Executive Summaries of 1994 Annual Reports

for

Programs, Units and Scientific Resource Groups

February, 1995

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BEAN PROGRAM

In 1994 CIAT underwent major transitions in organization including the move to project based management reflected in this summary For the Bean Program these changes were accompanied by important milestones in our work in addition to continued advances across a broad range of research and network activities Among the highlights are

The Core Collection of germplasm has moved fully from a development and testing stage to maturity as a research tool This year evaluations were conducted for seed protein types tolerance to low P and Mn toxicity adaptation to water deficit and temperature response of phenology

The Bean Program s 15 year old set of uniform nurseries was restructured focusing on one main nursery the International Bean Nursery (IBN) which will be run on a two year cycle National programs and the private sector are encouraged to contribute lines to the IBN and collaborators in several countries will evaluate the IBN for traits not readily tested by CIAT

The Program now has in house capabilities for developing molecular markers for economic traits Using recombinant inbred lines developed within the program molecular markers for genes for tolerance to common bacterial blight bean golden mosaic virus and drought are being developed

The tragic war in Rwanda lead to the Seeds of Hope initiative This major collaborative effort between IARCs NGOs and foreign aid programs has the duel goals of helping relief efforts provide Rwandan farmers with seed stocks of bean and other crops while protecting the genetic diversity in the region and of understanding how genetic diversity is affected by major catastrophes and how diversity should be managed in future relief efforts

Confirming our continued committment to improvement of bean production through plant breeding over 15 bean cultivars derived from CIAT materials were released by NARS in 1994

Bean Project Area BP *Phaseolus* Diversity

Project BP01 *Phaseolus* Conservation
Received about 2 000 accessions from Rwanda Burundi Honduras and Chile
Placed 1 356 accessions in long term storage
Renewed stocks for short term storage of 1 472 accessions
Distributed 8 877 accessions 6 007 within CIAT and 2 870 to researchers in 19 countries
Developed a GIS predictive model for presence of wild *P vulgaris*

Project BP02 *Phaseolus* Genetic Structure
Completed characterization of seed proteins in the core collection
Used RAPD markers to validate the selection procedure used to develop the core collection
Initiated laboratory evaluations to find molecular markers linked to drought tolerance resistance to BGMV and resistance to Common Bacterial Blight
Evaluated a uniform nursery of 208 entries in three environments in Colombia Chile Costa Rica Honduras Mexico USA Canada Spain and Iran to examine relations among phenology adaptation and disease reactions
Confirmed resistance to bean pod weevil (*Apion godmani*) in new germplasm (with INIFAP) Characterized climbing snap bean germplasm for pod traits growth habit days to flower seed characters and phaseolin type
Classified protein fractions of seed of *P coccineus* and *P polyanthus* using methods developed for characterizing races of *P vulgaris*

Project BP03 Wild and Cultivated *Phaseolus* Species
Expanded program of interspecific crosses to include a wider range of *P acutifolius* germplasm and the first *P coccineus* parents (immune to BGMV)
New sources of wild *P Vulgaris* resistant to *Zabrotes subfasciatus* were identified and characterized for arcelin variants

Project BP04 Bean Utilization
Demonstrated that *P coccineus* has higher protein content and digestibility than *P vulgaris*

Bean Project Area BY Bean Yield Stability

Project BY01 Biotic Stress Resistance
Characterized the virulence diversity of the angular leaf spot pathogen (*Phaeoisariopsis griseola)* for different geographic regions using differential cultivars The diversity was then associated with DNA polymorphisms detected with RAPDs in order to understand the evolution of the pathogen
Characterized the DNA polymorphism and virulence diversity of *Colletotrichum lindemuthianum* in Colombia using RAPDs and differential cultivars
Demonstrated differences in seed transmission of common bacterial blight *Xanthomonas campestris* for cultivars and bred lines in Uganda (with NARO Uganda)
Characterized the distribution of bean common mosaic virus (BCMV) for 12 countries in Africa showing that a NL3 type strain is the most widely distributed but is not found in Ethiopia (with Wellesborne UK)
Demonstrated that necrotic strains of BCMV were found in naturally infected seed of many wild legumes in Uganda and that aphids can serve as vectors between bean and wild legumes (with NARO and Wellesborne)

Demonstrated that CAL 143 possesses good multiple disease resistance for halo blight powdery mildew and ALS in several parts of Africa
Based on preliminary data found that resistance to *Apion godmani* is controlled by one or two dominant genes (with INIFAP Mexico)
Initiated a project for multiple insect resistance in Central America (with PROFRIJOL)
In evaluations of 180 F_3 populations in Tanzania for resistance to bean stem maggot (BSM) found that the line ZPv 292c gave especially promising progeny
Found variation among cultivars for adult attraction infestation and larval survival of BSM
Demonstrated that resistance to bean weevil (*Acanthoselides*) is not due to amylase inhibitors or certain volatile compounds but that avidin (not found in bean) is a very strong growth inhibitor (with NRI UK)
Found better sources of resistance to bruchids in *P acutifolius* and *P lunatus*

Project BY02 Abiotic Stress Tolerance
For Andean germplasm showed that variation in depth of rooting is a mechanism of drought avoidance
Using the simulation model BEANGRO showed that greater root growth would enhance yield under water deficit even in shallow soils and for early maturing cultivars
Through use of recombinant inbred lines showed that erect growth habit is not associated with poor yield under water deficit
For Andean and Mesoamerican germplasm developed lines showing excellent levels of drought tolerance compared to tolerant checks
Identified additional germplasm with high levels of field tolerance to low P availability including further germplasm from hot spots in Peru and Mexico
Found that root surface area root fractal dimension and rooting angle correlate well with efficient P uptake
Found cultivar differences in N_2 fixation under low P availability
Identified promising germplasm for tolerance to acid soils in Malawi
Characterized leaf bronzing associated with up to 50% yield loss in Tanzania (*Problem Y*) as associated with soils showing low Mn and Mg but found that the problem does not respond to simple fertilizer regimes

Project BY03 Improved Yield Potential
Found that some Andean lines developed for warm environments also grow well at high latitude sites in Argentina Chile and South Africa
Showed that the temperature sensitivity of photoperiod response of flowering is controlled by genes besides *Ppd* and *Hr*

Developed a crop simulation model for bean that uses genotypes (seven genes *Fin Ppd Hr Fd SSz 1* and two additional hypothetical genes for seed size) rather than cultivar specific coefficients to represent cultivar differences and that can account for over 60% of observed variation in seed weight and phenology
Through simulation experiments with the model BEANGRO showed that increasing leaf photosythetic rate by creating thicker leaves should increase seed yield even though LAI is reduced
Confirmed that use of Andean germplasm for improvement of Middle American cultivars (e g as sources of disease resistance) will be difficult due to reduced yield potential
Showed that random intermating in early generations can increase seed yield of S_4 families presumably due to breakage of undesirable linkages
In comparisons in Uganda of seed yield and cooking traits of multiline varieties confirmed the yield advantages of multilines but benefits varied with the mix of lines used

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

Project BL01 Germplasm Improvement (Latin America)
Liberation of CIAT lines selections from crosses or germplasm distributed by CIAT as cultivars by national programs included

Peru (INIA)	Jacinto Bayo Mochica and Garza INIA
Ecuador (INIAP)	INIAP 416 Canario
Brazil (various)	Ouro Branco Corrent Bambui Xamego

Project BL02 Network Development (Latin America)
Complementary subproject BL51 Proyecto regional de frijol zona Andina (PROFRIZA)
Formed farmer groups for artesan seed production in Bolivia Ecuador and Peru
Identified 23 races of anthracnose in the region permitting more strategic use of resistance
Identified promising sources of resistance for major diseases in the region
Using community based participatory methods developed soil conservation strategies for bean production regions In Ecuador the community El Inca received a special recognition from FAO for their efforts

Complementary subproject BL52 Proyecto regional de frijol para Centro America México y el Caribe (PROFRIJOL)
Identified promising sources of heat tolerance in nursery evaluated by the University of Puerto Rico (project co leader)
Advanced studies on breeding for multiple disease and pest resistance

Project BL03 Integrated Bean Production Systems (Latin America)
In follow up surveys in Colombia found that 50% of farmers spray on a calendar basis to control whitefly despite results indicating that the insect does not cause economic damage but that 78% of farmers were interested in applying concepts of simplified action thresholds
In comparisons of IPM systems with farmer practices found no differences in yield
While many components of IPM for insect pests are available for Colombia Ecuador and Peru concluded that more farmer participatory work is needed to refine methods
Established cultivar adaptation web blight and P fertilization trials in the forest margins of Brazil identifying web blight as a critical constraint (with CPAF/Acre)

Bean Project Area BA Sustaining Bean Productivity in Sub Saharan Africa

Project BA01 Germplasm Development (Sub Saharan Africa)
Distributed first African BCMV nursery (NIGPADN) with bc3 or $bc2^2$ sources of resistance which already show excellent yields
Evaluated 100 lines of the BALSIT for ALS resistance in Uganda in response to survey showing that ALS is the most important Pan African bean disease
Prepared random mated populations of the most tolerant materials for bean stem maggot
Distributed and evaluated AFBYAN III the third Pan African uniform yield trial

Complementary subproject BA54 Bean improvement in Malawi
Evaluated lines from the 1992 VEF Rwandan germplasm and the CIAT Core Collection
Conducted a preliminary bean variety trial of 34 entries in four environments

Project BA02 Network Development (Sub Saharan Africa)
Conducted Pan African workshops on edaphic stresses and on bacterial and viral diseases
Conducted first CIAT Multidisciplinary Course (8 weeks)

Subproject BA12/BA51 Collaborative bean research network for the eastern Africa region (EABRN) phase 3 Evaluated integrated management of root rots in Kenya (project headed by KARI) finding several tolerant lines representing diverse grain types

Subproject BA13/BA53 Great Lakes regional bean research network (RESAPAC) phase 3
Collaborated in the Seeds of Hope program to guide relief efforts and to aide farmers in protecting genetic diversity after the war in Rwanda

Complementary subproject BA52 Southern Africa regional bean research (SADC)
Established a system of zonal trials for the region The SAZBEN (100 lines) was distributed to 10 countries and SAZBYT (15 entries) to seven

Project BA03 Seed Distribution and Farmer Participation (Sub Saharan Africa)
Conducted workshop on alternative seed production systems in the region
Conducted diagnostic study of seed production in Uganda suggesting that farmers grow few varieties apparently due to the strong interest in bean as a cash crop
Studied strategies for low cost distribution of improved bean cultivars
Studied seed diffusion of cv Lyamungu 90 in Tanzania

Complementary subproject BA55 Swiss associate for the bean research program in Uganda
Used farmer participatory methods to guide research on soil improvement pest and disease management and release of new bean varieties
Developed strategy for conserving bean germplasm with seed drying to 6% over silica gel and storing seed in hermetically sealed containers

Publications and Workshops

Articles in refereed journals	15
Other articles	21
Presentations at meetings or workshops	
Invited papers	3
Regular papers/posters	7

CASSAVA PROGRAM

The CIAT Cassava Program in collaboration with the Genetic Resources Unit (GRU) the Biotechnology Research Unit (BRU) & the Virology Research Unit (VRU) organizes its activities around four research areas *Manihot* Genetic Resources Gene Pool Development Crop Management and Product Process & Market Development The Program also plays an active role in catalysing and promoting mechanisms for enhanced cooperation among institutions and individuals at national regional and global levels

Manihot Genetic Resources

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

New germplasm of cultivated cassava and *Manihot* species were incorporated into the world collection this year Collection activities followed newly recommended documentation schemes which should limit the likelihood of acquiring duplicate accessions and facilitate use of the germplasm Simultaneously a data base documenting the distribution of *Manihot* species was begun The data base is compatible with Geographic Information Systems and will be applied to appreciating the ecological provenances of wild germplasm

Molecular markers were used to confirm putative duplicates in the germplasm collection suggested by prior morphological and isozyme characterization resulting in a reduction of the total number of accessions to be maintained in the field gene bank Markers based on amplification of polymorphic DNA sequences (RAPDs) were applied to measuring relationships among elite clones adapted to different production ecozones to form a base data set for quantifying diversity in various components of gene pools available for cassava improvement Two types of molecular markers RAPDs and RFLPs from DNA probes developed at CIAT were used to construct the first genetic map of cassava based on their segregation in an intraspecific cross

Evaluation of the same cross for morphological and physiological characteristics has begun toward understanding the genetic basis of useful variation

The core collection of cassava germplasm was evaluated for four parameters of root quality to assess diversity available for the development of cassava for different end uses Dry matter content cyanogen content starch content and amylose percentage of starch were evaluated and association among these characters were studied Significant differences were found in starch functional properties between groups of genotypes with high and low cyanogen content

The heritability and effect of environmental conditions on cyanogenesis were also studied This investigation and germplasm characterization will be facilitated by improvements made this year in the assay procedure for cyanogens eliminating the need to work with noxious reagents Progress was also made toward understanding the basis of cassava s ability to maintain high photosynthetic rates under conditions of drought and temperature stress High activity of photosynthetic enzymes and unusual anatomic features possibly related to xerophytic adaptation were discovered in two *Manihot* species Research was initiated toward the recognition of biochemical indicators that could be used in screening cassava germplasm for resistance to post harvest deterioration or toward manipulation of deterioration through genetic engineering

Cassava Gene Pool Development

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

The efficiency of cassava breeding for dry matter production is being improved by basing selection of promising materials on indices developed by factor analysis taking into account the heritability of the most related traits such as number of commercial roots plant architecture and leaf retention

The development of a reproducible protocol for genetic transformation continues to be elusive Regenerated putative transformed cassava plants failed to express the GUS gene but two plants showed resistance to Basta herbicide The integration of the introduced genes is being studied

Additional sources of host plant resistance to mites thrips cassava bacterial blight and root rots have been detected in field and/or greenhouse germplasm evaluations Only differential tolerance has been observed in certain genotypes under heavy mealybug attack Resistance to whiteflies interpreted by low survival to adult stage a longer life cycle and a higher detachment of nymphs and pupae is closely related to the concentration of tricomes in young cassava leaves

Screening of cassava germplasm under low P and low K soils has resulted in the selection of several genotypes with very good nutrient use efficiency Those genotypes allocated more photosynthates to storage roots than to stems Although cooler climates impose serious constraints to photosynthetic capacity it has been possible to detect genotypes with considerably higher rates that will contribute to the improvement of yield potential in the highland ecosystems

A total of 27 new genotypes have been added to the elite clone pool which integrate higher dry matter yield resistance to the main biotic and abiotic constraints and good quality for different end uses The selection of two elite clones with high levels of resistance to bacterial blight in the highlands (SM 524 1 and CG 402 11) will contribute to the integrated control of the disease in that ecosystem

The continuous introduction of Latin American germplasm into Africa has resulted in the selection of several elite genotypes for the semi arid regions of Northern Nigeria Although the frequency of ACMV resistant genotypes among Latin American germplasm is very low two clones of pure Latin American origin have been selected with good levels of resistance by IITA scientists

Cassava gene pools developed jointly by CIAT and the Thai National Program are providing better chances for the selection of elite genotypes among Asian cassava breeders A steady progress in cassava breeding can be observed when comparing the latest selections with the local checks or previously released varieties Cultivars such as Rayong 60 and Kasetsart 50 are demonstrating broad adaptation capacity

Elite germplasm selected by Brazilian scientists within a special project for the semi arid and sub tropical ecosystems financed by IFAD is being subjected to farmers evaluation in order to gain feedback on selection criteria and speed up the varietal selection and diffusion process

Integrated Crop Management

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

Research on quality of planting materials indicated that stakes from well fertilized soils had higher nutrient contents better germination and higher root yield in subsequent crops under low soil fertility The increase in yield due to better stake quality ranged from 60 to 90% in absence of chemical fertilizer application These findings have important practical implications for cassava producers especially where soils are low in fertility

Data collection on soil losses and soil characterization on erosion plots in Quilichao and Mondomo in Colombia is in its seventh year and constitutes a valuable source for model validation and development

Erodibility of soils (K factor of the USLE model) increased with time and real soil losses were consistently higher than those predicted by the model Newly developed model equations to estimate K for the two sites were based on easy to determine physical surface soil characteristics and resulted in a much better prediction of soil losses

Contour ridges hedgerows with dwarf elephant and vetiver grass and undersowing with less competitive forage legumes e g *Chamaecrista rotundifolia* have been identified as sustainable cropping technologies and are in the process of farmers evaluation and on farm testing in collaboration with the Hillsides Program and national organizations A plant for extraction of essential oil from citronella hedgerows was constructed with a farmers group as an attempt to develop integrated concepts linking conservation components to opportunities for income generation

Following six years of research to develop a range of technology components for preventing soil degradation in cassava based cropping systems in Asia greater emphasis is now being placed on participatory evaluation with farmers of the most appropriate options In a project supported by the Sasakawa Foundation eight pilot sites in four countries (Thailand Indonesia China Vietnam) have been selected In July a workshop was organized at Rayong Thailand to familiarize national program agronomists and extension leaders with farmer participatory research methodologies

The complete sequence of cassava vein mosaic virus (CVMV) has been determined and a PCR method to detect the virus developed During the molecular characterization of cassava common mosaic virus (CCMV) the presence and the encapsidation of a defective RNA species was confirmed Defective RNA species often interfere with viral replication and may be a natural control for the disease caused by CCMV

Three species of phytoseiid predators of the cassava green mite from Brazil have been successfully established in Africa Two species of parasitoids of the cassava mealybug and one phytoseiid predator of the cassava green mite from CIAT have been released in N E Brazil Laboratory studies show that the dipteran midge *Forcipomyia eriophora* is capable of transmitting the baculovirus from infected to non infected cassava hornworm larvae This is the first recorded case as far as we know of an insect virus being vectored by another insect species

There has been enthusiastic response from national and state level agencies in N E Brazil to the farmer participatory techniques that are being implemented within the integrated pest management project funded by UNDP Diagnostic surveys completed during the year are providing an essential framework for integrated activities by researchers extensionists and farmers

Product, Process and Market Development

Purpose To strengthen links between farmers and markets and obtain orientation for gene pool development through research on process product and market development

An international meeting on Cassava Flour and Starch organized in collaboration with CIRAD SAR was held at CIAT in January 1994 130 scientists from 20 countries attended the meeting at which papers on current uses and future potential physico chemical properties bioconversion and by product use and treatment technology development new products and integrated cassava projects were presented

The pilot plant for the production of cassava flour located on the Atlantic Coast of Colombia has increased its sales to the small scale food industry and penetrated the adhesives market The plant has now moved to semicommercial production that will provide reliable data on its economic feasibility 4 cassava flour plants have been established in different regions of Peru by CARITAS

Fermented cassava starch has proven to be the unique in terms of conferring expansion properties to bakery products Trials with maize rice and potato failed to produce modified starches with expansion properties This cassava characteristic could open up important niche markets for starch in dietary and gluten free products

A hydrocyclone that concentrates starch milk and thereby reduces water use has been successfully field tested by NRI in small scale starch extraction factories in Colombia The adoption of this simple technology would substantially reduce the polluting effect of effluent from these factories

Institutional Development

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

The global cassava needs assessment exercise that was initiated in 1993 has been completed This study has quantified the major constraints faced by cassava farmers and processors by continent and by ecosystem This information is in the process of being further reviewed by national program collaborators

Program scientists participated in a rapid rural appraisal conducted during August 1994 in 3 provinces of South China as part of a larger strategic planning exercise to set priorities for cassava R and D

The study highlighted the overriding importance of cassava as an industrial crop for starch the growing demand for this product potential environmental problems associated with processing waste disposal and the reduced number of cultivars that are being grown

The Second International Scientific Meeting of the Cassava Biotechnology Network (CBN) held from 21 to 26 August in Bogor Indonesia was attended by 150 scientists Progress in the mapping of the cassava genome regeneration and genetic transformation was reported Priorities for the employment of these tools in resolving biotic and biotic constraints modifying quality characteristics or enhancing end use possibilities were established

Program Developments

Carlos Lozano the cassava pathologist since 1972 retired on 10 May 1994 Since then Fernando Correa the Rice Program pathologist has been supervising the research on cassava diseases Marcio Porto the CIAT IITA scientist resigned from CIAT on 30 March 1994 to take up a position as cassava agronomist with the Southern African Root Crop Research Network in Mozambique Susan Poat s contract with the Manabi Cassava Development Project terminated on 28 March 1994 Lincoln Smith biological control specialist joined the Program in May 1994 as a Senior Research Fellow to work with the IPM project The appointment in September 1994 of Claudia Guevara as Cassava Curator in the GRU has enhanced our capacity with respect to the germplasm mandate

TROPICAL FORAGES PROGRAM

This Annual Report was prepared for the Program Committee of the Board of Trustees meeting in February 1995 It follows a similar format to the 1992 93 Biennial Report and should be considered in conjunction with that document A policy was established in 1993 to produce a substantial report for widespread distribution in Spanish and English only every two years As the next comprehensive biennial report will be produced later this year the report of activities for 1994 will be brief

Tropical Forage Germplasm Development Clarifying the need and the vision

There were considerable developments both within the CGIAR and CIAT during the year that impacted on the Tropical Forages Program (TFP) The chief of these were availability of funds a move to matrix systems a Centers x Systemwide Programs in the CGIAR and Programs x Scientific Resource Groups in CIAT and staff and management changes There has been a continued attempt to maintain the integrity of the research program nevertheless there is uncertainty amongst staff of the Program on such fundamental issues as direction vision and capacity (or resources) Hence in addition to a summary of the research outcomes and priorities it is useful to clarify the current situation and indicate the future agenda

Program Strategy

Technical aspects The overall goal of the Tropical Forages Program (TFP) is to acquire identify and improve tropical forage germplasm for subhumid and humid tropical lowlands and mid altitude hillsides which will contribute to increased and more efficient meat and milk production soil improvement and weed and erosion control in tropical production systems

Inadequate nutrition is the major limitation to increased animal production in all tropical farming systems In tropical America quality rather than quantity of feed is the issue whereas in Asia and Africa where land resources are more limited both quantity and quality of feed are important and forage is a complement to crop residues

The utility of forages to contribute to more sustainable agricultural production systems under good management is not disputed But the issue deserves more attention in view of the on going public debate of harmful effect of livestock on natural resources where there is overgrazing and where government policies encourage unnecessary clearing of forests

Attentive readers will have observed that the words acid infertile soils have been dropped from the goal statement Historically the focus has been on the selection of species for acid infertile soils New accessions species and even genera were identified for vast areas for which there were no improved cultivars Many of these new cultivars were also highly productive on more fertile soils because of their vigor and disease and insect resistance The TFP will continue to evaluate new acquisitions under conditions of acid infertile soils and high disease and insect incidence However it will also evaluate the same germplasm on more fertile soils and look to specific needs for areas with more fertile soils

Though there was always a mandate for forage development for both subhumid and humid areas there was more activity in pasture improvement in the humid tropics where there is greater occurrence of acid soils In future we will endeavor to identify germplasm for the full extent of the subhumid zone (180 270 plant growth days) This will give a focus to provision of feed for the dry season which can be a major limitation in both zones Further the emphasis has changed to include other uses for forages than as grazed pasture namely fodder soil cover barriers for erosion control and green manure

These changes will also align the TFP more closely with the TAC priority ecoregion of the subhumid and humid tropical lowlands and more easily define the global role that the TFP can play within the Systemwide Livestock Program

The responsibility of scientists within the TFP is not fulfilled until they can be assured their contribution to various aspects of selection and improvement of forages has been incorporated into a production system Thus a crucial aspect of the strategy of the TFP is the delivery of new forage germplasm in the form of components for production systems through on farm participatory research and active collaboration with NARDS

When the strategy document was written for the TFP as a germplasm development program (Strategic Plan CIAT 1992) it was assumed that research on incorporation of forages into farming systems would be carried out by the Natural Resource Management Programs within CIAT and by the NARS The former are concerned with the impact of forage components on whole production systems in terms of soil processes and land use dynamics and policy issues that will contribute to sustainable production systems The NARDS (government universities and NGO s) are well placed to participate in advanced evaluation trials of new forage germplasm But due to continuing structural and staff changes in the NARDS it has become obvious that there is a need for the TFP to have an active role in facilitating the process of development and adoption We envisage achieving this through two projects Development of Forage Components and Institutional Development

Structural aspects The gradual replacement of the Section structure with a Project structure has given more responsibility for planning and financial management to individual scientists and caused the Program to focus on research that can be achieved with more limited resources Three are now 8 Projects within 3 Program Areas but with still a need for coordination and representation at the Program level

Collaboration across Programs is being accommodated within activities of individual projects within the TFP even where a project may be situated within another Program In addition there is more relaxed interaction and collaboration between scientists across Programs now that the new structure is becoming consolidated

From a Program perspective the Scientific Resource Groups are beginning to function within the areas of intra disciplinary exchange of ideas scientific oversight and inter program project formulation However some disciplinary areas are not well catered for e g animal production and economics We hope that there is a status quo on further structural change

Resource allocation The reduction in the number of core positions from 9 5 to 8 and the operational budget by 30 percent has placed heavy demands on the remaining scientists in the TFP The reduction in the number of staff is a greater limitation than the reduction in operating expenses because of the need for remaining staff to cover for areas for which there is no position and to spend time in special project development to recover lost resources Our policy is to attempt to recover these needed resources directly or through collaborative arrangements with our IARC NARDS and private sector partners

There is a lack of capability in the areas of socio economics entomology seed biology ecology and livestock production We are trying to source funds for a person with skills in sociology and economics to work in the area of forage component development and with the NARDS It is likely that a research fellow will be attracted to work on host plant resistance but there is a need to secure a permanent position in this area The seed biology position may be compensated for if resources can be attracted for seed physiology research on wild species within the GRU and by establishing a self supporting seed unit within the TFP It has been suggested that ILRI place a livestock production specialist at CIAT to complement the work of the TFP Additional resources are needed for postdoctorate positions in order to make fuller use of the capabilities of Senior Scientists who of necessity spend considerable time in representation and project development and supervision

More transparency and a simplified accounting system will be needed as we move more fully into a Project system Fixed costs for central services and research services now take up 30% percent of the project budgets

Special project funding The endeavor to source new funding is now bearing fruit During 1994 Special Projects were approved for Forage R&D in Southeast Asia (AIDAB) Research on anthracnose in Stylosanthes (ACIAR) Research into Genotype x Environment Interaction (GTZ) Forages for the forest margins Caqueta (Nestle) and there appear to be good prospects for several other collaborative projects

Structural changes within the CGIAR The proposed changes to the CGIAR removed the uncertainty of rapidly declining resources but also ra sed some uncertainty as to future direction We now see that we can be a party to the changes and thus influence the outcome
The TFP is well placed to participate in the Systemwide Livestock and Genetic Resources Programs and the Ecoregional Program for tropical America

The Systemwide Livestock Program has not been formally established but we were represented in the initial consultation for the Global Program of ILRI where the mandate of CIAT to develop forage germplasm for subhumid and humid tropical areas was recognized Several project proposals were submitted for the Systemwide Livestock Initiative and these will be discussed in March with the consultant appointed to develop this Initiative

The Systemwide Initiative on Genetic Resources is providing funds for a workshop to formalize the establishment of a Forage Genetic Resource Network CIAT is responsible for the organization of this meeting

Research Activities in 1994

Part of the process of determining needs and setting goals is the annual review of projects This review is well covered in the reports for each Project It is suffice here to highlight a few outcomes and priorities that have and will contribute to attaining the Program objectives

Project Forage Genetic Resources
Notable accomplishments in 1994

a procedure established for production of grass seed of high quality
progress in establishing a forage genetic resources network

Priorities for 1995

develop a strategic plan for future germplasm acquisition
publication of remaining germplasm catalogues
establishment of a research program in seed physiology

Project Forage ecotypes with known environmental adaptation

Notable accomplishments in 1994

new accessions with potential for pasture fodder soil cover and erosion barriers identified for the mid altitude hillsides savannas and forest margins MCAC and Southeast Asia within the genera *Arachis Cratylia Centrosema* and *Brachiaria*

Priorities for 1995

develop a strategy to meet global needs for forages in subhumid and humid regions
hold a workshop on *Cratylia* to set priorities for future research
commence evaluation of a range of new genera for their potential as forage
use the GIS data base to produce distribution maps and assist in interpretation

Project Brachiaria enhancement

Notable accomplishments in 1994

an international workshop held on the genus *Brachiaria*
new accessions of *Brachiaria* identified for regional evaluation
coarse mapping of the apomixis gene
sources of resistance to foliar blight identified

Priorities for 1995

multiply a set of 15 20 *Brachiaria* selections & hybrids for regional evaluation
continue with fine mapping of apomixis gene
re activate program on host plant resistance of spittlebug

Project Enhanced Arachis genepools

Notable accomplishments in 1994

100 accessions of *Arachis pintoi* are now available in Brazil 60 at CIAT
trials for G x E adaptation commenced at 6 sites in Colombia
superior accessions of *Arachis pintoi* identified for the humid tropics dry season savannas and Southeast Asia

Priorities in 1995

continued acquisition of germplasm of forage *Arachis* with emphasis on drier areas
multiplication of promising accessions for on farm trials
commence intensive studies on disease susceptibility
research on reducing costs of establishment
research on seed quality

Project Stylosanthes cultivars with anthracnose resistance and high persistence

Notable accomplishments in 1994

improved inoculation methods developed for anthracnose
set of host differentials developed & assembled for anthracnose
genetic diversity measured by RAPD analysis

Priorities for 1994

complete characterization of isolates of *Colletotrichum gloeosporiodes*
develop and acquire DNA probes
identity new sources of resistance to anthracnose

Project Forages with high nutritive value

Notable accomplishments in 1994

elucidation of factors necessary to develop screening procedures for tannins
the feed value of legumes demonstrated with cows of medium genetic potential

Priorities for 1995

develop liaison activities with other groups involved in studies on tannins
initiate studies on the effect of G x E on feed quality
commence collaborative grazing trials on forage quality with NARS

Project Adaptive attributes of forages to acid soils

Notable accomplishments in 1994

interspecific differences demonstrated in acquisition and utilization of N P and Ca
differences in Ca acquisition shown between Brachiaria species
greater Ca uptake occurs in grass legume than grass alone pastures

Priorities for 1995

evaluate usefulness of physiological traits for screening for acid soil adaptation
commence study to relate plant nutrition and forage quality attributes

Project Forage components of known performance in production systems

Notable accomplishments in 1994 (in collaboration with other Programs and NARDS)

success of legume *B dictyoneura* association in a silvopastoral system in Costa Rica
improved soil fertility of natural fallow in hillsides with *Centrosema macrocarpum*
usefulness of acid soil tolerant *Panicum maximum* as a live barrier in hillsides
publication of a forage seed systems review

Priorities for 1995

on farm trials to assess the utility of herbaceous & shrub legumes
assess methods of introduction of legumes into the natural fallow systems
establish a collaborative on farm evaluation program in 7 countries in SE Asia
seek funding for a position in socio economics to participate in on farm research

Project Institutional support and training for delivery of forage and forage systems

Notable achievements in 1994

funding obtained to develop a forage research and development network in SE Asia
regular newsletters produced for RIEPT MCAC and RIEPT Savannas
continued publication and widespread distribution of Pasturas Tropicales

Priorities for 1995

continued visits to establish priorities for forage research and identify collaborators
a RIEPT MCAC workshop on Establishment of *A pintoi* grass associations

Establish mechanisms for training using bi lateral funding
establish mechanisms for closer interaction with other forage scientists in the Systemwide Livestock Program

Achieving the vision

The program goal is very broad It is in setting clear objectives that facets of the goal become attainable However clarity of vision will only occur as the Program and more particularly each individual in the Program senses some contribution to that goal That this is occurring can be seen from outputs given in more detail in the following reports

Further we acknowledge that our goals will only be achieved with collaboration and input from other Programs and Units and Support Groups within CIAT and from colleagues outside CIAT in the government institutions universities and NGO s and other IARC s

Tropical Forage Germplasm Development Clarifying the need and the vision

There were considerable developments both within the CGIAR and CIAT during the year that impacted on the Tropical Forages Program (TFP) The chief of these were availability of funds a move to matrix systems a Centers x Systemwide Programs in the CGIAR and Programs x Scientific Resource Groups in CIAT and staff and management changes There has been a continued attempt to maintain the integrity of the research program nevertheless there is uncertainty amongst staff of the Program on such fundamental issues as direction vision and capacity Hence in addition to a summary of the research outcomes and priorities it is useful to attempt to clarify what is the current situation and indicate the future agenda

Program Strategy

Technical aspects The overall gaol of the Tropical Forages Program (TFP) is to acquire identify and improve tropical forage germplasm for subhumid and humid tropical lowlands and mid altitude hillsides which will contribute to increased and more efficient meat and milk production soil improvement and weed and erosion control in tropical production systems

Inadequate nutrition is the major limitation to increased animal production in all tropical farming systems In Latin America quality rather than quantity of feed is the issue whereas in Asia and Africa where land resources are more limited both quantity and quality of feed are important and forage is a complement to crop residues

The utility of forages to contribute to more sustainable agricultural production systems under good management is not disputed But the issue deserves more attention in view of the on going public debate of harmful effect of livestock on natural resources where there is overgrazing and where government policies encourage unnecessary clearing of forests

Attentive readers will have observed that the words acid infertile soils have been dropped from the goal statement Historically the focus has been on the selection of species for acid infertile soils New accessions species and even genera were identified for vast areas for which there were no improved cultivars Many of these new cultivars were also highly productive on more fertile soils because of their vigor and disease and insect resistance The TFP will continue to evaluate new acquisitions under conditions of acid infertile soils and high disease and insect incidence However it will also evaluate the same germplasm on more fertile soils and look to *specific* needs for areas with more fertile soils

Though there was always a mandate for forage development for both subhumid and humid areas there was more activity in the humid tropics where there is greater occurrence of acid soils In future we will endeavor to identify germplasm for the full extent of the subhumid zone (180 270 plant growth days) This will give a focus to provision of feed for the dry season which can be a major limitation in both zones

These changes will also align the TFP more closely with the TAC priority ecoregion of the subhumid and humid tropical lowlands and more easily define the global role that the TFP can play within the Systemwide Livestock Program

The responsibility of scientists within the TFP is not fulfilled until they can be assured their contribution to various aspects of selection and improvement of forages has been incorporated into a production system Thus a crucial aspect of the strategy of the TFP is the delivery of new forage germplasm in the form of components for production systems

When the strategy document was written for the TFP as a germplasm development program (Strategic Plan CIAT 1992) it was assumed that research on incorporation of forages into farming systems would be carried out by the Natural Resource Management Programs within CIAT and by the NARS

The former are concerned with the impact of forage components on whole production systems in terms of soil processes and land use dynamics and policy issues that will contribute to sustainable production systems The NARDS (government universities and NGO s) are well placed to participate in advanced evaluation trials of new forage germplasm But due to continuing structural and staff changes in the NARDS it has become obvious that there is a need for the TFP to have a role in facilitating the process of development and adoption We envisage achieving this through two projects Development of Forage Components and Institutional Development

Structural aspects The gradual replacement of the Section structure with a Project structure has given more responsibility for planning and financial management to individual scientists and caused the Program to focus on research that can be achieved with more limited resources There is still a need for coordination and representation at the Program level

Collaboration across Programs is being accommodated within activities of individual projects within the TFP even where a project may be situated within another Program In addition there is now more relaxed interaction and collaboration between scientists across Programs now that the new structure is becoming consolidated

From a Program perspective the Scientific Research Groups are now beginning to operate effectively within the areas of intra disciplinary exchange of ideas scientific oversight and inter program project formulation However some disciplinary areas are not well catered for e g animal nutrition and economics

Resource allocation The reduction in the number of core positions from 9 5 to 8 and the operational budget by 30 percent has placed heavy demands on the remaining scientists in the TFP The reduction in the number of staff is a greater limitation than the reduction in operating expenses because of the need for remaining staff to cover for areas for which there is no position and to spend time in special project development to recover lost resources Our policy is to attempt to recover these needed resources directly or through collaborative arrangements with our IARC and NARS partners

There is a lack of capability in the areas of socio economics entomology seed biology ecology and livestock production We are trying to source funds for a person with skills in sociology and economics to work in the area of forage component development and with the NARS It is likely that a research fellow will be attracted to work on host plant resistance but there is a need to secure a permanent position in this area The seed biology position may be compensated for if resources can be attracted for seed physiology research on wild species within the GRU and by establishing a self supporting seed unit within the TFP

It has been suggested that ILRI place a livestock production specialist at CIAT to complement the work of the TFP Additional resources are needed for postdoctorate positions in order to make fuller use of the capabilities of Senior Scientists who of necessity spend considerable time in representation and project development and supervision

More transparency and a simplified accounting system will be needed as we move more fully into a Project system Fixed costs for central services and research services now take up 30% percent of the project budgets

Special project funding The endeavor to source new funding is now bearing fruit During 1994 Special Projects were approved for Forage R&D in Southeast Asia (AIDAB) Research on anthracnose in Stylosanthes (ACIAR) Research into Genotype x Environment Interaction (GTZ) Forages for the forest margins Caqueta (Nestle) and there appear to be good prospects for several other collaborative projects

Structural changes within the CGIAR The proposed changes to the CGIAR removed the uncertainty of rapidly declining resources but also raised some uncertainty as to future direction We now see that we can be a party to the changes and thus influence the outcome The TFP is well placed to participate in the Systemwide Livestock and Genetic Resources Programs and the Ecoregional Program for tropical America

The Systemwide Livestock Program has not been formally established but we were represented in the initial consultation for the Global Program of ILRI where the mandate of CIAT to develop forage germplasm for subhumid and humid tropical areas was recognized Several project proposals were submitted for the Systemwide Livestock Initiative and these will be discussed in March with the consultant appointed to develop this Initiative

The Systemwide Initiative on Genetic Resources is providing funds for a workshop to formalize the establishment of Forage Genetic Resource Centers Network CIAT is responsible for the organization of this meeting

Research Activities in 1994

Part of the process of determining needs and setting goals is the annual review of projects This review is well covered in the reports for each Project It is suffice here to highlight a few outcomes and priorities that have and will contribute to attaining the Program objectives

Project Forage Genetic Resources
Notable accomplishments in 1994

established a procedure for production of grass seed of high quality
progress in establishing a forage genetic resource centers network

Priorities for 1995

develop a strategic plan for future germplasm acquisition
publication of remaining germplasm catalogues
establishment of a research program in seed physiology

Project Forage ecotypes with known environmental adaptation
Notable accomplishments in 1994

new accessions with high potential identified for the mid altitude hillsides savannas and forest margins MCAC and Southeast Asia within the genera *Arachis Cratlylia Centrosema* and *Brachiaria*

Priorities for 1995

develop a strategy to meet global needs for forages in subhumid and humid regions
hold a workshop on *Cratylia* to set priorities for future research
commence evaluation of a range of new genera for their potential as forage
use the GIS data base to produce distribution maps and assist in interpretation

Project *Brachiaria* enhancement
Notable accomplishments in 1994

an international workshop held on the genus *Brachiaria*
new accessions of *Brachiaria* identified for regional evaluation
coarse mapping of the apomixis gene

Priorities for 1995

multiply a set of 15 20 *Brachiaria* selections & hybrids for regional evaluation
continue with fine mapping of apomixis gene
reactivate program on hostplant resistance of spittlebug

Project Enhanced *Arachis* genepools
Notable accomplishments in 1994

100 accessions of *Arachis pintoi* are now available in Brazil 60 at CIAT
trials for environmental adaptation commenced at 6 sites in Colombia
superior accessions of *Arachis pintoi* identified for the humid tropics dry season savannas and Southeast Asia

Priorities in 1995

continued acquisition of germplasm of forage *Arachis* for drier areas
multiplication of promising accessions for on farm trials
research on reducing costs of establishment
research on seed quality

Project *Stylosanthes* cultivars with anthracnose resistance and high persistence
Notable accomplishments in 1994

improved inocuation methods developed for anthracnose and foliar blight
A set of host differentials developed for anthracnose
genetic diversity measured by RAPD analysis

Priorities for 1994

complete characterization of isolates of C gloeosporiodes
Develop and acquire DNA probes

Project Forages with high nutritive value
Notable accomplishments in 1994

elucidation of factors necessary to develop screening procedures fortannins
the feed value of legumes demonstrated cows of high genetic potential

Priorities for 1995

develop liaison activities with other groups involved in studies on tannins
initiate studies on the effect of G x E on feed quality
commence collaborative grazing trials on forage quality with NARS

Project Adaptive attributes of forages to acid soils
Notable accomplishments in 1994

interspecific differences demonstrated in acquisition and utilization of N P and Ca differences in Ca acquisition shown between Brachiaria species
greater Ca uptake occurs in grass legume than grass alone pastures

Priorities for 1995

evaluate usefulness of physiological traits for screening for acid soil adaptation
study commenced to relate plant nutrition and forage quality attributes

Project Forage components of known performance in production systems
Notable accomplishments in 1994

success of a an mixed legume *B dictyoneura* in a silvopastoral system in Costa Rica
Centrosema macrocarpum shown to improve soil fertility of natural fallow
usefulness of acid soil tolerant *Panicum maximum* as a live barrier in hillsides
publication of a forage seed systems review

Priorities for 1995

establishment of more on farm trials to assess the utility of shrub legumes
assess methods of introduction of legumes into the natural fallow systems
establish a collaborative on farm evaluation program in 7 countries in SE Asia
seek funding for a position in socio economics to participate in on farm research

Project Institutional support and training for delivery of forage and forage systems
Notable achievements in 1994

funding obtained to develop a forage research and development network in SE Asia
regular newsletters produced for RIEPT MCAC and Riept Tropical Lowlands

continued publication and widespread distribution of Pasturas Tropicales

Priorities for 1995

continued visits to establish priorities for forage research and identify collaborators
hold a RIEPT MCAC workshop on On farm trials and forage seed production
Establish mechanisms for training using bi lateral funding
establish mechanisms for closer interaction with other forage scientists in the Systemwide Livestock Program

Achieving the vision

The program goal is very broad It is in setting clear objectives that facets of the goal become attainable However clarity of vision will only occur as the Program and more particularly each individual in the Program senses some contribution to that goal That this is occurring can be seen from outputs given in more detail in the following reports

Further we acknowledge that these goals are only being achieved with collaboration and input from other Programs and Units and Support Groups within CIAT and from colleagues outside CIAT in the government institutions universities and NGO s and other IARC s (Appendix)

RICE PROGRAM

The Rice Program has been the smallest of CIAT s programs and in recent years experienced a significant reduction when it went from 6 Senior Staff (SS) positions in 1992 to 3 7 SS in 1994 The program has made an commendable effort to maintain research activities at the high level of commitment to excellence that has characterized it for more than 25 years Due to a funding crisis of the International Network for Genetic Evaluation of Rice for Latin America (INGER LAC) the rice program has also been in charge of maintaining although at a minimum level the network activities for the region while stable funding is found in collaboration with IRRI

Project 1 (RL01) Improved Lowland Rice Gene Pools

Activity Latin American Irrigated Rice Partnership Initiative, FLAR
A watershed event during 1994 was the effort to create an association of private and public sector rice institutions farmer cooperatives and industries to fund international irrigated rice research Subsequently (in early 1995) the Fondo Latinoamericano de Arroz de Riego became a reality As far as we are aware it is the first time in the developing world that an organization has been created to self fund international agricultural research on a food crop It should place Latin American rice improvement on a more sustainable long term path since the benefits derived from research will now feed the research itself as direct beneficiaries take its control and responsibility CIAT is one of six members (along with Brazil Colombia Uruguay Venezuela and IICA) that pledged a total of US$315 000 for 1995 The initial funding commitment is for three years CIAT was instrumental in coordinating the process that gave life to FLAR and gives the Fund the reliability and credibility needed for such an international effort

Activity Germplasm Development
Characterization of traits closely associated with high yields including early vigor and moderate tillering will enhance the opportunities to increase the yield potential in our regional germplasm adapted to the diverse direct seeded conditions found throughout LAC A recurrent selection project to increase the yield potential of lowland rice initiated in 1993 provided the elements to build four new base populations which will be distributed to key NARs in 1995 There are differences among these base populations mainly in terms of their genetic background and the cytoplasm source Breeding activities in collaboration with ICA/CORPOICA /FEDEARROZ in Colombia led to the release of Oryzica Yacu 9 as a variety for irrigated conditions in some areas in Colombia while collaborative activities with ICTA in Guatemala led to the identification of two promising lines that will be released as varieties in early 1995

Advanced breeding lines combining resistance to rice blast *Tagosodes oryzicolus* RHBV high yield potential and good grain quality were identified and will be distributed to NARs in 1995 The inheritance of the resistance to Tagosodes in Makalioka and Mudgo was studied results suggested that resistance may be under the control of a single dominant gene modified by a minor gene which affects the expression of the resistance depending on the plant genotype and length of exposure to the insect A course workshop on anther culture was held at CIAT to share CIAT s knowledge and expertise on using AC in breeding and to stimulate closer collaboration between tissue culturists and breeders The analysis on the genetics of AC response was completed Results corroborate the simple inheritance and is proposed that the AC response could be inherited as an incomplete dominant trait Results also suggested that gene(s) encoding for callus induction plant regeneration and grain length segregate independently Data from different experiments confirmed that AC is under genetic control and that the cytoplasm of the female parent in a cross combination is very important besides high response to AC can be transferred to *non* responsive types Therefore through a recurrent selection scheme it is possible to develop indica gene pools responsive to AC

Project 2 (RU01) Improved Upland Rice Gene Pools

Activity Germplasm Development

Since 1992 we have been emphasizing population improvement rather than pedigree breeding to increase genetic diversity and variability (hence potential response to selection) In 1994 the third cycle of recurrent selection for earliness grain quality and blast resistance was completed for three populations and a new one was created Advanced line development to help smaller and incipient NARS upland rice programs still plays an important role and is resulting in varietal releases and impact Bolivia released two varieties in 1994 Sacia 3 Tutuma and Sacia 4 Jisunu Genetic studies to understand the mechanisms and the genetic control of the most important traits for rice pasture associations was also initiated through an ODA funded special project in collaboration with EMBRAPA Brazil

Activity Silicon Efficiency of Rice Genotypes

Silicon deficiency was identified as a major previously unrecognized yield and yield stability constraint for savanna rice over the past several years and research reported in 1994 focused on the search for genetic variation in Si efficiency which might be useful in genetically raising the level of this element in the plant Significant variation on the order of 100% was found in percent tissue Si contents in several plant organs among 60 genotypes examined This appears to support the possibility of breeding for higher Si levels Further confirmatory work is underway

Activity Physiological mechanisms for acid soil tolerance
Historically breeders have usually screened empirically for edaphic adaptation at particular sites Basic genetics and mechanisms are rarely addressed which has hampered the development of effective screening methods To develop an understanding of principles and mechanisms we compared the growth patterns and nutrient uptake of both acid tolerant and susceptible genotypes under different liming rates in both field and pot experiments It was found that the range of soil acidity which differenciates tolerant from susceptible genotypes is much higher than expected Even a small amount of liming eliminated acid soil stress Second it was demonstrated that the certain genotypes could not attain high yield because of their inability to absorb certain nutrients (N P Ca) which was caused by inadequate rooting Third it was demonstrated that the tolerant genotypes attained higher yield because 1) they maintained higher rhizosphere pH lowering soluble Al concentration and excluded Al from entering the roots and/or 2) because they maintained a higher absorption rate of Mg

Project 3 (RP01) Durable Blast Resistance
Blast is the most important disease in rice cultivation Breeding for durable rice blast resistance has been one of the major efforts of the Rice Program in the last five years Characterization of the genetic structure and virulence diversity of the blast pathogen is allowing rice scientists at CIAT to develop a novel breeding strategy for this type of resistance The strategy is based on the relationship found between genetic families and virulence factors of the fungus that allows us to identify combinations of resistance genes which have no corresponding combinations of virulence genes in individual isolates of the fungus The lack of these combinations in the pathogen is associated with the presence of genetic lineages Resistance derived from this strategy is being demonstrated to be more durable than in the past

Project 4 (RP04) Rice Traits for Enhanced Weed Control

Activity Rice traits to resist the competition of an associated pasture
Rice based systems are relevant agropastoral alternatives for the acid soil savannas Competition between rice and some of the associated pastures can take a 5 30% toll on rice yields Basic understanding of the mechanisms involved in rice pasture competition is needed to guide breeding for specific key rice traits to withstand pasture interference For this purpose work was conducted in the Colombian Llanos involving above and below ground growth analysis for eight rice cultivars and *Brachiaria decumbens* also measuring PAR interception and estimating root mass of both species using carbon isotope discrimination analysis Under favourable rainfall (1585 mm) and nutrition competition was mainly an above ground process of light capture starting only once the pasture became taller and leafier than rice 45 days after emergence (dae)

Whereas rice height and root growth were not related to competition effects LAI and PAR interception were strongly correlated with pasture suppression and would thus be key traits in selecting for rice competitiveness against seedling *B decumbens* These traits must be recorded on rice growing in competition and screened for after 45 dae This work is sponsored by the British ODA involving also CNPAF/EMBRAPA in the Brazilian Cerrado

Activity RP01 Anaerobic seed vigor
Since rice cannot easily emerge and establish through a water layer under tropical conditions most farmers drain their paddies during the first weeks of crop establishment which unfortunately enables weeds to become established as well An interesting new idea is to develop rice lines which can emerge through a water layer leaving the weeds underneath In 1994 we acquired and multiplied a set of 104 IRRI lines which are reported to have anaerobic seeding tolerance We will attempt to confirm this reports in 1995 by implementing the screening technique at CIAT hopefully identifying some outstanding lines for use as parents in breeding

Project 5 (RP03) Diversified Tagosodes/Rice Hoja Blanca Virus

Activity Characterization of sources of resistance to RHBV
There are reports from Tolima in Colombia that the variety Llanos 5 is more susceptible to RHBV than previously thought It was confirmed that even traditional genotype used as a source of resistance to RHBV rice is susceptible when plants are juvenile The most important finding however is that the CIAT rice resistant varieties are more susceptible when tested with the Tolima colony and virus isolate as compared with the CIAT colony and virus isolate Although Colombia 1 remains an important source of RHBV resistance in the CIAT RHBV breeding program changes in the selection strategy are being implemented to make the selection process more rigorous These findings emphasize the importance of broadening the genetic basis of resistance to RHBV

Activity Control of RHBV through coat protein mediated cross protection and anti sense RNA strategies
The preparation of cDNA libraries and the molecular characterization of RHBV has led to the design of novel virus resistant strategies to genetically engineer commercially grown rice cultivars Two different strategies are being attempted a) the nucleocapsid (NC) cross protection and b) the antisense gene down regulation of the major NS4 non structural protein The down regulation of this protein may be a novel method of producing virus resistant plants by breaking the cycle of transmission Transgenic plants have the NS4 antisense and the NC constructs have been identified

The NS4 antisense was expressed as RNA This significant development allows for the analysis of the effect of the major non structural gene and to determine the down regulation of this viral gene There will be continuing analysis of transgenic rice containing both genes and of the progeny of these plants for their reaction to RHBV

Project 6 (RP04) Components for Integrated Pest Management

Activity Yield loss functions for multispecies weed interference This project attempts to develop components and methodologies for IPM and to assist national programs in formulating rice IPM projects and seeking funding (CIAT s Action Plan and position paper on IPM) Weeds of rice in LAC cost 218 million US$ a year and herbicide consumption in is on the increase Direct seeded rice is often sprayed with herbicide mixtures up to three or four times per season and tropical rice can be grown twice a year Late herbicide applications are often not economical This study developed a methodology to derive economic thresholds for multi species weed infestations in direct seeded rice with options to remove some site specificity constraints Such thresholds are the key to unlock IPM for weeds in rice and could reduce herbicide applications by up to 30% A simple and biologically realistic rectangular hyperbola was fitted to predict yield losses from weed infestations This model can be adjusted to account for relevant site constraints such as differences in growing seasons and in the interval between crop and weed emergence Yield loss predictions can be made from simple visual estimation of weed cover The model derived was incorporated into a simple decision support prototype programmed in LOTUS^{R} for making economic decisions on weed control The methodology derived has been presented at different meetings in Latin America and to the Colombian federation of rice growers (FEDEARROZ) who have considered this a prioritary area for work

Activity Latin American rice IPM workshop
October 23 28 1994 a FAO sponsored workshop on IPM in rice for LAC was held at CIAT with participants from Venezuela Ecuador Colombia Cuba and Brazil IPM in rice was reviewed and a project proposal to fund technology transfer and adaptive research by each country will be written

Project 7 Information and Technology Sharing

Activity Caribbean Rice Improvement Network (CRIN)
A search for renewed funding for the CRIN network continued without much progress The potential donor the EC accepted the concept in principle in early 1993 but asked CARDI rather than CIAT to lead it We have offered our help to CARDI and they confirm they will need our assistance based on our experience and the detailed proposal we prepared in 1992

Activity RL02 Latin American Rice Fact Sheet
A Latin American Rice Facts Sheet is nearing completion a handy yet detailed summary of the key facts regarding rice production trade consumption and the adoption of improved varieties across countries and in different agro ecologies

Activity RL53 Highlights of INGER Latin America in 1993 1994
Vigorous efforts continued to seek renewed funding for the rice germplasm network INGER LAC in close coordination with IRRI A comprehensive proposal was prepared for joint submission Although these efforts have not yet succeeded in finding a willing donor CIAT and IRRI continued to keep INGER LAC alive by sharing the costs in a bridging mode during 1994 In 1993 81 sets were dispatched to 14 countries in LAC Data on 44 nurseries were returned to the regional coordinator at CIAT giving a return rate of 54 3% The average rate of data return over the last 5 years was 46 1% In 1994 99 nurseries were distributed the data is just beginning to return During the period covered by this report (1993 94) the region released 18 varieties 10 of which (55 5%) were materials exchanged through INGER In the six varieties bred locally 4 of the 13 parents used in the crosses were distributed through the network In this period various publications were completed and distributed to NARS a) INGER Nursery Results 1991 b) IV Breeders Workshop Report 1992 c) INGER Nursery Results 1992 d) INGER Steering Committee Meeting 1993 and INGER Annual report 1994 Due to lack of funds only one meeting took place during this period the IX International Rice Research Conference for Latin America (IRRC LAC) 1994 The meeting was attended by 297 participants from 21 countries

HILLSIDE PROGRAM

Introduction

The Goal of the Hillside Program is to improve the welfare of the hillside farming community by developing sustainable commercially viable agricultural production systems Specific objectives are (1) To characterize the mechanisms leading to resource degradation and assess technological options (2) To generate agroecologically and economically viable components acceptable to farmers for soil and water conservation and management practices (3) To strengthen the capacity of national systems to generate and transfer resource enhancing technology

Program Development

Principal staff has doubled from three to six PhD level scientists due to special project funding In addition to the core funded sociologist (Program Leader) production systems specialist (in Central America) and soils specialist special project funding was obtained for two additional senior scientist positions (soils specialist resource economist) in Central America and a post doctoral fellow (anthropologist) at CIAT Palmira Three out of four staff members from the lowland program assigned in November 1993 to work in the hillsides agroecosystem are implementing joint workplans An Andean hillsides interprogram project was planned and field experiments were planted with significant additional input by bean cassava tropical forages land use and lowlands scientists who have activities within this project

Project Areas

Central American Hillsides

With the approval by Swiss Development Cooperation of US$1 000 000 for the first two year phase of a special project in Honduras and Nicaragua recruitment was completed for two scientists to be outposted in Honduras in fall of 1994 Agreement was reached for one of these positions to be a shared CIAT/CIMMYT soil scientist posted in Honduras The first official meeting of this project s steering committee was held in May 1994 with representatives from IARC regional and national partner institutions Research priorities were set and a 6 month workplan outlined Guidelines for cooperation with national and local institutions were agreed upon Site characterization surveys initiated in 1993 continued A case study of farmer decision making in the Atlantic littoral hillsides of Honduras showed that itinerant agriculture was more sustainable than previously believed Forest to pasture conversion was more a consequence of the low productivity of dairy farming in the lowlands which leads to the colonization of steep slopes for pasture Local operational committees the project s mechanism for interinstitutional collaboration in watershed sites were set up in Honduras and Nicaragua

Andean Hillsides

Project 1 ***The effects of soil degradation*** The hillside agroecosystem is characterized by extreme spatial diversity over short distances at plot farm and watershed scale In the Andean case study site (Rio Ovejas watershed) experiments across six benchmark land use types are supplying data for nutrient and water balance and crop models directed at understanding sources of variability Soil profile information compatible with the requirements of the IBSNAT suite of crop models has been keyed to mapping units to analyse sources of variability at the watershed scale Spatial autocorrelation of soil chemical properties across contrasting land uses stratified by environment showed autocorrelation for many properties notably C and Al and micronutrients across contrasting land use types The results of this study will be used to define representative properties for the different land use mapping units

Mechanisms of resource degradation A key issue is whether human pressure on land use has irreversibly changed for better or for worse the productivity potential of the soil For this exploratory study and until other indicators are validated irreversibility is defined as a change of state of the soil resource which cannot readily be overcome by the application of fertilizers Maximum yield trials using bean maize and cassava as indicator crops were seeded across six hillside land uses ranging from 40 year old secondary forest to intensively cropped cassava land Early results indicate that different land uses have not resulted in irreversible soil degradation which cannot readily be overcome by fertilizers Research on indigenous indicators used by farmers to assess soil degeneration showed that soil macrofauna specifically earthworms were a widely used indicator in the study site A survey of soil macro fauna patterned after the CIAT work in the Colombian savannas is being carried out across ten contrasting land use types during the wet and dry seasons in the Rio Ovejas watershed The lowest biodiversity of macrofauna is being found in the intensively cultivated bean maize cassava land use type Results will be related to the maximum yield potential trials to validate macrofauna biodiversity as an indicator of soil degradation

Project 2 ***Decision support systems*** A prototype decision support system for land use planning in the hillsides will help stakeholders to choose among alternative technologies An innovative prototype requires information about how technology choice at the farm level (ie farmer decision making) affects resource degradation at the watershed scale Available tools (eg expert systems GIS linked simulation models) do not transfer effects across different scales nor are suitable bioeconomic models calibrated for hillside farming conditions An innovative bioeconomic model was tested linking farmer decision making with crop models which simulate the effect of farmer decisions and results prepared for publication Progress was made in assessing the applicability with available data of simulation models to assess degradation processes such as run off and nitrate leaching

The effects of changes in land use on degradation processes at the watershed level have been modelled for a pilot catchment area determining consequences of plot level effects for degradation at the watershed scale This research will provide tools to be tested with CIPASLA the local consortium of institutions in Rio Ovejas

Diagnostic simulation modelling This research conducted with CIAT s Land Use and Impact Assessment Units developed methods for determining payoff to alternative research projects Methods were applied to three Andean case study watersheds to assist in site selection and project design a training manual was drafted The Land Use Unit began GIS analysis of regional soil degradation in the hillsides in relation to main drainage systems hydroelectric power installations and population distribution but results are not yet available Payoff to erosion control and improved fallow technologies were compared A 35 year regional (Central America and Andean) simulation run submitted for publication estimated US$378 million benefits from erosion control in the hillsides and US$282 million from improved fallow Off site beneficiaries obtained a significant portion of benefits from erosion control The regional simulation showed that the greatest impact from improved fallow technology (legume/pasture and crop rotations) is in improved livestock productivity supporting the emphasis given to this output in the Andean hillside interprogram project referred to above

Project 3 *Prototype agrosilvopastoral systems to intensify production* This research was planned jointly as an interprogram project which closely parallels the long term strategic experiments in the Lowlands program to test prototype crop pasture/legume improved fallow rotations Experiments were planted in September 1994 on approximately 4 ha of communal land with involvement of forage cassava bean lowlands and hillsides scientists in testing systems of components drawn from each of these programs

The systems being tested involve comparisons among treatments with monocrops multiple cropping crop grass/legume mixtures and rotations simulating the transition from traditional systems to more intensive systems with a higher proportion of perennial species Data are being obtained for crop modelling in the decision support project and participatory evaluation with farmers was initiated

Participatory Research

Sociology research determined the organisational design principles desirable for institutional development to support improved hillside watershed management Results are being prepared for publication and fed back to CIPASLA with workshops The institutional innovations being monitored in CIPASLA are the means whereby stakeholders for will make use of the progam s decision support models to better elaborate scenarios make decisions and put them into action

Farmer evaluation of forage legume nurseries in Rio Ovejas watershed was initiated

The interinstitutional consortium CIPASLA conducted joint projects testing participatory approaches to soil conservation which showed a five fold increase in adoption of conservation barriers in the pilot micro catchment area in Río Ovejas due to farmer participation in the adaptive research Participatory research in Honduras identified farmers objectives for clearing steep slope forested land to cultivate beans and initiated participatory testing of bean varieties adapted to low lying humid areas as an alternative strategy Training continued to national programs in Ecuador Bolivia and Peru and to the Cassava IPM project in N E Brazil

PUBLICATIONS AND CONFERENCE PAPERS

Ashby Jacqueline A and L Sperling Institutionalizing participatory client driven research and technology development in agriculture Development and Change (forthcoming)

Ashby Jacqueline A R D Estrada and D H Pachico An evaluation of strategies for reducing natural resource degradation in the hillsides of tropical America Journal of Impact Assessment (forthcoming)

Knapp E B J E Rubiano and J W White 1994 Analisis de Impacto ex ante empleando la simulación como herramienta para priorizar el uso de tierras agrícolas de la comunidad a nivel de cuenca hidrográfica In XI Encuentro nacional de Informática Universitaria ASCUN Santafe de Bogota Colombia

Pachico D J A Ashby and L Sanint Natural resource and agricultural prospects for the hillsides of Latin America Paper presented at the IFPRI Vision 2020 workshop Washington D C November 7 10 1994

Thornton P K J W Hansen E B Knapp and J W Jones 1994 Designing Optimal Crop Management Strategies In Eco Regional Approaches for Sustainable Land Use and Food Production in the series Systems Approaches for Sustainable Agricultural Development by Kluwer Academic Publishers Dordrecht The Netherlands

Ravnborg H M and J A Ashby Organising for local level watershed management lessons from Rio Cabuyal watershed Colombia Submitted to Technology and Society

TROPICAL LOWLANDS PROGRAM

Strategies

The research activities of the TLP fall broadly in two major categories (a) within agroecosystem *area based research* activities leading to the identification development and testing of prototype sustainable land use systems for representative sites in the savannas and forest margins based on an understanding of the underlying biophysical and socioeconomic processes and mechanisms and (b) *across agroecosystem research* led by or in cooperation with the Land Use SRG aimed at providing policy options and defining the profile of potential technological innovations and based on an understanding of past and present trends in land use and the analysis of past and present policies Area based research in the forest margins begun in the first semester of 1994 while that of the savannas was formally initiated in 1992 Exploratory research across agroecosystems traces back to the studies leading to the development of CIAT s Strategic Plan

The above set of research activities are organized around three major types of projects (1) dynamics of land use (2) mechanistic understanding of soil chemical physical and biological processes in agropastoral and sequential crop systems (3) development of prototype cropping systems plus a smaller set of special funded more specific projects To various degrees all of these attempt to quantify the tradeoffs involved in interventions in the two tropical lowlands agroecosystems researched namely the neotropical savannas and the intervened rainforest margins Functional aspects of the two agroecosystems are (1) the *provision of resources for agricultural production* both primary and secondary (e g soil water plants etc) (2) the provision of various *environmental services* including amenities and life support mechanisms (e g ecosystem stabilization climate regulation maintenance of genetic diversity) and (3) *assimilation of waste products* (e g CO_2)

Within this very large array of researchable issues CIAT places particular but not exclusive emphasis in the use and maintenance of the soil resources in view of the prevalence in both agroecosystems of marginal and low fertility soils and to the impact of farmers decisions regarding land use on natural resources In concurrence with CIAT s strategy in resource management the Program positions itself as one participant in the large array of R&D institutions involved in RMR in these agroecosystems Based on its international nature and neutrality the Program attempts to play a facilitating role in promoting the involvement of other research institutes in both agroecosystems

The highlights outlined in this report intend to document how the Program is attempting to carry out this dual role involving its own research most frequently developed in cooperation with others and research by other institutions which have been prompted by our own activities In this context special mention needs to be made of some institutions whose collaboration is essential for the Program s activities In our host country the support and collaboration received from CORPOICA Carimagua is crucial to the success of the Llanos work and the same comment applies to the contributions of EMBRAPA CPAC in the Brazilian Cerrados and CPAF Acre and CPAF Rondonia in the Forest Margins area Notwithstanding numerous other collaborators two international institutes have significantly contributed to the Program s research activities These are IFDC USA who has assigned a Soil scientist to work with the TLP in the area of soil fertility management and CIRAD France which has assigned a Savanna ecologist to conduct research on plant dynamics in the Colombian Llanos Major Program donors were the Colombian Government and the InterAmerican Development Bank

Research activities

Understanding land use dynamics

Understanding and predicting development paths of both agroecosystems and their interactions implies the analysis of past trends in land use the analysis of past and current policies and modelling of future alternative scenarios conditioned by potential policies and technologies

Such an analysis began in 1994 based on literature review and secondary data The root causes of deforestation in the Amazon are the opportunities it provides for land speculation to the rich and for increased labor returns to the poor The driving forces behind these opportunities originate primarily in government policies both within and outside the agricultural sector In the savanna productive technologies have enabled areas with good infrastructure to make important contributions to national agricultural production at the expense of on and off site degradation Speculative land demand has expanded the agricultural frontier into marginal areas A modelling exercise to depict future land use scenarios up to the year 2020 and their implications in terms of productivity labor absorption and ecological sustainability was initiated jointly by the TLP the Land Use SRG the Impact Assessment unit and an NGO Preliminary results show that the combination of favorable policies and technologies for ecosystem management could make a major contribution towards simultaneously reducing deforestation while enabling national governments to obtain economic and social benefits from the forest margin

Significant increases in agricultural output and agribusiness could be sustainably achieved in the savanna and this could enable it to divert pressure from the Amazon by contributing to government s economic objectives diverting venture capital and absorbing labor in agribusiness Aspects of the favorable scenarios have started to occur in recent years

Among them are changes in policies emerging international markets in ecological services which could provide powerful incentives for the adoption of sustainable systems and new ecological paradigms which provide opportunities for combining environmental enhancement with economic gain This constellation of events provides a unique opportunity for effective ecosystem management

Assessment of possible future land use scenarios require continued understanding of the factors driving farmer s adoption of new and emerging technologies An adoption study of pasture based technologies in the Colombian savanna showed that 98% of sample farmers had planted improved pastures 17% of the surveyed area consisted of planted pastures with the area increasing in the last 15 years at the rate of 14% p a

Only 18% of the improved area contained legumes and 1 5% was planted to the rice pasture technology the latter being a new technology at the time of the survey The predominant strategy of farmers was to supplement native savanna with a small area of planted grass pasture which was increased over time as capital became available Capital and management requirements were identified as key factors inhibiting area expansion of planted grass pastures and adoption of grass legume pastures and ley farming systems As natural increase in herd size occurs farmers appear to be accepting improved grass pastures as an alternative to overgrazing The study shows that reduction of the capital and management intensiveness of ley farming sytems even at the expense of productivity could make a major contribution to the prevention of overgrazing by speeding up the rate of adoption In terms of the savanna as a whole the study area lies towards the unfavorable extreme in terms of soil fertility In terms of infrastructure it is moving rapidly from the typical towards a more favorable direction The ley farming technology in its current form should be targeted to the most favorable areas of the savanna

Another external factor that may condition future land use in the forest margins and at least parts of the savannas is the emerging development of international markets for ecological services

Technological interventions such as deep rooted germplasm that can effectively sequester C in depth and possibly affect the exchange of other gasses as well (see below) may have an important role in the future and constitutes an area which the Program will modestly explore to assess implications for further technological developments

System characterization research

A great deal of effort and very significant resources were deployed in 1994 for the continued characterization and in depth analyses of land use dynamics in the two target agroecosystems under the leadership of the Land Use SRG

Given resource limitations the Acre Rondonia area was prioritized followed by the Colombian Llanos Some efforts were made to obtain additional and more detailed secondary information to improve the characterization of selected sites in the Cerrados of Brazil while characterization of the Venezuelan Savannas in cooperation with a number of national institutions has been on hold

Characterization research has been conducted in Acre and Rondonia in the Brazilian Amazon as part of the global initiative Alternatives to Slash and Burn Agriculture (ASB) funded by GEF and coordinated globally by ICRAF and by CIAT in Latin America and in partnership with EMBRAPA (in Acre and in Rondonia) PESACRE ICRAF IFPRI CIFOR and TSBF The purpose of the ASB is to develop technical and policy alternatives which would help to decrease rates of tropical deforestation while enhancing the well being of forest resource users

Tropical deforestation a contributor to global warming via release of atmospheric CO_2 is highest in Latin America compared to Africa and Asia Rates in the Amazon Basin of Brazil increased from the early 1960s through the mid 1980s due to national policies supporting road building tax and credit incentives to large corporations and ranches and colonization projects for the rural poor Changes in the same policies seem to have contributed to observed declining rates of deforestation for the Brazilian Amazon as a whole

Interviews conducted in the project area indicated that settler colonists had pa cels of a mean 88 ha in Pedro Peixoto (Acre) and 76 ha in Theobroma (Rondonia) These lands were approximately 60% in forest and 40% cleared for pastures and crops at the time of the interviews Farmers cleared slightly more than one ha per family per year to produce first rice for which yields were calculated to be approximately 1 5 t/h in the first year but dropped drastically such that maize and cassava were grown in second and in some cases a third year of cultivation

Lands were then converted to pasture as farmers not only banked their savings in cattle (some 85% of the settlers had cattle with herd sizes of about 25 30 head) but also and perhaps more importantly sought to take advantage of substantially higher values for improved lands i e cleared lands with pasture fencing corrals and ponds

Development of alternatives to slash and burn agriculture which would decrease rates of deforestation increase sustainability of resource use and enhance the well being of settlers would have to combine on farm and policy research

A detailed GIS coverage is being developed for the study area between Puerto Lopez and Puerto Gaitán Meta in the Colombian Llanos This will help refine existing (Cochrane s et al) classifications monitoring of land use changes and allow extrapolation of technological and policy options

Maps of soils and soils characteristics drainage topography vegetation etc have been digitized Critical to the effort of the Program in assessing externalities associated with present and potential land uses is the development of a digital elevation model which will allow accurate estimation of slopes and runoff for applying watershed management and erosion control models This is an ongoing highly time consuming activity Satellite images for previous years were obtained and are being subjected to unsupervised classification we expect to obtain a new satellite image for 1995 which will be groundtruthed to allow supervised classification of current land use

To complement the above efforts farms located in contrasting land systems (as classified originally by Cochrane et al) and that differ in the use of savanna resources have been monitored for over 18 months Inputs and outputs for specific fields and/or whole farms are quantified to the extent possible and soil vegetation and other resources are being characterized All of the data has been georeferenced but there are lingering doubts regarding the precision of the GPS instruments used so far The recent acquisition of precise GPS instrumentation by the Land Use SRG will allow verification of the coordinates in 1995 following which the data can be incorporated into a GIS database and overlayed onto the maps and images referred to above for use in land use simulation and other purposes

Similarly extensive studies were conducted during 1994 on the floristic composition of native savanna which constitutes the main (>70%) land use form of the region Species diversity was quantified during 1994 for a large cross section of the undulating savannas or *serranias* a formation that constitute nearly 60% of the Colombian and possibly also a large percentage of the Venezuelan savannas

As before these data have been georeferenced and extensive soil and plant tissue analyses were conducted Interviews with ranch managers and indigenous communities were also undertaken to assess management practices applied to native savanna communities that may affect plant dynamics On the whole 173 plant species were identified belonging to 40 different families Only 89 of these species are common to the levelled savanna studied in the past in Carimagua and surrounding areas Large differences in plant species composition associated with topography soils and seasonal hydrology exist but additional and longer term research is still required to understand and quantify the contribution of these plant communities to the savanna ecosystem and the possible tradeoffs involved if land use intensification significantly affects some or all of these important communities This is an area that requires the contribution of other disciplines particularly tropical ecology and for which the Program is attempting to involve other research institutions

As indicated previously longer term studies of the dynamics of savanna vegetation in response to current and potential uses are required

A large ongoing experiment set up in Carimagua was designed to provide information on the effect of season and frequency of burning and of grazing management on vegetation dynamics above ground and underground biomass production and seasonal changes in grazing preference Large differences are apparent in terms of species dynamics but it is still too early to draw conclusions Complementary observations are made on some of the farms being monitored as explained above Plant dynamics and changes in soil parameters are evaluated and will be related to management practices employed by farmers

Process oriented biophysical research

Intensification of land use in the savannas may bring about changes in many of its land resources including above and under ground fauna and in limnological properties of savanna water streams The latter two are not areas in which the Program has expertise An exploratory survey of above ground fauna is being conducted at Carimagua by a professor of the National University of Colombia Department of Biology Bogotá made possible by the financial support provided by CORPOICA Carimagua and the TLP An initial survey of soil fauna conducted earlier on by a French student in the Colombian Llanos ed to the design of a much more ambitious ongoing project conducted by a Spanish student under the supervision of an ORSTOM (France) specialist and a professor of the Universidad Complutense de Madrid

The study takes advantage of a large longterm experiment setup in Carimagua involving a wide range of highly contrasting prototype cropping and pasture systems that allows quantification of changes in soil fauna in response to temporal changes in land use Given the low natural fertility of savanna oxisols the experiment investigates a combination of crop and/or pasture components at two levels of intensification based on lime to determine biophysical measures of system performance and health This as well as an equivalent experiment set up in the Cerrados of Brazil are jointly run with the respective national institutions CORPOICA and EMBRAPA CPAC respectively plus the Universities of Bayreuth (Germany) and Cornell (USA) in the Brazilian case A large team of researchers is involved in both cases The Carimagua *cultIcore* experiment was set up partly in 1993 and the rest in 1994 The experiment essentially contrasts three major prototypes that modify soil and vegetation to various degrees with grazed native savanna representing the lowest degree of human intervention and a maize based set of treatments representing the highest degree of resource modification This last year witnessed the implementation of the high lime maize based systems using cv Sikuani commercially released by CORPOICA and CIMMYT for the Colombian Llanos in 1994 Legume green manures included as part of the system rapidly showed at least one of the tradeoffs involved

In effect grain yields significantly increased following the green manure but so did the concentration of NO_3 N down the soil profile suggesting that N leakage in these soils is a real possibility Maize grain yields in the experiment were 2 5 t ha ^{1} or approximately 1 ton less than in adjacent satellite experiments probably due to a combination of poor establishment and problems of machinery at sowing This is illustrative of some of the problems in setting up long term experiments with contrasting components when their agronomy is still not well developed Nevertheless the experiment is extremely successful overall and provides a common ground for a large interinstitutional and multidisciplinary team that is investigating nutrient cycling processes input/output relationships soil and crop management issues and soil fauna dynamics Results of this experiment are being used to calibrate available crop growth models that will allow the simulation of numerous other crop and pasture sequences and hopefully extrapolation to other soils as well

The Brazilian long term experiment or *crop pasture integration experiment* completed its third cropping year with the best treatments yielding in excess of 7 t ha ^{1} of maize Major yield effects so far are due to soil fertility management which in turn affects the weed population Although soil mechanical impedance has began to deteriorate under continuous cropping and to a lesser extent under a grass legume pasture as compared to the native Cerrado no detrimental effects are apparent as yet On the other hand mycorrhizal populations monitored over the last three years have shown temporal variations in relation to treatment

Initially there was a 25 fold increase during the pasture establishment phase and a 3 fold increase in soybeans relative to Cerrado but the differences have decreased significantly over time Detailed studies on soil organic matter contents and distribution and water and nutrient dynamics are being carried out The same experiment is being used by an EMBRAPA Cornell University team to monitor changes in carbon dioxide nitric oxides and methane Preliminary results suggest that these soils may constitute a large methane sink with methane oxidation being largest under corn and smallest under native Cerrado Nevertheless pore size and soil water balance as affected by tillage appear to modify some of this ability to dispose of methane

Current trends in tropical soil fertility management stress reliance on biological processes including the use of soil adapted germplasm enhancement of soil biological activity and optimization of nutrient cycling to maximize efficiency of use of external inputs The above listed longterm experiments together with a large array of short term field and laboratory trials are being used to quantify and model nutrient cycling processes Crops residues and crop and forages litter appear to play a key role in savanna oxisols and the lignin N ratio is the main regulator of decomposition with C N ratios and the polyphenols contents playing smaller roles The CENTURY model appears to be reasonably well suited to model some of these N cycling processes if modified to accommodate present experimental results

The transfer of N in forage legume litter to the associated grass was very slow whereas urine N was shown to cycle much faster This combination of the effects of organic additions via residues litter and/or animal manure and urine were shown to improve nutrient conditions for soil flora and fauna and as consequence appear to beneficially modify organic P availability measured using more elaborate partitioning techniques than the traditional laboratory methods An excellent indicator of these changes in the biological properties of savanna oxisols appears to be soil microbial biomass to the extent that nutrient cycling is very tightly linked to its turnover rate In fact P flux through microbial biomass at least under grass legume pastures (12 34 kg ha ^{1} year ^{1}) indicates that this could be a major pathway of P cycling in these soils
These findings are supported by the detection of high phosphatase activity under pastures which further indicates the importance of biological processes in soil P turnover

Introduced grass and grass legume pastures were found to make a major contribution to soil organic matter to a depth of at least 100 cm in both on station and on farm experiments As a minimum it was estimated that a three year old *B dictyoneura* pasture contributes 30 t C ha ^{1} in 3 years and that the addition of a legume significantly increases the amount of C sequestered These findings were published in ***Nature*** and do not require further elaboration here

On farm testing of prototypes

Longterm controlled experiments are absolutely essential to develop a detailed understanding of soil plant animal processes as shown above Nevertheless they have a certain rigidity regarding the crop and/or pasture components that can be tested To compensate for these limitations and more importantly to incorporate into the Program s research agenda farmer s perspectives and preferences regarding resources use a limited amount of on farm work is conducted in all of the area based activities carried out by the TLP This set of trials have the longest tradition in the savannas of both Colombia and Brazil whereas they only begun to be implemented in Acre Rondonia in mid to late 1994 To various degrees and depending on the specific location farmer participation in the design and conduct of the trials is included Thus farmer s controls are always included and farmers are involved in the discussion leading to selection of some of the experimental treatments selection of crop or forage components etc whereas still other treatments are purely researcher selected To the extent that farmer decision making processes are documented in these on farm activities this research is considered to be as strategic as that of purely biophysical origin

Only a brief mention is made here of one of these on farm tests whereas the rest are deferred to the main body of the report

The *Matazul* on farm trials in the Llanos of Colombia were described in the Savannas Annual Report 1992 1993 The oldest two trials in this farm completed 6 years in 1994

One of them involved continuous rice monocropping using the best available knowledge regarding management of soil physical and chemical properties Over the period 1989 1992 there was a linear decrease of 400 kg ha ^{1} year ^{1} Improved soil management practices applied subsequently were able to partially reverse this trend but continued negative changes in soil compaction weed buildup and decreased microbial biomass continue to conspire against the longterm success of this alternative Studies conducted on weed dynamics their nutrient uptake and overall competition with the sown crop are beginning to identify desirable plant ideotypes that could potentially be undersown to rice and compete with undesirable weeds In general then the monocrop prototype is providing very valuable information on the extent rate and characteristics of degradation processes in savanna oxisols

An equally old experiment whose details have been extensively reported elsewhere the rice pastures experiment entered into the second phase of pastures in the rice pasture rotation in 1994 following a renovation of the original pastures with rice in 1993 This experiment is beginning to illustrate some of the longterm tradeoffs involved with these relatively intensive systems

Pastures established under rice support high carrying capacity and higher levels of animal production than otherwise By the same token some aspects of the soil physical properties such as compaction estimated using traditional methods (cone penetrometer) begin to deteriorate relatively early on during the pasture phase A crop phase namely rice temporarily reverses this trend Trends in soil organic matter and microbial biomass contrast markedly with those of the monocrop referred to above

In the Acre Rondonia area (Forest Margins) agronomic work began in the second trimester of 1994 initially severely constrained by logistical and transportation difficulties later overcome

Existing agronomic knowledge on potential agrosilvopastoral components is scarce and make it unadvisable to set up longterm complex experiments as yet Following the research agenda agreed upon with the other participants in the Alternatives to Slash and Burn project the Program began its research activities with the introduction of germplasm of the main staple foods in the region namely beans maize rice and cassava to be followed later on by grass and legume forages including multipurpose shrubby and tree legumes Fertilizer inputs although included as experimental treatments are unfeasible under the current economic conditions so that biological management of soil resources is even more crucial than in the other mandated regions of the Program Initial still highly tentative results suggest that it is possible to use dead mulches that protect the soil while at the same time reducing the incidence of web blight in beans based cropping systems A number of mulches was tested both on station and on farm including velvet bean *Pueraria phaseoloides* maize and rice

Preliminary results indicate that mulches such as those provided by *P phaseoloides* that decompose at a slower rate provide better protection against web blight and presumably protect the soil for a longer time Nevertheless it was obvious that the majority of the introduced lines and varieties did not have an yield advantage over farmer s checks (mostly Carioca)

Inter program projects

Brief reference was made above to various research activities involving collaboration of Program scientists with other researchers both inside and outside CIAT Several other joint projects will be mentioned here

Several Program scientists were instrumental in designing and implementing a large interprogram project in the Cauca (Colombia) hillsides together with members of most other CIAT s programs

A program specialist is also responsible for the maintenance and characterization of the forage legumes *Rhizobium* collection and for screening and selecting *Rhizobium* strains in cooperation with the Tropical Forages Program

Several Program scientists were heavily involved in designing and implementing maize based cropping systems with CIMMYT and CORPOICA in the Colombian Llanos Similarly Program researchers actively contributed to evaluation of maize rice and forages germplasm for alternative production systems in the Cerrados of Brazil and maize rice cassava beans and forages germplasm in the Acre Rondonia sites

Institutional strengthening and relations

In the area of institutional building several important events took place during 1994 A C sequestration workshop took place with the participation of several NARs and international institutions to develop an interinstitutional project on the subject for submission to potential donors

Similarly the Program was heavily involved in a Land Use led workshop leading to development of a regional project for the savannas entitled *Strategies for Sustainable Agricultural Land Use in the Lowland Savannas of South America* SSALLSSA

The Program participated in the Global Steering Committee meeting of the ASB Project and later on in a training workshop on characterization offered in Nairobi Kenya in the context of that same project

The third Workshop on Agropastoral Systems was held in Venezuela which was supported by IDB and Venezuelan funds
Junior staff of the TLP were heavily involved in the development of an International Course on Agropastoral Systems for Acid Soils offered in Villavicencio Colombia for extension agents and private technical assistants

Lastly numerous students developed their BS and MS thesis working in existing research projects

In a different context various Program scientists were regularly involved in technical consultation meetings with the MAS consortium PROCITROPICOS and its savannas consortium PROCIANDINOS FAO CORPOICA and various others Similarly through some of its members the Program has been involved in two system wide initiatives namely CIAT s Ecoregional project and the Soil Water and Nutrient Management initiative Lastly it also provided limited input through the Tropical Forages Program to the system wide livestock initiative

LAND MANAGEMENT SRG

The Land Use Program as it appears in the Annual Report 1993 has been transformed in 1994 into the Land Management Scientific Resources Group as part of the definition of the new Action Plan for CIAT

The basic research themes of the Group focus around the understanding and anticipation of land use changes the determinants and impacts of land management and their implications for technology development and diffusion The major goals are to influence policy making and technology generation (insofar as helping to identify the required technological profile for sustainable agriculture) This requires the causal analysis of trends in land use the study of the spatial distribution of agricultural land use patterns in relation to ecological factors understanding the role of cross scale (micro macro) interactions in land use dynamics and the identification and development of policy relevant indicators of sustainable land use

The activities of the Group focus mainly on three target agroecosystems savannas hillsides and forest margins Some of the projects have broader scope

The major clients of the Group are policy makers at the national and regional levels and the NARD s and other CIAT s Programs that concentrate on technological generation and diffusion

This report presents the research activities during 1994 by project divided into core projects and complementary subprojects For completeness the research activities performed as part of projects executed by other Programs or Units are also included here but reported more extensively in the corresponding Program or Unit

Project UT01 Maintenance of the GIS Unit Facility

An updating and expansion of the GIS hardware and software as well as the database software was made
The number of ARC INFO GIS software licenses rose from 10 to 20 Data input was upgraded from Atlas Draw to ARC INFO for map data base preparation The number of ERDAS remote sensing analysis licenses increased from one to three in 1994

The number of SUN workstation computers rose from two to ten by the beginning of 1995 A new Tektronix Phaser 440 dye sublimation printer was acquired to facilitate high quality output of analyzed satellite images A small 600dpi Ricoh FS2 color scanner was also purchased to allow tabular data input and to scan color photos from the field and from the air A further 32 gigabytes of disk was purchased to facilitate data handling of satellite images

Two Wild/Leitz model 200 dual frequency P code Global Positioning Satellite (GPS) systems were acquired These will allow the Unit to perform control surveys for satellite images and digital ortho photography as well as detailed project mapping

Complementary Subproject UT54 Design of a GIS Pilot Project for Cenicaña

Work started on this fully funded project in 1994 Several sugarcane plantations were selected as pilot sites and maps and plans were obtained for each plot along with their associated historical database of information Survey fieldwork was initiated using Global Position Satellite (GPS) systems All the relevant data were entered such as contours spot heights plot boundaries canals rivers as well as their associated attribute data A relational database structure was designed for historical tabular data on plots fertilizer treatments varieties grown time of planting and harvesting These data were linked to the GIS using parcel numbers Large scale accurate maps were produced Additional data such as climate soils depth of water table slope roads processing plants were added to the GIS and overlays of various combinations were produced Training of Cenicaña personnel has been ongoing in GIS Unix and database management

Project UT02 Background GIS /Database Activities Needed to Maintain Credibility and Flexibility on Handling Spatially Referenced Data

In 1994 work continued on converting many of the old map coverages already existing in CIAT to ARC/INFO These include all the maps digitized for the various CIAT projects over the last 8 years the administrative units of many countries in Latin America the data files that relate to them the climate maps produced from the CIAT databases in the past the crop distribution files elevation and soils maps that we have produced Other coverages include the Land System study of Cochrane et al the Brazil soils map 1 5 000 000

Recent work completed includes the tertiary administrative boundaries of Mexico Central America Ecuador and Peru Work in progress includes the tertiary boundaries for Colombia Venezuela and Brazil It also includes the acquisition of topographic maps air photos and satellite images for different agroecosystems

The digital coverage of Latin America protected areas has matured into a maintenance and update state The vegetation map of South America has been also incorporated

A comprehensive network of data exchange has been in place for years The program has sent data in 1994 to 21 institutions including CG Centers International Organizations and National Organizations and Universities

Project UT03 CIAT Climate Database for the Tropical World

The CIAT climate database covers the whole of the world tropics It has been built over the last 17 years and now contains long term climatic normals for 9 864 stations in Latin America 5 536 in Africa and 3 721 in Asia Recently it was given a major update adding data for almost 2 000 additional stations

The database exists in two forms The base data is stored in a direct access system by climate coordinates A second set of files is interpolated to a regular grid for mapping purposes A major task during 1994 has been to transfer the databases from the IBM mainframe to the new UNIX network server The climate station data are now available in a temporary system under ORACLE The interpolated grid files for Latin America and Africa are available as UNIX files for access by FORTRAN or as GIS images in IDRISI and ARC/INFO

Further work is still needed to implement the full data management system under UNIX and to produce the interpolated climate files for Asia

Stochastic rainfall models The first publication from this research theme appears in the 1993 Report P K Thornton of IFDC has recently employed this model in Burkina Faso in a project associated with the Famine Early Warning System of FAO (FEWS) Work has proceeded with the generalization of the model aiming to provide interpolated mapping of the model parameters to interface with GIS linked models of cropping risk

Project UT04 Ecoregional research and exploratory activities

Land Quality Indicators An international workshop on land quality indicators for the lowland savannas and hillsides of tropical america was organized jointly with the World Bank at CIAT Participants included the WB CIMMYT IBSRAM IICA FAO AGCANADA IFPRI USDA One of the four basic documents was written jointly by scientists from CIAT (LM SRG) CIMMYT and GASE (an environmental NGO) CIAT also participated in a later workshop organized by the WB in Washington Two preproposals from the LMSRG are being considered by he WB

Agroecosystem Health A principle of cooperation with the University of Guelph Canada was established to perform joint research and training activities in the area of agroecosystems research and agroecosystem health (a new concept being discussed internationally)
A paper on its potential for agricultural research was published The coordinator of the Canadian agroecosystem health project spent a week at CIAT invited by the LMSRG to interact with the scientists and prepare joint proposals A general Cooperation Agreement between CIAT and the University of Guelph has been approved by CIAT and is being considered by the University of Guelph

Cooperation with UNEP Though the contacts and activities carried out within the project CIAT was invited to become and is now one of a selected few UNEP Collaborating Centres for International Environmental Assessment Reporting and Forecasting This has already opened new channels of collaboration such as with the Dutch RIVM

InterAmerican Group on Sustainable Development of Agriculture and Natural Resources Participation in the Group continued during 1994 including contributing to the preparation of a basic document It is expected that the Group will address the June 1995 Session of the UN Commission on Sustainable Development dedicated to discuss the agricultural and land use issues of Agenda 21

Complementary Subproject UT51, TA51, and Alternatives to Slash and Burn

System characterization research has been conducted in Acre and Rondonia in the Brazilian Amazon a) as the main activity of subproject UT51 (A diagnostic study of agricultural land use in the southwest Brazilian Amazon) b) as a major activity of subproject TA51 (Alternatives to slash and burn) and c) as part of CIAT s contribution to the global initiative Alternatives to Slash and Burn Agriculture (ASB) The purpose of the ASB is to develop technical and policy alternatives which would help to decrease rates of tropical deforestation while enhancing the well being of forest resource users

Interviews conducted in the project area indicated that settler colonists had parcels of a mean 88 ha in Pedro Peixoto (Acre) and 76 ha in Theobroma (Rondonia)

These lands were approximately 60% in forest and 40% cleared for pastures and crops at the time of the interviews Farmers cleared slightly more than one ha per family per year to produce first rice for which yields were calculated to be approximately 1 5 t/h in the first year but dropped drastically such that maize and cassava was grown in second and in some cases a third year of cultivation Lands were next converted to pasture as farmers not only banked their savings in cattle (some 85% of the settlers had cattle with herd sizes of about 25 30 head) but also and perhaps more importantly sought to take advantage of substantially higher values for improved lands i e cleared lands with pasture fencing corrals and ponds

Thus development of alternatives to slash and burn agriculture will have to combine on farm and policy research

Complementary Subproject UT52 Strategies for Sustainable Agricultural Land Use in the Lowland Savannas of South America Planning Study

The Planning Study was completed in 1994 with the formulation and submission of a 5 years project to the Dutch Ministry for Development Cooperation (DGIS) The project is now under consideration by the DGIS The project purpose is to identify and assess strategic and policy options for the sustainable use of the lowland savannas of South America

The project was designed through a participatory process and it was approved at a Workshop convened and hosted by CIAT The Workshop involved agricultural environmental business and NGOs institutions of Bolivia Brazil Colombia and Venezuela and the preparation of position papers by each of the participant countries plus scientists from Wageningen and CIAT The structure of SSALLSSA reflects a tripartite collaboration one research team in each of four countries a project team at CIAT and a project team in the Netherlands

Complementary Subproject UT55 A data center for sustainability indicators for Latin America and the Caribbean

An agreement was signed with UNEP to support the development of a project proposal for a data center for sustainability indicators for Latin America and the Caribbean to be located within the Land Management SRG An original proposal to UNEP was made by CIAT and a consultation meeting with the participation of UNEP (ROLAC) ECLAC and IICA was held in Mexico City UNEP has already provided funds to support the installation of a Consultant at CIAT in February 1995 to develop the final proposal for the establishment of the Center The purpose of the Center is to assist decision making on policies that affect sustainable agriculture and land use in Latin America and the Caribbean A bi annual report of policy relevant indicators of sustainability will be produced The Center would be financed by UNEP with CIAT providing logistic support and space

Collaboration with CIAT s Programs and Units

Research has been carried out within the following projects HA01 HA02 HC01 HC11 HC51 (Hillsides Program) TC03 TL03 (Tropical Lowlands Program) BA56 BP03 (Beans Program) CC01 CC51 (Cassava Program) and UG03 (Genetic Resources Unit)

Staff Recruitment and Training
One SS and other staff were recruited Various training activities were implemented

BIOTECHNOLOGY RESEARCH UNIT

In 1994 the Biotechnology Research Unit (BRU) continued to carry out its scientific bridging role for the integration of modern biological techniques into CIAT research and contributed to link advanced research with the NARS of developing countries This year special attention has been paid to the use of biotechniques in the characterization analysis and enhancement of genetic resources

About one half of the Unit s total operational budget corresponded to complementary funding Most of the work highlighted here has been carried out through cooperation between BRU and CIAT Programs/Units scientists

Project Area Molecular characterization and analysis of genetic diversity

Project Molecular characterization of *Phaseolus* bean germplasm collections The single most important development has been the implementation of a new DNA based technology named AFLP (Amplified Fragment Length Polymorphisms) which including components of RFLP and PCR technologies offers significantly increased power for fingerprinting and gene tagging In 1994 we have analyzed the entire wild bean core collection i e 140 accessions using two primers which often allowed the display of around 200 bands in a single run Similarly we have used AFLP to fingerprint the Colombian common bean collection
This work constitutes part of our efforts to integrate DNA base marker technology with GIS for the analysis of *Phaseolus* genetic diversity

Project Construction of a molecular map of cassava For the first time two cassava genetic linkage groups have been constructed (10 linkage groups for the male parent 17 groups for the female) using RFLP and RAPD markers While work on the construction of the map continues mapping populations for gene tagging purposes have been generated by the Cassava Program including traits such as photosynthetic efficiency and bacterial blight resistance Resistance to ACMV is a trait of interest for cooperative work with IITA

In addition using RAPD markers we have obtained a first insight into the genetics of cassava particularly with reference to disomic inheritance Funding RF

Project Molecular tagging of apomixis gene in *Brachiaria* Following the first tagging of the apomixis gene we have been able to confirm the linkage using both RAPD and SCAR markers the primer N14 was identified at 11 cM of distance from the gene Fine mapping using AFLP s is being initiated but additional funding will be needed to carry out this phase of the project to completion

Project Molecular tagging of resistance genes to rice blast fungal lineages Two linkages have so far been tagged We have initiated the analysis of three mapping populations for tagging additional resistance genes against three new fungal lineages Funding RF

Project Area Molecular biochemical characterization of stress response mechanisms

Project Biochemical molecular basis of resistance to the bean weevil The objective is to identify factors responsible for resistance to the bean weevil and their use in the screening of germplasm and in developing genetic approaches for the transfer of resistance to common bean cvs In early work a protein fraction highly toxic to the bean weevil was identified in a resistant wild *P vulgaris* accession on the other hand wheat α amylase inhibitor was found to strongly inhibit the bean weevil s amylase *in vitro* and egg white Avidin has also been found to be a strong inhibitor of the insect s development Testing these inhibitors under a variety of circumstances in underway Funding AGCD

Project Biochemical molecular mechanism of CO_2 assimilation of cassava under stress We are assembling anatomical physiological and biochemical data of cassava and wild *Manihot* spp to characterize adaptation mechanisms of their response to water stress conditions

This year we have described anatomic xeromorphic adaptations of *M rubricaulis M crassisepala* and *M grahami* and the information will be used by the Cassava Program for inheritance studies *In situ* hybridization with non radioactive gene probes (e g PEP Case) will be carried out to study the compartmentalization of gene expression under stress conditions

Project Biochemical genetic basis of tolerance to low nutrient stress in *Brachiaria* The objective is to characterize physiologically and biochemically adaptation to low soil fertility using *Brachiaria* as a model with a future view of manipulating key genetic points Following hydroponic studies we have initiated the search of Al chelating compounds in response to stress by analyzing (with HPLC) organic acids and phenolics exudated by the roots Funding Austrian Academy of Sciences

Project Characterization of amylolytic bacteria for cassava sour starch fermentation In previous work using biochemical criteria we have selected some bacteria isolates as potential started inocula This year we have initiated molecular taxonomic analysis by sequencing hypervariable regions of PCR amplified 16S RNA genes This will allow us to develop specific DNA probes or primers to carry out monitoring of bacterial isolates during the fermentation process

Project Area Gene transfer and conservation of genetic diversity

Project Inter specific *Phaseolus* hybridization assisted by embryo rescue/culture and molecular markers The immediate objective is to facilitate the transfer of useful traits from *Phaseolus* spp to common bean A longer term aim is to develop inter specific gene pools for bridging trait transfer between *Phaseolus* spp and common bean Our initial focus has been the hybridization of common bean with the tepary bean (*P acutifolius*) In a previous effort with Bean Program Genetics large numbers of recurrent and congruity hybrids have been produced and moved to the field for evaluation This year selected populations highly resistant to bacterial blight have been further advanced and characterized

Evaluation trials by the Bean Program also includes resistance to *Empoasca* drought tolerance and adaptation to low fertility soils Congruity backcrossing continues in order to achieve maximum possible fertility levels Our data shows a significant fertility increase between the first congruity hybrids (CBC_1 F_1) and the nineth congruity hybrids (CBC_9 F_1) Monitoring introgression of tepary chromosome segments into advanced hybrid populations is being initiated using AFLPs Funding AGCD (partial)

Project Development of transgenic rice with resistance to rice Hoja Blanca virus (RHBV) and *Rhizoctonia* Initial efforts have focused on standardizing a transgenic methodology in order to then move to the transfer of RHBV resistance the latter in cooperation with the Virology Research Unit (VRU) and the Rice Program This year we have provided molecular and genetic confirmation of transgenesis with LA *indica* rice varieties using Southern Northern and inheritance analyses The RHBV coat protein and antisense RNA genes cloned in the VRU have been used for transformation with the particle bombardment devise Molecular evidence of integration and expression in the transformed plants has been provided The next step is to challenge the plants with the virus under containment conditions Funding RF

Project Development of genetic transformation methodologies for cassava, beans and tropical forages We have earlier regenerated **cassava** plants following *Agrobacterium* mediated transformation using a plasmid construct with marker genes This year we have shown resistance to basta (a selection agent) using leaf discs from greenhouse grown transformed plants Because initial molecular analysis suggests that only very few copies are probably integrated in the cassava genome we are currently conducting Northern tests of the putative transformants in order to show expression at RNA level In parallel we have adapted a highly prolific system of cyclic somatic embryogenesis for use in transformation experiments with new plasmid constructs

Organogenic tissue cultures capable of shoot production have been generated for the first time with five common bean varieties these cultures have been used for particle bombardment mediated transformation and shoots surviving selection have been moved further to grow into whole plants Funding GTZ

With tropical forages we have previously regenerated whole plants from callus of five species of *Brachiaria Arachis pintoi Centrosema brasilianun* and two species of *Stylosanthes* Work is underway with *Flemingia Chamaecrista* and *Desmodium* Using isolated embryos transformation experiments are underway with *Brachiaria* as part of the apomixis project

Project Crypreservation of cassava shoot tips Previous work has resulted in the consistent recovery of whole plants from shoot tips frozen in liquid nitrogen (LN) using one cassava variety as a model In 1994 we succeeded in recovering plants from LN frozen shoot tips of otherwise recalcitrant varieties by manipulating pre and post freezing conditions Another refinement will come from using encapsulated shoot tips for cryopreservation Encapsulation should allow the tissues to better tolerate stresses caused by cryoprotection dehydration freezing and thawing As a first step shoot tip encapsulation has been standarized using sodium alginate and their growth into complete plants achieved We are joining forces with IPGRI to undertake a pilot project for developing a cryopreserved cassava collection

Other Activities

In order to carry out its bridging role with CIAT and the NARS of developing countries in 1994 the BRU has contributed to the following training and awareness activities in biotechnology

Fifteen scientists from five LA Southern Cone countries attended an intensive 2 week Course Workshop at CIAT on molecular characterization and diversity analysis of the rice blast fungal pathogen *Pyricularia grisea* Teams of three scientists per country institution comprising a breeder pathologist and molecular biologist participated in the course Funding IDB/PROCISUR

Seventeen participants from ten LA countries attended an international 4 week Course at CIAT on biotechnology for the conservation of agrobiodiversity Funding OAS ICETEX COLCIENCIAS

Eighteen scientists from nine LA countries attended a Course Workshop at CIAT on rice anther culture breeding Teams of two scientists per country institution comprising a breeder and a tissue culture specialist participated in the Course Funding RF

In 1994 ten support staff members of CIAT Bean Cassava and Tropical Forages Programs were trained in the BRU in various molecular technologies Funding BRU Core and Programs

Also this year 16 scientists from Colombian institutions (e g CORPOICA CENICAÑA several Universities) attended individualized and in service, training in a range of molecular and cellular technologies in the BRU In addition scientists from national organizations of Mexico Ecuador Venezuela Peru China Switzerland and the U S participated in similar training in the BRU Funding BRU Core and institutional

The BRU co organized and participated in a biosafety workshop in Cartagena addressing the status and prospects for the Andean countries Funding DGIS USDA IICA

Project development The following project ideas have been developed through cooperation between the BRU and CIAT Program/Unit scientists and are at various stages of development for seeking external funding

Fine mapping and cloning the apomixis gene in *Brachiaria*

Establishment of a world network for the identification and utilization of genes from wild germplasm for the improvement of yield and nutritional quality in rice and field beans

Single chain antibodies (SCABs) and phage antibodies (PHABs) for detection of viral diseases

Improving cassava marketability through the minimization of post harvest deterioration of roots using an integrated genetic approach

Novel genetic strategies for improving cassava starch quality

Biotechnology of tropical plants applications to crop improvement and genetic diversity Proposal for a training/updating mechanism in LA

Publications. In 1994 BRU staff authored or co authored four articles in refereed journals (two in Theor Appl Genet one in Plant Science and one in Economic Botany) one Book one article several Abstracts and one Lab Manual (Molecular Markers Protocols)

GENETIC RESOURCES UNIT

Purpose

To assemble conserve characterize and make freely available all critical germplasm resources in *Phaseolus Manihot* and several genera of tropical forages and to research these collections so that they can be used more fully by national programs and international organizations

Project UG01 Conservation of the biodiversity of *Phaseolus* Beans germplasm

Status of the *Phaseolus* beans collection The *Phaseolus* germplasm collection grew to 27 435 accessions during 1994 Distribution of percentages of both cultivated species and their wild forms are as follows *P vulgaris* (89 5%) *P lunatus* (5 6%) the complex *P coccineus* and *P polyanthus* (3 2%) *P acutifolius* (1 0%) the wild non cultivated species 19 species represents 0 6% of the collection

Acquisition About 2 000 accessions were received from four countries i e Rwanda Burundi Honduras Chile these materials are under study to elucidate how many of these materials are already represented in the collection

Conservation Emphasis has been placed for augmenting the number of accessions under long term storage of the cultivated *Phaseolus* species different from *P vulgaris* a total of 1 356 accessions were placed under this type of storage including 230 of *P acutifolius* 576 of the complex *P coccineus P polyanthus* and 550 of *P lunatus* With the above additions at present there are a total of 6 579 accessions of *Phaseolus* beans already placed under long term storage Likewise 1 472 accessions of *P vulgaris* were either multiplied and/or rejuvenated for short term storage

Characterization A biochemical characterization using isozyme systems has been initiated as a means of finding and adequate technique which can be used as a selection tool for germplasm acquisition Eight isozyme systems were tested using starch gel electrophoresis on *P vulgaris* materials from different geographic origin Four of those systems detected polymorphism (DIAP MDH SKDH PRX) Diaphorase (DIAP) and Malate Dehydrogenase (MDH) appeared as the isozyme systems showing more variability when comparing geographic origins as well as seed type (color and size) Preliminary results indicate that seeds from the Andean region have more variability than those from Mesoamerica

Documentation All available passport data has been have been already transferred to the newly implemented database system Concerning the *P vulgaris* germplasm besides the passport information (about 25 600 accessions) additional characterization and evaluation data have been incorporated completion and validation of such data is underway and it is expected to have the database for this species completely operational by the end of the year The other cultivated species and the wild non cultivated species

UG01 5 Distribution A total of 8 877 accessions were distributed Most of these materials were requested by the bean program 6 007 (68%) while 2 870 (32%) accessions were distributed to 19 countries through 41 requests A special request is worth to mention and relates to preparation of three complete sets of the germplasm from Rwanda which were sent to several African countries for multiplication so when conditions allow in Rwanda its national collection will be ready for reiniting the research work

Likewise the seed health testing lab analyzed about 1 261 accessions (intended for international distribution from the bean program) for virus bacteria and fungi The results of those analysis showed that the percentage of clean materials among the different sections of the bean program ranges between 41% to 85% indicating that the agreed precautions for field multiplication of nurseries for international need to be reinforced in order to increase the percentages of clean materials

Perspectives The recent established System Wide Initiative for Genetic Resources has established goals to ensure that the collections held at the international centers are adequately conserved in order to meet the global responsibility for the conservation of the genetic variability An assessment of the status of the collection will help to identify priorities on management to fullfil such goals

Project UG02 Conservation of the biodiversity of the tropical forages germplasm

Status of the Tropical Forages Germplasm Collection The collection now consist of about 21 000 conserved accessions of more or less 155 genera with more than 730 wild undomesticated legumes and grass species of possible forage potential About 90% of the collection belongs to the legume family and 10% to grasses The main genera represented in this collection by about 50% of the accessions are the leguminous genera *Stylosanthes Desmodium Centrosema Zornia* and *Aeschynomene* in order of importance At present 15 699 accessions that represent almost 76% of the collection have enough seed for distribution

Acquisition Of the accessions acquired this year 60% were new accessions of *Arachis pintoi A repens* donated by Centro Nacional de Pesquisa de Recursos Genéticos e Biotecnologia (CENARGEN) Brazil and wild *Arachis* species donated by Instituto Nacional de Tecnologia Agropecuaria (INTA) Argentina The other important acquisition was the forage type pigeon pea (*Cajanus cajan*) donated by the International Crops Resources Institute for Semi Arid Tropics (ICRISAT)

Conservation Initial multiplication of about 1 500 accessions were carried out in CIAT S green houses and fields in Palmira Quilichao and Popayan So far one third of the legume germplasm is conserved under long term storage and the first 100 accessions of grasses were stored this year under long term storage condition with germination range of 70 80% as a results of the good quality grass seed produced at Popayan

Characterization Morphological characterization A study was carried out on fourteen *Arachis glabrata* accessions using 46 vegetative and reproductive descriptors The cluster analysis indicated broad genotypic variability within this germplasm The study on the collection of 32 *Arachis* accessions of section *caulorrhizae* indicated that there may not be duplicates within the collection the range of morphological variation showed by the collection increased as accessions were added the morphological descriptor evaluated showed a broad and continuous range between *A repens* and *A Pintoi* Preliminary results of the *Stylosanthes capitata* morphological characterization present the species with high degree of morphological variability clusters by origin Brazil and Venezuela showed a different morphological patterns that could even be different by suborigin

Biochemical characterization Broad biochemically polymorphism was found in 290 characterized accessions of *Stylosanthes capitata* The results of the biochemical study on the 32 accessions of *Arachis* section *Caulorrihizae* indicated large intrasectional and intraspecific variability no genetic duplicates were detected The study of 288 accessions of *Stylosanthes guianensis* Besides the broad intraspecific variability has permitted to associate defined patterns of genetic polymorphism with the geographic distribution of *Stylosanthes guianensis* germplasm

Taxonomical classification Validation of the species *Centrosema macrocarpum* Bentham var *andinum* was made on base of the type CIAT 25008 For the biochemical evidence 24 accessions were analyzed for the separation of *Centrosema macrocarpum* var *andinum* from var *macrocarpum* using α EST DIA GOT

Herbarium Identification and species confirmation of 586 accession of *Desmodium* by Dr B Schubert of the Arnold Arboretum also 87 accessions of different species were sent to 12 taxonomists Seedling characterization was carried out on 157 to get a total of 2 094 accessions

Special Research Topics a) Evaluation of morphological marker white flower on *Centrosema brasilianum* white vs colored Using this marker the outcrossing rate was found ranging between 31 2% to 57 5% b) *Centrosema virginianum* Colored (dominant) vs white (recessive) the outcrossing was 18 37% It was also found that plants with small flowers presented cleistogamy c) *Desmodium heterocarpon* Colored vs white the outcrossing rate was 3 72% d) Seed color as marker One (1) accession of *Centrosema plumieri* two (2) accessions of *Centrosema acutifolium* and two (2) accessions of *Centrosema macrocarpum* were used to study the seed coat color as morphological marker 104 crosses were made of which 17 were successful and will be used for a more detail study of this trait

Documentation Data base is now fully operational for all germplasm management process Thus it fulfills the requirements of the user for specific information in specific combinations of parameters on specific accessions Germplasm catalog of Colombia was published and its distribution initiated Computerized labels for the herbarium were developed

Distribution The Genetic Resources Unit attended 150 requests and 3 000 samples of 70 genera were distributed to 18 countries

Perspectives Complete characterization of the key genera Additional efforts will be placed in documentation Catalogs of germplasm from Brazil and Africa will published Research on production handling and storage of grass seed for long term storage urgently needed

Project UG03 In vitro conservation of the Cassava *Manihot* Germplasm

Status of the *Manihot* collection The in vitro germplasm holds a total of 5 991 accessions represented in 5 491 accessions of cultivated *Manihot esculenta* 349 accessions of 29 wild species 4 genotypes of 3 unclassified wild spp and 147 genotypes from a cross for a genetic mapping project

Acquisition Fifty seven out of a total 165 clones of cassava from the 1993 collaboration expedition of INIA to Argentina were received this year The clones have very complete passport information also they have and a preliminary description of each accession under field conditions They will eventually be virus indexed before moving them to the field for further evaluation

In 1994 62 accessions were introduced from CENARGEN/EMBRAPA together with *Manihot brachyloba* and *Manihot carthaginensis* collected in Colombia during this year constitute 17 species with well documented information

Conservation To meet wit the efforts of conserving diversity rather than quantity a genetic diversity study on the cultivated *Manihot esculenta* species has been started this year focusing in Colombia This will be a guideline for future acquisition To date the activities have been concentrated on cultivated cassava however very limited efforts have been placed on collection ex situ conservation and characterization of the crop s wild relatives
Adaptation to artificial media seemed to be the major limitation for in vitro growth likewise under field condition they have rooting problems and/or lack of adaptation Preliminary data on evaluation of 24 wild species on five different media some species with good response to specific media On the other hand the loss of 25% of clones from the field bank during the last year urge us to review the ex situ conserving method while experimentation to improved methods of vegetative propagation in the field must be continued

Five years after the formation of the TCL a constraint for room availability is presented and five options discussed Remodeling the actual structure together with redistributing within the actual facilities it seems the more viable alternative to take This space constraint resulted to be an open eye to the actual germplasm system and decisions will depend on how big is the collection to grow and what parameters to take?

Characterization Isozyme characterization of the cassava collection for α β esterase is 88% complete this year Isozyme has served to develop a description of each accession based on its banding pattern

As a way of measuring genetic variability it used as one of the criteria to define the core collection as well as additional criteria to identify duplicates in the collection After three year study and simultaneously comparing morphological characterization and isozyme banding a 17% of duplicates are estimated in the collection Further testing using molecular markers will be used for deciding whether or not to eliminate clones from the collection

Distribution A core collection identified to be the selected representation of the diversity from the base collection is together with other elite materials and wild germplasm frequently requested This year 435 clones were distributed for use in National Breeding Programs gene banks or advanced laboratories This adds to a total of 1 880 clones during the last five years distributing fully virus free clones as a complimentary function of the GRU

Perspectives With the appointment of the new cassava curator this year input to the delayed activities such as the international network and seed physiology of both cultivated and wild species will be expected

Seed Health Testing Laboratory (SHL)

The seed health testing lab analyzed about 1 261 accessions (intended for international distribution from the Bean Program) for virus bacteria and fungi The results of those analysis showed that the percentage of clean materials among the different sections of the bean program ranges between 41% to 85% indicating that the agreed precautions for field multiplication of nurseries for international need to be reinforced in order to increase the percentages of clean materials

BIOMETRY UNIT

Role Functions

The Biometry Unit is a research support Unit of advisory training and methodological nature dealing with Applied Statistics and Mathematics in support to CIAT s agriculture and environmental research Functions include
* Statistical/mathematical advice to CIAT researchers
* Collaborative methodological studies with CIAT scientists
* Training in biometrical methods/research data analysis to CIAT and selected groups of NARS researchers
* Assistance to CIAT in defining center wide standars for statistical software
* Identification of areas of CIAT s research where external Biometrician Consultants could add useful contributions

Highlights 1994
* Collaborative Methodological studies with CIAT s scientists
* International Symposium on Statistics in Agriculture and Environmental Research Satellite meeting CIAT June 7 9/95 Planning organization financing
* CIAT PROCITROPICOS NARS Methodological Workshop on agro pastoral research Santa Cruz Bolivia Oct 95 Planning and organization
* New project proposals for external funding (linked to CIAT program s projects)

1 Collaborative Methodological Studies
with CIAT s scientists

a Germplasm Development
Study 1 Optimizing genetic progress with the use of selection indexes in a cassava breeding program *C Iglesias and E Mesa* (Presented at 10th ISTR meeting Brazil Oct 94)

Study 2 Sensitivity of cassava (Manihot esculenta Crantz) clones to environmental changes *C Iglesias F Calle C Hershey G Jaramillo E Mesa* (in progress)

Study 3 A comparaison between the Pedigree Method (PM) and Biothecnology methods (Anther Culture) in the generation of rice lines with stable resistance to blast Use of Categorical Data Analysis Methods *M C Amezquita C Martinez F Correa G Lema* (Presented at the III annual meeting of the Biometric Network Caracas June 27 July 2 1994)

Study 4 A mathematical model to describe Diffusion Patterns of Rice Commercial varieties in Colombia and Brazil *F Cuevas M C Amezquita G Lema* (accepted for publication)

Study 5 Analysis of performance of herbaceous and woody forage species in Central and West Africa *M C Amezquita (CIAT) B Peyre de Fabregues (CIRAD) S A. Tarawali (ILCA) K P Agbemelo tsinafo (Universite de Benin Togo)* Presented at the 4th annual meeting of RABAOC Bamako Mali April 94

Study 6 A Data analysis methodology for the evaluation of large germplasm collections Case study CIAT Brachiaria collection in Brazil *C do Valle and M C Amezquita* (presented at the XVII International Grassland Congress in New Zealand March 1993)

b Genetic Diversity

Study 7 The use of the Coefficient of Parentage to estimate genetic diversity among Andean and Mesoamerican Common Bean Cultivars *O Voysest M C Amezquita M C Valencia* Published in Crop Sciences Feb 1994

Study 8 Use of Similarity Coefficients to study variability in isolates of Pyricularia grisea saac *M C Amezquita E Mesa and F Correa* (Presented at the III Annual Meeting of the Biometry Network Caracas June 27 July 2 1994)

Study 9 Analisis de genotipos de frijol de origen mexicano con datos provenientes de RFLP *M C Duque S Beebe* (en progreso)

Study 10 Estudio de diversidad en materiales elite de yuca *M Duque M Bonierbale* (en progreso)

c IPM

Study 11 A metodology to determine the minimum evaluation period for disease resistance characterization in rice *M C Amezquita E Guimaraes G Lema and F Correa* (in progress)

Study 12 A logit model to evaluate genetic progress in disease resistance *M C.Amezquita E Guimaraes F Correa G Lema* (Presented at the IX Int Rice Conference for Latinamerica and the Caribbean Goias Brazil 21 25 March 1994)

Study 13 Diversidad de la virulencia de poblaciones de Phaeoisariopsis friseola en America Latina y Africa *M Pastor Corrales M C Duque* (en progreso)

d Production Systems/Agroecosystems

Study 14 Bases bioquimicas de la resistencia de Phaseolus vulgaris L a Acanthoscelides obtectus (Say) *C Cardona M C Duque* (en progreso)

Study 15 A Logistic Regression Model on a 3 level categorical variable Case Cassava variety Venezolana adoption *M V Gottret G Henry M C Duque* 1993

Study 16 Methodologies for Design and analysis of a Census Case Microcuenca del Rio Ovejas *G Lema M C Amezquita and J Ashby* (in progress)

Study 17 Weed Population Ecology with Prototype sustainable Cropping Systems for the Colombian Llanos *A Fischer E Mesa* (in progress)

Study 18 Caracterizacion de la Sabana Nativa en Carimagua *Rippstein E Mesa* (in progress)

2. International Symposium on Statistics in Agriculture and Environmental Research to be held in Colombia in June 95

This International event will be a Joint Meeting of the Biometry Network for Central America the Caribbean Colombia and Venezuela (4th Annual Meeting) the Interamerican Statistical Institute (IASI 6th Annual Meeting) and the National Symposium of Statistics It will have two phases

a) A Satellite Meeting at CIAT June 7 9/95 with 80 100 participants where three specific topics will be discussed through Invited Conferences and Round Table Discussions

   Statistical Methods in Environmental Research
   (Environmentrics)
   Statistical Methods in Biotechnology and Molecular Biology
   Statistical Methods in Agricultural Epidemiology

b) The full Joint Meeting at Santa Marta at Pozos Colorados Convention Center June 11 15/95 with 400 participants where a wider variety of statistical topics will be discussed

The CIAT Biometry Unit is responsible for planning organizing and financing the Satellite Meeting

Given the emphasis of CIAT through its SRG s and NARS research on environmental conservation agricultural sustainability IPM and genetic diversity the three selected topics for the CIAT meeting are of high relevance to CIAT s present research agenda The Biometry Unit thanks CIAT SRG s and DDG research for their offert to finance four Invited Speakers who will also be available as Consultant Biometricians to CIAT s scientits during some days previous to the meeting

3. CIAT PROCITROPICOS NARS Methodological Workshop on agro pastoral research to be held in Santacruz, Bolivia, October 1995

As a response to NARS needs the CIAT Biometry Unit together with scientists from TLP prepared in May 94 the proposal Methodological Standarization within the Agro Pastoral Network whose objetive was to clearly define within the Agro Pastoral Research Network methodological aspects of experimental design response variables to be measured indicators of performance statistical methodology for data analysis and conceptualization of an Information System for the Agro pastoral Network to assure the sharing and extrapolation of research results The above proposal was presented discussed and fully supported by PROCITROPICOS and NARS in Sept 94 and a Methodological Workshop was approved to be held in October 1995 in Santa Cruz Bolivia simultaneously with the 4th Annual Meeting of the Agropastoral Network An Organizing Committee was nominated with members from NARS PROCITROPICOS and CIAT

4 Training Activities

The Biometry Unit collaborated with the Biotechnology Unit in two training courses for Latinamerican researchers 1 Taller de integracion de Fitopatologia Mejoramiento y Biologia Molecular para el desarrollo de resistencia estable a Anublo del arroz (Pyricularia grisea) CIAT Oct 94 and
2 Curso internacional de Biotecnologia para la conservacion de la Agrobiodiversidad CIAT Nov 94
Our participation involved conferences on Categorical Methods used in the analysis of molecular biology electrophoretic patterns

5 New Project proposals for external funding (linked to CIAT program s projects or subprojects)

Three proposals were jointly prepared by the Biometry Unit and CIAT scientists

a) Title Analysis and use of the information generated by the International Networks for tropical forages evaluation in Tropical America and Africa
Prepared by M C Amezquita G Rippstein P Kerridge

b) Title Analysis and use of the information generated by Bean Regional Trials Networks in Latin America (1976 1994)
Prepared by O Voysest M C Amezquita R Lepiz and F Saladin

c) Title Methodological standaritation within the Agro pastoral research network
Prepared by M C Amezquita J I Sanz R Thomas M A Franco
The first two have been informaly presented to the World Bank to explore possibilities for funding The last was approved and incorporated within the Savanna Mega Project of the TLP

Future Plans

1 Continue collaborating with CIAT research projects through methodological studies

2 Successfull achievement of aims for both the International Symposium on Statistics as well as for the Methodological Workshop on agro pastoral research 3 Continue opening opportunities for CIAT s researchers to benefit from inviting high level external Biometrician Consultants when there is a clear and practical need for it

VIROLOGY RESEARCH UNIT

The Virology Research Unit (VRU) conducts research on plant viruses of economic or quarantine importance to the commodity and natural resource management programs of CIAT and collaborating national agricultural research institutions Regarding its research capacity the VRU is one of the most complete plant virology facilities in the developing world The VRU has adequate glasshouse screenhouse growthroom and insect rearing space for germplasm improvement and virus characterization purposes The VRU manages an animal colony and an immunology laboratory for the production of polyclonal and monoclonal antisera The main virology laboratory also includes scanning and transmission electron microscopy facilities and a molecular virology laboratory with the proper safeguards to handle radioactive materials The cloning sequencing and amplification (PCR) of viral genomes are standard techniques at the VRU for diagnostic and genetic engineering purposes The VRU s main research commodities include cassava beans rice and tropical forage grasses and legumes

Project Area No 1 Identification and Characterization of Plant Viruses of Economic or Quarantine Significance

Research priorities at the VRU are defined in response to specific Programs needs according to the socio economic importance of the plant viruses that affect a particular commodity However the safe international exchange of plant germplasm requires the implementation of highly sensitive diagnostic techniques for the detection of seed borne plant viruses regardless of their direct economic importance This requirement includes the capacity to detect viruses transmitted in vegetative propagules such as cassava or many tropical forages as well as *in vitro* In this capacity the VRU supports the Seed Health Laboratory of CIAT

Cassava

Subproject No 1 Characterization of cassava vein mosaic virus

In order to characterize the pathogen and develop control strategies the complete sequence of cassava vein mosaic virus (CVMV) was determined The genome is 8158 bp in size and contains a $tRNA^{met}_{i}$ binding site that probably acts as a primer for minus strand synthesis The genome contains five open reading frames (ORFs) It appears that CVMV is distinct from the other well characterized plant pararetroviruses A PCR method to detect CVMV was developed The method is most sensitive and accurate when total nucleic acids are extracted from fresh leaves There is accumulating evidence on the field spread of CVMV

Through training of a Brazilian virologist at the VRU the epidemiology of CVMV can now be studied Knowledge of the vector is critical to the control of this disease

Subproject No 2 Characterization of cassava common mosaic virus

During the molecular characterization of cassava common mosaic virus (CCMV) the presence and the encapsidation of a defective RNA species was confirmed Defective RNA species often interfere with viral replication and may be a natural control for the disease caused by CCMV

Tropical Forages

Subproject 1 Characterization of a virus affecting *Calopogonium muconoides* in the eastern plains of Colombia

The cultivation of calopo *Calopogonium mucunoides* Desv as a promising forage legume for the lowland tropics was hindered by its susceptibility to a severe yellow mosaic disease observed in the Eastern Plains of Colombia An isometric virus ca 28 nm in diameter was observed by electron microscopy in calopo leaf extracts purified preparations and in phloem cells of systemically infected calopo plants

The virus was transmitted by mechanical means and by the chrysomelid beetle *Diabrotica balteata* Although the virus could not be shown to be seed borne in 150 seeds harvested from infected calopo plants the virus could be serologically detected in pod and seed extracts The host range of the virus was restricted to the legumes *Phaseolus vulgaris Vigna unguiculata V radiata Centrosema* spp and *Senna occidentalis* The physical and chemical properties of the calopo virus were similar to those reported for the sobemovirus group and the virus was closely antigenically related to the bean and cowpea strains of southern bean mosaic virus (SBMV) However the pathogenicity spectrum of the calopo virus differed from the pathogenicity spectra of the bean cowpea Ghana and Mexican strains of SBMV Thus the causal agent of calopo yellow mosaic is tentatively identified as a new strain of SBMV

Subproject 2 Molecular characterization of a potyvirus of *Brachiaria* spp related to guineagrass mosaic virus

The 3 terminal region of a tropical forage (*Brachiaria* spp) potyvirus related to guineagrass mosaic virus (GGMV) was compared to that of the sugarcane mosaic subgroup of potyviruses The reaction of total nucleic acid extracted from infected

B brizantha resulted in the amplification of a ca 0 9 kb DNA product The cDNA product was cloned and sequenced revealing the presence of an open reading frame of 149 aminoacid residues and a 3 untranslated region (UTR) of 474 nucleotides

Optimal alignments of the 3 UTRs of the *Brachiaria* potyvirus and members of the sugarcane mosaic subgroup of potyviruses showed percentage nucleotide sequence similarities of ca 42 46 46 and 46% between the *Brachiaria* potyvirus and maize dwarf mosaic virus (MDMV A) sugarcane mosaic virus (SCMV SC and SCMV MDB) and sorghum mosaic virus (SrMV SCH) respectively

Higher nucleotide sequence homologies of ca 88 89 and 92% were obtained between the *Brachiaria* potyvirus and johnsongrass mosaic virus (JGMV) strains MDO MDKS1 and JG

The analysis of the deduced amino acid sequence of the *Brachiaria* potyvirus coat protein fragment revealed a 97 3% similarity between this virus and the JG strain of JGMV However the *Brachiaria* potyvirus did not infect johnsongrass oat or sorghum genotypes used as diagnostic hosts for JGMV ELISA tests of mosaic affected *Brachiaria* johnsongrass maize and sorghum plants grown under field conditions revealed notable antigenic differences between the *Brachiaria* potyvirus and the west African strain of GGMV It is proposed here that the *Brachiaria* potyvirus should be considered as a strain of JGMV (JGMV Brac) rather than GGMV

Project Area No 2 Control of Economically Important Plant Viruses Affecting CIAT Mandated Commodities

Bean

Subproject 1 Screening for common mosaic resistance

The presence of necrosis inducing (black root) strains of BCMV in Africa poses a continuous threat to bean production in that continent The strategy of the VRU and the Bean Program of CIAT has been to combine recessive and dominant BCMV resistance genes to protect bean materials bred for Africa This year a total of 519 segregating materials were screened for their reaction to a black root inducing BCMV strain The resistant plants were individually selected to be increased and progeny tested next year

The screening for common mosaic resistance in Latin America has been a continuous task of the VRU since 1988 In 1994 a total of 1 244 breeding materials were evaluated for their reaction to mosaic inducing strains of BCMV To date most (over 90%) of the bean lines released by CIAT in Latin America possess resistance to BCMV

Subproject 2 Pyramiding genes for resistance to bean golden mosaic virus (BGMV) in *Phaseolus vulgaris*

The VRU has identified various BGMV resistance mechanisms in different races of beans particularly in the Mesoamerican Andean and Durango races

This year 260 segregating materials generated from crosses combining up to four different resistance mechanisms were artificially inoculated with BGMV to select resistant plants A final selection of 18 materials was made These genotypes should be very valuable as parental sources of resistance to broaden the genetic base of BGMV improvement projects throughout Latin America

Rice

Subproject No 1 Characterization of sources of resistance to RHBV

There are reports from Tolima in Colombia that the variety Llanos 5 is more susceptible to RHBV than previously thought It was confirmed that even traditional genotype used as a source of resistance to RHBV rice is susceptible when plants are juvenile The most important finding however is that the CIAT rice resistant varieties are more susceptible when tested with the Tolima colony and virus isolate as compared with the CIAT colony and virus isolate Although Colombia 1 remains an important source of RHBV resistance in the CIAT RHBV breeding program changes in the selection strategy are being implemented to make the selection process more rigorous These findings emphasize the importance of broadening the genetic basis of resistance to RHBV

Subproject No 2 Control of RHBV through coat protein mediated cross protection and anti sense RNA strategies

The preparation of cDNA libraries and the molecular characterization of RHBV has led to the design of novel virus resistant strategies to genetically engineer commercially grown rice cultivars Two different strategies are being attempted a) the nucleocapsid (NC) cross protection and b) the antisense gene down regulation of the major NS4 non structural protein The down regulation of this protein may be a novel method of producing virus resistant plants by breaking the cycle of transmission

Transgenic plants have the NS4 antisense and the NC constructs have been identified The NS4 antisense was expressed as RNA
This significant development allows for the analysis of the effect of the major non structural gene and to determine the down regulation of this viral gene There will be continuing analysis of transgenic rice containing both genes and of the progeny of these plants for their reaction to RHBV

Tropical Pastures

Subproject 1 Development of a reliable screening methodology to select *Brachiaria* genotypes resistant to potyviruses

Manual inoculation tests conducted in 1994 yielded infection rates of up to 35% and 80% for vegetative propagules and seedlings of *Brachiaria* sp respectively While the latter rate is adequate for selection of virus resistant *Brachiaria* genotypes other artificial inoculation techniques will be tested We expect to increase the inoculation efficiency up to 90 100%

Subproject 2 Effect of a potyvirus infecting *Brachiaria* spp on seed production

A preliminary study on the effect of the *Brachiaria* potyvirus on plant biomass and nutritional quality did not show significant differences between virus infected and healthy test plants This year the focus was on the effect of the virus on seed yield In a preliminary growth room test 15 plants were artificially inoculated and compared to 15 virus free *B brizantha* plants The results showed that while some infected plants produced normally approximately 70% of the virus infected plants yielded less seed or failed to produce any viable seed when compared to virus free test plants This experiment will be repeated on a larger scale

GERMPLASM DEVELOPMENT SRG

INTRODUCTION

Our mission at CIAT is to contribute to the alleviation of hunger and poverty in tropical developing countries by applying science to the generation of technology that will lead to lasting increases in agricultural output while preserving the natural resource base (CIAT 1992)

Agricultural production is based on the efficient management of soil water sunlight external inputs and germplasm resources Our efforts are dedicated to optimize the use of the natural resource base with the guiding principle that it must remain indefinitely available Within that context the focus of CIAT s research is on long term human benefits resulting from higher purchase power better nutritional status and overall improved livelihood

Germplasm resources represent a major component of the natural resource base exploited in agriculture justifying the major focus of the activities developed at CIAT Cultivars developed from improved germplasm have probed to be one of the most attractive components of production technology Improved varieties can be easily adopted by farmers with low adoption cost and with a long term contribution toward sustainable agriculture without recurring costs

The strategy of our Center is to effectively utilize the genetic diversity to improve the level and stability of production and quality for our major crops with an efficient use of nutrient and water resources and low agro chemical inputs Although our main focus is the production system at the farm level our strategy also takes into consideration the quality requirements by the intermediate and final consumers of what is produced at the farm level

The research cycle for germplasm enhancement starts with the definition of the problem within the production system that can potentially be solved by the development of a genetic technological component

Such problems could be low net income for farmers due to poor yield potential of the available varieties limited production due to the incidence of diseases or pests the expansion of a crop to environments that are marginal for the existing varieties or an increased demand for higher nutritional quality products Considering the characteristics of client groups with respect to varietal needs is crucial for establishing our priorities The time lag between setting priorities and the improved variety as a final product makes it relevant to have adequate and reliable processes for focussing our future perspectives

Once the problem is stated the genetic base of our crops must be screened in order to identify sources of genetic variability to enhance production potential and/or overcome existing constraints This is a multidisciplinary task that requires expertise from the Programs Research Units and scientist in National Programs advanced laboratories and other international centers Continued progress in germplasm enhancement has relied on understanding plant mechanisms of biochemical and physical stress resistance or adaptation the physiological basis of yield variation and the interaction between the genetic base and production environment for relevant quality traits

The identified genetic variability is then assembled and recombined into gene pools and complexes for variety development Once the desired genetic variability is found within the target species it is integrated through conventional crossing and recombination However the development of advanced tools is continually increasing the range of genetic diversity available for the modification of any given species to include not only distantly related species but also unrelated species

The following major component of the germplasm enhancement research cycle is the development of efficient selection strategies for the rapid accumulation of desirable genes and gene complexes into adapted genotypes and populations The role of the breeder is to integrate different traits in a common genetic background from which valuable options can be selected out by the intermediate and final users Most of our breeding activity can be summarized in a cyclic open ended recurrent process of evaluation selection and recombination Conventional selection techniques are now being complemented by biochemical and molecular marker assisted selection technologies to improve the accuracy and speed up the process of selection

CIAT dedicates itself primarily though not exclusively to pre breeding work for the development of broad based gene pools directed to regional needs We foster and promote appropriate networks for effective dissemination of improved germplasm to National Program breeding and varietal development programs who are in charged of the adaptative selection process We need to work very closely to the National Program counterparts to ensure that our work is relevant to them and to the final users and that the diffusion process of most appropriate genotypes is adequate to attain the expected impact To close the research cycle for germplasm enhancement the application of tools for the diagnosis of the dynamics of varietal adoption is invaluable for getting appropriate feedback to refine the problem definition process selection criteria and varietal deployment strategies

Each program has built an interdisciplinary teamwork on germplasm enhancement Today there is a renewed emphasis on ecoregionality for the activities our center is developing It is also recognized that we ought to work for the improvement of production and nutritional systems where our mandate crops interact among themselves and with other species

There are several activities and research areas that involve two or more of the existing Programs at CIAT which have not been fully exploited and may bring benefits to the fulfillment of our mission

Based on the outputs produced during more than 20 years of research in germplasm development for particular commodities we should be able to strengthen even more the role of our Programs to deliver results in line with our mission At the same time we should explore the integrated effort around an ecosystem research topic or breeding tool to produce outputs that can transgress what individual commodity programs are able to achieve There are areas of synergy and complementarily to exploit for our future efforts in germplasm enhancement

Within this concept is that the SRG for Germplasm Development is evolving to make the most efficient use of scientific resources for the improvement of the production potential and stability of cropping systems within the context of sustainable agriculture development

THE ROLE OF THE SRG GERMPLASM DEVELOPMENT

The role of our SRG is to explore the opportunities and mechanisms for fostering interaction and integration across programs leading to future areas of research with expected outputs in line with the problems we intend to solve As a result of this interaction the flow of ideas in germplasm development across programs should be facilitated leading to the identification of reserchable constraints (mainly missing competencies) the formulation of projects and the search of funds to conduct the projects within existing Programs

MECHANISMS TO FULFILL THE ROLES OF THE SRG

The group recognized that across program projects could be an important element fostering interaction among scientists in the group Nevertheless other alternative mechanisms should be exploited which at the end may result in the formulation of new project ideas In order to promote interaction the group recognized the need to identify researchable constraints and form small brain storming groups to analyze and formulate across Program projects The selection of priority areas should be analyzed together with Program leaders and other SRGs taking into consideration that the chosen area should be relevant for the Programs and/or cover missing competencies within them Regular group meetings seminars on topics within the interaction areas and the review of current activities being carried out by group members are scheduled to promote interaction

AREAS OF INTERACTION

For an effective interaction around reserchable it was necessary to select few areas to work for a period of around 2 years Within those topics there is room for literature review internal seminars workshops formulation of projects etc The areas chosen should cover a missing competence within CIAT or in some of the Programs That is why it is important to choose them in consultation with the Programs In the case of certain topics there is a need for the support of scientists outside our SRG Restricted groups will be formed to support activities in each of the topics and organize seminars internal or international workshops and project profiles

Germplasm Development for Low fertility Soils

This subject is highly relevant for the Programs at CIAT and there seem to be complementarities from which we can all benefit Given that our group includes scientists from a broad disciplinary spectrum the group will be sub divided around issues related to low fertility such as plant nutrition mechanisms genetic control and plant breeding plant/microbe interactions product quality affected by low fertility sustainability and economic impact experimental design and screening methodologies

One of the concrete ideas within this areas is the proposal for Phosphorus acquisition and recycling in low P supplying tropical soils Given that P is the major nutrient limiting crop and forage production in low fertility soils of Latin America one of the best options for resource poor farmers is the use of germplasm adapted to this soil constraint Crop and forage genotypes that can use scarce P more efficiently should improve and stabilize production The key research components of this project are i) characterization of soil P environments and P sources ii) elucidation of plant attributes contributing to P efficiency iii) development of P efficient crop genotypes using conventional and advanced genetic approaches and iv) development of integrated crop pasture systems based on P efficient germplasm that can benefit from combined organic and inorganic P inputs Particularly areas ii) and iii) have direct relationship to our SRG

Similar approaches will be formulated for germplasm development with tolerance to low K levels in the soil and soil acidity in consultation with the Programs

Genetic Basis and Improvement of Nutritional and Product Quality

CIAT Programmes have been mainly involved in the improvement of crop/forages productivity with relatively lesser efforts in the area of nutritional and product quality With the exception of some Programs there seem to exist a missing competence in this area that can be covered with the development of research ideas that cut across commodities into projects

Two Programs (beans and cassava) are presently involved in a global initiative coordinated by IFPRI for Breeding Staple Crops with High Micronutrient Density In the case of beans the objectives are i) to explore the genetic variability for content of total Fe Zn tannin and tannin activity phytate fiber methionine cysteine and lysine ii) to determine the relative roles of nutrient content and anti nutrients in influencing the bioavailability of Fe and sulfur containing amino acids iii) to determine susceptibility of low tannin genotypes to soil borne pathogens and iv) to determine the inheritance of traits found to result in higher bioavailability of nutrients be these higher nutrient content or lower activity of anti nutrients and to formulate a breeding strategy to employ the respective traits

In the case of cassava the project is addressing the need for information on the genetic diversity available to improve the level of micronutrients in the roots and derived products The work is based on the screening of the cassava core germplasm the elite clone collection held at CIAT and the elite cassava germplasm for semi arid regions of Brazil for pro vitamin A iron zinc and iodine Based on the results from the screening the mode of inheritance of selected traits controlling high levels of bioavailable micronutrients in cassava roots will be determined Preliminary results from the screening of B carotene levels have shown that it is possible to select genotypes with an average concentration of 2mg/100 of fresh roots the daily requirements being 3 mg

The increased interest by other Programs in this type of work could lead to a more comprehensive project across CIAT s commodities or an ecoregional project for the improvement of nutritional quality
This may require an update on lab equipment for individual micronutrient analysis with a laboratory that could centralized the work at CIAT

Application of Biotechnology in Tropical Crops

The expertise developed by our Biotechnology Unit in the areas of gene identification and transfer as well as in the development of molecular maps and their use in plant breeding will be applied for the benefit scientist working in our Programmes and having the potential to benefit other crops outside CIAT s mandate

One of the activities proposed within this area is a training event with the purpose of contributing to bridging the gap in biotechnology research between developed and Latin American and Caribbean countries and to strengthen the efforts to orient biotechnology research towards the challenges of sustained agricultural development in the region A first course workshop will be held in 1995 for 18 scientists from the region followed by a period of individualized training at CIAT involving two participants every four months and a follow up activity

The expected outcomes of this project are a core of well trained scientists in advanced biotechnology the establishment of collaborative links and regional mechanisms for updating scientist in the applications of biotechnology to challenges in agriculture and biodiversity

There are other two initiatives for direct applications of biotechnology tools A project has been formulated and initial steps taken for the tagging and cloning of the apomixis gene in Brachiaria The project aims at opening the way for the development of apomictic crops which in turn will have an enormous payoff by fixing heterozygosity at farmers level The activities planned within this project are to develop mapping populations and screen F1 plants both for apomixis and RAPD markers conduct linkage analysis and screen rice mapped clones as a first step toward comparative mapping Significant progress is expected toward the cloning of the apomixis gene at the end of this project

The other project is intended to apply novel genetic strategies for the modification of cassava starch quality Although the project is specific to cassava results from it could be applicable to other root and tuber crops of relevance

The purpose of the project is to provide a wider range of genetic variability in terms of concentrations of amylose and amylopectin expanding the industrial use of cassava starch and the markets for cassava as a cash crop The main activities within this project are the establishment of a reproducible genetic transformation protocol for cassava the cloning and manipulation of key genes related to starch synthesis and metabolism and the testing of transgenic plants to detect useful variants The project will provide avenues for the synthesis of new genetic information and its application to other root crops

Statistical Methods in Germplasm Development

Although the application of statistical tools is an issue that concerns all Programs and SRGs there is a particular gap in the area of quantitative genetics applied to conventional breeding and the application of molecular maps developed at CIAT Our SRG is supporting a set of technical conferences and round table discussions on statistical methods in molecular biology as a part of an International Symposium on Statistics in Agriculture and Environmental Research to be held at CIAT in June 1995 This will be the initial step to build up a proposal for a more permanent support from the Biometry Unit to the scientists working on germplasm development

FUTURE PROJECTIONS

Our SRG is starting to develop activities around areas of interest for the scientists

One of the problems encountered in this process is the complexity of the group and the need to count with scientists from other SRGs for the development of certain activities It is expected that the group will shift toward smaller sub groups involving scientists directly related and interested in the subjects we have chosen to work in There may also be a need to accommodate other areas that could become priority for our Center on a global perspective or for certain Programs The SRG Germplasm Development has adopted a flexible attitude towards promoting interaction among members and that should be the predominant trend during 1995

GENETIC DIVERSITY SRG

Organizational aspects

Purpose The purpose of the Genetic Diversity Scientific Resource Group (SRG GD) is to stimulate scientific discussions and coordinate research initiatives across Center for developing strategies for securing the conservation and use of genetic diversity in CIAT mandate crops and agroecosystems

Scope The efforts of research on genetic diversity at CIAT concentrate on two major food crop genera *Phaseolus* and *Manihot* several key legume and grass Tropical Forage genera and MPTS and other relevant species associated with CIAT mandate agroeco systems

Comparative advantage CIAT has a particular comparative advantage for research in
genetic diversity steaming from the world germplasm collections of *Phaseolus Manihot* and Tropical forages and associated information covering a number of plant families and genera variable propagation systems and life forms and variable genetics and reproductive biology the technological capabilities of the Center especially in modern biology geographic information agronomy and social sciences/communications are assets for GD research

Expected outputs Major outputs of the SRG GD are research proposals and recommendations for actions on

> Ways in which genetic diversity can be better described measured and conserved
>
> Links between *ex situ* collections and *in situ* conservation and rationalization of conservation strategies
>
> Links with utilization characterization and analysis of gene pools populations and genes enrichment of gene pools and broadening genetic bases

Clients and partners Primarily CIAT Programs and Unit scientists the NARIs of LDCs other national/regional organizations involved in agrobiodiversity conservation and research (NGO s universities intergovernmental inst)

Composition of the SRG GD (attached Table)

Activities in 1994

Shortly after its organization the Group s major activities included group meetings and consultations to develop research proposals in agrobiodiversity and to contribute towards developing CIAT s inputs related to the Convention on Biological Diversity (CBD) the CGIAR System Wide Program on Genetic Resources (SGRP) and the Inter Center Working Group on Genetic Resources (ICWG GR) In addition the Group has supported a few initiatives in targeted germplasm collections training of LA germplasm specialists and Theses research projects and travel of SRG members to relevant meetings

SRG Genetic Diversity research initiatives

(i) A Latin American Regional Consortium in Agrobiodiversity Integration of conservation approaches *ex situ* and *in situ* for improved utilization of genetic resources This initiative responds to the CGIAR System Wide Genetic Resources Program and seeks to pull together the cooperation of CIAT CIP CIMMYT and IPGRI and a range of partners including national organizations of Latin American and Caribbean countries regional institutions and intergovermental organizations The goal of the alliance is to develop and implement a regional program for the conservation and use of agrobiodiversity and thus to contribute towards strengthening LAC national capacities for implementing priorities steaming from the Convention on Biological Diversity (CBD) It is proposed to achieve that goal by focusing on priorities identified in the region Four potential major areas of cooperation have been considered

Contribute to the inventory of agrobiodiversity in LAC
Complete the efforts to improve the affordability and sustainability of *ex situ* conservation and develop cost efficient and biologically viable *in situ* conservation for portions of the agrobiodiversity
Enhance the sustainable utilization of *ex situ* collections through traditional and modern breeding and seek for new technological attributes of agrobiodiversity
Contribute to training and public education in conservation and sustainable use of agrobiodiversity in the region with special emphasis on the integration of modern biological technologies with eco geographical information

(ii) The strategy to follow includes an organizational phase to develop the agenda and priorities for the Consortium through consultations with our national partners in LAC and the IARCs of the region The Consortium would provide an umbrella for developing research projects as well as for implementing programs for building institutional capacities

Assessment of genetic diversity by integrating spatial analysis and molecular markers To develop integrated use of DNA based biotechnologies and GIS to assist in the spatial analysis of agrobiodiversity The project will focus on wild *Phaseolus* and Manihot species resources

(iii) Linking Universities IARCs and NGO s for using modern biological technologies in agrobiodiversity research Case of Colombia The goal is to develop a research training program to bridge modern biology from the North with agrobiodiversity from the South Continuation of the training updating program would be provided by an endowment fund

(iv) Development of a pilot cryopreserved cassava collection The objective is to assess all logistical and technical aspects involved in the establishment of a base germplasm collection through cryopreservation using cassava as a model Collaboration between CIAT IPGRI and NARS

Collaborative activities The SRG has also promoted collaboration in genetic resources with countries in Central America and the Andean region By supporting consultation and germplasm collection trips of Group members it is expected that a program will be implemented to bring NARS scientists for short medium term internships at CIAT Contacts have also been established with institutions involved in biodiversity in Colombia (NGOs Universities Ministry of Environment CORPOICA) and well recognized international organizations such as the Smithonian Institute

Response to the CGIAR Stripe Report on Genetic Resources The SRG prepared a document which was submitted to TAC through IPGRI dealing with Conservation of genetic resources CIAT s role in germplasm research The main message of the response is a plea for integrating and emphasizing research on conservation and utilization of genetic resources in the CG genetic resources activities in contrast to the traditional role of GR as a sole service to breeding It was proposed to integrate a range of disciplines/areas in GR research such as biotechnology ecogeography etnobotany participatory research and social sciences in order that the Center s outputs should now contribute not only to increased productivity but to the conservation of the natural resources base

Upgrading CIAT genebank operations and facilities
The SRG has commissioned a sub group comprising the GRU s Curators and the Program s Germplasm characterization specialists to study and assess the current status of CIAT Gene Bank and propose means and ways to upgrade its operations and facilities Attention will be given to the state of the collections in terms of seed viability availability of collections and phytosanitary conditions and to the physical conditions of the gene banks

Also the Group will include assessment of future collection needs for the *Phaseolus Manihot* and tropical forage collections vis a vis the currently available diversity Furthermore research needs in GR will be identified by the Group aiming at gaining information on diversity between and within species rationalization of conservation and targeted collection of new variability The study will be submitted to CIAT management

It is envisaged that additional funding needed for upgrading the operations and improving the facilities of CIAT Gene Bank could in part come from CIAT core and other sources such as the SGRP The Group feels that CIAT has an immense responsibility with the countries of origin of the germplasm for whom it holds in trust and with the scientific community to maintain these resources at the highest possible international standards

Composition of the Genetic Diversity SRG

A great deal of effort and very significant resources were deployed in 1994 for the continued characterization and in depth analyses of land use dynamics in the two target agroecosystems under the leadership of the Land Use SRG

Given resource limitations the Acre Rondonia area was prioritized followed by the Colombian Llanos Some efforts were made to obtain additional and more detailed secondary information to improve the characterization of selected sites in the Cerrados of Brazil while characterization of the Venezuelan Savannas in cooperation with a number of national institutions has been on hold

COMPOSITION OF THE GENETIC DIVERSITY SRG

Scientist	Competence Area	Sub Area	Program/Unit
S Baba	Genetics	Germplasm	Beans
R Hidalgo	Genetic Resources	Germplasm	GRU Beans
M Bonierbale	Genetics	Germplasm	Cassava
C Guevara	Genetic Resources	Germplasm	GRU Cassava
B Maass	Genetic Resources	Germplasm	T Forages
A Ortiz	Genetic Resources	Germplasm	GRU T Forages
P Kerridge	Genetic Resources	Agronomy	T Forages
E Pizarro	Genetic Resources	Agronomy	T Forages
D Debouck	Genetic Resource	Botany	CIAT/IPGRI
A M Thro	Genetics	Biotech Network	Cassava
W Roca	Biotechnology	Cell biology	BRU
J Tohme	Biotechnology	Molecular genetics	BRU/Beans/Rice
F Angel	Biotechnology	Molecular biology	BRU/Cassava
M Fregene	Biotechnology	Molecular genetics	BRU/Cassava
A Mejia	Biotechnology	Cell biology	BRU/Beans
Z Lentini	Biotechnology	Cell biology	BRU/Rice/T Forages

Out Posted staff (Brazil)
Joint CIAT/IPGRI appointment since 1994
PDFs

DISEASE AND PEST MANAGEMENT SRG

Organizational Aspects

Purpose The purpose of the Pest Management SRG is to stimulate scientific interactions to promote and foment new ideas and research initiatives within CIAT and represent CIAT in global IPM activities

Scope Pest management activities at CIAT involve the Center s mandated crops beans rice cassava and tropical pastures as well as those ecosystems of major CIAT activity Hillsides Tropical Lowlands and Semi arid regions

Comparative advantage CIAT has considerable expertise in the diagnostic and research/technology development phases of IPM especially in our commodity crops In recent years CIAT has actively participated in IPM pilot projects (Phase 3) with NARS in Brazil Colombia Ecuador and Venezuela and we have gained considerable knowledge and experience in IPM implementation CIAT scientists represent considerable expertise in doing strategic and applied research to develop pest control technologies This provides a strong base on which to build a more assertive program for actively promoting IPM throughout Latin America

CIAT s working collection of arthropod biodiversity has become widely recognized as an important and essential resource in IPM research and technology development Our links to taxonomists and systematicists in developed and developing countries help provide a useful service to agricultural and natural resource specialists

Our excellent laboratory facilities and expertise in strategic and applied research together with our existing links to researchers and IPM specialists in developed and developing countries place CIAT in a unique position to

a Identify problems and opportunities This includes the identification of hot spots those areas where excessive pesticide use occurs

b Provide a bridge between developed and developing countries

c Identify partners in research and IPM implementation

Expected outputs Expected outputs include

a Formulation of fundable PM projects with NARS

Pests in this document refers to both diseases and arthropods

b Coordinate PM related research and activities across CIAT s commodity and resource management programs

c Resolution of existing and new problems in pest management

d Participate in cross IARC Centers PM activities and develop collaborative projects for funding

e Development of methodologies for the implementation of successful PM projects

f Provide models for the training of researchers extensionists and farmers in PM implementation

Partners and collaborators Successful IPM can only be achieved through the close collaboration with national program researchers and extensionists with direct access to farmers Non government organizations in many regions can also play an important role as they often have a direct link to producers and can provide needed resources Scientists from developed countries can provide needed expertise in technology development implementation and impact assessment

Composition A bio database is available on each member of the Pest Management SRG This includes information on areas of research and crop specialty geographic expertise and education background A list of SRG members is attached (Table 1)

SRG Activities, 1994

The Pest Management SRG (PM/SRG) was organized early in 1994 and a series of meetings have been held on a periodic basis (averaging about one per month) throughout 1994 It was initially decided that the composition of the SRG would remain as Entomologists Pathologists Virologists and Weed Scientists however it was decided that additional expertise would be required such as sociologists economists plant breeders biochemists etc and that these would be resource persons that would be invited to participate in group activities as the need arose

Working document A position paper titled A Regional Initiative for Integrated Pest Management in Latin America and the Caribbean How CIAT can Contribute was started prior to the formation of the SRG This was finalized into a formal CIAT document and describes CIAT s initiative and role in IPM The position paper includes the status of current pest management research at CIAT and outlines expected outputs and resource requirements of an IPM initiative An important component of this document is the description of phases and key features of IPM and details activities and procedures

This document is available for distribution and has been circulated to NARS and Donor agencies and at international meetings and workshops

Project formulation An important function of the PM/SRG is to formalize projects to present to donors for funding IPM initiatives and related research activities All SRG members participated in several meetings to develop inter commodity program projects Project profiles are now available for 10 project areas

These include initiatives in IPM (whiteflies and hillsides) host plant resistance arthropod biodiversity biological control of plant diseases and arthropods characterization of genetic structure and virulence diversity of major pathogens across CIAT s commodities and integrated weed management This project portfolio has been distributed to and discussed with selected donors

Exploration for potential project funding Contact with donor organizations were made whenever the opportunity arose throughout 1994 Organizations contacted include UNDP USAID Rockefeller Foundation Sustainable Agriculture Facility World Wildlife Fund Conservation International World Bank World Resources Institute BID The Smithsonian Institute CARE and others Several expressed interest in funding IPM projects especially where an excessive use of pesticides exists The work the SRG did on describing hot spots for potential IPM projects was well received by several organizations Follow up visits to those institutions expressing interest is planned

CGIAR IPM Network A planning meeting for the UNCED CGIAR Intercenter IPM Initiative was held at As Norway from May 4 to 6 1994 The leader of the PM/SRG participated in this meeting This meeting was organized in response to the UNCED Conference held in Rio in 1993 and the CGIAR set up a Task Force to address three possible areas for intercenter collaboration and one of these was for an IPM initiative
The Norway meeting was attended by nine IARC s and recommended the formation of an inter Center IPM Network and formulated examples of potential collaborative projects which were submitted to the CGIAR Agenda 21 Task Force and Center Directors for consideration This IPM Network was approved at ICW 1994 and IITA was designated the Convenor Center

The first working meeting for the network will be held from Feb 22 to 24 1995 at ISNAR The Hague The Netherlands

IPM Workshops CIAT scientists participated in general IPM workshops held during the latter part of 1994 CIAT hosted a FAO sponsored Workshop for IPM in irrigated rice in Latin America from Oct 23 to 28 1994 NARS participants from Brazil Colombia Cuba Ecuador and Venezuela attended the workshop and presented country reports Potential rice IPM projects were formulated and will be presented for funding

The Integrated Pest Management Working Group (IPMWG) was set up in 1989 under the auspices of the Technical Advisory Committee (TAC) of the CGIAR by a group of donor organizations (which include ACIAR CABI FAO IDRC ODA and USAID) to promote the implementation of IPM The Group has sponsored a series of regional workshops at which country representatives are brought together to discuss the different constraints on IPM implementation and identify plans and initiatives that can be put into practice A regional workshop for South America was held in Quito Ecuador during Nov 20 to 25 1994 The organizational planning for this workshop was held at CIAT and CIAT scientists actively participated in selection of participants and five scientists attended the workshop

This workshop was well attended by all of the spanish and portuguese speaking countries of S America Approximately 100 scientists extensionists economists and sociologists participated Topics covered included definition and concepts of IPM actual and future perspectives limitations institutional political organizational and legal aspects socio economic aspects financing impact evaluation training environmental ecological and technical aspects

We are awaiting the final reports from this workshop but the general consensus is that too much time was spent in discussion of IPM theory and not enough effort was dedicated to identifying potential IPM projects and seeking funding for pilot projects and implementation

Collaboration with National Programs We have received requests and inquiries from Ecuador Colombia Venezuela and Cuba for CIAT s participation in collaborative IPM projects The most common theme that has occurred is that of IPM for control of whiteflies on numerous crops in all the aforementioned countries While attending the afore described IPM Workshop in Quito Ecuadorian Ministry of Agriculture (INIA) officials strongly requested that they be consulted and included in any IPM whitefly project that CIAT might design On Oct 14 1994 several members of the CIAT PM/SRG met with Colombia CORPOICA representatives including Aristobulo Lopez the director of IPM for CORPOICA to discuss CIAT/CORPOICA future collaboration It was jointly decided that IPM/whiteflies on numerous crops including CIAT commodities was a number 1 priority It was agreed that the two institutions would draw up a project proposal and we will seek donor financing It is most probable that other countries will also participate in this initiative A follow up meeting is scheduled for early Feb 1995

IPM Facility The IPM Facility is a recently (late 1994) negotiated consortium of four funding agencies World Bank UNDP UNEP and FAO FAO will be the managing co sponsor This Facility has several goals which include

a Reduction of existing and anticipated increased indiscriminate use of pesticides in LDC s

b Maintain or increase net crop yields

c Long term commitment of resources for IPM projects

d Act as an honest broker in selection and funding of IPM projects

e Assess promising opportunities for implementing IPM

f To monitor and evaluate IPM projects

This facility should be a good source for funding of IPM projects in which CIAT can actively participate It is planned to approach the Facility with viable IPM projects

On going CIAT IPM activities Two IPM projects will be briefly described The first is housed in the Cassava Program the second in the Bean Program A more detailed description of activities and results of these projects can be found in the Cassava and Bean Annual Report Both projects were initiated prior to the formation of the DM/SRG They are included here to demonstrate that CIAT scientists are actively participating in IPM activities that CIAT has expertise in this area and as an example of the collaborative efforts we have with NARS in IPM

1 PROFISMA This cassava based IPM project is designed as Ecologically sustainable cassava plant protection in South America and Africa It involves collaborative efforts between CIAT and IITA Brazil and four African countries Benin Nigeria Ghana and Cameroon This 4 year UNDP funded pilot project was initiated in 1993 In Brazil EMBRAPA/CNPMF is the lead institute joined by state research and extension institutes in Bahia Ceara Pernambuco and Paraiba Although emphasis is given to the research and implementation of pests and diseases management practices considerable crop management input is included A diagnostic survey has been carried out with more than 1000 farmers Strategic research is being carried out at CIAT in support of project activities in Brazil A first year evaluation of project activities was carried out by a UNDP selected panel of experts in Sept 1994 The project received a very positive evaluation especially citing the farmer participatory activities being carried out by the extension services and the quality of support research being done by CNPMF and CIAT

2 Beans/Andean Zone There is excessive use of pesticides by small bean farmers in the Andean Zone especially in Colombia Ecuador and Peru Numerous arthropod pests and diseases reduce bean yields significantly and farmers apply up to 27 different agrochemicals mostly on a weekly basis to reduce pest and disease severity An IDRC funded IPM project is entering into its second phase with its main objective to reduce the use of pesticides

Activities include

1 Surveys and diagnosis

2 Determination of LD 50 values

3 Measurements of yield and economic returns at varying pest population levels

4 On farm testing of control methods

5 Participatory research trials

6 Training of scientists in IPM methods and concepts

The collaborating NARS are CORPOICA in Colombia INIAP in Ecuador and INIA in Peru Initial results in the first phase of this project showed that a 62% reduction in insecticide use and a 36% reduction in fungicide use by farmers could be achieved

Table 1 COMPOSITION OF DISEASE AND PEST MANAGEMENT SRG
Associated Unit Virology Research Unit

Scientist	Competence area/Program
Anthony C Bellotti (Leader)	Entomologist (Cassava)
Cesar Cardona	Entomologist (Beans)
Lincoln Smith	Entomologist (Biological Control Cassava)
Steve Lapointe	Entomologist (IPM/Cassava Brazil)
J Kwasi Ampofo	Entomologist (Beans/Africa)
Fernando Correa	Pathologist (Rice)
Marcial A Pastor Corrales	Pathologist (Beans)
Segenet Kelemu	Pathologist (Tropical Forages)
Robin A Buruchara	Pathologist (Beans/Africa
Francisco Morales*	Virologist (Beans/Tropical Forages)
Lee Calvert*	Virologist (Cassava/Rice)
Albert Fischer	Weed Science (Rice)

* Virology Unit

PRODUCTION SYSTEMS & SOILS MANAGEMENT SRG

INTRODUCTION

Details of the background to and justification for the PSSM SRG were published in the documents presented to the 1994 External Program and Management Review and will not be repeated here

The group has met infrequently as a result of the overwhelming amount of other meetings and discussions that have severely disrupted the normal work of the institute following the requirement to transform the center onto a project basis early in the year and other events associated with a change of management It is hoped that some return to normality will occur in 1995 and that a reasoned progression of the SRG s can be expected over the near future

ACTIVITIES

Soils Research Unit

The PSSM SRG unlike all other SRG s in CIAT does not currently have a support unit attached to it The soils research unit was proposed as the attached unit early in 1994 and the position paper for the creation of this unit is attached as Annex I A decision on this unit has yet to be taken by Senior Management

Visiting Scientist

Dr Kate Wilson principal scientist from CAMBIA Australia vis ed CIAT twice during 1994 from July 17 21 and November 26 to December 21 She worked with Drs D Beck (beans) and R Thomas (Tropical Lowlands) on the insertion of molecular marker gene into *Rhizobium* and *Bradyrhizobium* strains with a view for use as markers in nodulation competition studies and strain persistence studies under controlled conditions in the laboratory and glasshouse Support staff were trained in the techniques required to accomplish this task Her visit was supported by funds from the PSSM SRG

Project development

The PSSM SRG met and developed a number of projects which were all of an inter program nature in the early part of 1994 After revision and discussion four projects were prioritized and developed further they appear in Annex II

Of these projects the C sequestration project has been submitted directly into Phase II of the Global Environment Facility and is currently under review for funding If successful this will require a further year of project development and will be managed by Dr M Fisher of the Tropical Lowlands Program where the project will most probably be housed in accordance with CIAT BOT recommendations

The Phosphorus project has been discussed at both the PSSM SRG and Germplasm Development SRG and is currently being further developed by Drs Beck (beans) and Rao (forages) The other projects have not been developed further at this stage but may be considered relevant to the CG systemwide initiative on soil water and nutrient managment discussed below

Involvement in the systemwide initiative on soil water and nutrient management (SWNM)

The leader of the PSSM SRG has been involved in the development of this initiative following the presentation of an IBSRAM promoted document on the subject to the mid term CGIAR meeting held in New Dehli in May 1994 and in the development of the CIAT led consortium on the Management of Acid Soils (MAS) A project on the savannas of tropical Latin America developed by the MAS consortium was presented as an important theme on SWNM at an IBSRAM organized meeting held in Zschortau Sept 26 30 1994
The project was modified and incorporated into the Zschortau plan which was presented at the CGIAR Centers Week meeting in October 1995 Following CG centers week a further meeting on the SWNM initiative was organized in Rome Dec 17 18 1995 At this meeting chaired by the interim Director of CIAT R Havener the role of CIAT as co convenor of the SWNM initiative with IBSRAM was endorsed by Center Directors and other Center representatives CIAT is currently undertaking the task of collating the information on system wide activities in the area of SWNM and will be responsible for the preparation of a position paper before the mid term 1995 CGIAR meeting

Currently all the projects proposed by the PSSM SRG fit into one or more of the six themes proposed for the systemwide initiaitive on SWNM

ANNEX I

To Drs W Scowcroft & F Torres

From R Thomas

Date 18 2 94

Re Production systems and soil management research group (PSSM)

A proposal for the Soils Research Unit

The creation of a soils research unit (SRU) is proposed to bring the PSSM into line with the other science research groups at CIAT and also CIAT s action plan 1994 1998 Annex II (Version 21/1/94)

Aims and Purpose of the SRU

1 The SRU will be mainly dedicated to maintaining and updating analytical procedures for soil chemical and biophysical studies ensuring that CIAT scientists use wherever possible the same methodologies internally which are consistent with internationally accepted methods (e g the Tropical Soil Biology and Fertility group manual A handbook of methods) CIAT is affiliated with TSBF and an adoption of the latter handbook of methods would be appropriate The library currently holds two copies of this manual with a further copy in the former nitrogen fixation section of the tropical lowland program

1 The unit will monitor developments in analytical methodologies for research in soils and water management including sampling procedures the application of geostatistics for spatial studies and potential linkages with GIS

2 The unit will have responsibility for the organization of the sharing of equipment (e g the minirhizotron root washing equipment) whenever necessary and procedures for this should be discussed and prepared by the group

3 The unit will act as a forum for centre wide issues related to analytical procedures for soil and plant samples and field equipment for research and will oversee the functioning of the existing analytical services unit to ensure cost effectiveness and efficiency

4 The unit will provide advice to the CIAT Institutional biosafety committee on the safety procedures for potentially hazardous analytical techniques (e g toxic chemicals radioisotopes)

Constitution of the SRU

In physical terms the unit would consist of the laboratories currently used by scientists from the tropical lowlands and rice programs (ZL 5 ZL 6 ZL 7 ZL 8) ZL 1 a room currently fitted out for student/visiting worker cubicles ZL10 the analytical services labs and LE 2 the lab currently used by the nitrogen fixation section (soil microbiology) of the tropical lowland program In addition the lab housing the mass spectrometer (LO 16) should also be included in the new SRU although both plant and soil samples are analyzed by this facility on a CIAT wide basis

Equipment for the SRU has been gradually acquired during the financial year 1993 to complement existing equipment from the soils microbiology lab and former IFDC lab In addition to soils equipment the unit should also house the recently acquired mini rhizotron system for measurements of root growth in the field
Further equipment for soil physics studies may be needed but decisions on these will be postponed until the vacant position is filled during 1994

Various scientists have under their supervision soil sampling equipment at Palmira and at various research stations (R Knapp A Fischer D Freisen I Rao R Thomas K Okada J Sanz) No change in the management of this equipment is proposed but any new purchases should be discussed firstly within the group (in fact scientists currently working on roots have held two meetings together to discuss equipment choice and purchase so a mechanism is already in place)

The unit will be comprised of scientists working on soil and water related research activities within existing CIAT programs and the PSSM In this respect the SRU will differ from other support units in not having senior staff exclusively assigned to the unit Staff affiliated with the SRU are currently allocated to CIAT programs However as the bulk of the analytical work for soils and plant research is handled by Analytical Services with only specialized methodologies handled by individual scientists the inclusion of the analytical services labs and staff within the SRU is proposed with representation at unit meetings of the head of analytical services

An active scientist is required to nominally head the unit and organize an agenda for tri monthly meetings of the unit Dr D Freisen currently in charge of the analytical services lab would be the ideal person to head the unit

Proposed list of SRU members
D Friesen IFDC/Tropical Lowlands
R Thomas Tropical Lowlands
J Sanz Tropical Lowlands
A Gijsman Tropical Lowlands
I Rao Forages
K Okada Rice

A Fischer Rice
D Beck Beans
E Amezquita Tropical Lowlands
O Mosquera Analytical Services
R Knapp Hillsides

Annex II Project profiles developed by the PSSM SRG

CIAT Project Profile

Phosphorus Acquisition and Recycling in Low P Supplying Tropical Soils

Purpose To identify plant traits and mechanisms responsible for efficient acquisition utilization and recycling of P and to match requirements of upland rice beans cassava maize and tropical forages to the low P supplying constraints of soils

Rationale Phosphorus (P) is the major nutrient limiting crop and forage production in low fertility soils (oxisols ultisols and andisols) of Latin America The P supply capacity of these soils is low even in those soils with a high total P content because of chemical reactions that fix phosphate P into forms that are unavailable to most plants A major option for resource poor farmers using these soils is the adaptation of plants to the soil constraints rather than attempts to modify the soil via high inputs of fertilizer Crop and forage genotypes that can use scarce nutrients more efficiently would improve and stabilize production for resource poor farmers One advantage of phosphorus fertilizer is that it tends to remain in the soil plant system and is not subject to large losses via leaching associated with the use of N fertilizers for example Therefore basal or corrective P fertilizer applications could be viewed as a capital investment with beneficial residual effects occurring over time

However in general socioeconomic constraints impede the application of large quantities of P to low P supplying soils of Latin America There is a need then to devise a strategy to manage native and applied P resources more efficiently for low P supplying soils in the region The key research components to develop such a strategy are 1) characterization of soil P environments and P sources 2) identification of plant traits and mechanisms to develop screening procedures to evaluate genotypic differences in P uptake and use efficiency 3) development of P efficient crop genotypes using conventional and advanced genetic approaches and 4) development of integrated crop pasture systems that can benefit from combined organic and inorganic P inputs

The proposed research would be done in collaboration with national programs universities and institutes in developed countries CIAT would conduct strategic research and facilitate the exchange of germplasm and information across state/country borders

Expected Benefits The project will allow closer matching of crops with the environment an increased efficiency of phophorus fertilizer use and the identification of traits conferring adaptation to the major constraining nutrient in tropical soils

Expected Outputs
Characterized soil P environments and available P sources
Defined plant traits and mechanisms and improved screening procedures for morphological/physiological molecular traits
Nutrient efficient genotypes developed
Integrated production systems efficient in P utilization and recycling

Activities
▲Develop methods to characterize available P sources
▲Produce thematic soil maps
▲Conduct diagnostic surveys of constraints to farmer adoption of alternative P supply strategies
▲Elucidate plant attributes for P uptake/utilization
▲Determine critical levels of tolerance to soil constraints
▲Evaluate germplasm for P use
▲Evaluate P balance and cycling in prototype systems
▲Develop a P decision support model
▲Conduct ex ante analysis of practices that prevent P fertility maintenance

Research Partners CIMMYT ICRAF IFDC EMBRAPA CPAC EMBRAPA CNPAF EMBRAPA CNPAB CORPOICA Cornell University University of Hohenheim CSIRO University of Hawaii

Potential Donors IDB UNDP DLO NORAID

Time frame 5 years

Funding $6 2 million

CIAT Project Officer Idupulapati Rao

CIAT Project Profile

Sequestration of Carbon and Gaseous Fluxes in Tropical Production Systems

Purpose To understand the processes of uptake and loss of greenhouse gases and their controls so as to devise systems of sustainable agriculture for the tropical lowlands that contribute to lessening of global warming

Rationale Concentrations of greenhouse gases in the atmosphere (carbon dioxide CO_2 methane CH_4 and nitrous oxide N_2O) are increasing at rates that will cause substantial climate change within 50 100 years Of the one quarter of the total that agriculture contributes one third comes from the tropics mainly by deforestation and converting the savannas to agriculture

Changes in patterns of land use in the lowland tropics to continuous cropping to crop pasture rotations or to permanent pastures have important implications for greenhouse gas emissions There are few data on the amounts of soil carbon lost to the atmosphere during deforestation or the amounts of carbon that can be fixed in tropical soils during reclamation of degraded lands or in mixed agropastoral systems We need to quantify the changes in gains and losses of greenhouse gases as land use in the tropical lowlands changes

Concern has been expressed that more than 50% of the area sown to improved pastures is degrading due to mismanagement However there is a need to identify more precisely using satellite information linked to GIS the exact areas and extent of degradation occuring in the savannas This project will examine these issues for tropical lowland production systems

Expected Benefits The project will produce information of benefit to the farmer and to the global community at large in terms of reductions in greenhouse gases

Expected Outputs

Quantified carbon dioxide/methane pools and fluxes
Quantified nitrous oxide pools and fluxes
Manangement practices to promote C storage and reduced methane emission
Improved fertilizer N efficiency and management of green manure to reduce nitrogenous gas volatilization

Activities

- Establish long term exeriments on farm and on station in Colombia and Brazil
- Estimate above and below ground biomass production
- Estimate litter and root decomposition
- Measure and model soil organic matter dynamics
- Develop C N_x and methane flux models

- Estimate regional effects and compile GIS database
- Estimate burning and degradation of pastures

Research Partners CABO DLO (The Netherlands) CENA and EMBRAPA (Brazil) CIET IVIC (Venezuela) Cornell Ohio State Colorado State Universities (USA) ICRAF University of Bayreuth (Germany)

Proposed Donors GEF UNEP EPA UNESCO

Funding $6 million

Time frame 5 years

CIAT Project Officer Myles Fisher

CIAT Project Profile

Integrated Nutrient Management for Tropical Lowland Agroecosystems

Purpose To integrate the use of inorganic and organic inputs with germplasm adapted to the soil constraints of tropical lowland agroecosystems

Rationale Intensification of agricultural production on the acid soil forest margins and savannas of Latin America is constrained by the lack of diversity in acid soil tolerant germplasm and low soil fertility The use of high levels of inputs and machinery especially in monocrops is thought to be unsustainable since it results in deterioration of soil biophysical properties soil and nutrient loss and a potential escalation of pest and disease problems To manage these marginal soils better a new paradigm is needed that relies more on biological processes by 1) adapting germplasm to adverse soil conditions 2) maximizing nutrient cycling to minimize external inputs and 3) increasing the efficiency of input use

To match germplasm requirements to soil constraints soil environments need to be further characterized involving the production of thematic soil maps Critical levels of tolerance to soil constraints need to be established for the range of adapted germplasm available in addition to the further improvement of germplasm for soil constraint tolerance

Improved legume based pastures are an important component of this new paradigm as they can be used to recuperate degraded soils by accumulating organic matter and providing a source of N input via biological nitrogen fixation But they require investments in inputs for establishment that are often beyond the means of graziers Establishment of pastures in association with a crop such as rice defrays the costs of inputs for pasture alone and has proven to be a viable alternative in frontier areas of the savannas However as farmers see the profits to be made from rice this development could deteriorate into rice or other monocropping with detrimental effects on the soil resource base and environment Alternative systems incorporating components that attenuate or reverse the deleterious effects are required and biophysical measures of system performance need to be developed

This project includes an investigation of best bet options using grain legumes green manures intercrops and leys as system stabilizing components The data obtained will be used to develop integrated models that simulate the effects of system components and management on system sustainability Indicators of land quality will be developed by on station and on farm studies The latter will involve cross sectional analyses of existing farming subsystems in an attempt to mimic in space what happens in time A diagnostic analysis of farmer s perceptions and problems is also included

The project will be of a long term nature involving crop rotation cycles of 5 years on station and will focus on the strategic aspects of ley farming in the savannas and forest margins The development of technological options will occur in parallel with the identification of farmers needs and perspectives of ley farming systems

Expected Benefits Prototype systems combining crop and livestock components will improve nutrient cycling pest and disease control and soil quality in a productive and sustainable manner

Expected Outputs

Characterized soil environments and critical levels of soil constraints determined in adapted germplasm
Analysis of inputs and performance of contrasting cropping systems
Models of soil plant dynamics
Integrated use of inorganic/organic inputs
Guidelines for on farm decision making

Activities

- Produce thematic soil maps characterized by biophysical constraints
- Quantify inorganic/organic inputs
- Determine nutrients released from residues/fertilizers
- Determine crop yields/animal production
- Analyze carry over effects of crop rotations
- Monitor pest and diseases
- Develop predictive models of organic input decomposition
- Develop practices to efficiently use organic/inorganic inputs
- Model fluxes of nutrients through inorganic/organic pools
- Analyze farmers resource allocation patterns
- Conduct system economic analysis
- Develop chronograms for integration of organic/inorganic inputs

Research Partners CORPOICA CIMMYT EMBRAPA CPAC EMBRAPA CPNAF EMBRAPA CNPAB Cornell University Ohio State University IFDC

Proposed Donors UNDP World Bank BID

Funding $?

Time frame 5 years

CIAT Project Officer Richard Thomas

CIAT Project Profile

Integrated Inorganic/Organic Farming Methods for Smallholders

Purpose To integrate the use of inorganic and organic inputs on smallholder farms and to understand how farmers decide on the allocation of materials time labor and financial resources

Rationale Intensified land use in marginal areas such as the hillsides and forest margins is resulting in large scale environmental degradation and loss of soil and biodiversity Resource poor farmers are forced to exhaust the nutrients in the soil and apply inappropriate crop and soil management technologies many revolving around shifting cultivation Remedies like those associated with the Green Revolution are inappropriate for this sector of the farming community A new soil paradigm that relies more on biological processes by adapting germplasm to adverse soil conditions maximizing nutrient cycling to minimize external inputs and increasing their efficiency of use has been suggested as one means of rectifying unsustainable farming systems for smallholders One of the key aspects of this approach is the integration of on farm resources such as manures and crop residues (organic inputs) with off farm resources such as fertilizers (inorganic inputs) and pesticides

Research is needed both on the strategic aspects of the integration of on and off farm resources and on the decision making processes of farmers with respect to their allocation of materials time labour and financial resources to these inputs

Benefits Stabilization of the shifting cultivator will drastically reduce further tropical deforestation and will have a large impact in frontier areas

Expected Outputs

Inventory of inorganic/organic inputs of smallholders
Integrated use of inorganic/organic inputs
Guidelines for on farm decision making with respect to inputs

Activities

- Quantify amounts and nutrient contents of crop residues/manures/tree clippings available on farm
- Quantify nutrients released by litter and roots
- Quantify amounts types and placement of fertilizers
- Develop predictors of organic input decomposition
- Model fluxes of nutrients through inorganic/organic pools
- Quantify role of soil fauna in nutrient cycling
- Analyze farmers decision making on resource allocations
- Identify reasons that farmers continue unsustainable practices
- Develop calendars for integration of inorganic/organic inputs

Research Partners Bayreuth University and University of Hohenheim (Germany) CENICAFE (Colombia) CIRAD/ORSTOM EMBRAPA CPATU (Brazil) IBSRAM ICRAF North Carolina State University Ohio State University University of Florida (USA) University of Madrid
CIAT Project Officer R Thomas

Proposed Donors GTZ SDC UNDP Rockefeller Foundation

Funding $700 000

Time frame 5 years

CIAT Project Officer Richard Thomas

INSTITUTIONAL RELATIONS AND DEVELOPMENT SUPPORT

In 1993 the highlight was the dramatic downsizing of Institutional Relations and Development Support In 1994 we learned what can be done and what are the limits to delivery under the new configuration We also started to pursue new avenues of regrowth

INFORMATION AND DOCUMENTATION UNIT

In addition to the regular high workload the Unit carried out sixteen separate activities within four project areas 1) Improved access to and utilization of information 2) Improved collaboration 3) Capacity building and 4) Innovations using new information technologies All activities were undertaken to improve internal effectiveness in access to and delivery of scientific information and to strengthen working relationships with external partners Workload statistics for public and technical services remained fairly constant with those of recent years The Unit installed a cd rom server which was a major innovation in automated services This provides desktop access for CIAT scientists to the local as well as the commercial bibliographic databases available through the Library The Unit is making a renewed effort to contact commodity and NRM research network participants to encourage greater participation in CIAT s bibliographic databases in exchange for receipt of information bulletins and other services

The year was productive despite a much reduced work force However due to the accumulated effects of constant high inflation in scientific publications (printed and electronic) increasing personnel costs because of ongoing strong revaluation of the local currency and the need to meet new information needs of natural resource management research it will be unavoidable to invest additional core resources in CIAT s information collections and related hardware software and telecommunications access if services according to the information needs of CIAT s scientists are to be maintained

The high capital investment in information collections (83% of the Unit s annual working budget) cannot be recovered from charges for library services Neither is it feasible to run core ongoing services on a special project basis
In summary it must be realized that libraries are never self financing their performance always depends on adequate levels of subsidies which in CIAT s case have to come from core or core like funds

COMMUNICATIONS AND PUBLIC AWARENESS UNIT

A dearth of human resources has been alleviated partially by bringing in three journalism students who helped mainly with internal publications while free lance editors relieved the load on English language documents

Fourteen scientific publications (11 in Spanish and 3 in English) were released More than 70 000 copies of CIAT serial publications were distributed more than 16 000 books were sold and another 3 700 distributed free

Twenty one press releases in English and Spanish were distributed to 1 100 addresses CIAT appeared in the press at least 350 times including features in such prestigious media as *The Washington Post London Financial Times The New York Times New Scientist The Australian The Hindu Handels Zeitung* and *Die Weltwoche CIAT On Line* summarizing CIAT research highlights continued in its second year with three issues The *Shareholders in Development* series was continued with a brochure on CIAT and Canada

A brochure *Biotechnology Research and Cooperation at CIAT An Invitation* emphasizing the Center s strengths as a research partner was published in December This inaugurates a new approach to promoting CIAT s services and products

Production of the English version of a video *Wild Savanna South America s Frontier of Hope* was virtually finished in 1994

Graphic arts printed 3 1 million pages to support CIAT programs produced 2 600 pages of camera ready text about 64 000 slides and 8 500 B&W and color photos

SCIENTIFIC TRAINING, CONFERENCES, AND VISITORS

In 1993 CIAT s investment in scientific training and the number of trainees fell to an all time low 58 trainees from NARS received individualized training and 13 participated in a specialized course Trainees travel and living expenses were covered almost without exception by their own institutions or other external funding sources while research costs were absorbed by CIAT One third of the trainees in individualized programs pursued higher degree research

The figures and funding sources for individualized training in 1994 remained practically the same 62 trainees one third of them on higher degree thesis work

But there was a substantial increase in group training Seventy five trainees (as against 13 the previous year) participated in four courses on (1) anther culture for rice genetic improvement co funded by CIAT and the Rockefeller Foundation (2) molecular techniques for breeding durable blast resistance in rice co funded by

CIAT and PROCISUR (3) biotechnology for conservation and utilization of agrobiodiversity co funded by CIAT the Organization of American States the Instituto Colombiano de Credito Educativo y Estudios Tecnicos en el Exterior (ICETEX) and the Colombian Science and Technology Foundation (COLCIENCIAS) and (4) Documentation for Plant Genetic Resources co funded by IPGRI CIAT and CIP COTESU (Swiss Technical Cooperation)

In summary scientific training has started to recover from the severe setback suffered in 1992 1993 New funding sources and co funding arrangements have helped us getting back on track The dissemination of advanced techniques to NARS for plant genetic improvement and the conservation and utilization of agrobiodiversity have been at the center of the four training courses

The number of trainees from industrialized countries has increased from 30 in 1993 to 41 in 1994 but the number of higher degree students among them has remained more stable 13 in 1993 and 16 in 1994

The number of Colombian undergraduates completing their thesis work at CIAT has gone down from 45 in 1993 to 33 in 1994 probably as a reflection of the decreased resources available to senior CIAT researchers

Twelve international conferences (four more than the previous year) were held with an average of about forty participants Ten of these events took place at CIAT one in Indonesia and one in Venezuela

The flow of visitors through CIAT has not changed significantly from earlier years in the 1990s staying at slightly over 200 groups and over 3 000 persons per year

DEVELOPMENT OF NATIONAL AND SUBREGIONAL TRAINING CAPACITIES AND OF TRAINING MATERIALS

The Section for Training Capacity Development and Training Materials (TCDTM) has continued its evolution towards financial self sufficiency Services have been sold to external users and some of the services to in house clients are being charged on a cost recovery basis

Services to external clients

During 1994 the TCDTM served three external clients namely ISNAR the Central American Bean Network (PROFRIJOL) and the Colombian Ministry of Agriculture

Support was given to ISNAR s project to improve planning monitoring and evaluation of agricultural research (PME AR) in Latin America and the Caribbean National research directors and management specialists participated in planning the project undertook thirteen case studies designed training materials and taught in

three subregional courses and a final workshop Tangible outputs were four instructional modules and four fasciculi on PME AR and a manual for training trainers in agricultural research management

For PROFRIJOL the TCDTM supported the design and production of training materials to be used by trainees of PROFRIJOL s team of trainers (developed in earlier years by the TCDTM)
Thus instructional materials have been produced not only for the use of trainers with their trainees but also for the use of trainees with farmers

Colombia has decentralized public technical assistance to farmers by creating UMATAS i e municipal units for technical advice to farmers The TCDTM has supported the development of a team of trainers which in turn trains technical staff of the UMATAS nationwide

Services to in house clients

These were mainly the production of training materials

A new media the video book that is the combination of a video and a book for a specific training purpose is being developed with anther culture serving as a trial subject

Four training modules for tropical forages are being reviewed after having been tested in a training the trainers event in the Eastern Plains of Colombia

Four learning units originally produced for the bean technology trainers in Central America were translated into French for use in Haiti

Six learning units for the Andean Bean Network PROFRIZA are at an advanced stage of development

PROJECT DEVELOPMENT OFFICE (PDO)

The number of detailed proposals for special project funding increased from 8 in 1993 to 24 in 1994 A total of 14 projects (with CIAT share of total budgets of $5 M) were approved in 1994 3 were rejected and 7 are still pending a decision with the donor agency

A large volume of documentation on donor country interests programming themes and submission procedures for special projects was collected
The PDO was able to collect information on new funding opportunities for CIAT from the bilateral and environmental windows of CIAT s traditional donors Contact was also made with some potential new donors both in the United States and Europe

In addition the PDO provided assistance to the Directors and Program Leaders in the preparation of CIAT s project based Action Plan and in the designing of a priority setting mechanism for projects A revision of a manual for CIAT project identification design approval and administration was also completed in 1994