK (RIEPT).



## OUTPOSTED STAFF

In keeping with CIAT's goal of increasingly decentralized research programs, the Center has stationed outposted staff in South and Central America, Africa and Asia. These outposted personnel work closely with national programs, and they act as a catalyst to network activities. The Cassava Program has a breeder in Thailand who works with several national cassava improvement programs in Southeast Asia. Three bean scientists are stationed in Central America. Currently, there are two multidisciplinary bean research teams in Africa, and more are to be added during the next two years.

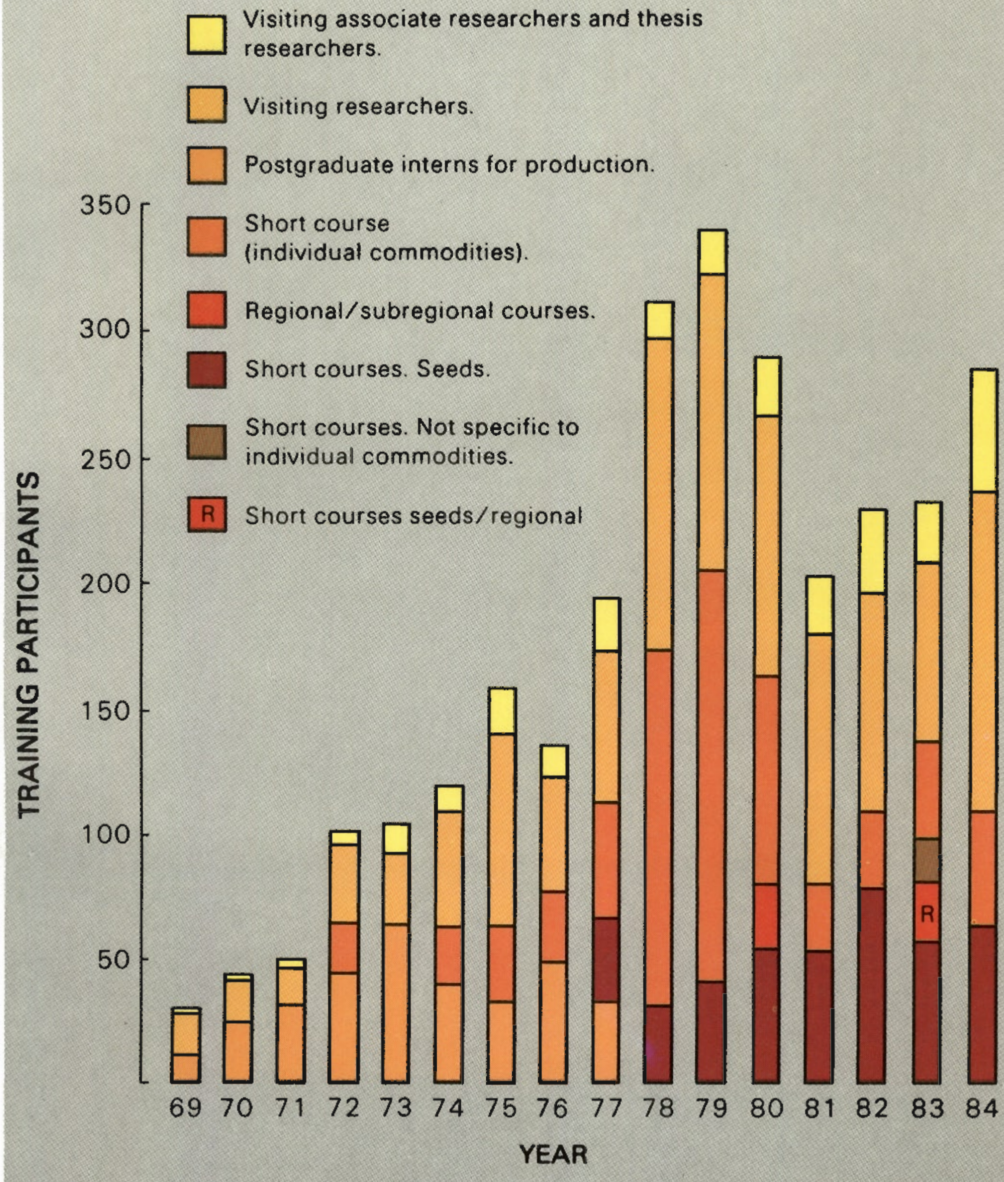
## IN SUMMARY. . .

CIAT's minimum-input philosophy, which underlies all its research strategies, defines the Center's involvement in the worldwide effort to develop resource-efficient technology to support the ever-growing population in tropical countries.

In a broader perspective, as the world's population increases, and as agriculture becomes simultaneously more expansive and intensive, man will have to take more precautions to protect this fragile, shrinking environment from the risks of contamination from all sources. Minimum input technologies foster the future of agriculture in the developing world.

Although CIAT's mandate, in its narrowest sense, calls upon CIAT to do all it can to strengthen and support agricultural development in the tropics, its philosophy reflects sensitivity and stewardship for the broader world as well.

FIGURE 2. NUMBER OF TRAINING PARTICIPANTS WHO HAVE COMPLETED TRAINING AT CIAT FROM 1969 TO 1984.



# RESEARCH HIGHLIGHTS

# BEAN PROGRAM

# BEAN TEAMING

## REFINING BREEDING TECHNOLOGY

Beans are produced by thousands of small farmers, in different ecological zones and under different cropping systems. Additionally, bean seed size and color preferences vary widely from region to region.

The Bean Program of CIAT could not possibly attend to all the specific needs for different varieties for local conditions. That is why the Bean Team works closely with a network of researchers where each participating national program develops its own varieties to fit particular needs. The breeding strategy of the network is highly decentralized, but geared around CIAT's gene bank, which with its 35,000 accessions represents all the exciting variability of this species.

### SUCCESS OF NETWORK DEVELOPED VARIETIES

Breeding is a key element in improving productivity in beans, especially for small farmers who cannot control insects and diseases with costly pesticides. Breeders have to provide farmers with alternatives—varieties that carry resistance to crop-damaging problems.

Over the past 10 years of breeding, about 50 new varieties were released in the network. A 1984 study of the adoption rate of those new varieties measured the return to investment over the years.

The study revealed that the impact of CIAT varieties has been felt all over Latin America. However, in some countries the results are especially noteworthy.

### HIGHER YIELDS FOUND

In Argentina, for example, bean growers are estimated to have netted US$2.15 million in 1984 from new bean varieties. In Costa Rica, an ICA line is yielding an average of 1052 kg/ha, compared to 600-700 kg/ha for traditional local varieties.

In Guatemala, three new, golden-mosaic-resistant lines, developed by CIAT and ICTA (Instituto de Ciencia y Tecnología Agrícolas), are now grown by 60 percent of the farmers in certain regions. These varieties earned the King Baudouin Prize for agricultural development for their contribution to Guatemala's achievement of self-sufficiency in bean production.

The study also let the farmers tell what their requirements are for a variety developed for their production region. By describing the strong points and weaknesses of new varieties, the farmers provided feedback to the breeders, so that they could refine their breeding strategies

## NEW CHALLENGES

Studies in several countries show that adoption rates are less than hoped for; this was often due to the fact that farmers were not aware of new technology. The studies also indicated that on-farm research does increase farmers' exposure to new technology and provides feedback to researchers. Based on the impact studies, CIAT will further strengthen in-country courses with extension scientists and researchers to promote new technology—new bean varieties and improved agronomic practices. CIAT participated in five such courses during 1984.

For example, in Guatemala, farmers preferred new varieties because they resist diseases and are upright plants (which helps the plant avoid diseases). Farmers did not like their lateness to flowering and seed production. In the bean research network, BGMV resistance is now being combined with earliness to adjust to farmers' requirements.

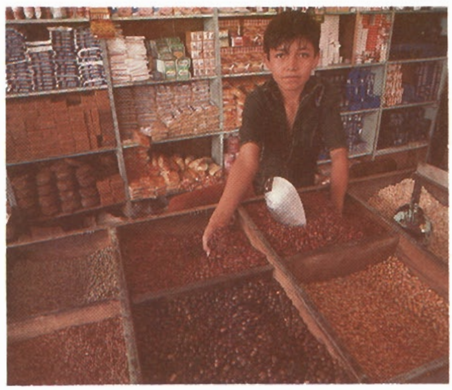
## CONSUMER STUDIES

A separate study of consumer preferences revealed that most lower-income housewives prefer beans that cook quickly. In Medellín, Colombia, consumers had distinct preferences by social class. For example, those in the lower income bracket wanted a dark broth and high water absorption. The well-to-do were concerned principally with the size of the beans.

## CROP PRODUCTION PRACTICES

Colombian farmers in Antioquia have adopted improved disease-control practices developed in on-farm trials conducted by CIAT in collaboration with ICA (Instituto Colombiano Agropecuario). This adoption resulted in increased income of 2.6 million dollars to farmers in this bean production region.

Bins of beans in a Colombian market: Something for everyone's taste



CIAT-improved beans. Colors to suit consumer preferences

# PHOTOPERIODISM

## UNDERSTANDING A POWERFUL GROWTH SWITCH IN PLANTS

Manipulating day length: Gives clues to adaptation in different latitudes and altitudes

Photoperiodism, or a plant's rate of physiological development as a reaction to day length, is an important determinant of yield and adaptation. Most plants are sensitive to the photoperiod, or day length, so that the longer the day, the longer it takes them to flower Also the longer flowering is delayed, the longer the period from planting to the production of a mature crop.

For nearly a decade, CIAT bean scientists have studied photoperiod effects. By evaluating different bean lines grown under artificially extended daylight (18 hrs), they have been able to measure the light sensitivity of these lines, which ranges from insensitive to highly sensitive.

The research, done in collaboration with Cornell University's Title XII project, is carried out at three locations in Colombia where the mean temperatures are different It was found that temperature, in combination with the photoperiod, affects flowering time. Warmer temperatures tend to *accelerate* flowering and maturity, while lower temperatures generally *delay* flowering in sensitive varieties. However, rather than reducing the effect of long periods of daylight, higher temperatures sometimes delay flowering further. Photoperiod response, therefore, is more critical in warm areas than in cool This research explains why high altitude varieties are more photoperiod sensitive and indicates that screening for photoperiod sensitivity is best done at higher temperatures.

## THE RESEARCH CONTINUES

The strong interaction between photoperiod and temperature has complicated attempts to identify varietal adaptation To deal with this problem, CIAT and Cornell formed the International Flowering and Adaptation Nursery (IFAN). The IFAN contains 50 lines representing the complete range of variation in types of photoperiod response Nurseries for further evaluation have been sent to six countries. The results of the IFAN nursery will provide valuable leads in the extrapolation of data from one region to another and will thus help in evaluating potential adaptation of breeding lines in different areas of the bean-growing world

# BEAN DROUGHT TOLERANCE

## GETTING TO THE ROOT OF THE PROBLEM

During the last year it has been confirmed that bean cultivars show differing degrees of drought tolerance. Tolerant varieties could be used in drought-prone areas. For several years, Bean Program scientists have been investigating how these characteristics can be identified.

Present criteria for identifying the characteristic rely on comparing yield with leaf canopy temperature differences in water-stressed and non-water-stressed plants.

Previous studies, using an infrared thermometer, compared leaf temperatures in water-stressed plots with temperatures in irrigated plots. By comparing the difference an index was developed that pinpointed the more tolerant plants. Comparing four varieties, two tolerants and two susceptibles identified in this manner, the drought-tolerant ones, under severe stress, lost 42% of their yield, the drought-susceptible ones lost 79%. With adequate moisture, both types yielded 2 7 t/ha.

The differences are related to the tolerant plants' capacity to hold their leaf temperatures lower than that of the drought-susceptible lines The tolerant varieties maintain comparatively high transpiration rates under water stress which is attributed to better moisture extraction due to a deeper or more efficient root system.

This hypothesis was tested by measuring root growth and soil water extraction of the four lines at two locations. At the site with deep soils, tolerant lines under stress produced roots reaching over 130 cm deep,

Drought-devastated bean and corn in northeast Brazil. Beans with genetic tolerance to water stress could lower the stakes of farming

while roots of susceptible ones scarcely passed 70 cm. Differences in soil moisture also reflected this pattern: the drought tolerant lines had extracted a larger amount of soil moisture by exploiting a greater (deeper) soil volume.

In shallower soils with a high aluminum saturation in the subsoil into which roots do not penetrate, differences in root growth of tolerants and susceptibles were not found. Tolerant lines under stress yielded the same as the susceptible lines. This confirmed that deeper roots allow the tolerant lines to avoid extreme stress where soil conditions allow, emphasizing the important

Measuring bean canopy temperatures: Searching for telltale signs of tolerance to water stress

Infrared aerial photograph of bean fields: Subtile shades of difference between plants help scientists spot drought tolerance

role of the soil in determining root growth and related drought tolerance.

These results are insufficient to indicate whether varietal differences in root growth are due to heritable differences in root morphology or to other characteristics, such as overall plant vigor, which indirectly determine root growth. This question is being addressed in further studies.

CIAT researchers are encouraged by the findings. It appears that drought tolerance in beans may be related to increased nutrient absorption, possibly N fixation, and yield potential which are affected by root depth.

# BEAN BLACK ROOT RESISTANCE

## A BOOST TO AFRICAN GROWERS

Black root, caused by certain strains of the bean common mosaic virus (BCMV), is a major problem for bean growers in Eastern Africa. These black root-causing strains can attack even mosaic-resistant plants and kill them. The problem occurs in Latin America, but it is more severe in Africa. The virus is seedborne, too, making it infectious from year to year.

CIAT's African BCMV research aims at reducing the effects of black root by genetically improving bean cultivars carrying mosaic resistance. The process combines mosaic-and multiple-disease-resistant CIAT bean lines with black-root-resistant plants. The resulting lines are crossed with African cultivars. Many mosaic and black-root-resistant lines have been identified and are now being bred for adaptation in Africa.

### EXPANSION INTO AFRICA

The Bean Program's outreach staff in Africa, which began in Rwanda in 1983 with one person, has been expanded to four, including a breeder, an anthropologist, a pathologist and a nutritionist. In recent months a pathologist and a breeder have been stationed in Kenya. Their activities are already generating national and regional collaboration in bean production

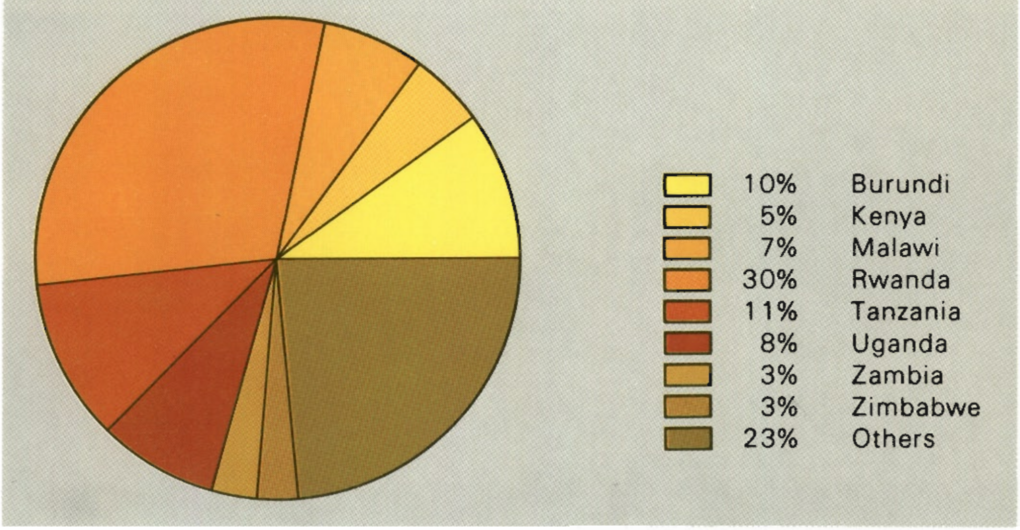
### BREEDING FOR AFRICA

Initial breeding emphasis in Africa has been placed on evaluating potential parental materials, or crossing blocks, and advanced lines During the past year, 1131 lines were included in the crossing blocks The best-adapted, resistant sources developed in the Latin America network are identified and crossed at CIAT with local, adapted, African cultivars.

CIAT's crossing program, using cultivars from the principal African collaborators, is illustrated in Figure 1. Since the establishment of the Great Lakes regional bean research program, emphasis has been given to crosses with cultivars from Rwanda, Zaire and Burundi. Collaborative efforts have been developed with the Title XII CRSP projects in Malawi and Kenya, and especially in Tanzania.

CIAT's large germplasm collection and ideal growing conditions, allow four generations to be produced yearly at CIAT headquarters This will serve the African network well.

# FIGURE 1. CROSSES MADE BY CIAT FOR AFRICAN COUNTRIES IN 1984.




The seed can be multiplied rapidly and sent in bulk to Africa for local selection of segregating populations.

A number of lines from the crossing programs have reached advanced stages of testing in certain countries: a bush bean line, ICA-Palmar, is being tested in on-farm trials in Rwanda as Rubona 5; in Zambia, BAT 85 and Carioca (the latter introduced from Brazil via CIAT) were the highest yielding in the Zambia Advanced Bean Varietal Trial in 1983-84 In on-farm trials in Central Province (Zambia), Carioca was reported to yield 3-4 times as much as local cultivars under all agronomic treatments.

Black root: Even mosaic-resistant plants fall prey to African virus strains

Harvesting beans in Africa: CIAT research should improve the pickings

# COMMON BEAN BLIGHT

## BREEDING CROSSES OUT A PROBLEM

Common bean blight: Severe symptoms on a very susceptible variety

Common bean blight (CBB) ranks near the top of the list of bean production problems throughout most of the world. The causative bacteria attacks the leaves of the bean plant, sometimes killing 35-40% of them, thus reducing the photosynthetic, food-producing area of the plant. The disease also systematically attacks the seed-producing pods, thereby affecting the commercial value of the beans. Since farmers traditionally save their own seed, the bacteria can be transmitted to successive generations, thereby continuing the disease cycle. Developing plants with genetic resistance to the disease is the most practical approach, in keeping with CIAT's low-input strategy.

### GENETICALLY TRANSFERRING RESISTANCE

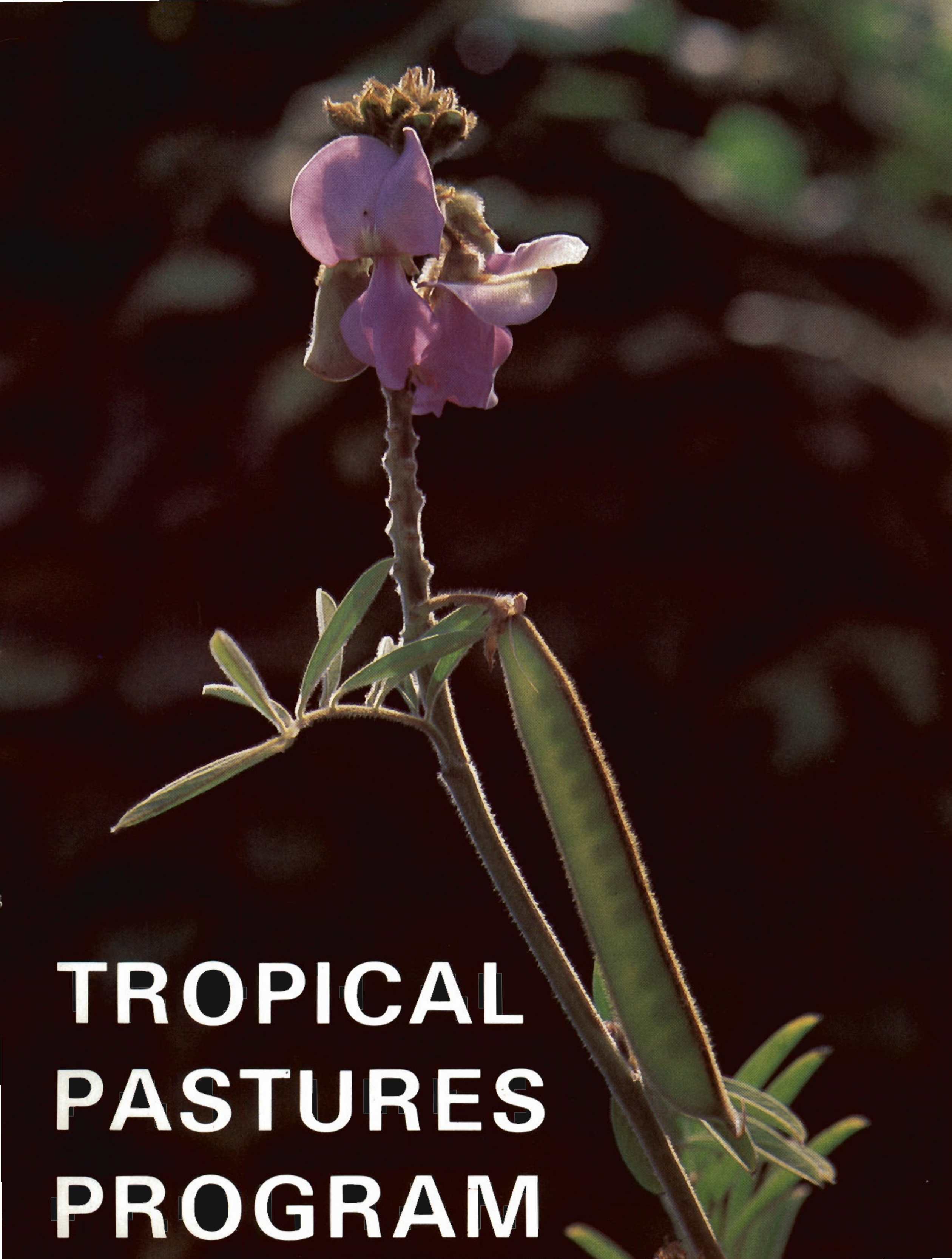
The most commonly grown and consumed species of bean is *Phaseolus vulgaris* in which no high level of CBB resistance has been found. A less-cultivated species, *Phaseolus acutifolius*, is highly resistant to CBB.

Artificial inoculation with CBB pathogen: One step closer toward finding the best genetic cure

In 1983, CIAT scientists obtained from the University of California, Riverside, seed from an inter-specific cross of these two species and started to select to combine their desired characteristics, especially *P. acutifolius'* tolerance to CBB.

Using the *P. acutifolius*-derived interspecific hybrid as a parent, six crosses with *P. vulgaris* were made and studied in detail. The results indicate that high resistance to CBB is a trait that can be readily tranferred to *P. vulgaris* types by crossing, selection, and several cycles of backcrossing.

Besides resistance from interspecific crosses, resistance found within the common bean gene pool is also exploited. CIAT bean scientists evaluated 780 accessions from the germplasm bank in 1984. A total of 23 were selected for retesting and consideration for the International Common Blight Nursery (VIB). Some will also be used as parents in the breeding programs.



# TROPICAL PASTURES PROGRAM

# TROPICAL PASTURE GERMPLASM

## A KALEIDOSCOPE OF GENETIC POSSIBILITIES

The genetic characteristics of plants are encoded in their seeds or germplasm. These characteristics differ within the same species. Genetic characteristics, such as tolerance for diseases, drought, insects, temperature, soil conditions, and innumerable others, have evolved under a wide range of natural conditions and over long periods of time. For this reason, collecting seed of variable germplasm from different regions of the world is important as the base for the process of selecting improved plants.

In 1984, Tropical Pastures scientists collected new germplasm on three continents: South America, Asia and Africa. The legume and grass entries add to CIAT's collection of more than 15,000 accessions.

### SUMMARY

SOUTH AMERICA: The natural variability of legumes was further explored during 1984 by expeditions in the continent recognized as one of the major centers of diversity of legume forage plants.

COLOMBIA: Three legume-collection expeditions were carried out in collaboration with CIAT's Genetic Resources Unit. A total of 538 new entries were added to the CIAT collection.

VENEZUELA. In all, 410 legume entries were collected by a joint expedition involving CIAT and the Fondo Nacional de Investigaciones Agropecuarias (FONAIAP)

BRAZIL: In collaboration with the Centro Nacional de Recursos Genéticos of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA-CENARGEN) and the International Board of Plant Genetic Resources (IBPGR), a collecting expedition for grasses and legumes was carried out in the states of Mato Grosso and Pará. Scientists gathered 533 new entries.

SOUTH EAST ASIA: This region of the world is the center of diversity of important legume genera. (Altogether 300 new accesions of the very important *Desmodium* and allied genera, and *Pueraria* were added to CIAT's tropical pastures collection.)

CHINA: In collaboration with the South China Academy of Tropical Crops (SCATC), the herbaceous and shrubby legume vegetation on a major portion of Hainan Island was sampled.

THAILAND: A combination Thai and IBPGR expedition collected

New grasses and legumes: CIAT's collection tops 15,000 entries

native legume germplasm in the country's east provinces

INDONESIA: CIAT and the Sukarami Research Institute for Food Crops sampled native legumes in West Sumatra.

AFRICA Spittlebug is a major plague of *Brachiaria* spp. (*B decumbens, B humidicola*) and other grasses in tropical America. In cooperation with the International Livestock Center for Africa (ILCA), during 1984, a major effort in germplasm collection of grasses was conducted in part of the center of diversity (Ethiopia, Kenya) of the genus *Brachiaria* spp This expedition yielded 228 new legumes and 470 new grasses; among them more than 300 belong to the genus *Brachiaria* spp These 300 new *Brachiaria* spp entries represent a 10 fold increase in the genetic base for selection of spittlebug tolerant materials

# GRASSES AND LEGUMES

## A WEIGHT-DOUBLING ASSOCIATION

The number of animals that a pasture can support depends on several factors. Simply stated, the stocking rate per unit of land depends on the pasture's yield and the nutrition value of the forage. In some marginal lands of Latin America, 5-10 hectares may be needed to sustain one animal, if it feeds only on native grasses.

Tropical Pastures Program scientists are increasing the stocking rate with pasture management technology that is based on the use of new grasses grown in association with nitrogen-fixing legumes. This has resulted in a stocking rate of three or more animals per hectare. The measure of success is shown in comparisons of daily or yearly weight gains of the animals.

For example, in a four-year study of improved pastures grazed by young steers eating only native savanna grasses, each animal gained an average of 75 kg per year. When grazed on only an improved grass, the gain averaged about 130 kg. But when grazed on an improved grass/legume association, liveweight gains approximated 187 kg/yr. Grass/legume associations increase weight gains because the association improves the productivity of the grass and the efficiency of utilization. Animal nutrition studies show that animals grazing the association select a nutritionally better diet than those grazing only on grass. The better diet is also responsible for higher weight gains.

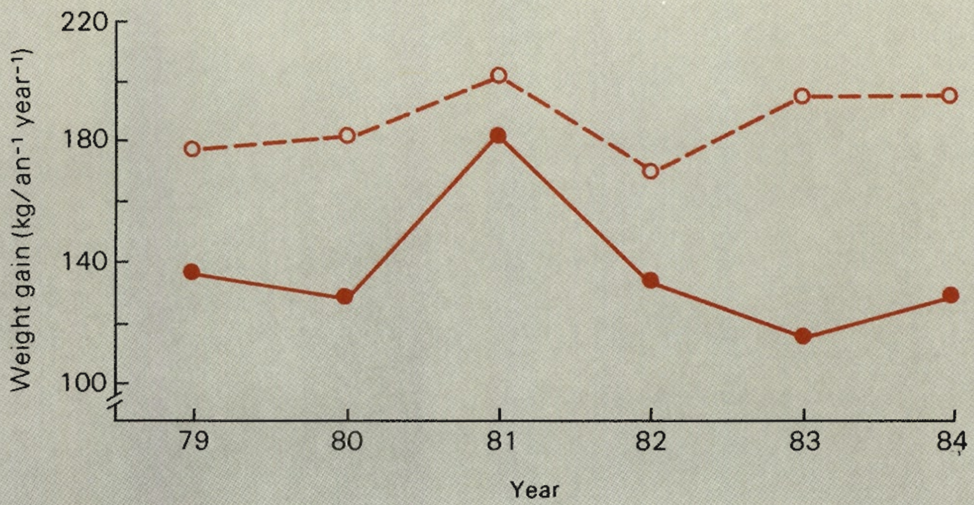
### HIGHER YIELDS FOUND

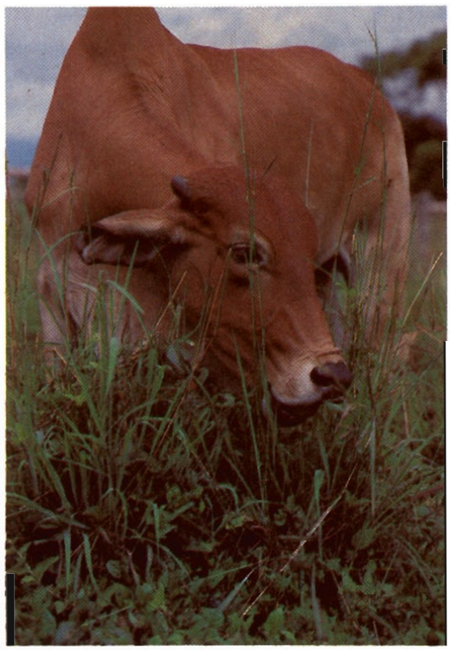
Improved pastures with grass/legume mixtures have consistently produced nearly 44% higher gains per animal and 15% higher gains per hectare than grasses alone, with the major benefit coming during the stressful dry season.

For six years, CIAT Tropical Pastures Program scientists have been evaluating a forage grass, *Brachiaria decumbens*, alone or with *Pueraria phaseoloides*, a legume. The results of this study are shown in Figure 1. They verify other findings supporting the value of the grass/legume association as a weight producer in heifers.

The grass/legume association has shown higher and stable animal yields over six consecutive years, whereas animal yields on the grass-alone pasture have been far more variable, with a tendency toward smaller weight gains during the last three years.

FIGURE 1. AVERAGE YEARLY WEIGHT GAINS IN HEIFERS WITH *B. DECUMBENS* ALONE (●—●) AND ASSOCIATED WITH *PUERARIA PHASEOLOIDES* (○---○) IN STRIPS (CARIMAGUA).



Grasses and legumes: A combination for higher animal productivity and longer pasture persistence.

# A. PINTOI

## PLANTING PERENNIAL PEANUTS IN THE PASTURE

A major aim of CIAT's Tropical Pastures Program is to develop pastures (grasses and legumes) that will grow well in the savannas under low fertility conditions. These pastures containing N fixing legumes that increase soil fertility and raise the forage protein level, make marginal lands agriculturally more productive.

The grass/legume combination, as a rule, produces more and better quality forage which contributes to greater animal weight gains CIAT's Tropical Pastures scientists are identifying the best combinations of grasses and legumes to produce the best forages, especially for the tropical American savannas. These vast, underused tropical lands could become the new frontiers of the cattle industry.

*Brachiaria* spp. (*B decumbens, B. humidicola*, etc.) are commonly used in the acid poor soils of tropical America. Farmers prefer these grasses for their good productivity and, especially, for their high competitive ability against weed encroachment in the pastures. Finding compatible legumes with these highly aggressive grasses to increase productivity and persistence of pastures is one of the important challenges of this research endeavor.

*Arachis pintoi*, a species of perennial peanuts, is especially effective when grown with the highly aggressive *B humidicola* and *B. dictyoneura* It is tolerant to heavy grazing. Cattle like it; however they do not eat it to the exclusion of the *Brachiaria* species The legume content in all *Brachiaria* species/*A pintoi* mixtures recovers well under a rotational grazing system: 7 days grazing, 21 days deferment.

*Arachis pintoi* A promising legume for association with aggressive *Brachiaria* spp grasses

*A. pintoi* is a prolific underground seed producer. This is important in any legume/grass combination to warrant the persistence and stability of the botanical composition through time

The average *in vitro* digestibility of *A pintoi* associated with *Brachiaria* species is 60.0% Mean crude protein in *A. pintoi* ranges from 14 8% to 16 6%

The great potential of *A. pintoi* as a legume pasture compatible with the aggressive *B. humidicola* and *B. dictyoneura* is very encouraging.

# GOOD FORAGES:

## THEY CAN MAKE A DIFFERENCE IN REPRODUCTION

The reproductive behavior of cattle (that is, the age at which they first conceive and the rate of reconception) is related to the quality of the forage they eat. This conclusion was reached by tropical pasture scientists following a three-year study. On-farm trials were carried out at two locations. Heifers that grazed the native savanna under traditional management were compared with those who had access to improved pastures. The latter grazed the CIAT-developed combination of *Andropogon gayanus*, a grass, and *Stylosanthes capitata*, a legume.

On one farm studied, the percentage of births at the first conception and at a later reconception were compared. While no differences have been found to date in the proportion of heifers conceiving for the first time when they grazed the improved pastures, conception did normally occur at a significantly lower age (one year earlier). Even with the difference in conception which implied more stress due to lactation, animals that had grazed on the better forage were heavier

Striking results were found at the second farm. The weights and ages at the first conception reflect the limited potential of the native savanna. Savanna-grazing cows had their first conception and gestation at three or more years of age, while cows eating *A gayanus/S. capitata* were already giving birth at that age

Farmers at both farms, whatever the grazing system, commonly supplement the diets of the cattle with minerals. Comparing the performance of heifers in the savanna with those in *A. gayanus/S. capitata* fields, it is clear that given the equal levels of the mineral supplementation, quality forage is the determining factor in the reproductive behavior of heifers.

Better pastures: A determining factor in higher reproduction in tropical America

*Andropogon gayanus* and *Stylosanthes capitata*: A highly productive association for the tropical American savannas

# COMBINED PLANTER

## AN IDEA WHOSE TIME HAD COME

Combined fertilizer/planter: An economical and ecologically sound approach for pasture establishment

In the American tropics there are approximately 200 million hectares of underutilized savanna lands, of which 54% are the Colombian and Venezuelan *llanos*. They are vast grasslands with scattered trees, interrupted by fingers of forest along the creeks and rivers. The soils are poor and acid, and water is scarce at certain times of the year. Yet, these vast underutilized areas, due to long growing seasons and excellent soil physical conditions, invite agricultural development.

Sowing these lands in pasture grasses and legumes requires respect for the characteristics of the land. For instance, deep cultivation cannot be used. Since the land is vulnerable to erosion by water and wind, the less the soil is disturbed, the better.

Faced with this agronomic reality, CIAT's tropical pastures specialists devised a combined, tractor-pulled fertilizer/planter that lightly plows the land, applies fertilizer, and drops the seed, in one pass over the land. The fertilizer spreader and seed drill are mounted on the rear bar of a chisel plow.

Aerial view of sown savanna Broadening the horizons for cattle production in the savannas

Two rows of grass are planted in the middle of a 2.5 meter strip with a row of legumes on each edge. The aggressive, creeping legume plays the role of pioneer, invading the savanna and creating more favorable fertility conditions for the subsequent invasion of the grass. The method is called strip planting.

Strips were planted 12 5 meters apart leaving a 10 meter strip of undisturbed savanna. Planting is done immediately after burning. The fresh regrowth of native species helped distract leaf cutter ants from the introduced species until they became established, and provided valuable forage for the herd.

The planting device is efficient in terms of time, labor and materials Approximately 1 hectare per hour can be planted. This low-cost pasture technology allows for significant increase in carrying capacity over time (8-10 times more animals per hectare) as well as more than doubling annual weight gains of the animals.

# RICE PROGRAM

# RICE ANTHER CULTURE

## DEVELOPING NEW LINES IN MONTHS INSTEAD OF YEARS

CIAT rice breeders have used anther culture to reduce the time required to produce new rice varieties. Working with the Biotechnology Research Unit, they developed breeding lines in less than one year, instead of the usual half a dozen generations. The results are considerable savings, including management time, labor costs, and field space.

Rice anther culture uses the pollen sac of the rice flower to regenerate plants. Generally, a minimum of five generations must be grown before homozygous, or genetically uniform breeding lines are obtained. Anther culture produces seed with genetic uniformity from the first generation cross (hybrid $F_1$).

The process begins by planting hybrid $F_1$ anthers on a special medium which causes undifferentiated tissue, or calluses, to form. The calluses are moved to a second medium, which induces further differentiation into plantlets. Then the plantlets are transferred to pots and, within a few weeks, are transplanted in the field.

It is found that about one-half of the regenerated plants are diploids, produced from the spontaneous doubling of the haploid pollen. Seeds from the diploid plants, when resown, produce lines that are genetically uniform.

The *in vitro*-to-verification process takes approximately nine months—as compared to three to six years using conventional breeding methods.

In the past year, 23 rice cultivars have been evaluated for their response to the anther culture process. Ten were found unresponsive to the procedure. In the remainder, 21.9% of the regenerated plants were triploid and 31.8% were haploid or infertile. Diploidy resulted in 46.3% of the cases. From these fertile plants came homozygous, or purebred lines.

### MASS PRODUCTION NEXT

The testing has gone beyond the purely experimental phase. It is being applied in routine breeding. Current research is concentrated on the mass production of anther-regenerated plants.

The medium in which the anthers are planted seems critical to mass production of regenerated plants. Researchers are gauging the effects of four different media on callus induction and plant regeneration (Table 3).

## TABLE 3. RESPONSE OF A SINGLE RICE LINE TO DIFFERENT MEDIA.*

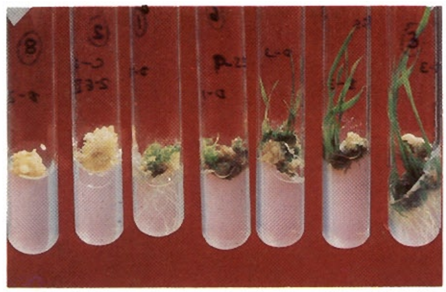
| Medium | Source of medium | Calluses induced Anthers (No.) | Calluses induced Callus (%) | Plants regenerated from calluses Callus (No.) | Plants regenerated from calluses Regeneration (%) |
|---|---|---|---|---|---|
| Liquid | CIAT | 742 | 23.9 | 178 | 24.7 |
| [1]Solid | | 732 | 18.3 | 134 | 35.0 |
| Liquid | China (modified) | 880 | 19.2 | 169 | 33.7 |
| [2]Solid | | 824 | 15.2 | 130 | 26.0 |
| Liquid | China | 712 | 25.0 | 179 | 63.5 |
| [3]Solid | | 584 | 27 9 | 163 | 16.4 |
| Liquid | IRRI | 776 | 6 0 | 5 | 0 |
| [4]Solid | | 816 | 1 2 | 1 | 0 |

* $F_1$: IR 5/Bbt 50//Colombia 1/TOX 1011.

Medium 1 is the one normally used by CIAT rice breeders, media 2 and 3 are used in China, but slight modifications have been made by CIAT researchers for their use Medium 4 is recommended by IRRI

All four media come in either liquid or solid form CIAT scientists prefer the liquid media because they induce more calluses 30 days after planting than the solid materials. Organogenesis—the development of green areas—and plant regeneration occurred quicker, too.

In the past year, a number of crosses were made for the temperate areas of Brazil, Argentina and Chile Next, anther-culture-regenerated lines will be evaluated by the national research programs in these countries



*In vitro* anther cultured rice: Compressing six years into months

Anther culture regenerated rice Mass production and national program evaluation are the next phase

# THE INTERNATIONAL RICE TESTING PROGRAM

## THE LATIN AMERICAN- CARIBBEAN CONNECTION

The International Rice Testing Program has become a highly effective network to concentrate and coordinate rice research. Organized in 1976 by CIAT and IRRI (International Rice Research Institute), its primary function is to distribute germplasm to Latin American national agricultural research programs for evaluation.

The rice research network aims to increase the stability of irrigated and upland rice production by identifying high-yielding varieties with resistance or tolerance to major insect, disease, soil, and temperature stresses

Annually, from CIAT, IRRI, or other national breeding program entries, CIAT scientists select promising rice lines, organize them into nursery packages, and distribute them to the 24 Latin American and Caribbean national research programs.

Because soils, diseases, temperatures, and pests differ from one region to another—for example, from Mexico to Chile—a great deal of data can be obtained by growing and evaluating rice cultivars under differing ecological constraints.

Before the nurseries are assembled, the entries are evaluated at two ecologically different locations in Colombia. Final evaluation, conducted at CIAT-Palmira, looks at *Sogatodes* resistance and grain quality

### NETWORKING GROWS

A two-week IRTP nursery tour in Venezuela, Colombia, Ecuador, Panama and Costa Rica explored the constraints faced by commercial growers in these countries. Ten scientists participated, including the Latin American coordinator for the IRTP A report in Spanish and English has been prepared for publication.

In addition to participating in International Rice Testing Program activities, CIAT scientists attended several important rice conferences. One, the Rice Technical Working Group, held in Louisiana, USA, raised the possibility of CIAT-USA cooperation in rice improvement

A Rice Breeders' Workshop, held in Panama, attracted breeders from Mexico, Guatemala, El Salvador,

Rice testing nursery: Scientists select new cultivars on an international scale

At CIAT, readying rice seed for shipment. Another collection nursery bound

Costa Rica, and Panama, as well as CIAT.

A Caribbean Rice Research Network is proposed to strengthen national rice research capabilities in the Caribbean region and to stimulate collaborative research. The network would increase the transfer of production and seed technology among the participating countries.

## NEW LINES

National programs of nine countries nominated 71 promising lines for the IRTP nurseries. These entries are being multiplied at CIAT-Palmira for distribution in 1985.

CIAT breeders provided 244 advanced lines for the IRTP nurseries. These materials are under seed multiplication at CIAT-Palmira and will enter into the 1985 nurseries.

# IRON TOXICITY

## TOLERANT PLANTS THROUGH BREEDING

Iron toxicity reduces the yield of irrigated rice grown in acid soils Caused by the absorption of ferrous iron from water or soil, the problem creates a significant annual loss for rice growers in Latin America

In 1984, Rice Program scientists began evaluating and selecting iron-tolerant cultivars having acceptable grain quality and general disease resistance. It was later decided that a more thorough screening program could benefit large areas of Latin America where soils contain high levels of ferrous iron, such as Venezuela, central and southern Brazil, Argentina, Peru, and the *llanos* of Colombia.

Following are these six breeding stages used to produce the best iron-tolerant cultivars

(1) Initial cultivar screening under high disease pressure to eliminate susceptible genotypes

(2) Evaluation of $F_2$ populations under high rainfall, upland conditions, for disease tolerance

(3) Evaluation of $F_3$ populations for tolerance to iron toxicity

(4) Evaluation of $F_4$ populations under high pressure of iron toxicity and diseases; selection for crosses (Table 2).

(5) Evaluation of advanced generations ($F_6$-$F_7$)

(6) Evaluation of the best cultivars

Next, 300 plants were selected for evaluation in southern Brazil Bulk populations of the selected families were sent to Corrientes, Argentina, where iron toxicity and straighthead, a soil-related physiological disease, are present Remaining seed of these selections is being multiplied and purified at CIAT-Palmira for distribution and further evaluation and adaptation by breeders in the International Rice Testing Program.

## TABLE 2. SELECTIONS COMBINE ACID TOLERANCE, GOOD GRAIN QUALITY AND DISEASE RESISTANCE.

| CROSS | No. OF LINES |
|---|---|
| 7152//3555/ Camponi | 10 |
| CICA 8//CICA 4/Camponi | 17 |
| 5006//Flot 36/2940 | 16 |
| 5006//Eloni/5461 | 11 |
| 5006//H-5/Ceysvoni | 10 |
| 15352//7152/5006 | 10 |
| 17330//7152/5006 | 32 |

The toxic touch of iron. Leaf bronzing and few tillers tell the story

# WHITE BELLY

## IRRADIATION CURES A RICE HEADACHE

Irradiation with cobalt has been used successfully to reduce white belly in rice. White belly, identifiable as a lighter white area in a rice grain, causes the rice to have poor milling quality, and is visually unattractive to the consumer.

CIAT's research on the problem began in 1983, using Oro, a variety cultivated on a large scale in Chile because of its low-temperature tolerance and adaptability. Oro is severely affected by white belly.

Oro plants were irradiated with cobalt, which produced mutations in progenies grown from the seed. Some of the mutants had a reduction in the degree of white belly, ranging from 0.8 to 1.4 on a 0 to 5 scale, with 0 representing no white belly. Discovering that white belly could be reduced and the trait fixed early, 181 fourth generation, mutant lines, representing six families, were planted in Chile.

The results are encouraging. The mutant lines had a much lower incidence of white belly than the original Chilean Oro. The findings in Chile confirmed those made at CIAT-Palmira. Two lines, 606-1-1 and 606-1-5, appear to have even a better yield quality.

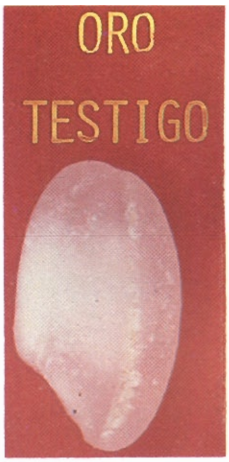
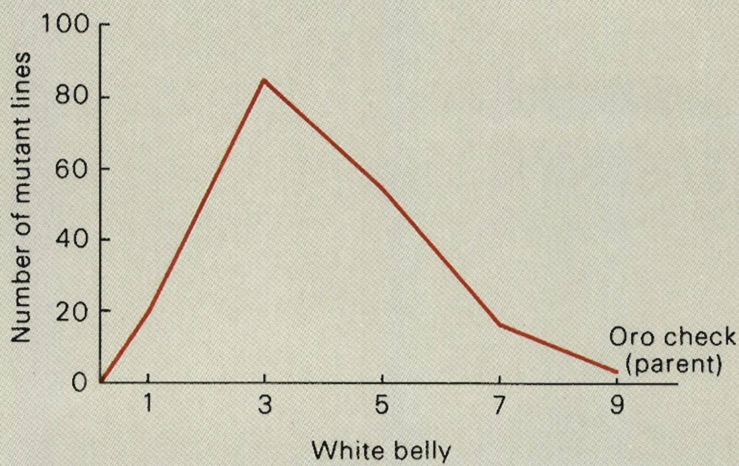



Figure 1 shows the frequency distribution of white belly in the 181 lines grown in Chile. The mode of white belly was 3, an acceptable level. About 10% of the lines had a rating of 1, indicating no white belly, while the Oro check had a rating of 9.

FIGURE 1. FREQUENCY DISTRIBUTION OF WHITE BELLY IN IMPROVED MUTANT PROGENIES IN COMPARISON WITH ORIGINAL PARENT (ORO), CHILE, 1984.





Cobalt-mutated rice: Dwarfing disease-resistant varieties

# NON-IRRIGATED RICE

## NEW VARIETIES FOR LATIN AMERICA'S INFERTILE SOILS

Rice is one of the most important crops in Latin America It is planted in several ways, ranging from direct seeding in dry land to transplanting in water-flooded paddies. Each system requires different levels of fertilizer and pesticide technology.

Irrigated rice and the non-irrigated varieties (called upland rice) are, with few exceptions, affected by the same insect pests and diseases, however, the severity and incidence are greater with upland rice. Upland rice faces constraints from environmental stress, especially problems of soil imbalance, such as mineral deficiency, toxicity, and the interaction between the two.

For the future, one of the major areas eyed for rice production is characterized by acid soils Large underutilized areas of land—approximately 300 million ha—could be used to grow rice, especially upland rice.

CIAT's Rice Program scientists believe that more upland rice could be produced in Latin America if there were varieties adaptable to these problem soils.

Given the actual and potential area that could be sown in upland rice throughout Latin America, even moderate yields could greatly increase total rice production. This underscores the importance of developing varieties suited to the region's soils.

### BREEDING IN TOLERANCE

CIAT's upland rice research is limited to infertile savannas with high levels of rainfall. The Program is looking for varieties that are suitable for minimum input systems; that is, varieties that do not require many costly commercial inputs. Successful varieties must tolerate the characteristics of savanna soils, soils with high aluminum levels and deficiencies in nitrogen, phosphorus, calcium, magnesium, sulphur, and zinc.

In 1984, approximately 1360 rice cultivars, representing advanced breeding materials, traditional landraces, and native varieties were obtained from different institutions, including IITA, IRRI, and CIAT. They were screened for aluminum tolerance. About 180 were well adapted to the savanna environment.

Taking advantage of the great genetic variability available in aluminum-tolerant germplasm, a hybridization program was begun. Crossing was designed to combine aluminum-tolerant germplasm having disease resistance and other traits that are desirable for the savanna ecologies. Table 1 shows the characterization of improved cultivars by origin and their reaction to major production constraints in the savanna ecology

## TABLE 1. IMPROVED RICE CULTIVARS

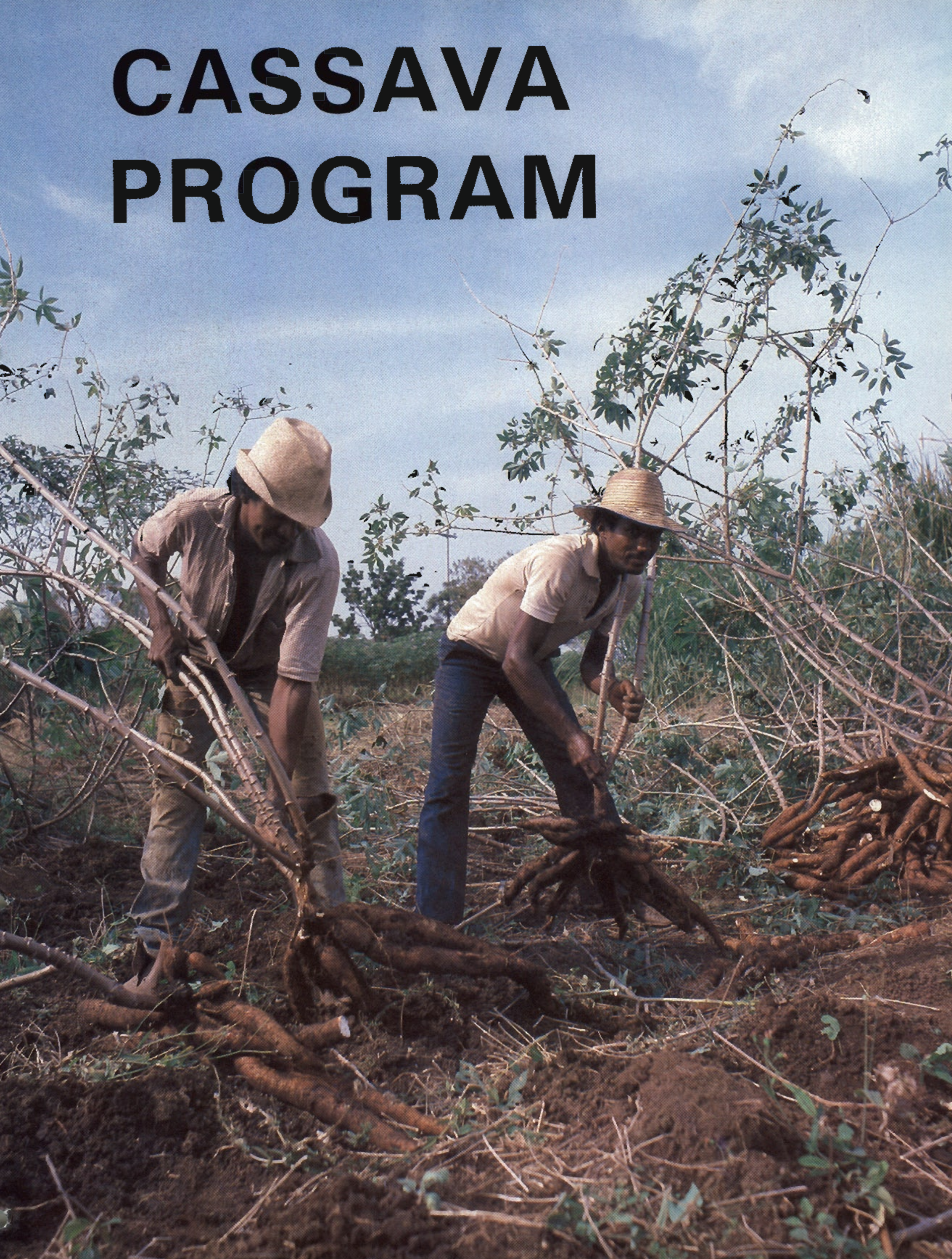
| Savanna Constraints | Reactions[1] | | | |
|---|---|---|---|---|
| Cultivar: | IITA (TOX) | IRAT | Surinam | Japonica |
| Al toxicity | R | R | M,S | M,S |
| Blast | R | R | R | R |
| Dirty panicles | R | R | M | M |
| Leaf scald | S | S | R | M |
| Hoja blanca | S | S,R | S | S,R |
| Brown spot | M | M | R | R |
| Sogata | S | S,R | S | S |
| Stem borer (*Diatraea*) | S | S | M | 2/ |
| Grain quality | Poor/good | Poor | Good | Poor |
| Root system | Good/excell. | Poor/excell. | Fair | Fair |
| Plant type | Good/excell. | Good/excell. | Fair | Poor |

[1] R = Resistant, M = Moderately resistant, S = Susceptible.

[2] Under investigation.

Rice crop in Latin America: CIAT helps increase production, improve quality and meet consumer demands

# CASSAVA PROGRAM



# CASSAVA

## NEW USES FOR AN OLD STAPLE

With the advent of new and improved varieties of cassava, and a developing technology for processing and preserving the commodity, emphasis necessarily shifts to utilization. The animal feed grain and the baking industries are potential markets. Cassava can be substituted for sorghum in animal feed, and it can reduce the amount of wheat flour in bakery products

A two-year CIAT project with the Bogotá based Instituto de Investigaciones Tecnológicas (IIT), begun in 1984, is producing the technical, economic, and sociological information necessary to prescribe what needs to be done to encourage the use of composite wheat-cassava flour in bakery products. It will include recommendations on how to implement the use of the composite flour in the baking industry.

In the second year, an IIT-operated pilot plant in Colombia will produce cassava flour. Bakery trials will work out what proportions of cassava flour can be used, what fortification might need to be added, and what baking procedures will be required to use the product.

Seven tons of composite wheat-cassava flour will be produced to test baker and consumer acceptance of the flour and the bakery products made with composite flour. This information will become part of a 'cookbook' for other cassava flour programs.

### AGRICULTURAL MARKET

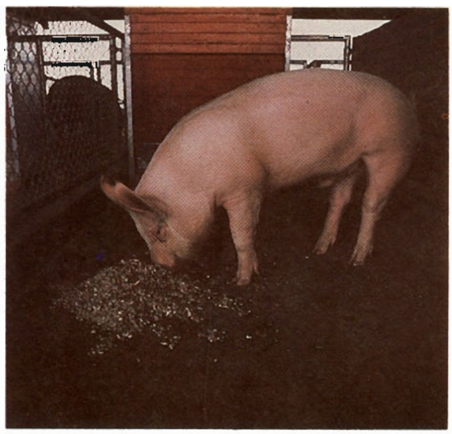
The animal feed industry represents a large potential market for cassava use. In Mexico, for example, the demand for animal feed has grown rapidly in the last decade or so. It has forced Mexico to import feed grains such as sorghum. Sorghum imports grew from virtually zero in the early 1970's, to 1.5 million tons per year in the 1980's. This has contributed to the country's balance-of-payment problems. Mexico connot easily increase its sorghum production. Further growth for this crop is limited by poor soils and competition for land with the country's staples, maize and wheat

Fresh cassava in the market: The demand does not go down when incomes go up

Cassava, in the opinion of the Mexican Government, is the logical answer. The cattle, poultry and swine feed industries could be very receptive to using cassava in both fresh and dried form.

A study evaluated potential production areas in Mexico. These areas are now research targets for the Mexican Federal Department of Agriculture (SARH) and the Instituto Nacional de Investigación Agrícola (INIA).

At present, the two agencies are increasing their research in these areas and have started 10 projects that will integrate cassava use by poultry and swine producers



Chipped and dry cassava: In many countries it could reduce imports of feed grains

# STORING FRESH CASSAVA

## TESTED TECHNOLOGY MOVES TO MEET THE MARKET

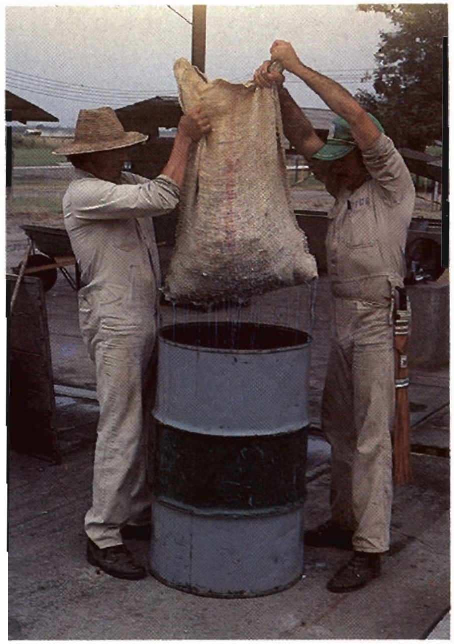
Cassava production costs are only a small part of the total consumer price; the major constraint in increasing the consumption of fresh cassava is the high marketing cost. Marketing margins are high largely because of the extreme risk involved in handling such a perishable crop If the perishability is reduced, then the marketing margin can be decreased.

CIAT has now developed a simple technique for storing cassava for up to two weeks. It involves dipping cassava in a fungicide solution (thiabendazole) followed by packing it in polyethylene bags. If this technology were adopted in Latin America the savings could be significant, both for consumers and middlemen, and the increase in income to farmers very large. Similar benefits could be expected in Asia and Africa if the technology were utilized.

There was initial concern about the fungicide residue However, residues are extremely low with thiabendazole Commercially sold potatoes and bananas are routinely treated with thiabendazole to prevent microbial growth Roots have residue levels well below the maximum permitted level for potatoes (5 mg/kg) Furthermore, normal cooking of the cassava roots decreases the residue level even more

The quality of the stored cassava using the new technique is virtually identical to that of the fresh roots eaten directly after harvesting. A survey in northern Colombia of consumer attitudes toward cassava and other crops indicates that consumers find cassava as desirable or tasty as potatoes or rice. However, cassava is less convenient to store The easy storage technology could completely change the cassava 'convenience factor.'

The data from CIAT's survey suggested that if the convenience-factor score of cassava were increased to 50% of the yam convenience-factor score, then urban consumption would increase by 50%. Clearly, the potential for increasing consumption, if cassava were to become a more convenient food, is immense.


Dipping fresh cassava: Fungi are one of the storage culprits


Polyethylene bagged fresh cassava: The sealed humid environment cures the roots

# CASSAVA DRYING PLANTS

## A DESIGN FOR FEED AND PROFIT

Since 1981, seven commercial cassava drying plants have been built on Colombia's Atlantic coast. This number will be increased to 20 this year. The plants chip and sun-dry the large, starchy roots, which are being used increasingly as a substitute for cereal grains such as sorghum in poultry and swine feed.

CIAT's Cassava Program has been assisting the Colombian Integrated Rural Development (DRI) Program develop the project. In the first half of 1984, the plants dried 2395 tons of fresh cassava. Drying is necessary to get a transportable, non-perishable product. It requires 30-40 continuous hours of slow drying, with 18-28 total daylight hours

Tests in the north coastal area of Colombia show that natural drying is technically feasible and can be made economically profitable. A net profit of approximately US$7 was made on each ton of dry cassava—equivalent to double the minimum Colombian daily wage.

Besides cassava's use as a substitute for imported cereal grains, other benefits are expected. The drying plants create an income through plant profits for small-farmer association members and assure a stable market for cassava. The plants also provide employment and can spur more cassava production. For instance, by the end of 1985, dry cassava production in the region is expected to rise more than four times above the 1983 level

Chipping cassava for feed· A stable market could mean a stable income for Colombian cassava growers

Drying cassava The sun also reduces the cyanide level

# CIAT IN ASIA

## CASSAVA BREEDING EXPANDS

For a decade CIAT has worked with Asian national cassava breeding programs. The majority of genetic materials used by these programs originated at CIAT.

Sexual seed has been the major means of germplasm transfer, occasionally supplemented by meristem culture. In the past 10 years, more than 100,000 hybrid seeds from approximately 1800 crosses have been distributed for evaluation by cassava breeding programs in eight Asian countries (Table 1).

The Center has recently augmented its support to the Asian programs by outposting a cassava breeder in Bangkok, Thailand. This scientist consults with a number of national programs on germplasm use and development, training; and communication.

Recently he helped researchers in the Philippines set up a full-scale varietal evaluation program, and he is present when they make their field selections. In other countries in the region he is also actively involved in the selection process, working closely with national program staff. In Malaysia, the CIAT's breeder presently participates in every step of germplasm evaluation and selection along with scientists from the national programs. He reports the results to the headquarters breeders so that they can send superior crosses to the Asian national programs in the subsequent years

### THAILAND

More than 95% of the 1.4 million hectares of cassava grown in Thailand are planted with only one variety. The Thai national program has a strong breeding program to produce alternative varieties—not only to increase yield potential, but also to reduce the vulnerability implicit in having only one major clone in such a vast area.

Rayong 3, a new variety originated from CIAT seed introduction in 1975, was recently released by the Ministry of Agriculture. New materials in the pipeline have been yield tested, and they are significantly ahead of Rayong 1, the most common cultivar grown on the million hectares committed to cassava production.

### PHILIPPINES

In the Philippines, emphasis is being placed on the root crops, including cassava, as a source of energy in animal feed to replace imported grains.

## TABLE 1. CIAT CASSAVA $F_1$ HYBRID SEEDS DISTRIBUTED TO ASIAN PROGRAMS.

| Country | Year* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1977 | 1978 | 1980 | 1981 | 1982 | 1983 | 1984 | Total |
| Thailand | 900 | 6170 | 7720 | 3050 | 1400 | 7450 | 7900 | 8000 | 42490 |
| Indonesia | 900 | 700 | | | | | 4600 | | 6200 |
| Philippines | 900 | 950 | | | 5100 | 4700 | 5500 | 2350 | 19500 |
| China | | | | | | 2300 | 6100 | | 8400 |
| Malaysia | 900 | 1500 | | 2050 | 1250 | 4050 | | | 9750 |
| India | 900 | 850 | | | | | 1050 | 7900 | 10700 |
| Vietnam | | | | | | | 1900 | | 1900 |
| Rep. China (Taiwan) | 500 | | | | | 1200 | | | 1700 |
| TOTAL | 5000 | 10170 | 7720 | 5100 | 7750 | 19700 | 27050 | 18250 | 100740 |

* No distribution in years 1976 and 1979.

In 1982, 2200 seeds from 43 CIAT crosses were grown by the Philippine Root Crop Research and Training Center at Visayas State College of Agriculture. From the first seedling population introduced from CIAT, breeders narrowed the selection to 418 plants; then through further trials to 120 and, finally, to only 25 clones. Recent data show that these varieties yield 30%-100% more than local cultivars.

### INDONESIA

CIAT is also contributing to Indonesian cassava research. Over the years the Indonesian program has produced excellent hybrids from crosses with local materials; however, several newer CIAT lines show potential for outyielding even those varieties.

Processing cassava in Asia. The root is the raw material of several agri-industrial products

# CIAT AND IITA

## SISTER CENTERS COLLABORATE AGAINST A SPREADING MENACE

In the CGIAR system, CIAT has global responsibility for cassava research, and IITA, Nigeria, has the regional responsibility for cassava in Africa. Although CIAT's research on the commodity is done in Latin America, the results are very important for cassava production in Africa and Asia as well.

Over the years, the IITA program has been the largest single recipient of sexual seed from CIAT; over 70,000 genetically distinct seeds have increased the IITA gene pool used for crosses. In 1984, CIAT began making crosses with specific characteristics for IITA. Emphasis is on producing plants with resistance to one of the worst African cassava pests: the green spider mite.

### A BREAKTHROUGH

CIAT and IITA are collaborating to combine different types of resistance to the green spider mite and African mosaic disease (AMD). CIAT's materials are resistant to the green spider mite; IITA's are resistant to, or tolerant of AMD. Quarantine restriction made it impossible in the past to provide IITA with mite-resistant clones to cross with AMD-resistant or tolerant clones.

Under a new arrangement, IITA will send AMD-tolerant clones to CIAT, after passing quarantine in the United Kingdom. CIAT will cross them with mite-resistant materials, and the progeny or sexual seed will be returned to IITA for testing and evaluation.

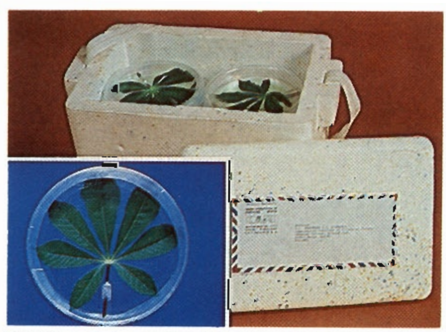
### ACTION FOR THE SHORT TERM

The green spider mite and another pest, the mealybug, cause millions of dollars in losses each year to African farmers. In the long run, the resistant or tolerant varieties that are under investigation will be needed, but in the short run, biological control offers a partial solution to the problems

CIAT Cassava Program entomologists have identified natural enemies of these pests. For example, predatory mites have been sent by CIAT to Africa, and IITA has tested them under specific local conditions and shown them to be effective in controlling green spider mites in preliminary field trials.

The mealybug and the green spider mite: On African cassava, it's two against one

*In vitro* cassava clones: Quarantine in the U.K protects a continent



CIAT-produced mite and mealybug natural enemies for IITA. The cooperation is two-way.

# SUPPORT UNITS AND SPECIAL PROJECTS

# BIOTECHNOLOGY AT CIAT

## USING NEW TECHNIQUES TO SOLVE OLD PROBLEMS

As population pressures grow, as arable land resources are increasingly depleted,* and as more food must be grown on more marginal lands, agricultural production will become more intensive To increase crop yield per unit area, however, will require the use of advanced technologies that can manipulate the cellular and genetic structures of food plants.

Growing with the need, CIAT's Biotechnology Research Unit (BRU) was created in 1984. The BRU will benefit Latin American and Caribbean agriculture by conducting basic research in biotechnology to support the applied research conducted by the commodity research networks, by encouraging a continuous exchange of information and sharing of research results, and by providing thorough training

BRU staff working with Rice Program scientists are using anther culture to compress the time required to breed a rice line from six generations into one Biotechniques being developed in collaboration with Genetic Resources scientists will help to solve the problems of crossing the common bean with distantly related species.

Tissue culture techniques are helping Tropical Pastures Program breeders select *Stylosanthes* plants with superior attributes, among them tolerance to anthracnose, the most destructive legume disease in the tropics.

Cell and tissue culture are now used to regenerate cassava plants. Work continued during the year to incorporate more of CIAT's cassava clones into the *in vitro* gene bank as meristem cultures.

During the year the unit offered training to research personnel from national programs in tissue culture and in handling *in vitro* germplasm

The BRU has initiated several collaborative projects. One, with the Plant Biotechnology Institute, Saskatoon, Canada, is looking at the regenerative characteristics of cassava plantlets frozen for a time in liquid

Anther cultured rice: Regenerating haploids in the laboratory

nitrogen. The evidence indicates that the process does not alter the cellular or genetic structure. Plants grew satisfactorily after cryogenic storing and are being evaluated in the field. The technology may permit long-term storage of cassava germplasm

A project funded by the International Development Research Centre, at the University of Manitoba, Canada, is developing methods for genotypic characterization of cassava, beans, and pasture germplasm This can help eliminate duplicates within CIAT's large germplasm collection and, eventually, lead to linking biochemical criteria with unique plant traits.

Electrophoretic characterization: Fingerprinting by enzymes *in vitro*-grown cassava and *Stylosanthes* clones

# THE SEED UNIT

## A VITAL LINK IN TECHNOLOGY TRANSFER

Since 1979, the Seed Unit working with CIAT's commodity programs, has helped move newly developed, improved varieties to farmers This is done, first by producing seed for national programs and, second, by training Latin American and Caribbean seed technologists.

### SEED PRODUCTION

The Seed Unit works with the Farm Operations Unit and the commodity programs to grow and multiply seed of new varieties of beans, rice and pasture species. After harvest, the seed is dried, cleaned and graded, and treated against diseases; then bagged and stored. The seed is sold, which helps to finance part of the Unit's activities.

Throughout the process, field inspection in the seed nurseries and testing of seed samples assure quality control. The seed is made available to seed networks for further multiplication or for local adaptation trials. In 1984, 102,306 kg of seed were sold (Table 1). During the same period, 353 tons of seed were conditioned

### TRAINING

Training is at the core of the Seed Unit's program Multidisciplinary, short courses are offered, both for basic level and advanced. Workshops, management courses, and in-country instructional programs also provide training opportunities for a variety of people involved in the Latin American seed industry.

Highlights in 1984 included a postgraduate course on seed production and technology, seed training for CIAT's and CIMMYT's commodity courses, as well as a course on seed enterprise management and marketing. A tropical pasture seed production course and a workshop on testing tropical pasture seeds were done jointly with the Tropical Pastures Program.

There were ninety-one participants in Seed Unit training programs in 1984 from 69 national institutions and seed enterprises located in 15 Latin American countries. In addition, the staff participated in eight in-country courses.

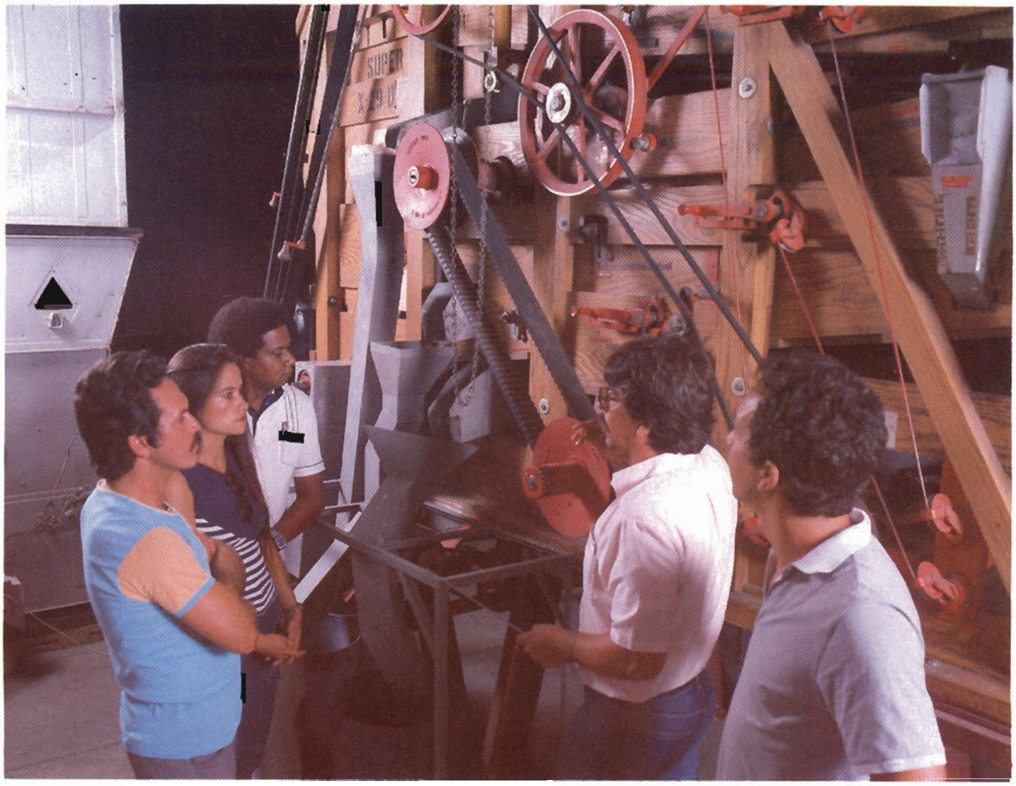
### RESEARCH

Significant progress was achieved in research to improve methodologies for description of the morphological characteristics of rice and beans. Clarifying seed descriptors could make variety identification more objective and accurate. As new varieties are multiplied, it is important to be able to recognize and maintain their identity so farmers will receive seed comparable to that originally developed by the breeders.

## TABLE 1. SEED SOLD IN 1984.

| KIND OF SEED AND VARIETY | QUANTITY OF SEED SOLD (kg) | SEED CONSIGNEE |
|---|---|---|
| BEANS | | |
| A-179 | 40 | Farm Operations Unit |
| BAT 1230 | 10 | Bean Program |
| BAT 1367 | 40 | Farm Operations Unit |
| BAT 1370 | 40 | Farm Operations Unit |
| L-23 | 10 | Phosphorus Project |
| L-24 | 64 | Farm Operations Unit |
| Pai 9 | 60 | Haiti |
| Pai 45 | 20 | Haiti |
| Pai 81 | 30 | Haiti |
| Pai 92 | 50 | Haiti |
| Pai 97 | 40 | Haiti |
| Tamazulapa | 400 | Haiti |
| Total | 804 | |
| PASTURES | | |
| *Andropogon gayanus* | 160 | Tropical Pastures Program |
| Total | 160 | |
| RICE | | |
| CICA 4 | 8,200 | ICA - Colombia |
| CICA 7 | 12,222 | ICA - Colombia |
| CICA 8 | 400 | Secretariat of Natural Resources, Honduras |
| IR-22 | 31,475 | ICA - Colombia |
| Oryzica 1 | 48,995 | ICA - Colombia |
| Line 11643 | 50 | ENASEM, Panama |
| Total | 101,342 | |
| Grand Total | 102,306 | |

Training seed technologists. The Seed Unit's first priority



Explaining the mechanics of seed sizing Specialized courses sow the seeds of modern technology

## NETWORKS

Technical collaboration between the Seed Unit staff and specialists with the International Seed Testing Association, the International Fertilizer Development Center, the International Executive Service Corps, universities, national programs, and the seed industry in the region greatly contributed to achieving program objectives and the building of seed technology networks. These networks strengthen seed production programs and help disseminate seed technology. There are several networks: the National Seed Program and Training Participant Network, the Seed Association Network, consisting of seed technologists and trade associations throughout Latin America and the Caribbean, and the University Network in Central and South America. A subregional network composed of seed specialists in national programs in the Central American, Andean and Southern Cone areas is developing.

To support the networks, the Seed Unit publishes a quarterly newsletter that is sent to 1500 individuals and organizations.

In addition, work continued on audiotutorial units, publication of proceedings of conferences and workshops, and the translation of key materials into Spanish.

# COMMUNICATION AND INFORMATION SUPPORT UNIT

## WORLDWIDE SERVICE TO SCIENTISTS

The role of the Communication and Information Support Unit is to make agricultural information readily accessible to CIAT staff and to its national program collaborators in the commodity research networks. The unit consists of the library and information services, the training materials section, writing and development, editing of publications, and the graphic arts and printing section

Publishing of CIAT research is done in both Spanish and English, making a wide range of research information available to CIAT's collaborators in national research programs. Publications range from simple reports of research data to newsletters for the networks to sophisticated, full-color monographs.

These publications are supplemented by information services that bring the rest of the world's research to the commodity networks The library and information services section publishes a trimestral journal of abstracts of the scientific literature for each of three commodities—beans, cassava and tropical pastures—as well as a monthly Pages of Contents service containing listings in plant science, soil science, and agricultural economics These are sent to suscribers all over the tropics

A major undertaking of the section in 1984, was the formation of a new collection of African documents in the Bean Information Center (BIC) The BIC compiled and published the first two editions of the African Bean Bibliography, containing a total of 1171 references to bean research conducted in 32 African countries

CIAT library The world's most complete repository of scientific information on cassava

CIAT's Heidelberg press: Publishing research results on a large scale

Selecting slides for audiovisuals: Self-teaching concept that has gained wide acceptance

## TRAINING SUPPORT

Self-teaching audiotutorials are an important part of CIAT's instructional program. More than 100 audiovisual units have been developed in the last five years. Produced in Spanish and English, the slides, pulsed cassette tapes, study guides and evaluation sheet are geared to the needs of technician-level agriculturalists in national programs.

A 1984 survey estimates that there are approximately 100,000 users of the audiovisual teaching tools. It found that extensionists comprised 22%, students 21%, researchers 19%, educators 15%, and farmers 11%. Other groups that included business and agri-industries totaled 12%.

# ALUMINUM-TOLERANT SORGHUM

## ADAPTING THE PLANT TO THE SOIL

Latin America's sorghum imports have rocketed in the past decade. Production of feedgrain for the region's livestock and poultry industries is limited by soils that are infertile and highly acid. Approximately 840 million hectares fall into this category

A two-year-old sorghum research project based at CIAT has been growing and selecting sorghum plants that can tolerate Latin America's acid soils. It is conducted by the International Sorghum and Millet Program (INTSORMIL) and Mississippi State University, in collaboration with the Instituto Colombiano Agropecuario.

Research focuses on aluminum toxicity because high concentrations of the element can kill a plant by inhibiting the growth of the roots and it's capacity to absorb water and nutrients. Breeders are looking for aluminum-tolerant plants. These lines will be valuable in future sorghum breeding. The idea is to ultimately adapt plants to the soil rather than to amend the soil to suit the plant.

Plants less dependent on purchased inputs are less costly for a farmer to grow Also, they will allow more marginal agricultural lands to be brought into production. Lime, commonly used to reduce aluminum toxicity, is being used in this case as a fertilizer. The challenge, though, is to find good-yielding sorghum cultivars that require minimal liming.

Evaluating sorghum cultivars at CIAT Susceptible plants dwarfed by tall aluminum-tolerant types

About 3000 lines are being evaluated from Purdue University's large sorghum collection, which is part of the world collection. Additional sorghum germplasm from ICRISAT and other INTSORMIL programs is also being evaluated

Mississippi State University plant breeders are in charge of the project.

# ANNEXES

# CIAT PUBLICATIONS IN 1984

## ACTIVITY REPORTS:

CIAT 1984. A Summary of Major Achievements during the Period 1977-1983

CIAT 1984. Reseña de los Logros Principales durante el Período 1977-1983

Midterm Report. Two-year Budget 1984-1985

Programa de Pastos Tropicales Informe anual 1982

Programa de Pastos Tropicales. Informe anual 1983

Tropical Pastures Program. Annual Report 1983

Programa de Frijol. Informe Anual 1983

Bean Program. Annual Report 1983

## TECHNICAL REPORTS:

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Vivero Internacional de Roya del Frijol (International Bean Rust Nursery). Resultados (Results) 1979-1980

Vivero Internacional de Roya del Frijol (International Bean Rust Nursery) Resultados (Results) 1981-1982

Vivero Centroamericano de Adaptación y Rendimiento. VICAR, 1981-1982

Ensayos Preliminares (Preliminary Trials) EP 1982-1983 Programa de Frijol (Bean Program)

## MANUALS:

Viveros Internacionales de Rendimiento de Frijol. Manual Descriptivo

Sistema de Evaluación Estándar para Arroz

Germoplasma Forrajero bajo Pastoreo en Pequeñas Parcelas. Metodología de Evaluación. Red Internacional de Evaluación de Pastos Tropicales

Variedades de Frijol en América Latina y su Origen

## RESEARCH MONOGRAPH:

Management and Evaluation of Intercropping Systems with Cassava

## TECHNICAL BULLETIN:

Cosecha y Beneficio de Semilla de *Andropogon gayanus* (Serie Boletines Técnicos No. 1)

## PROCEEDINGS:

Report on the Fifth Conference of the IRTP for Latin America, 9-13 August, 1983

Memorias 10º Aniversario, CIAT

Proceedings 10th Anniversary, CIAT

Improved Seed for the Small Farmer

## COMMODITY NEWSLETTERS:

Arroz del CIAT y América Latina (Vol.4 No 3)

Arroz en las Américas (Vol 5 No 1)

Pastos Tropicales. Boletín Informativo (Vol.5 Nos. 1 y 2)

Hojas de Frijol para América Latina (Vol.6 Nos 1 y 2)

Boletín de Yuca (Vol 8 Nos. 1 y 2)

Cassava Newsletter (Vol 8 No 1)

Semillas para América Latina (Vol.3 Nos. 1, 2, 3)

## NEWSLETTERS:

CIAT International. Report of Research and International Co-operation (Vol 3 Nos 1 and 2)

CIAT Internacional Reseña de Investigación y Cooperación Internacional (Vol.3 Nos 1 y 2)

ARCOS. Periódico para información interna (published monthly) Nos. 73-83

ARCOS Noticias (weekly news bulletin)

## BIBLIOGRAPHIES AND INFORMATION SERVICES:

Abstracts on Cassava, Vol 10 Nos 1-3

Abstracts on Field Beans, Vol. 9, Nos. 1-3

Bibliografía de Trabajos Publicados por el CIAT y su Personal Científico

Bibliografía sobre *Andropogon gayanus* (con revisión de la literatura)

Bibliography on Bean Research in Africa (reprint of the 1983 edition)

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Boletín Bibliográfico, 1984, Nos. 1-12

Cassava Directory—Preliminary edition

Determinación de la calidad nutritiva de los forrajes, 1970-1983

Páginas de Contenido, 1984, Nos. 1-12, 6 sections each

Resúmenes Analíticos sobre Yuca, Vol. 10 Nos 1-3

Resúmenes Analíticos sobre Frijol, Vol. 9 Nos. 1-3

Resúmenes Analíticos sobre Pastos Tropicales, Vol. 6 Nos. 1-3

Scientific and Common Names of Tropical Forage Species

Publications Catalogue. Catálogo de Publicaciones (reprint from Publications on International Agricultural Research and Development, section on CIAT)

OTHER:

Information for Visiting Researchers (instructions manual)

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# FINANCIAL INFORMATION

## REPORT OF INDEPENDENT ACCOUNTANTS

ARTHUR ANDERSEN & CIA., COLOMBIA

APARTADO AEREO 4145
CALI, COLOMBIA

To the Board of Trustees of

Centro Internacional de Agricultura Tropical (CIAT):

We have examined the balance sheet of CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT) (a Colombian non-profit organization) as of December 31, 1984, and the related statement of revenue and expenditures and unexpended funds and changes in financial position for the year then ended. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such test of the accounting records and such auditing procedures as we considered necessary in the circumstances. The financial statements for 1983, which are presented for comparative purposes, were not examined by us; they were examined by other auditors, whose report dated February 20, 1984 expressed an unqualified opinion on those statements.

In our opinion, the financial statements referred to above present fairly the financial position of Centro Internacional de Agricultura Tropical (CIAT) as of December 31, 1984, and the results of its operations and changes in its financial position for the year then ended in conformity with generally accepted accounting principles for non-profit organizations, applied on a consistent basis.

Our examination has been made primarily for the purpose of forming the opinion stated in the preceding paragraph. The data contained as supplementary information in exhibits 1 to 4*, inclusive, although not considered necessary for a fair presentation of financial position, results of operations and changes in financial position, are presented as supplementary information and have been subjected to the audit procedures applied in the examination of the basic financial statements. In our opinion, these data are fairly stated in all material respects in relation to the basic financial statements, taken as a whole.

Arthur Andersen & Co.

Cali, Colombia,
March 14, 1985.

* Information not included in this report. CIAT will provide such information to anyone who requests it.

ARTHUR ANDERSEN & CIA., COLOMBIA

# CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL
## BALANCE SHEETS AS OF DECEMBER 31, 1984 AND 1983

(EXPRESSED IN THOUSANDS OF U.S. DOLLARS)

| | 1984 | 1983 |
|---|---|---|
| **ASSETS** | | |
| CURRENT ASSETS: | | |
| Cash and Banks | 2,841 | 3,698 |
| Accounts Receivable | | |
| Donors | 834 | 1,177 |
| Employees | 168 | 210 |
| Others | 1,975 | 1,276 |
| | 2,977 | 2,663 |
| Inventories | 1,678 | 1,492 |
| Prepaid Expenses | 72 | 47 |
| Properties for Sale | 201 | 58 |
| Total Current Assets | 7,769 | 7,958 |
| LONG-TERM ACCOUNTS RECEIVABLE AND OTHER ASSETS | 1,019 | 823 |
| PROPERTIES AND EQUIPMENT: | | |
| Buildings, Lands, and Construction in Progress | 7,766 | 7,268 |
| Equipment | 5,787 | 5,300 |
| Vehicles | 2,796 | 2,655 |
| Furniture and Office Equipment | 2,154 | 1,458 |
| Airplane | 1,299 | 1,271 |
| | 19,802 | 17,952 |
| Total Assets | 28,590 | 26,733 |

| | 1984 | 1983 |
|---|---|---|
| **LIABILITIES AND FUND BALANCES** | | |
| CURRENT LIABILITIES: | | |
| Bank Overdrafts | 125 | - |
| Accounts Payable | 3,851 | 3,439 |
| Employees' Social Benefits | 1,516 | 1,840 |
| Grants Received in Advance | - | 1,052 |
| Total Current Liabilities | 5,492 | 6,331 |
| FUND BALANCES: | | |
| Invested in Properties and Equipment | 19,802 | 17,952 |
| Unexpended Funds (deficit) | | |
| Core: | | |
| Unrestricted | (39) | (15) |
| Working Fund | 1,245 | 1,562 |
| Special Core Projects | 1,220 | 519 |
| Other Special Projects | 870 | 384 |
| | 3,296 | 2,450 |
| Total Fund Balances | 23,098 | 20,402 |
| Total Liabilities and Fund Balances | 28,590 | 26,733 |

The accompanying notes are an integral part of these financial statements.

# CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL
# STATEMENT OF REVENUE AND EXPENDITURES AND UNEXPENDED FUNDS
# FOR THE YEARS ENDED DECEMBER 31, 1984 AND 1983

**(EXPRESSED IN THOUSANDS OF U.S. DOLLARS)**

| | 1984 | 1983 |
|---|---|---|
| REVENUE: | | |
| Core Programs | | |
| Operating Grants | | |
| Unrestricted | 11,969 | 10,689 |
| Restricted | 7,928 | 8,293 |
| Total Operating Grants | 19,897 | 18,982 |
| Capital of Donations | 524 | 605 |
| Total Core Programs | 20,421 | 19,587 |
| Special Core Projects | | |
| Operating | 2,665 | 1,723 |
| Others | 1,736 | 1,226 |
| Total Special Projects | 4,401 | 2,949 |
| Earned Income | 375 | 1,189 |
| Total Revenue | 25,197 | 23,725 |
| EXPENDITURES: | | |
| Core Programs | | |
| Research Programs | 8,373 | 7,768 |
| Research Support | 3,404 | 2,869 |
| International Cooperation | 2,510 | 2,140 |
| Administration | 2,953 | 2,506 |
| General Operating Expenses | 2,681 | 3,948 |
| Total Core Programs | 19,921 | 19,231 |

| | 1984 | 1983 |
|---|---|---|
| Special Core Projects | | |
| Operating | 1,436 | 1,476 |
| Others | 1,144 | 1,008 |
| Acquisition in Properties and Equipment | 1,850 | 1,522 |
| Total Expenditures | 24,351 | 23,237 |
| Excess (deficit) of Revenue over Expenditures | | |
| Unrestricted Operating Grants | (24) | (180) |
| Working Funds | - | 350 |
| Capital Grants | (951) | (147) |
| Special Core Projects | 1,229 | 247 |
| Other Special Projects | 592 | 218 |
| Total Excess of Revenue over Expenditures | 846 | 488 |
| Transfers between Funds | | |
| (From) To Working Funds | (317) | 113 |
| To (From) Capital Grants | 951 | 147 |
| (From) To Special Projects | (634) | (260) |
| Fund Balances at Beginning of Year | 2,450 | 1,962 |
| Fund Balances at End of Year | 3,296 | 2,450 |

The accompanying notes are an integral part of these financial statements.

# CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL
# STATEMENT OF CHANGES IN FINANCIAL POSITION
# FOR THE YEARS ENDED DECEMBER 31, 1984 AND 1983

(EXPRESSED IN THOUSANDS OF U.S. DOLLARS)

| | 1984 | 1983 |
|---|---|---|
| **SOURCES OF CASH AND BANKS** | | |
| Revenue | 25,197 | 23,725 |
| Capitalization of Properties and Equipment | 1,850 | 1,522 |
| Increase in Bank Overdrafts | 125 | (40) |
| Increase in Accounts Payable | 412 | 1,119 |
| Increase in Employees' Social Benefits | - | 178 |
| Increase in Grants Received in Advance | - | 982 |
| Total Sources of Cash and Banks | 27,584 | 27,486 |
| **APPLICATIONS OF CASH AND BANKS** | | |
| Expenses | 24,351 | 23,237 |
| Invested in Properties and Equipment | 1,850 | 1,522 |
| Increase in Accounts Receivable | 314 | 744 |
| Increase in Inventories | 186 | 605 |
| Increase in Prepaid Expenses | 25 | (5) |
| Increase in Properties for Sale | 143 | (2) |
| Increase in Long-Term Accounts Receivable and Other Assets | 196 | 385 |
| Decrease in Employees' Social Benefits | 324 | - |
| Decrease in Grants Received in Advance | 1,052 | - |
| Total Applications of Cash and Banks | 28,441 | 26,486 |
| Increase (Decrease) in Cash and Banks | (857) | 1,000 |
| Cash and Banks at Beginning of Year | 3,698 | 2,698 |
| Cash and Banks at End of Year | 2,841 | 3,698 |

The accompanying notes are an integral part of these financial statements.

# CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL
# NOTES TO FINANCIAL STATEMENTS
# AS OF DECEMBER 31, 1984 AND 1983
(AMOUNTS EXPRESSED IN THOUSANDS OF U.S. DOLLARS)

1. STATEMENT OF PURPOSE

The Centro Internacional de Agricultura Tropical (CIAT) is a private, autonomous, not-for-profit scientific and educational institution chartered under Colombian law, devoted to the agricultural and economic development of the tropics.

2. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

CIAT follows accounting policies recommended by the Consultative Group on International Agricultural Research (CGIAR), an international association co-sponsored by The World Bank (BIRF), the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Development Programme (UNDP), and financed by some 40 countries, international and regional organizations, and private foundations. These policies are in accordance with generally accepted accounting practices for non-profit organizations and are summarized as follows:

a) CIAT uses the accrual method of accounting for transactions, with the exception of revenue for special projects that are registered on a cash basis; its books of account are kept in US dollars. Transactions in other currencies (mainly Colombian pesos) are recorded at the rates of exchange prevailing at the dates when the transactions occur.

b) Purchase orders issued prior to December 31, but pending of receiving the goods and services ordered, are treated as expenses of the year in question and are shown on the financial statements under accounts payable. The amounts of these purchase orders included in the financial statements, to December 31, 1984, are as follows:

| 1984 Commitments | |
|---|---|
| Core Operations | 685.6 |
| Capital | 756.7 |
| Special Projects | 204.5 |

c) During periods of cash surplus CIAT makes short-term investments through U.S. banks. This resulted in interest earnings which were credited as income during the period and are shown in Schedule No. 2 of these financial statements. Requirements for funds are satisfied by credit lines established with Colombian and U.S. banks.

d) Inventories are valued at the average cost, but not exceeding market value.

e) Properties and Equipment are carried at cost. The following policy is used for replacement of equipment: the actualization of cost of the replaced assets is registered to the capital grants account. The difference between the cost of new assets and the proceeeds obtained from the sale of the old assets is charged against current operations. At December 31, 1984, new imported vehicles amounting to 700 were in transit; based on an estimated value, CIAT recorded the old vehicles as sold, resulting a charge to current operations of 290.

The land on which CIAT carries out its headquarters operations was ceded to CIAT under an agreement with the Colombian government; the agreement expires in July 2000, and may be extended thereafter by mutual consent; if it is not, CIAT will be obligated to transfer the buildings to the Colombian government.

f) In conformity with generally accepted accounting principles applicable to non-profit organizations, CIAT does not record depreciation on its Properties and Equipment.

3. FOREIGN EXCHANGE TRANSACTIONS

All foreign exchange transactions are controlled by the Colombian government and accordingly all foreign currencies received in Colombia must be sold through official channels. The following exchange rates were used to translate Colombian pesos (P) to US dollars ($) for the year 1984.

| | P/$1 | |
|---|---|---|
| Peso balances included in Current Assets and Current Liabilities. | 113.89 | Year-end official exchange rate |
| Peso income and peso disbursements in Colombian pesos for Properties and Equipment and Expenses. | 100.57 | Annual average of the official exchange rate |

4. ACCOUNTS RECEIVABLE AND OTHERS

The Accounts Receivable and Others as of December 31 are as follows:

| | 1984 | 1983 |
|---|---|---|
| Affiliated Organizations | 745 | 366 |
| Debtors | 540 | 205 |
| Advances to Suppliers and Contractors | 513 | 626 |
| Taxes | 177 | 79 |
| | 1,975 | 1,276 |

5. INVENTORIES

The Inventories as of December 31 are as follows:

| | 1984 | 1983 |
|---|---|---|
| Supplies | 610 | 453 |
| Spare Parts | 372 | 323 |
| Cattle | 696 | 716 |
| | 1,678 | 1,492 |

6. LONG-TERM ACCOUNTS RECEIVABLE AND OTHER ASSETS

This account is mainly housing loans made to Senior Staff which are secured by mortgages on properties acquired.

7. ACCOUNTS PAYABLE

The Accounts Payable as of December 31 are as follows:

| | 1984 | 1983 |
|---|---|---|
| Suppliers | 2,665 | 2,705 |
| Affiliated Organizations | 910 | 296 |
| Taxes | 76 | 303 |
| Others | 200 | 135 |
| | 3,851 | 3,439 |

## 8. EMPLOYEES'SOCIAL BENEFITS

The Social Benefits for non-internationally recruited personnel as of December 31 are as follows:

| | 1984 | 1983 |
|---|---|---|
| Social Benefits (Cesantias) and Interests on Cesantias | 1,197 | 1,536 |
| Vacations and Vacations Benefits | 292 | 278 |
| Others | 27 | 26 |
| | 1,516 | 1,840 |

## 9. CONTINGENCIES

A former employee has filed a claim against the Center for compensation and certain benefits based on Colombian labor legislation totalling Col. Ps. $30,000 (US$263). Management and the Legal Advisor are of the opinion that the final outcome of this claim will be in favor of the Center and accordingly no provision has been recorded.

# BOARD OF TRUSTEES

John L. Nickel**
Director General
Centro Internacional de Agricultura Tropical (CIAT)
Colombia

Marco Palacios Rozo**
Rector
Universidad Nacional de Colombia
Colombia

John A. Pino [1985*]
Agricultural and Forestry Development Division
Inter-American Development Bank
United States

Martín Piñeiro [1985*]
Centro de Investigaciones Sociales sobre el Estado y la Administración (CISEA)
Argentina

Aston Zachariah Preston [1986]
Vice Chancellor
University of the West Indies
Jamaica

Erwin Reisch [1987*]
Leader, Center for Agriculture in the Tropics and Subtropics
University of Hohenheim
Federal Republic of Germany

Rodrigo Tarté [1987]
Director
Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)
Costa Rica

William Tossell [1987*]
Dean of Research
University of Guelph
Canada

Hernán Vallejo Mejía**
Minister of Agriculture
Colombia

Elmar Wagner [1987*]
Coordinator IICA/EMBRAPA
Escritorio no Brasil
Brazil

Fredrick Joshua Wang'ati [1986]
Agricultural Secretary
National Council for Science and Technology
Kenya

[ ] Term expires at conclusion of annual meeting of year indicated
* Inelegible for re-election.
** Ex officio member

# SENIOR AND PROFESSIONAL STAFF
**(AS OF DECEMBER 1984)**

## OFFICE OF THE DIRECTOR GENERAL

**Senior staff**
John L. Nickel, Ph.D., Dr.sc.agr. h.c., Director General
Douglas R. Laing, Ph.D., Deputy Director General
Gustavo A. Nores, Ph.D., Deputy Director General
Fritz Kramer, Ph.D., Assistant to the Director General
Gertrude Brekelbaum, Ph.D., Projects Officer

**Associate**
Uriel Gutiérrez, M.S., Administrative Associate

**Assistant**
Cecilia Acosta, Administrative Assistant

## BEAN PROGRAM

**Senior staff**
Aart van Schoonhoven, Ph.D., Entomologist, Coordinator
David Allen, Ph.D., Plant Pathologist, Regional Coordinator, Eastern Africa Bean Project (stationed in Thika, Kenya)
Stephen R. Beebe, Ph.D., Plant Breeder, Central America Bean Project (stationed in Asunción Mita, Guatemala)
Jeremy H. Davis, Ph.D., Plant Breeder, Plant Breeding
Michael Dessert, Ph.D., Plant Breeder, Great Lakes Bean Project (stationed in Rubona, Rwanda)
Guillermo E. Gálvez, Ph.D., Plant Pathologist, Regional Coordinator, Central America Bean Project (stationed in San José, Costa Rica)
Guillermo Hernández Bravo, Ph.D., Plant Breeder, Co-leader, World Bank/INIPA (Peru)/CIAT Collaborative Bean Project (stationed in Chiclayo, Peru)
Francisco J. Morales, Ph.D., Virologist, Virology
Silvio H. Orozco, M.S., Agronomist, Central America Bean Project (stationed in Guatemala City, Guatemala)
Douglas Pachico, Ph.D., Agricultural Economist, Economics
Marcial Pastor-Corrales, Ph.D., Plant Pathologist, Plant Pathology
Shree P. Singh, Ph.D., Plant Breeder, Plant Breeding
Steven R. Temple, Ph.D., Plant Breeder, Plant Breeding
Michael D. Thung, Ph.D., Agronomist, Agronomy, (stationed at CNPAF, Goiania, Brazil)
Peter Trutman, Ph.D., Pathologist, Great Lakes Bean Project (stationed in Rubona, Rwanda)
Oswaldo Voysest, Ph.D., Agronomist, Agronomy
Jeffrey White, Ph.D., Physiologist, Physiology
Jonathan Woolley, Ph.D., Agronomist, Cropping Systems

**Senior research fellows**
Jairo Castaño, Ph.D., Plant Pathology
N. Ruaraidh Sackville Hamilton, Ph.D., Data Management Systems

**Postdoctoral fellows**
* Guy Hallman, Ph.D., Entomology
Joachim Voss, Ph.D., Great Lakes Bean Project (assigned by the Rockefeller Foundation, stationed in Rubona, Rwanda)

**Visiting research associates**
Krista C. Dessert, M.S., Nutrition (Great Lakes Project, stationed in Rubona, Rwanda)
* Elizabeth Lewinson, M.S., Agronomy (Gembloux Project)
* Jeffrey MacElroy, M.S., Plant Breeding
Veronique Schmit, M.S., Associated Expert (assigned by the FAO)

**Research associates**
Mauricio Castaño, Ing. Agr., Virology
José Ariel Gutiérrez, M.S., Plant Breeding
Nohra R. de Londoño, Ing. Agr., Economics
* Carlos Adolfo Luna, M.S., Economics
Jorge Ortega, M.S., Agronomy

**Research assistants**
Lucía Afanador, Biol., Plant Pathology
Jorge Beltrán, Ing. Agr., Cropping Systems
Jose Isnain Bolaños, Ing. Agri., Plant Breeding
César Cajiao, Ing. Agr., Plant Breeding
Jesús A. Castillo, Ing. Agr., Physiology
Carlos Francisco Chavarro, Ing. Agr., Office of the Coordinator
Aurora Duque, Ing. Agr., Microbiology
Oscar Erazo, Ing. Agr., Agronomy
Diego Fonseca, Ing. Agr., Physiology
Grace Frenc, Nut., Nutrition
** Oscar Herrera (RIP), Ing. Agr., Cropping Systems
Carlos Jara, Ing. Agr., Plant Pathology
Germán Llano, Plant Pathology
Nelson Martínez, Ing. Agr., Agronomy
Gustavo Montes de Oca, Ing. Agr., Agronomy
Carlos Aníbal Montoya, Plant Pathology
* Andrea Niessen, Biol., Virology
Gloria Isabel Ocampo, Bact., Microbiology
Carlos Pino, Ing. Agr., Entomology
Darío Ramírez, Ing. Agr., Plant Breeding
Diego Santacruz, Ing. Agr., Agronomy
* Miguel S. Serrano, Biol., Ent., Entomology
Gerardo Tejada, Ing. Agr., Agronomy
Tomás Zúñiga, Ing. Agr., Entomology

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* Left during 1984
** Deceased

**Senior staff**

James H. Cock, Ph.D., Physiologist, Coordinator
Anthony C. Bellotti, Ph.D., Entomologist, Entomology
Clair Hershey, Ph.D., Plant Breeder, Plant Breeding
Reinhardt Howeler, Ph.D., Soil Scientist, Plant Nutrition and Soils
Kazuo Kawano, Ph.D., Plant Breeder, Plant Breeding (stationed in Rayong, Thailand)
Raúl Moreno, Ph.D., Agronomist, Agronomy
* Dietrich Leihner, Dr.agr., Agronomist, Cultural Practices
J. Carlos Lozano, Ph.D., Pathologist, Plant Pathology
John K. Lynam, Ph.D., Agricultural Economist, Economics (on sabbatical leave)

**Senior Research Fellows**

Rupert Best, Ph.D., Utilization
Mabrouk El-Sharkawy, Ph.D., Physiology

**Postdoctoral fellows**

Ewald Sieverding, Dr.agr., Soil and Plant Nutrition
Steve Romanoff, Ph.D., Economics
Christopher Wheatley, Ph.D., Utilization

**Research associates**

Rafael Orlando Díaz, M.S., Economics
Rafael Alberto Laberry, M.S., Plant Pathology
Bernardo Ospina, Ing. Agric., Utilization (stationed in Sincelejo, Colombia)
Benjamín Pineda, M.S., Plant Pathology
Octavio Vargas, M.S., Entomology

**Research assistants**

Lisímaco Alonso, Ing. Agric., Utilization
Bernardo Arias, Ing. Agr., Entomology
Darío Ballesteros, Ing. Agr., Soils (stationed in Carimagua)
Eitel Adolfo Burckhardt, Lic. Biol., Soils
Luis Fernando Cadavid, Ing. Agr., Soils
Fernando Calle, Ing. Agr., Germplasm
José Aquileo Castillo, Biol., Entomology
Carolina Correa, Econ., Economics
Miguel A. Chaux, Tec. Ing. Ind., Office of the Coordinator
Diego Izquierdo, Econ., Economics
Gustavo Jaramillo, Ing. Agr., Agronomy
Javier López, Ing. Agr., Cultural Practices
Jorge Orrego, Ing. Agr., Utilization
Germán E. Parra, Ing. Agr., Physiology
José Antonio Puente, Ing. Agr., Cultural Practices
* Edgar Salazar, Ing. Agr., Cultural Practices
Ana Cecilia Velasco, Lab. Clin., Plant Pathology

* Left during 1984

## RICE PROGRAM

**Senior staff**

Peter R. Jennings, Ph.D., Plant Breeder, Coordinator (assigned by the Rockefeller Foundation)
* Sang-Won Ahn, Ph.D., Plant Pathologist, Plant Pathology
Joaquín González F., M.S., Agronomist, Agronomy
César Martínez, Ph.D., Plant Breeder, Plant Breeding
Edward Pulver, Ph.D., Plant Breeder, Co-leader, World Bank/INIPA (Peru)/CIAT Collaborative Rice Project (stationed in Tarapoto, Peru)
Manuel Rosero, Ph.D., Plant Breeder, IRRI Liaison Scientist
* Héctor Weeraratne, Ph.D., Plant Breeder, Plant Breeding

**Senior research fellow**

Surapong Sarkarung, Ph.D., Plant Breeding (stationed in Villavicencio, Colombia)

**Research associate**

Marco Perdomo, Ing. Agr., Agronomy (stationed in Villavicencio, Colombia)

**Research assistants**

Luis Eduardo Berrío, Ing. Agr., International Trials
Luis Eduardo Dussán, Ing. Agr., Plant Breeding (stationed in Villavicencio, Colombia)
* Yolanda Cadavid de Galvis, Ing. Agr., Agronomy
Jenny Gaona, Ing. Agr., International Trials
* Luis Eduardo García, Ing. Agr., Plant Breeding (stationed in Villavicencio, Colombia)
Julio Eduardo Holguín, Ing. Agr., Plant Breeding
Victor Manuel Nuñez, Ing Agr., Plant Breeding
Eliseo Nossa, Ing. Agr., Plant Breeding (stationed in Villavicencio, Colombia)
Miguel Eduardo Rubiano, Ing. Agr., Plant Pathology
Edgar Tulande, Ing. Agr., Plant Pathology (stationed in Villavicencio, Colombia)

## TROPICAL PASTURES PROGRAM

**Senior staff**

José M. Toledo, Ph.D., Pasture Agronomist, Coordinator
Rosemary S. Bradley, Ph.D., Soil Microbiologist, Microbiology
* Mario Calderón, Ph.D., Entomologist, Entomology
Walter Couto, Ph.D., Soil Scientist Pasture Development (on sabbatical leave, stationed at CPAC, Brasilia, Brazil)
John E. Ferguson, Ph.D., Agronomist, Seed Production
Bela Grof, Ph.D., Agrostologist, Legume Agronomy (stationed in Carimagua)
Carlos Lascano, Ph.D., Animal Scientist, Pasture Quality and Nutrition
Jillian M. Lenné, Ph.D., Plant Pathologist, Plant Pathology

---

* Left during 1984

John W. Miles, Ph.D., Plant Breeder, Agronomy/Forage Breeding
Esteban A. Pizarro, Ph.D., Agronomist, Regional Trials
José G. Salinas, Ph.D., Soil Scientist, Soil and Plant Nutrition
Rainer Schultze-Kraft, Dr.agr., Agronomist, Germplasm
Carlos Seré, Dr.agr., Agricultural Economist, Economics
James M. Spain, Ph.D., Soil Scientist, Pasture Development (stationed in Carimagua)
* Luis E. Tergas, Ph.D., Agronomist, Pasture Productivity and Management
Derrick Thomas, Ph.D., Forage Agronomist, Agronomy (stationed at CPAC, Brasilia, Brazil)
Raúl R. Vera, Ph.D., Animal Scientist, Cattle Production Systems

**Senior research fellows**
Pedro J. Argel, Ph.D., Collaborative Work in Panama, IDIAP/AID/Rutgers University/CIAT Bilateral Project (stationed in David, Panama)
* Haruo Hayashi, B.S., Studies on native savanna of Colombian Llanos
Tsuyoshi Mitamura, Ph.D., Pasture Establishment
Saif ur Rehman Saif, Dr.agr., Soil Microbiology

**Postdoctoral fellows**
Gerhard Keller-Grein, Dr.agr., Germplasm
Julie M. Stanton, Ph.D., Plant Pathology
Philip K. Thornton, Ph.D., Cattle Production Systems

**Visiting research associates**
Brigitte Mass, Dipl. agr., Germplasm
Bernardo Rivera, D.V.M., Cattle Production Systems
Charmian Sackville Hamilton, Ph.D., Ecophysiology
José Ignacio Sanz, M.S., Soil and Plant Nutrition
* Martin Schneichel, Dipl.agr., ETES Project (stationed in Carimagua)

**Research associates**
Carlos Castilla, M. S., Soil and Plant Nutrition
Rubén Darío Estrada, M.S., Economics
Obed García, D.M.V.Z. Cattle Production Systems
Silvio Guzmán, M.S., Cattle Production Systems
Libardo Rivas, M.S., Economics

**Research assistants**
Amparo de Alvarez, Ing. Agr., Plant Pathology
Guillermo Arango, Lic. Biol., Entomology
José A. Arenas, Ing. Agr., Germplasm
Alvaro Arias, Ing. Agr., Germplasm
Patricia Avila, Zoot., Pasture Quality and Nutrition
Hernando Ayala, D.V.M.Z.., Cattle Production Systems (stationed in Carimagua)
* Javier Belalcázar, Ing. Agr., Germplasm

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Gustavo Benavides, Ing. Agr., Germplasm
Javier Asdrúbal Cano, Lic. Econ., Office of the Coordinator
Carlos Iván Cardozo, Ing. Agr., Seed Production
Fernando Díaz, Ing. Agr., Agronomy (stationed in Carimagua)
Martha Lucía Escandón, Ing. Agr., Forage Breeding/Agronomy
Julián Estrada, D.V.M.Z., Pasture Quality and Nutrition (stationed in Carimagua)
Luis H. Franco, Ing. Agr., Regional Trials
Manuel Arturo Franco, Ing. Mec., Office of the Coordinator
César Augusto García, Ing. Agr., Entomology and Plant Pathology (stationed in Carimagua)
Hernán Giraldo, Ing. Agr., Office of the Coordinator
Arnulfo Gómez Carabaly, Ing. Agr., Regional Trials
José Manuel Gómez, Zoot., Pasture Productivity and Management (stationed in Carimagua)
Ramón Gualdrón, Ing. Agr., Pasture Development (stationed in Carimagua)
* Phanor Hoyos, Zoot., Pasture Quality and Nutrition
Jesús A. Méndez, Ing. Agr., Microbiology (stationed in Carimagua)
Carlos Humberto Molano, Ing. Agr., Forage Breeding/Agronomy
Dazier Mosquera, Ing. Agr., Soil Microbiology
Gloria Navas, Ing. Agr., Entomologia
Carlos E. Perdomo, Ing. Agr., Soil and Plant Nutrition (stationed in Carimagua)
Fabiola de Ramírez, Lic. Bact., Microbiology
* Hernando Ramírez, Biol., Germplasm
José Ignacio Roa, Ing. Agr., Forage Breeding/Agronomy/Seed Production (stationed in Carimagua)
Edgar Salazar, Ing. Agr., Legume Agronomy (stationed in Carimagua)
Manuel Sánchez, Ing. Agr., Seed Production
Blanca Torrez, Lic. Bact., Cattle Production Systems
Celina Torres, Ing. Agr., Plant Pathology

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**Research associates**
Rigoberto Hidalgo, M.S., Germplasm (Beans)

**Research assistants**
Javier Beltrán, Biol., Physiology
Graciela Mafla, Biol., Physiology
Javier Narváez, Ing. Agr., Physiology

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• Jorge Alberto Rodríguez, Ing. Agr., Physiology
Hember Rubiano, Ing. Agr., Germplasm (Beans)
Isabel Salas, Biol., Seed

## SEED UNIT

**Senior staff**
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**Senior research fellow**
• Juan Carlos García, M.S., Training and Seed Production

**Research associates**
Edgar Burbano, M.S., Laboratory and Seed Production
• Joseph E. Cortés, Ing. Agric., Training
Carlos Domínguez, M.S., Training

**Research assistants**
José Fernández de Soto, Ing. Agric., Communication
Guillermo Giraldo, Ing. Agr., Seed Production
Napoleón Viveros, Ing. Agric., Seed Conditioning

## TRAINING AND CONFERENCES

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Carlos Flor, M.S., Beans Agronomy
Elías García, Ing. Agr., Rice
Marceliano López, M.S., Beans Communication
Alberto Ramírez, M.S., Tropical Pastures Agrostology
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Oscar Sierra, M.S., Tropical Pastures Animal Science
Eugenio Tascón, Ing. Agr., Rice

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Jaime López, Lic. Psi., Counselor
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Peter Jones, Ph.D., Agrometeorologist, Agroecological Studies

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**Research associates**

James Harbey García, M.S., Biometrics
José Eduardo Granados, M.S., Biometrics
Hugo Macías, Ing. Civil, System Programer

**Research assistants**

Miriam Cristina Duque, Mat., Biometrics
María del Rosario Henao, Ing. Sist., Computing
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Diego Arce, Econ., Bibliographer
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Stella Gómez, Lic. Bibl., Supervisor, Bibliographic Services
Francy González, Ing. Agr., Information Specialist, Beans
Mariano Mejía, Lic. Educ., Information Specialist, Tropical Pastures
Lynn Menéndez, Information Specialist, Editing and Translations
Piedad Montaño, Supervisor, Acquisitions
Hernán Poveda, Lic. Bibl., Supervisor, Technical Processes
Nora Rizo, Bibliographer
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**Visiting Editor**

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**Associates**
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**Research associate**
Javier Carbonell, M.S., Head, Palmira Station

**Research assistants**
Ramiro Narváez, Ing. Agric., Head, Quilichao Station
Edgar Quintero C., Ing. Agr., Production, Palmira Station
Raimundo Realpe, Ing. Agr., Head, Popayán Station
Gonzalo Rodríguez, Ing. Agric., Head, Santa Rosa Station

## SPECIAL PROJECTS

### BIOLOGICAL NITROGEN FIXATION PROJECT

**Senior research fellow**
David J. Harris, Ph.D., Agronomy/Soils

### CIMMYT/CIAT ANDEAN REGION MAIZE PROJECT

**Associate Member Senior staff**
Gonzalo Granados, Ph.D., Entomologist, Head
* James B. Barnett, Ph.D., Plant Breeder, Andean Regional Services
Shivaji Pandey, Ph.D., Plant Breeder, Andean Regional Services

### IFDC/CIAT PHOSPHORUS PROJECT

**Senior staff**
Luis Alfredo León, Ph.D., Soil Scientist, Head
Jacqueline A. Ashby, Ph.D., Rural Sociologist, Sociology

**Research assistants**
Carlos Arturo Quirós, Ing. Agr., Agronomy/Sociology
Luis Guillermo Restrepo, Ing. Agr., Agronomy
Janeth Orozco Lamy, Tec. Sist., Statistics

### INTSOY/ICA/CIAT PROJECT

**Associate Member Senior staff**
Luis H. Camacho, Ph.D., Plant Breeder, Head

**Research Assistant**
Alvaro E. Múnera, Ing. Agr.

### INTSORMIL/CIAT REGIONAL SORGHUM PROJECT

**Associate Member Senior staff**
Lynn Gourley, Ph.D., Plant Breeder, Head

**Research Assistant**
Manuel Coronado, Ing. Agr., Plant Breeding

* Left during 1984

REPRESENTATION OF COLLABORATING INSTITUTIONS IN CIAT

CIP REGIONAL REPRESENTATION

**Associate Member Senior staff**
Oscar Malamud, Ph.D., Liaison Officer, Head (stationed in Bogotá, Colombia)
Jan Henfling, Ph.D., Liaison Officer (stationed in Medellín, Colombia)

IBPGR REGIONAL REPRESENTATION

**Associate Member Senior staff**
Miguel Holle, Ph.D., IBPGR Regional Representative for Latin America

GTZ REGIONAL REPRESENTATION

**Associate Member Senior staff**
* Gunther John, Dr.agr., Liaison Officer

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Andrew V. Urquhart, F.C.A., Chartered Accountant, Director

**Associate**
Fabiola Amariles, Lic. Educ., Administrative Associate

ADMINISTRATIVE PROCEDURES

**General Administrative Services staff**
Héctor Flórez, C.P.A., Head

**Assistant**
* Emil Pacini, Ing. Ind., Analysis

ADMINISTRATIVE SYSTEMS

**General Administrative Services staff**
Héctor Villalobos, Ing. Ind., Head

**Assistants**
Hector Fabio Botero, Ing. Ind., Systems
Jaime Campo, Programming
Iván Cataño, Ing. Sist., Analysis
Fabio González, Data Processing
Carlos Meneses, Ing. Elect., Analysis
Rubén D. Osorio, Analysis
Rodrigo de los Ríos, Ing. Sist., Analysis

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Jesús Antonio Cuéllar, M.B.A., Executive Officer

**General Administrative Services staff**
Carlos Gavilanes, Superintendent, Carimagua Station
Harold Domínguez, Ing. Agr., Head, Station Operations
Jesús A. Vergara, Adm. Emp., Head, General Services

**Associates**
Camilo Alvarez, M.S., Administrative Associate
Ricardo Castañeda, Administrative Associate, Government Relations (stationed in Bogotá)

**Assistant**
Edgard Vallejo, Adm. Emp., Head, Travel Office

### Food and Housing

**General Administrative Services staff**
David Evans, Head

**Associate**
Leopoldo Hurtado, Chef

### Human Resources

**General Administrative Services staff**
Germán Vargas, M.B.A., Head

**Associate**
Germán Arias, Abog., Personnel Officer

### Maintenance Services

**General Administrative Services staff**
Germán Gutiérrez, Ing. Mec., Head

**Associates**
Marvin Heenan, Head, Motor Pool
Jorge Uribe, Head, Electricity
Oscar Sánchez, Head, Air Conditioning and Refrigeration
Jorge A. Manrique, Ing. Electron., Communications

### Laboratory Services

**Associate**
Octavio Mosquera, M.S., Analytical Services

**Assistants**
Charles McBrown, Tec. Elec., Instruments Maintenance
Roberto Segovia, Ing. Agr., Greenhouses/Landscaping

CONTROLLER'S OFFICE

**General Administrative Services staff**
Alejandro Rebolledo, C.P.T., Controller

**Assistants**
* Alexis Corrales, Treasury (stationed in Carimagua)
Jaime E. Cumba, Payroll
César Moreno, C.P.T., Accounting
Mario Rengifo, Treasury
Emil Pacini, Ing. Ind., Budget

SUPPLIES

**General Administrative Services staff**
Luis Antonio Osorio, Ing. Ind., Head

**Assistants**
Diego Mejía, Head, Purchasing
Ricardo Castellanos, Head, Warehouse
Julio Galindo, Head, Importing

INTERNAL AUDITING

**General Administrative Services staff**
Luis Fernando Montoya, C.P.T., Internal Auditor

**Assistants**
Carlos Alberto Calderón, C.P.T.
* Jorge Alberto Bermúdez, C.P.T.
Francisco Orlando Millán, C.P.T.

VISITORS' OFFICE

**Associate**
* Fernando Mora, B.A., A.H.A., Head

**Assistants**
Rodrigo Chávez, Information Services
Jorge Enrique Paz, Ing. Agr., Information Services

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# THE CGIAR SYSTEM


The Consultative Group on International Agricultural Research (CGIAR) was formed in 1971 to provide a mechanism for mobilizing broadbased financial support for the global system of 13 international agricultural research centers and organizations. The creation of CGIAR indicated the desire of donor agencies to provide long-term support for agricultural development in the developing world. In addition, in consultation with the Technical Advisory Committee—a panel of top-level scientists who oversee the research programs of the centers—CGIAR is able to assure financial donors that their resources are being used to achieve maximum benefits.

The soundness of this system is evidenced by the fact that donor membership in CGIAR has grown from 15 in 1972, who contributed about US$20 million, to 40 in 1984, with a total contribution of about US$178 million.

Each center or organization in the CGIAR system is autonomous, with its own Board of Trustees or other governing body. Each develops its own budget for funds provided by CGIAR, consistent with the total money pledged to be available for the coming year and the center's program in relation to the goals of the system. Each center budget is submitted annually during the center's review week, when a short overview of its programs and accomplishments is presented before the body of CGIAR donors and other representatives.

CGIAR operates informally and by consensus and provides outstanding example of effective, flexible, and successful cooperation between the industrialized and developing worlds. Headquarter offices are furnished by the World Bank in Washington, D.C. The Bank also provides the services of a Chairman and an Executive Secretariat. The Secretariat of the Technical Advisory Committee is provided by the Food and Agriculture Organization of the United Nations in Rome.

The nine international agricultural research centers and four associated organizations have the following headquarters and research responsibilities

## LATIN AMERICA

- Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia cassava, field beans, rice and tropical pastures
- International Center for Maize and Wheat Improvement (CIMMYT), El Batán, Mexico maize and wheat
- International Potato Center (CIP), Lima, Peru: potatoes

## ASIA

- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India, chickpea, pigeonpea, pearl millet, sorghum, groundnut, and farming systems.
- International Rice Research Institute (IRRI), Los Baños, Philippines rice

## MIDDLE EAST

- International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria: farming systems, cereals, food legumes (broad bean, lentil, chickpea), and forage crops.

## AFRICA

- International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria: farming systems, maize, rice, roots and tubers (sweet potatoes, cassava, yams), and food legumes (cowpea, lima beans, soybean).
- International Laboratory for Research on Animal Diseases (ILRAD), Nairobi, Kenya trypanosomiasis and theileriosis of cattle
- International Livestock Center for Africa (ILCA), Addis Ababa, Ethiopia livestock production systems
- West Africa Rice Development Association (WARDA), Monrovia, Liberia: rice

## EUROPE AND THE UNITED STATES

- International Board for Plant Genetic Resources (IBPGR), Rome, Italy plant varieties collection and information.
- International Service for National Agricultural Research (ISNAR), The Hague, the Netherlands research support
- International Food Policy Research Institute (IFPRI), Washington, D C , USA analysis of world food problems