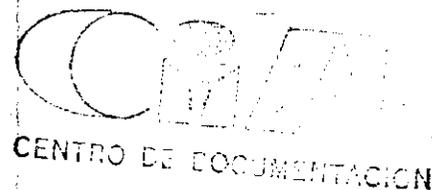


CIAT in the 1980s revisited

A medium-term plan
for 1986 to 1990



CENTRO DE DOCUMENTACION

CIAT is a nonprofit organization devoted to the agricultural and economic development of the lowland tropics. The government of Colombia provides support as a host country for CIAT and furnishes a 522-hectare site near Cali for CIAT's headquarters. In addition, the Colombian Foundation for Higher Education (FES) makes available to CIAT a 184-hectare substation in Quilichao and a 73-hectare substation near Popayán; the Colombian Rice Federation (FEDEARROZ) also makes available to CIAT a 30-hectare farm—Santa Rosa substation—near Villavicencio. CIAT co-manages with the Colombian Agricultural Institute (ICA) the 22,000-hectare Carimagua Research Center on the Colombian eastern plains and carries out collaborative work on several other ICA experimental stations in Colombia; similar work is done with national agricultural agencies in other Latin American countries.

CIAT is financed by a number of donors, most of which are represented in the Consultative Group on International Agricultural Research (CGIAR). During 1985 these CIAT donors include the governments of Australia, Belgium, Brazil, Canada, France, the Federal Republic of Germany, Italy, Japan, Mexico, the Netherlands, Norway, the People's Republic of China, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America. Organizations that are CIAT donors in 1985 include the European Economic Community (EEC), the Ford Foundation, the Inter-American Development Bank (IDB), the International Bank for Reconstruction and Development (IBRD), the International Development Research Centre (IDRC), the International Fund for Agricultural Development (IFAD), the Rockefeller Foundation, the United Nations Development Programme (UNDP), and the W. K. Kellogg Foundation.

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

TROPICAL PASTURES PROGRAM

Introduction

The abundance of underutilized land resources in tropical Latin America seems inconsistent with the existence of a large sector of small farmers. In most countries coexistence of intensive farming, both large- and small-scale, and abundance of underutilized land can be explained by a combination of two factors: (a) the low or fragile fertility status of the soils in the agricultural frontier, and (b) the poor infrastructure development in these areas. Under these poor fertility conditions, productivity is low and soil amendments are not economical due to high input and transportation costs. Crop production with available technology is unprofitable without sizable subsidies.

Tropical and subtropical areas of Latin America have some 800 million hectares of significantly underutilized savannas and forests, two-thirds of which have acid, infertile soils (Oxisols and Ultisols). The tropical savanna areas (some 250 million hectares) have great agricultural potential because of their abundant solar radiation, adequate rainfall and favorable temperature regimes for extended growing seasons. Topography and soil physical properties are also generally favorable. Parts of the forest areas (100 to 150 million hectares) also have high agricultural potential. They are, however, at high environmental risk, given current practices and available technology.

In order to contribute to the development of ecologically sound and stable productive systems for these areas, CIAT aims to help broaden the resource base of Latin American agriculture through a low-cost, low-input approach based on the selection of species most adapted to local edaphic, climatic and biotic conditions. Tropical pastures are the Center's major effort in these areas. Associated efforts in upland rice and cassava are also described in this plan.

Beef and Milk: Staple Food Commodities

Tropical Latin America has an estimated 204 million head of cattle, about 17% of the world total. In this region beef consumption per capita of 16 kg per year is significantly higher than in Africa and Asia, and about two-thirds that of Europe.

the IRTP. Duties include the selection, distribution and evaluation of germplasm nurseries. Materials created for distinct ecologies are sent to all countries in the Western Hemisphere. The IRRI scientist also plays an important leadership role in organizing conferences and field selection workshops. This position entails extensive international travel to promote national use of promising materials developed by the network.

Decentralized Regional Programs

In addition to the senior staff based in Colombia, two outpost regional positions are projected for Latin America and the Caribbean. One position would be based with the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) as a CIAT-IRRI-EMBRAPA liaison scientist and the other in the Caribbean, as coordinator of the proposed regional network.

A 1984 regional workshop approved the establishment of a Caribbean Regional Network and authorized CIAT-IRRI to seek funds for supporting the regional coordinator, who would organize germplasm introduction and evaluation, regional training courses, and research on irrigated and rainfed production constraints. This position should be filled in 1985.

The proposal for a CIAT-IRRI scientist in Brazil was developed in joint discussion among CIAT, IRRI and EMBRAPA (Centro Nacional de Pesquisa de Arroz y Feijao, CNPAF) in view of the need to make a greater impact on rice production in Brazil, which accounts for 75% of the rice area in Latin America. Preliminary analysis of the potential for expanded production in tropical Brazil indicates that the underutilized *varzeas* will provide a major contribution to future rice production. Brazilian breeding objectives for *varzeas* are similar to CIAT objectives for irrigated rice. Hence improved germplasm is now available for evaluation and varietal release. The liaison scientist could concentrate on identifying new varieties for *varzeas* in cooperation with the national program, as well as act in an overall capacity as liaison scientist between Brazilian rice scientists and those at CIAT and IRRI.

During the last two decades, consistent increases in beef production have been recorded in most countries of the region; but with few exceptions, supplies have lagged behind demand growth.³² As a result, in most countries beef prices increased in real terms during the period. These price increases have serious implications since the proportion of family income spent on beef is becoming extremely high among low-income urban consumers.³³ In the lowest income quartile of the population, beef expenditure shares ranged from 12.4 to 26.0% of total household expenditures while expenditure shares for milk and dairy products ranged from 7.0 to 13.0%. Recent studies in Colombia indicate that food expenditure shares for beef and milk are also high for the rural population: 24.4% as compared to 28.2% for urban areas.³⁴ These same studies also documented high income elasticities at all income levels for beef and dairy products throughout Latin America. In the lowest quartile, income elasticities ranged from 0.79 to 1.28 for beef and from 0.78 to 1.55 for dairy products. The lower income elasticity observed at higher income levels indicates that increased supplies of these commodities will particularly benefit the low- and middle-income families in both urban and rural areas.

Potential for Livestock Improvement

Appropriate livestock production technology can be developed for the region's vast underutilized land resources. These areas have an extremely high potential for cattle production with little or no opportunity costs. The current average stocking rate in the acid soil savannas of 0.1 to 0.2 animal/ha can potentially be increased about tenfold. In addition, annual beef production per animal could be more than doubled. Milk production could also be improved significantly in these areas. Most milk and dairy products consumed in the region come from small dual-purpose herds, usually crosses of native and Zebu

³² CIAT, *Latin America: Trend Highlights of CIAT Commodities*, Internal Document Econ. 1.6, CIAT, Cali, Colombia, 1981.

³³ E. Rubinstein and G. Nores, *Beef expenditure by income strata in twelve cities of Latin America*, Internal Document, CIAT, Cali, Colombia, 1979.

³⁴ L. R. Sanint, L. Rivas, M. C. Duque and C. Seré, *Food consumption patterns in Colombia: A cross sectional analysis, 1981*, paper presented at Internal Workshop of the Agricultural Research Centers on Selected Economic Research Issues in Latin America, 1984.

breeds. This type of dual-output production system is found not only in the densely populated areas with relatively fertile soils, but also in frontier areas with acid, infertile soils.

In tropical America, it is recognized that animal health is not a major problem (as is the case in Central Africa) and that better breeds and better animal management will only be profitable after availability and quality of forages and feedstuffs are improved for better animal nutrition. The critical factor limiting animal production in tropical America, especially in the frontier lands, is the primary production (pastures and feed) of the animal production system. In the savanna ecosystems, native grasslands provide quality forage for only a few weeks after burning. The forage accumulated afterward is only sparingly consumed and essentially constitutes fuel for the next burning (1 to 2 years later). In the more humid environments, pastures are normally established successfully after clearing and burning of the forest and can initially support more than 2 animals/ha; thereafter, they rapidly degrade, losing productivity in 3 or 4 years and reaching severe degradation in a few more years. This process strongly affects animal productivity since low-quality species and weeds dominate the degraded areas. This degradation has strong ecological and economic implications as the net effects are destruction of native forests, very low levels of productivity per animal and per hectare, and a reduced carrying capacity (less than 0.5 head/ha).

The development of an appropriate pasture technology to improve availability and quality of forage on offer, as well as the stability of pastures over time in these marginal and frontier lands, is expected to have a large impact on beef and milk production in the region, while maintaining or improving soil fertility through soil coverage and nutrient recycling.

Program History and Accomplishments

The Tropical Pastures Program has evolved through three stages. During the formative stage (1969-1974), the then Beef Production Systems Program dealt with the identification of problems and potential solutions in the areas of animal health, animal management and cattle production systems under the assumption that significant

gains in animal productivity could be achieved through improved management practices. A relatively small proportion of program resources was devoted to pasture and forage evaluation during this period. Most field research was conducted in Colombia. Information collected during this initial period showed that low cattle productivity in tropical Latin America was due mainly to extreme malnutrition and nutrition-related diseases. Lack of mineral supplementation and good quality, year-round forage were identified as the most common critical constraints to increased productivity.

From 1975 to 1977, the renamed Beef Production Program focused attention on the acid, infertile savannas of Latin America. The program broadened the geographical scope of its activities to include other countries and sharply narrowed its research to pasture evaluation with the goal of removing the principal production constraints in the savanna ecosystem.

Grazing experiments in the Colombian Llanos documented the limited potential of native savannas. It became evident that the most serious limitations were the low productivity and poor quality of most native species, combined with the low fertility status of the soils and varying degrees of seasonal water stress. These limitations resulted in low animal production, malnutrition and related disease susceptibility. Overall productivity, both per unit area and per animal unit, was extremely low.

The use of edaphically well-adapted exotic grasses such as *Melinis minutiflora* provided for moderate increases in carrying capacity and production per unit area. However, production per animal continued to be disappointing. Protein supplementation in the form of concentrates was successful at the experimental level, but was too costly.

Preliminary experimental results obtained during this period with grass-legume pastures clearly indicated that persistent grass-legume associations under low-input conditions could provide an economically attractive solution to the problem. During 1978, the Program consolidated its research emphasis in the development of germplasm options for a low-input, low-cost grass-legume pasture technology for the acid soil savannas (Llanos and Cerrados). To reflect this new focus, the Program was renamed the Tropical Pastures Program in mid-1979.

After determining the genotype-by-environment interactions defining adaptation of germplasm, the need was perceived for developing strong cooperative activities with the national programs in the region for in situ pasture evaluation and development. The program and the national research institutions jointly launched the International Tropical Pastures Evaluation Network (RIEPT in Spanish) in 1979. This network screens large numbers of experimental materials at selected sites, covering the lowlands of tropical America. The network approach has made it possible to achieve important economies of scale, allowing national research programs to advance promising germplasm rapidly into pasture evaluation under grazing and into farmers' systems.

The most important achievements the program has made toward its present objectives are as follows:

1. Classification of tropical American land resources in terms of climate, soils and landscape, providing a geographically oriented ecological perspective to define the target area and the data base on which to build a cost-effective outreach strategy.
2. Identification of major farm constraints to cattle production in savanna ecosystems and in-depth characterization of cattle production system in Brazil, Colombia, Venezuela and Panama (a project partially supported with German funds through BMZ-GTZ).
3. Inventory of pasture pests and diseases, by forage species and ecosystem, with an assessment of current relative importance and control strategies for several of the most important problems.
4. Assembly of a large germplasm collection of 14,000 accessions including 12,500 legumes and 1,500 grasses; and identification of key promising species for the different ecosystems.
5. Identification of a large number of materials with low nutrient requirements and tolerance to soil acidity and high aluminum levels for the "Llanos" and "Cerrados" savanna ecosystem in collaboration with ICA at CNIA-Carimagua for the Llanos in Colombia and with EMBRAPA/CPAC at Planaltina for the Cerrados in Brazil.

6. Development of simple, low-cost pasture establishment methods adapted to savanna conditions. These low-cost methods range from conventional land preparation to minimum tillage for establishing grass-legume pastures, and from rapid to gradual replacement of native vegetation utilizing the attributes (adaptation and aggressiveness) of selected new germplasm, minimum fertilizer inputs and appropriately modified machinery for maximum economical and biological efficiency.
7. Testing of highly promising materials at both on-station and on-farm production system levels, evaluating several options ranging from complete replacement to the strategic supplementation of the native savanna to measure their biological and economic impact.
8. Release of several new cultivars including (a) the grasses *A. gayanus* CIAT 621, commercially available in Brazil and Colombia since 1980 and in Venezuela, Peru and Panama since 1983; (b) the legumes *Stylosanthes capitata* CIAT 10280 in Colombia and *S. guianensis* var. *pauciflora* (CIAT 2243) and *S. macrocephala* (CIAT 1582) in Brazil in 1983; and (c) *S. guianensis* (CIAT 184) for the humid tropic areas of Peru in 1985. Initial seed multiplication at official and commercial levels is also under way.
9. Training of more than 300 researchers from national programs, which has been instrumental in the rapid expansion of the tropical pastures network throughout the lowland tropics of Latin America.

Program Objectives

The primary objective of the Tropical Pastures Program is to develop low-input pasture technologies for the acid soil lowlands of the humid and sub-humid tropics, with primary responsibility for tropical America. In close cooperation with national research programs, the Program seeks to develop appropriate pasture-based animal production technology for the largest agricultural frontier of the continent. The specific objectives of the program are as follows:

1. To increase beef and milk production and productivity on currently marginal lands.

2. To contribute to the economically and ecologically sound expansion of the agricultural frontier lands.
3. To release more fertile lands presently under grazing systems for the expansion of crop production.

Agroecological Zones and Their Research Priorities

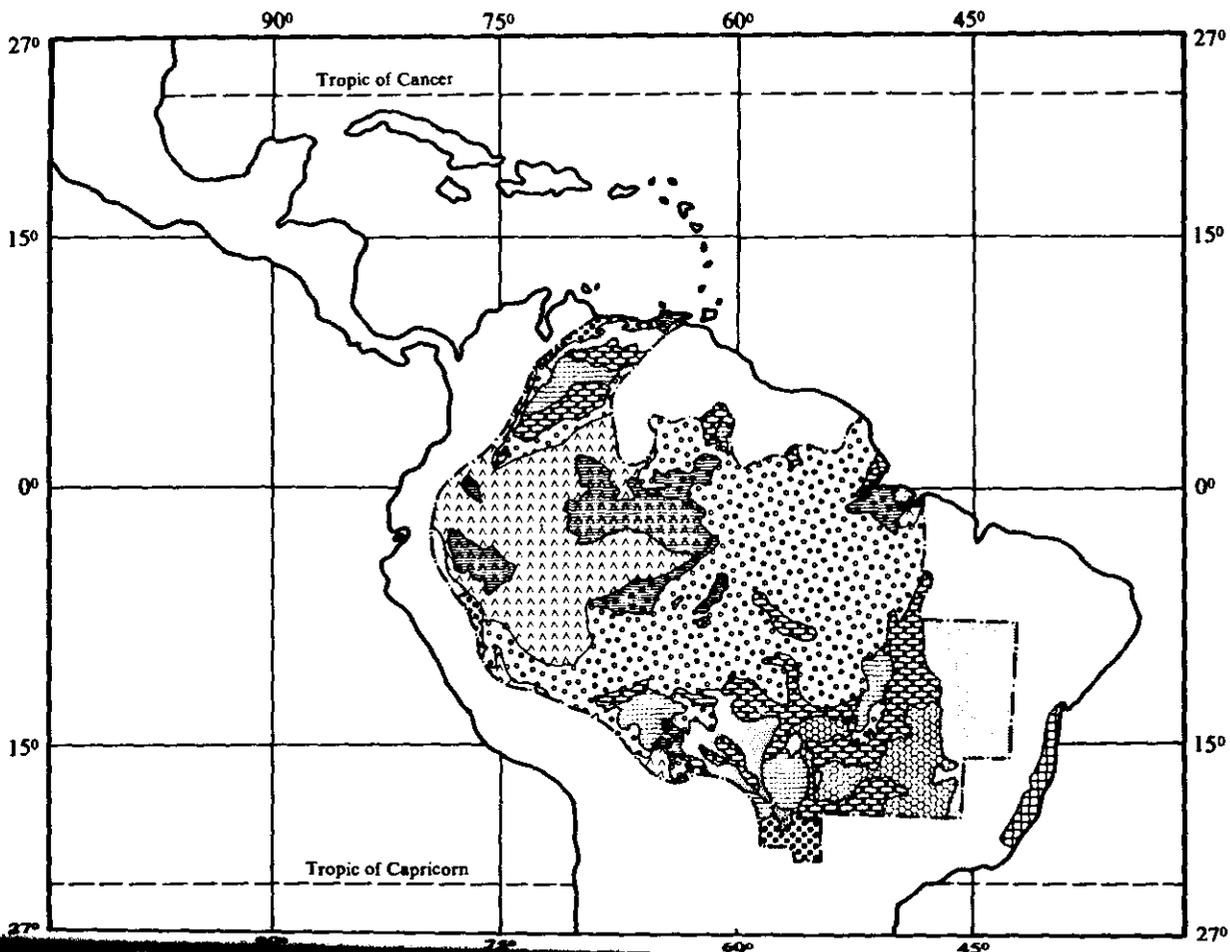
An in-depth survey of tropical Latin American regions with acid, infertile soils was finished in 1981, the final publication of which will appear in 1985,³³ thereby making it possible to divide the region into several major agroecological zones (Fig. 3) in order to design research strategies for developing the new pasture technology within a decentralized approach. This classification of land resources in terms of climate, landscape and soils provides a geographically oriented ecological perspective to the program's areas of interest. Distribution of native vegetation is measured quantitatively on the basis of total wet season potential evapotranspiration (TWPE), a measure of solar energy available for plant growth during the wet season (when water is not restrictive for plant growth). Wet season mean temperature (WSMT) was also used as a parameter to divide the area of interest further into relevant ecosystems for pasture growth and vegetation.

Major Ecosystems

The three main ecosystems and their priorities within the program's area of interest are as follows:

1. **Well-drained tropical savannas.** This important ecosystem is composed of two large groups: (a) the "Well-Drained Isohyperthermic Savannas"; i.e., the lowland areas (Llanos) close to the equator in Colombia, Guyana, Surinam, Venezuela, and northern Brazil (Roraima and Amapa), with a TWPE of 901 to 1060 mm, 6 to 8 months wet season, and wet season mean temperature (WSMT) over 23.5°C; and (b) the "Well-Drained Isothermic Savannas"; i.e., areas at higher latitudes and/or elevation (about 1000 masl) with

³³ T. T. Cochrane, *Land in Tropical America* (3 Vol.). CIAT, Cali, Colombia (in press).



 Well-Drained Isohyperthermic Savannas (mostly Llanos)

 Tropical Rain Forest

 Well-Drained Isothermic Savannas (mostly Cerrados)

 Poorly Drained Forest Regions

 Poorly Drained Savannas

 Deciduous Forests, Caatinga,^c etc.

 Semi-Evergreen Seasonal Forest

 Others^c

^c Not included in the activity area of the Tropical Pastures Program.

Figure 3. Main ecosystems of tropical South America.

the same TWPE and wet season, but with WSMT under 23.5°C, represented primarily by the Cerrados of Brazil, which extend into Paraguay and Bolivia (Fig. 3).

These regions support extensive livestock systems (0.1 to 0.2 AU/ha) on native pastures. The extreme acidity and low fertility of the soils result in poor-quality native grassland vegetation. As only young regrowth can be grazed, the pastures have to be burned regularly; therefore, only a small proportion of primary production is available for animal feed.

The program's research effort has focused primarily on this ecosystem, for which a large number of materials, both legumes and grasses, are in advanced stages of evaluation. Several are being evaluated under grazing on research stations throughout the region and on commercial farms; and some have already been released. During the rest of the decade, there is a need to consolidate the development of new cultivars for a wider range of pasture options.

Carimagua (ICA/CIAT), located in the Eastern Plains of Colombia, is the major screening site for the well-drained isohyperthermic savannas and will continue to be the central research site for the program due to its representativeness of acid soil conditions and proximity to headquarters. However, screening new materials at Carimagua will be gradually reduced, and greater emphasis will be placed on outreach through networking activities, with slightly increased emphasis on breeding for selected characters in several promising species (*Centrosema* spp., *Desmodium ovalifolium*, *Zornia* spp., etc.), as well as both on-station and on-farm testing of materials under grazing.

Activities in Planaltina (Centro de Pesquisa Agropecuária dos Cerrados, CPAC, EMBRAPA/CIAT), the major screening site for the isothermic savannas (Cerrados), will continue during the decade. Emphasis will be given to selecting promising new grasses and legumes; networking; developing pasture establishment techniques; and both on-station and on-farm testing promising pastures under grazing.

2. **Poorly drained tropical savannas.** These areas occur throughout the South American lowlands, the largest areas being found in Bolivia (Beni), Brazil (Pantanal de Mato Grosso and Ilha do Bananal), Colombia (Casanare), and Venezuela (Apure). The poorly drained savannas usually have a somewhat higher natural fertility and higher cattle inventory than the well-drained savannas, and cattle productivity is usually higher. On the other hand, distance to markets and limited infrastructure due to seasonal flooding seriously limit production system intensification, particularly crop production.

Native species (*Leersia hexandra*, *Hymenacme amplexicaulis*, *Eriochloa* spp. and *Echinochloa* spp.) are of relatively high quality and productivity. This forage resource is available to cattle in abundant quantities during the drier, unflooded periods; however, during the extended flooded periods, the quality and availability of forage in the slightly higher, unflooded areas are limited, thus becoming the major constraint to increased production and productivity. Some CIAT materials that tolerate high grazing pressure are considered promising for these unflooded areas.

Very limited germplasm exists in the CIAT collection for poorly drained and flooded conditions. Strategies to solve the problem of excess water in the soil would imply either substantial infrastructure development or a significantly different genetic base (germplasm) and focus of the program. Because of difficulties in developing infrastructure in these areas, these savannas are considered as having limited potential for crop production in the near future and will probably continue to be devoted to extensive livestock production systems. In terms of program focus, these areas are regarded as the most distant frontier of the continent. No specific germplasm collections or establishment of major screening sites are planned, but regional trials in the higher, unflooded areas will be continued and slightly expanded.

3. **Tropical forests and humid tropics.** This ecosystem is comprised of two large areas: (a) the "Semievergreen Seasonal Forest," characterized by a short, but defined dry period (8-9 mo wet season, TWPE 1061-1300, WSMT over 23.5°C) and found in vast areas of the

Amazon and Orinoco basins of Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru and Venezuela, as well as sizable areas in Central America and the Caribbean; and (b) "Tropical Rain Forests," which are higher in total rainfall and with no defined dry period, occurring in the Andean Piedmont of the Amazon in Colombia, Ecuador and Peru, as well as in the west central lowlands of the Amazon Basin including southeastern Colombia, northeastern Peru and northwestern Brazil.

The tropical forests and humid tropics are characterized by (a) an accelerated process of spontaneous colonization, which is supported by the policies of the countries concerned, to orient or promote colonization of the region in response to demographic, socioeconomic and geopolitical pressures; (b) the possibility of introducing more intensive agricultural and/or livestock farming systems (dual-purpose systems in particular), justified by the high land-clearing costs and the higher soil fertility levels available after clearing and burning; (c) a strong and continuously growing demand for beef and milk as a consequence of population growth and increased incomes in most countries in the region; (d) an accelerated process of degradation of the ecosystem due to lack of ecologically stable pastures in farming systems; and (e) a continued and accelerating land-clearing process for pasture establishment to compensate for current degradation of pastures and the growth of the herds. Pastures are not, at present, a stable land use alternative due to the lack of germplasm adapted to edaphic, climatic and biotic conditions of the ecosystem. At present it is estimated that 30% of the 8 million ha in pastures in the Amazon forests, established after clearing, are in advanced stages of degradation and that about 50% are in the process of degradation.

New grass and legume germplasm options are urgently required to reclaim these degraded pastures. The promise of several grasses and legumes selected by CIAT for poor acid soils has been demonstrated by the RIEPT. In addition to the herbaceous germplasm with which the program is presently working, leguminous trees and shrubs should play an important role in the future within an agro-silvopastoral ecological approach. With better adapted grasses and herbaceous and shrubby legumes, the options for assembling and

managing productive and stable pastures will greatly improve, thereby optimizing nutrient recycling.

In an effort to reduce the pressure to clear even more native forests, the program is concentrating its research on the development of new germplasm options and pasture technology in order to improve productivity in formerly degraded areas. The program is thus initiating a major screening effort for this ecosystem in the Peruvian Amazon, in collaboration with two Peruvian institutions, the Instituto Veterinario de Investigaciones Tropicales y de Altura (IVITA) and INIPA. CIAT will outpost two senior scientists, and additional part-time involvement from other headquarter's staff is planned. This implies a substantial increase in involvement in this ecosystem from the present level, which is limited to backstopping the network of regional trials.

The aforementioned ecosystems occur in large areas of tropical South America, where low fertility, acid (pH 3.5-4.5) soils (Oxisols and Ultisols) predominate. Somewhat similar ecosystems also occur in Central America and Caribbean countries; however, soil acidity tends to be less (pH 4.5-5.5) and fertility is frequently better. These slightly better soil regions are also found in piedmont areas of the Magdalena, Orinoco and Amazon basins in Bolivia, Colombia, Ecuador, Peru and Venezuela.

4. **Moderately acid soils.** Regions with moderately acid soils (pH 4.5-5.5) are found across major ecosystems, scattered across tropical South America and in large areas of Central America, have rainfall patterns ranging from subhumid to humid tropic types. Because of their slightly higher soil pH and fertility, these areas support more intensive farming systems. The importance of small farms and dual-purpose systems is much greater than in the low-fertility savannas. Because of higher human population densities, infrastructure is also better than in the savannas, and the cattle numbers are substantial.

Since 1979 the RIEPT has provided preliminary evidence of the high degree of adaptation of many species to these distinct subhumid and humid, moderately acid soil environments. This and several other experimental results suggest that CIAT germplasm

selected under more stressful conditions frequently responds very well under these conditions. This leads to the hypothesis that the potential for short- and medium-term adoption of improved materials in these areas may be higher than in the savannas. On the other hand, other aspects of pasture management and weed control are as important as new improved germplasm.

One senior staff position, as well as headquarter's support for this ecosystem, is projected from 1987 onward to screen germplasm systematically and develop management techniques for this environment. It is expected that this will result in a gradual shifting of more of the benefits of CIAT's work to smaller dual-purpose farms.

Major Regions in CIAT's Mandate

CIAT has thus far concentrated its pasture research and cooperation efforts in tropical Latin America and the Caribbean; however, humid and subhumid ecosystems with acid, low-fertility soils are not restricted to the tropical American lowlands. In Africa and Southeast Asia, there are extensive areas with similar characteristics and demands for pasture improvement.

1. **Africa.** This continent has extensive areas of forest and savannas in the subhumid and humid belts where moderately acid to acid soils predominate. Trypanosomiasis and other cattle and small ruminant diseases constitute the major livestock production constraints.

ILCA and African national programs are interested in developing pasture research network activities throughout the continent. Some CIAT germplasm has already been tested in an exploratory way at a few locations, and its performance seems to be promising, especially with respect to tolerance to diseases and pests (e.g., anthracnose of *Stylosanthes* spp.). Thus CIAT's germplasm and network organization could represent important contributions, especially for the humid and subhumid regions of Africa.

On the other hand, Africa is the center of origin and diversity of most grass species utilized in the tropics as commercial cultivars. This wide variability in grasses has yet to be thoroughly collected and evaluated. During 1984-85, a major collection effort under-

taken in cooperation with ILCA and IBPGR yielded a substantial number of accessions with a wide range of variability in *Brachiaria* spp., a genus so far only superficially explored despite its great importance for the tropical American lowlands, where spittlebug is a devastating pest of *B. decumbens*, a single cultivar which is widespread.

Consequently, it is envisaged that, in the future, cooperative activities with ILCA will be expanded to the point where a liaison scientist will be necessary in order to facilitate the movement of germplasm in both directions and to conduct network activities with ILCA on the African continent. Although this position figures in CIAT's projections for 1988, it will depend on a joint ILCA/CIAT decision.

2. **Southeast Asia.** Humid and subhumid zones predominate in Southeast Asia. Most of these areas range from acid to moderately acid soils. Vast areas of the unproductive *Imperata* grasslands are the result of burning and shifting cultivation on the poorer acid soils. Some national pasture research programs are successfully testing CIAT germplasm, for which there has been an increasing demand; however, it should be kept in mind that most cattle in S.E. Asian countries (cattle and buffaloes) are predominantly for working (drafting) in farmers fields; and the role of pastures in these farming systems is strongly contrasted with that of pastures in extensive savanna farming systems where CIAT has accumulated its germplasm options and experience. CIAT will continue providing germplasm to national programs in the region upon request. It is envisaged, however, that at the end of the decade (after gaining experience and selecting pasture plant germplasm for the more intensive farming systems in the humid tropics and moderately acid soils), the program will be in a position to develop stronger cooperative activities with national programs in Southeast Asia. The possibility of outposting any liaison scientist in the region, however, will be considered at the end of the decade.

General Research Strategies

Basically, the Program's strategy will remain the same: generating new germplasm options for pastures adapted to the multiple subhumid and

humid ecosystems and suitable for the range of farming systems that predominate in the tropical lowlands. The emphasis will continue to be on germplasm and pasture technology development. The program's general research strategy is based on the following principles, which are in compliance with its general objectives:

1. **Low-input technology based on indigenous resources.** Given the long-term nature of pasture research, the future economic framework within which farms in the target area will operate should be taken into account. Forecasts point to limited availability of fertilizer and lime and high transportation costs, as well as political pressures for low beef and milk prices. Given these perspectives and the present characteristics of frontier production systems (i.e., extensive operations, limited capital and credit availability, and limited managerial resources), research needs to be focused on low-input systems based on adapted germplasm and efficient utilization of available local resources rather than correcting soil deficiencies with large amounts of amendments and fertilizers.
2. **Exploitation of natural genetic variability.** Program emphasis is on collecting, characterizing and evaluating a wide range of species, especially those that have not been domesticated, in order to provide genetic alternatives for use in acid soils. Thus emphasis is on selecting materials based on natural variability rather than on plant breeding although specific constraints of otherwise promising materials are being dealt with through breeding.
3. **Use of grass-legume mixes.** The introduction of forage legumes into traditionally grass-based pasture systems is emphasized. Legumes in symbiosis with rhizobia are expected to contribute directly to the diet of animals in terms of protein (particularly during the dry season) and to improve the yield, quality and persistence of grasses due to enhanced nitrogen availability in the system.
4. **Development of frontier systems.** Consistent with the land resource base of tropical America and the demand for low-cost beef and milk, the program works with national programs on the joint development of pasture-based technology that will allow for the intensification of livestock production on frontier lands with low opportunity cost. Emphasis is being placed on various options of

pasture technology for different farming systems, ranging from extensive cow-calf operations in the distant frontier areas to small-scale dual-purpose systems in areas closer to markets.

5. **Collaboration with national programs.** In collaboration with the national programs, CIAT has developed a research strategy that includes: (a) developing a broad germplasm base; (b) undertaking basic germplasm characterization research; (c) multilocational screening of germplasm for each distinct ecosystem; (d) assembling promising germplasm into legume-grass associations and evaluating their management and productivity under grazing; and (e) exposing promising pasture technology to relevant farming systems.

Recent developments such as the significant on-station and on-farm increases achieved in terms of stocking rate and animal productivity have effected a radical change in land and capital productivity, thereby opening up completely new production possibilities. In particular, substantially smaller production units become viable under these conditions. Furthermore, research results from the program and the RIEPT indicate that many of the highly promising materials selected under extremely poor conditions perform very well under somewhat more favorable conditions; i.e., in the humid tropic and moderately acid soil environments, often in areas closer to markets, where smaller farms frequently have dual-purpose cattle and crops. These regions normally benefit from more favorable input/output price ratios due to proximity to markets; however, land prices are higher, making more intensive land use necessary. Milk production increases the return on investment in improved pastures and improves cash flow, thus facilitating the financing of pasture improvements.

The program will continue to focus its attention on the development of germplasm and technology for the frontier lands with acid infertile soils while allocating some resources to testing materials for smaller farms on acid and moderately acid soils. In the long run, major benefits are expected from the increased beef supply from the frontier regions; moreover, sizable additional benefits are expected, in the short to medium term, from the intensification of smaller dual-purpose (beef and milk) farms closer to markets with positive income distribution effects.

Program Organization

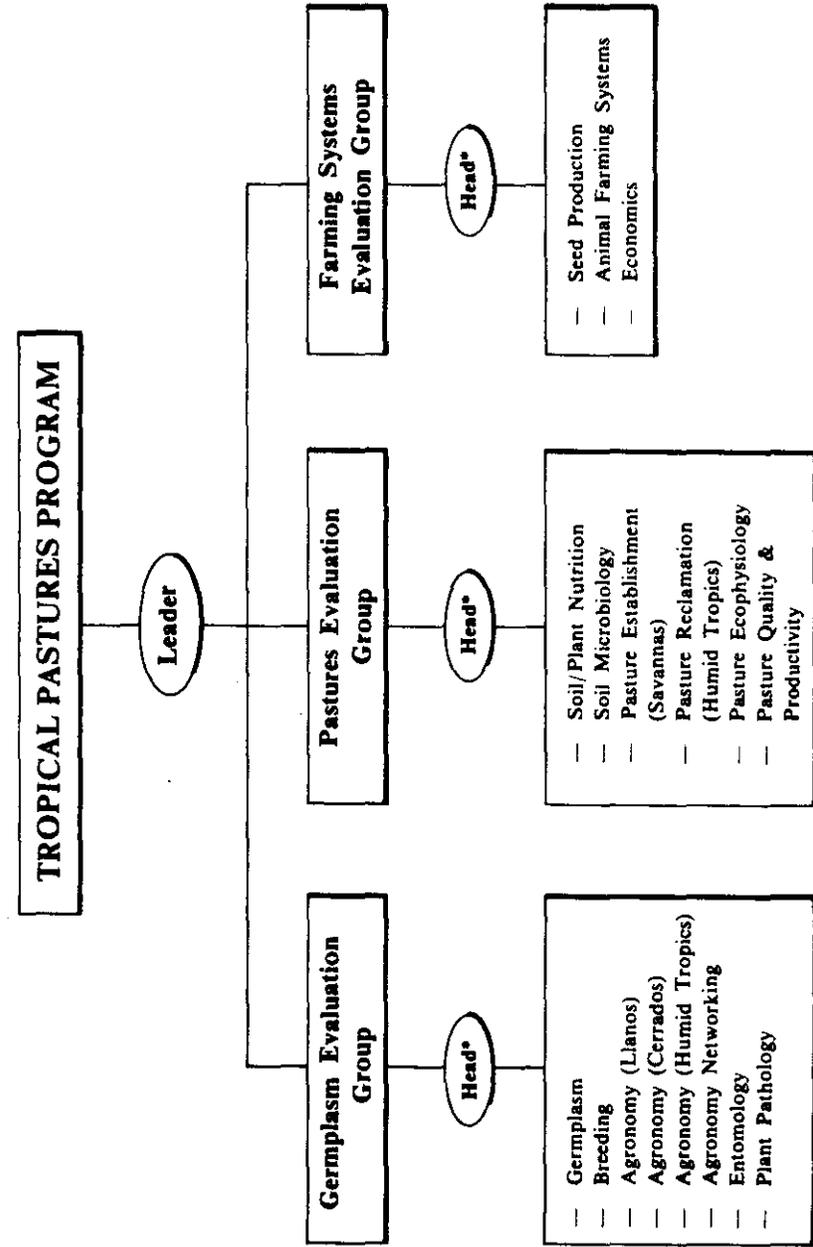
The multidisciplinary Tropical Pastures Program team has been organized on the basis of three groups of researchers to integrate activities and communication and to achieve the program's objectives more effectively (Fig. 4). The three groups are (a) **Germplasm Development**, including germplasm specialists, breeders, a pathologist, an entomologist and agronomists; (b) **Pasture Evaluation**, including the soil/plant nutritionist, soil microbiologist, pasture development specialist, ecophysiological, animal nutritionist; and (c) **Farming System Research**, including the animal scientist-farming systems specialist, seed production specialist and economist.

The basic strategies and structure of the program will remain the same for the rest of the decade. However, with new developments and consolidation of the present research approach, changes in emphases are expected.

Germplasm Development Group

Upon extending the program's activities from savanna ecosystems to the humid tropics (1985) and moderately acid soils (Central America in 1987), the germplasm group will have the following changes in emphases and strategies:

1. Increased emphasis on collecting grasses and shrubby legumes in tropical America, Asia and Africa. Future collection activities will be highly specialized to increase the variability of key species.
2. Greater decentralization of germplasm screening, establishing major screening sites for the humid tropics (INIPA/IVITA, Pucallpa, Peru), as well as for moderately acid soils (Central America).
3. Further decentralization of the network (RIEPT) activities in four parallel subnetworks in the continent: (a) the Llanos in Colombia, Venezuela, northern Brazil, Guyana and Surinam; (b) Central America and the Caribbean (Mexico, Nicaragua, Costa Rica, Panama, Guatemala, Honduras, Jamaica, Cuba, Dominican Republic); (c) the humid tropics of Ecuador, Peru, Bolivia, Brazil and Colombia; and (d) the Cerrados and Beni (Brazil, Bolivia,



* The position of Head corresponds to one of the scientists in the respective group.

Figure 4. Organizational Chart of the Tropical Pastures Program.

Paraguay, northeastern Argentina). A similar networking approach would eventually be developed for Africa and Southeast Asia.

4. Increased breeding activities over time in order to solve specific problems of highly promising germplasm after specific characters have been defined and parental donor material identified. In addition to the current breeding program in *Stylosanthes*, the potential for breeding has already been identified for the following legumes and grasses: *Desmodium ovalifolium* for the combination of resistance to stem gall nematode and higher forage quality; *Centrosema* spp. for tolerance to various diseases (bacteriosis, *Cercospora* and virus) and seed production; *Zornia* spp. for tolerance to *Sphaceloma* scab and drought; and *Brachiaria* spp. for resistance to spittlebug.

Pasture Evaluation Group

The group working on pasture evaluation and development will continue its research based at Carimagua and Quilichao. In addition to current responsibilities of evaluating and managing the soil/plant and plant/animal interactions for the savanna ecosystems, they will also be responsible for developing grazing management techniques and research methodologies to be used in the humid tropics and the moderately acid soils ecosystems.

Emphasis will be placed on nutrient recycling in pastures under grazing (integrating soil/plant nutrition, soil microbiology and grazing systems) to understand fully the ecophysiology of pasture associations in order to optimize productivity and persistence.

A second scientist is projected to be outposted in the humid tropics ecosystem (Pucallpa, Peru) specifically to address the problem of pasture reclamation of degraded areas. Pasture establishment and reclamation research will follow two strategies: (a) development of low-cost techniques by making effective use of naturally available resources and low levels of inputs (e.g., minimum tillage, fertilizer placement, use of colonizing legumes or grasses, etc.), and (b) integrated establishment of pastures with trees and annual crops, particularly in the humid tropics and moderately acid soils ecosystems.

Farming Systems Research Group

The economist and the production system specialist have been providing important feedback to the program, especially for the savanna ecosystems. The team has accumulated experience in the monitoring and evaluation of improved technology at the farm level in extensive systems.

With the expansion of activities to the humid tropics and the moderately acid soils, the program will face more intensive farming systems [e.g., mixed (pasture-crops) and dual purpose (beef and milk)], where the roles of pastures and forages are different. The group will carefully select a few case studies of relevance to the program to produce the required feedback and simultaneously develop on-farm research methodologies for technology validation by national programs. With the release of new cultivars, the group, which includes a seed technology specialist, has an important role in providing seed production recommendations and monitoring the adoption and performance of these new pastures jointly with national programs.

Staffing Projections

The foregoing changes require some modifications in the discipline structure and location of senior staff positions in the program. These are included in the staff projections 1985-90 (Table 5). Currently, the program has 16 senior staff positions, heavily concentrated at Palmira headquarters. Over the next five years, total core positions are projected to return to the previous level of 20.

Because of the need to decentralize activities, particularly for the new ecosystems, the number of headquarters positions is expected to be reduced to 14 (Fig. 5). Staff will be outposted to the Cerrados screening site, the humid tropics and moderately acid soils ecosystems. At the same time, the advance of germplasm will require increased networking activities to test these materials over a wider range of locations. Consequently, the agronomists as well as other program scientists will gradually increase their involvement in networking activities (Fig. 5). Finally, one further position is projected outside of Latin America as a liaison officer with ILCA to support germplasm exchange with Africa. This position is tentatively planned for 1988.

Number of
senior scientist
positions

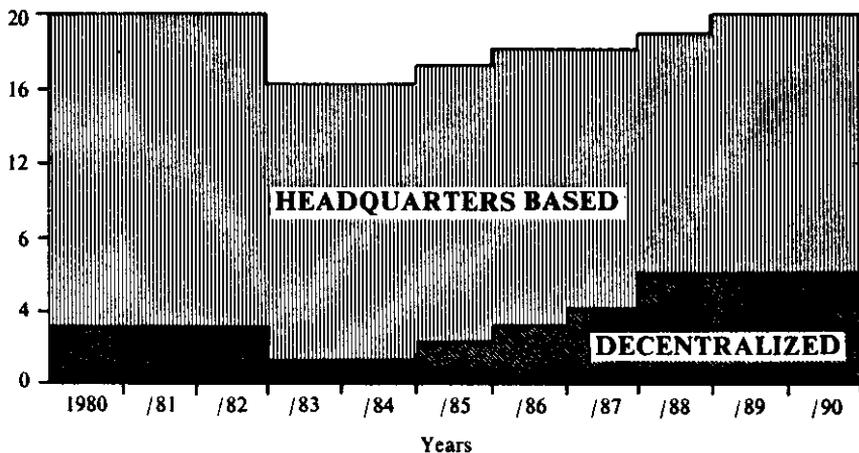


Figure 5. *Development and decentralization of senior scientist positions in the Tropical Pastures Program, 1980-1990.*

The decentralization of activities to cover the program's growing mandate appropriately is shown in Figure 6. At the same time there will be increased networking activities to catalyze and enhance the research and development of national programs. This will be achieved without losing the critical mass of scientists at headquarters, which is essential to the maintenance of the high standard of scientific research for the generation of germplasm and new technology. In the next decade, this critical mass of core staff at headquarters will gradually be reoriented toward more basic research as national programs increasingly take on more responsibilities in technology development.

Table 5. Approved senior staff positions in the CIAT Tropical Pastures Program for 1980-1985 and projected positions for 1986-1990 from core funding (CF) and corelike (CL) projects.

Positions	Funding source	80	81	82	83	84	85	86	87	88	89	90
Headquarters based												
Leader	CF	1	1	1	1	1	1	1	1	1	1	1
Germplasm Specialist	CF	1	1	1	1	1	1	1	1	1	1	1
Agronomy (Regional trials, Llanos)	CF	1	1	1	1	1	1	1	1	1	1	1
Breeder	CF	1	1	1	1	1	1	1	1	1	1	1
Breeder	CF	1	1	1 ^a	-	-	-	-	-	-	1	1
Regional trials	CF	1	1	1	1	1	1	1 ^b	-	-	-	-
Pathologist	CF	1	1	1	1	1	1	1	1	1	1	1
Entomologist	CF	1	1	1	1	1	1	1	1	1	1	1
Soil/Plant Nutritionist	CF	1	1	1	1	1	1	1	1	1	1	1
Microbiologist	CF	1	1	1	1	1	1	1	1	1	1	1
Pasture Development Specialist	CF	1	1	1	1	1	1	1	1 ^c	-	-	-
Pasture Management & Evaluation	CF	1	1	1	1	1 ^d	-	-	-	-	-	-
Ecophysiologist	CF	-	-	-	-	-	1	1	1	1	1	1
Pasture Quality/Productivity	CF	1	1	1	1	1	1	1	1	1	1	1
Seed Production Specialist	CF	1	1	1	1	1	1	1	1	1	1	1
Livestock Systems Specialist	CF	1	1	1	1	1	1	1	1	1	1	1
Economist	CF	1	1	1	1	1	1	1	1	1	1	1
Animal Health	CF	1	1	1 ^e	-	-	-	-	-	-	-	-
Decentralized regional programs												
Tropical South America (Cerrados ecosystem)												
Agronomist (Regional trials)	CF	1	1	1	1	1	1	1	1	1	1	1
Soil Pasture Develop. Specialist	CF	1	1	1 ^f	-	-	-	-	-	1	1	1
Pasture Management	CF	1	1	1	-	-	-	-	-	-	-	-
Tropical South America (Humid tropics ecosystem)												
Agronomist (Regional trials)	CF	-	-	-	-	-	1 ^g	1	1	1	1	1
Pasture Reclamation Specialist	CF	-	-	-	-	-	-	1 ^g	1	1	1	1
Central America (moderately acid soils)												
Agronomist (Regional trials)	CF	-	-	-	-	-	-	-	1 ^h	1	1	1
Africa												
Regional liaison (CIAT-ILCA)	CL	-	-	-	-	-	-	-	-	1 ⁱ	1	1
Total headquarters		17	17	17	15	15	15	15	14	13	14	14
Total decentralized		3	3	3	1	1	2	3	4	6	6	6
GRAND TOTAL		20	20	20	16	16	17	18	18	19	20	20

a Breeder. This position was discontinued in 1982 due to center-wide budget cuts, but it has been projected to be reestablished in 1989 as the requirements of increased breeding intensify and as more basic research on selected species becomes more critical.

b Regional Trials. This position is projected for discontinuation at headquarters in 1986 as research increasingly becomes a decentralized collaborative effort with the RIEPT. It will be moved to Central America for screening research and networking activities (see h).

c Pasture Development Specialist. This position is projected for discontinuation at headquarters as the research on the Llanos reaches a stage where basic technology components have been developed for this ecosystem. It is projected to be reestablished in the Cerrados in 1988 (see f).

d Pasture Management and Evaluation. This position was discontinued in 1984 and the responsibilities reassigned to other scientists in order to allow increased upstream emphasis on pastures ecophysiology, thus providing a better understanding of environmental and management interactions in associations.

e Animal Health. This position was discontinued in 1982 as part of center-wide budget cuts. Research in animal health had reached a stage where the basic problems had been described; thus further research and extension became a national responsibility. Monitoring of animal health issues in association

f Soil/Pasture Development Specialist. This position was discontinued in 1982 due to center-wide budget cuts. The position is projected to be reinstated in 1988 as second-generation problems in the Cerrados ecosystem create a need for further research (see c).

g Humid Tropics Positions. In line with the expansion of the program into this ecosystem, two positions for 1985 and 1986, respectively, will complete the team required for this outposted research. These positions have been endorsed by the Technical Advisory Committee (TAC) since 1983 and recommended for funding in 1984 and 1986, respectively.

h Agronomist in Central America. An outposted regional agronomist position is projected for 1987 as program germplasm research provides appropriate materials for testing in this ecosystem. This position will be moved from headquarters to conduct ecosystem-specific research (see b).

i Regional Liaison Africa. This outposted regional liaison position with ILCA is projected as a means of increasing germplasm collection and development research collaboration between the two institutions for the more humid and subhumid areas of Africa. The role of this position will be somewhat dependent on the evolution of pasture research at ILCA.

Relative emphasis
of total senior
scientist
positions
(%)

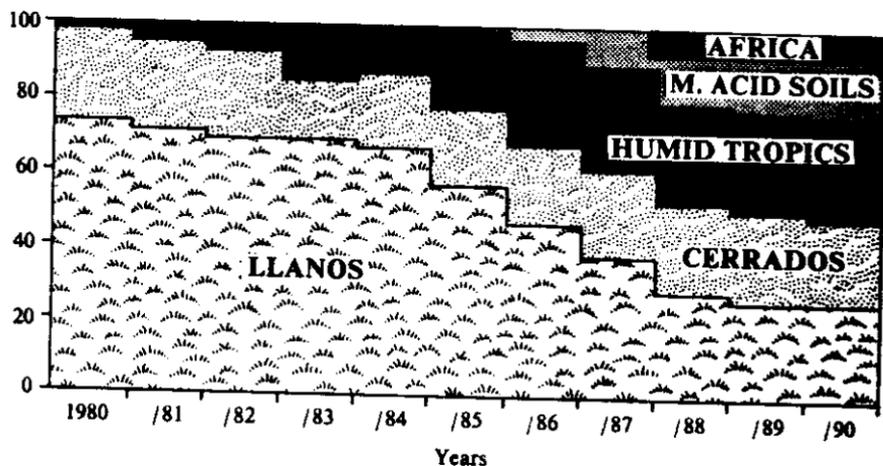


Figure 6. *Relative emphasis of total senior scientists in the Tropical Pastures Program dedicated to the different ecosystems and continents, 1980-1990.*