Annual Report

1995

TROPICAL AGRICULTURAL RESEARCH AND HIGHER EDUCATION CENTER

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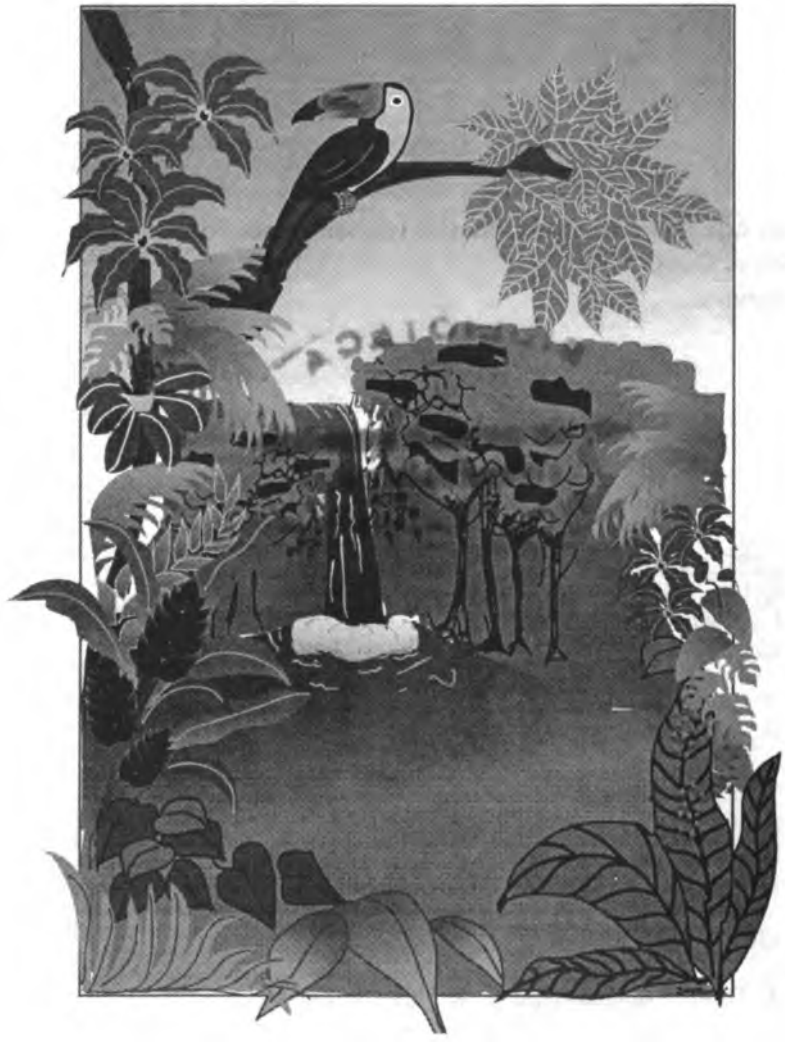
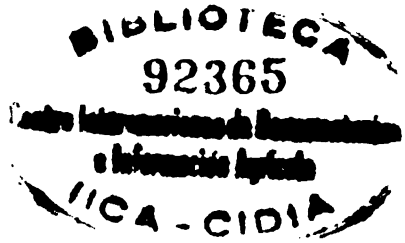
Annual Report



1995

TROPICAL AGRICULTURAL RESEARCH AND HIGHER EDUCATION CENTER

CATIE is an international, non-profit, regional, scientific and educational institution. Its main purpose is research and education in agricultural sciences, natural resources and related subjects in the American Tropics, with emphasis on Central America and the Caribbean.



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FOREWORD

CATIE IS BETTER PREPARED FOR THE NEW MILLENNIUM

It gives us great pleasure to present the CATIE 1995 Annual Report with an Executive Summary in Spanish. Last year, demand for our first edition of 650 copies exceeded supply in July and an additional print run of 200 copies was required. It gives us immense satisfaction to be able to serve the English speaking community in this way from our headquarters in tropical America.

1995 was a key year for CATIE's institutional life with important events affecting financial and structural positions. As in 1992, the conclusion of several important projects during the following year raised difficulties that required prompt attention. USAID informed CATIE that all RENARM projects would have to be completed on the date stipulated. There would be no possibility of renewal, owing to decreased aid and cooperation to Central America following changes in the US Government's strategic political position. At that time CATIE was executing four RENARM projects: Integrated Pest Management, Multi-purpose Tree Dissemination (Madeleña-3), Tropical Forest Management and Watershed Management, representing an estimated budget of US$4 million a year. Since three of these projects at that time represented three of the Center's Technical Areas, the problem was very serious.

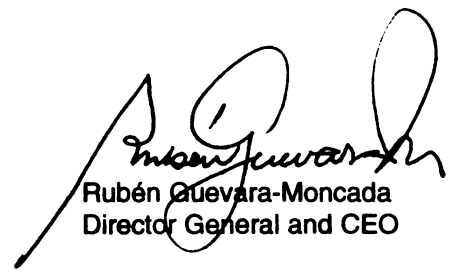
A great deal of effort has been required and much must still be done to overcome the situation, but we can currently extend our gratitude to the international donor community, especially to Sweden, Denmark and Switzerland, for renewing their confidence in our work and giving us the opportunity to continue fulfilling our Mission. As a result of this new cooperation, a new Institutional Development Plan was arrived at to accomplish the specific objectives needed in the development of tropical American countries. This new agenda is interindependant of that of the donors as it is based on the reinforcement of the institution's core budget.

A most important result of this cooperation has been that 90 percent of the principal staff, and world-class Graduate School Professors are still in CATIE, and the total institutional budget decreased by less than 5%. In addition to the financial situation, the opportunities for CATIE to carry out outreach activities in its member countries will be increased by changes introduced by the Board of Directors to the structural organization. These changes were made when the Institutional Development Plan was prepared in October 1995. The main impact of these changes has been to create a new Outreach Program and to establish a unique Research program with five Technical Areas. Starting in 1996, there will be three main Programs at CATIE: Education for Development and Conservation, Research and Outreach. There is also a revamped and innovative Gender Policy in effect, which permeates all of CATIE, and our activities with our partners.

Finally, in 1995, the Board of Directors took the historic step of deciding to introduce a Ph.D. Program in CATIE, starting April 1996. A joint program was negotiated with Colorado State University for a Forestry Ph.D. and with the University of Florida for an Agroforestry Ph.D. pro-

gram. After 50 years of offering the most successful and oldest Masters degree program in agricultural sciences in Latin America, CATIE continues to lead in the preparation of high quality human resources needed for the development of our region.

As the current century draws to a close, a new millennium awaits with new challenges. CATIE will be ready to offer alternatives to resolve global problems through local solutions that have impact at a global level. No other regional institution will be similarly equipped to achieve the goals set out in CATIE's maxim: to produce while conserving and conserve while producing.



Rubén Guevara-Moncada
Director General and CEO

INFORME ANUAL 1995

RESUMEN EJECUTIVO

CATIE

INFORME ANUAL DEL CATIE 1995

RESUMEN EJECUTIVO

El año de 1995 fue muy prolífero en la producción científica del Centro, gracias a las condiciones financieras sanas y a políticas administrativas adecuadas, que brindaron a los científicos un ambiente ideal para la producción. Igualmente se lograron avances importantes en la proyección de las actividades del Centro hacia los países miembros, como se verá más adelante.

Este año también fue clave en la toma de decisiones para desarrollar acciones que, en definitiva, aseguraran la continuidad de las actividades científicas y educacionales, en vista de la finalización de los cuatro proyectos que tenía el CATIE financiados por el Proyecto Manejo de Recursos Naturales (RENARM), con fondos de la USAID, por un monto de alrededor de US $ 4.0 millones anuales.

Desde finales de 1992, previendo tal circunstancia, la Dirección General, junto con la Oficina de Cooperación Externa y los Directores de Programas, se dedicaron a la búsqueda intensa de allegar nuevos recursos que permitieran sustituir el financiamiento norteamericano.

Gracias a estos esfuerzos, realizados a lo largo de 1993, 1994 y1995, y al apoyo de la Junta Directiva, se llegó a la feliz realización de nuevos convenios con los donantes europeos, principalmente Suecia, Dinamarca, Noruega y Suiza, con los que fue posible asegurar, de manera efectiva, la continuidad de las actividades mencionadas. Estos nuevos convenios trajeron consigo nuevas formas de apoyo al presupuesto básico y al desarrollo institucional, dándole así oportunidad a la Institución de manejar, por primera vez en mucho tiempo, su propia agenda.

El éxito alcanzado en estas gestiones constituye el logro más importante del trabajo de 1995, pues sin duda, permitió asegurar la continuidad de las actividades en las Areas que los proyectos RENARM dejaron descubiertas.

SITUACION FINANCIERA

La situación financiera del Centro durante 1995 fue muy estable, como se aprecia en el Cuadro 33 de la página 137 de este informe, donde se consolidan en forma global los ingresos y egresos regulares.

El balance positivo entre ingresos y gastos al final de 1995, indicó la existencia de una reserva operativa adecuada y significativa para iniciar 1996. Debe destacarse el hecho de que al 31 de diciembre de 1995, el pasivo del CATIE con el fondo de retiro del Personal Profesional Principal, fue completamente saldado, resaltando el hecho de que en 1992 este pasivo superó la suma de US $ 1.4 millones. También los pasivos con el fondo de contingencias del personal nacional se

están pagando puntualmente, de acuerdo con el plan de pago establecido para su cancelación total a finales de 1996, habiendo sido el monto una suma cercana a los US $ 375,000l en 1992, versus US $ 32,542 al 31 de diciembre recién pasado. Ambos fondos, en la actualidad, son pagados puntualmente a la finalización de cada mes calendario.

Otro aspecto relevante en la estructura de los ingresos institucionales es el incremento importante que se ha dado en los ingresos registrados por las actividades productivas, que provienen principalmente de la explotación de las fincas, los servicios de hotelería, alquiler de residencias y vehículos, entre otros servicios. Durante 1995 alcanzaron la suma de US $ 1,705,353, mostrando un incremento de US $ 47,193, pero en relación a los gastos hubo una disminución de US $129,083 en relación con1994, para una ganancia neta total en 1995 de US $ 584,676.87.

Un rubro importante de fondos que se manejan separadamente a los listados en el Cuadro referido, lo constituyen los aportes de FUNDATROPICOS, los cuales están destinados al mantenimiento de la infraestructura, financiamiento de becas y de investigación científica.

El Cuadro 39 que se presenta en la página 145, muestra el estado de ingresos y gastos de la operación de las fincas, durante los últimos cuatro años. Se hace la acotación que los saldos netos de la operación que se muestran, incluyen las inversiones hechas durante cada año, contabilizando las inversiones como un gasto del período, sin contabilizarlas a largo plazo, como sería normal en una explotación comercial, pero que en el caso del CATIE, por ser una institución sin fines de lucro, contablemente se ha establecido el procedimiento en esa forma. Sin embargo se agrega un saldo neto sin contabilizar las inversiones, para reflejar este aspecto. El Cuadro muestra saldos netos de US$ 221.685 para 1994 y de US$ 357.623 para 1995.

PLANIFICACION ESTRATEGICA Y COOPERACION EXTERNA

Como se mencionó anteriormente, esta fue una de las actividades más importantes durante 1995, por la situación expuesta de la finalización de los proyectos RENARM antes apuntada.

En octubre de 1995, la Junta Directiva aprobó una serie de cambios en la estructura organizativa del Centro, para adecuarla a las nuevas circunstancias. Fue así como la nueva estructura organizativa transformó los Programas de Agricultura Tropical Sostenible y de Manejo Integrado de Recursos Naturales en dos nuevos Programas, un Programa de Investigación y un Programa de Proyección Externa, en una estructura matricial que comprende cinco Areas Técnicas y cuatro Areas de Servicios en forma horizontal. Esta reestructuración se ejecutará a partir del 1 de enero de 1996.

Además fue aprobado por la Junta Directiva el nuevo Plan de Desarrollo Institucional, enmarcado dentro del Plan Estratégico "Agenda para una Década Crítica 1993 - 2002", un instrumento que permite a la Administración y a los donantes, monitorear, de forma efectiva y oportuna, las acciones técnicas del CATIE en los países miembros y su impacto a nivel nacional. En este Plan se definen con precisión los principales indicadores sobre los cuales se deberán evaluar las activi-

dades. Además el Plan considera también una importante coordinación con los Planes de Acción de cuatro años y los Planes de Acción a dos años de las diferentes Areas Técnicas.

Los esfuerzos por conseguir nuevos proyectos durante 1995, coronaron con la firma de 11 nuevos convenios, como se muestra en el Cuadro 29 de la página 129.

También durante 1995 se firmaron 48 acuerdos de cooperación con diferentes instituciones nacionales de los países miembros y otras instituciones educativas de fuera de la región los que se muestran en detalle en el cuadro 30 de la página 131.

ACCIONES DE INVESTIGACION Y PROYECCION

Durante 1995 se mantuvo vigente la estructura institucional que involucraba un Programa de Agricultura Tropical Sostenible y otro de Manejo Integrado de Recursos Naturales.

A. PROGRAMA DE AGRICULTURA TROPICAL SOSTENIBLE

El Programa de Agricultura Tropical Sostenible incluye las Areas de Cultivos Tropicales, Fitoprotección y Agroforestería. Los resultados de investigación y proyección alcanzados durante 1995 en cada una de esas Areas se presenta a continuación.

1. Area de Cultivos Tropicales

Durante 1995, por iniciativa de la Junta Directiva se realizó una revisión de los objetivos de esta Area, con el fin de establecer un nuevo marco de referencia para sus trabajos, acorde con las necesidades de los países, considerando los aspectos relacionados con la sostenibilidad, la protección del ambiente y los recursos naturales y revitalizando la importancia de los sistemas de producción de cultivos en forma congruente con el desarrollo económico de la Región. Por ello se dividió esta Area en dos Unidades: Unidad de Biotecnología y Unidad de Caracterización de Recursos Fitogenéticos..

Los trabajos más importantes se concentraron en la evaluación de accesiones de leguminosas (*Vigna* spp.), tubérculos (*Dioscorea* spp.) y chile (*Capsicum*), mediante ensayos de campo que comprendieron varios ciclos de cultivo. Mediante estos ensayos fue posible seleccionar accesiones con diferentes niveles de resistencia a las enfermedades más importantes que las atacan en la Región.

Se iniciaron estudios tendientes a evaluar los sistemas de cultivos asociados, como el caso de siembras de camote (*Ipomoea batatas*) con cowpea (*Vigna ungiculata*), yuca (*Manihot esculenta*) con jícama (*Pachyrhizus erosus*) y yuca con camote, considerando diferentes densidades de

siembra y diferentes variedades del banco de germoplasma. Los resultados de estos trabajos se traducen en la selección de variedades, que por sus características pueden ser utilizadas en esas plantaciones en siembras de altas densidades, con resultados económicos favorables. Estas variedades pueden ponerse a disposición de los agricultores.

En un esfuerzo cooperativo entre el CATIE, la Universidad de Winsconsin, el AVRDC y el CIRAD/OSTOM, se iniciaron aplicaciones de la técnica de marcadores moleculares (RAPD), para la caracterización de germoplasma animal y vegetal, de las colecciones que custodian diferentes centros., con el objeto de medir la extensión de la variabilidad y similitud de estos germoplasmas.

Para ello, una muestra aleatoria de 100 accesiones de tomate del banco de germoplasma del CATIE y un número similar de accesiones provenientes del AVRDC, fueron enviadas a la Universidad de Winsconsin para analizarlas y compararlas. Los resultados mostraron que mientras existió poca similitud genética, las dos colecciones son complementarias, como se muestra en la Figura 4 de la página45.

Alentados por estos resultados, nuevamente la Universidad de Winsconsin y el CATIE compararon muestras de las colecciones de chile del CATIE y las variedades comercialmente explotadas en los Estados Unidos. En este caso, las muestras del CATIE mostraron una rica y amplia diversidad genética, que en efecto tienen algunas especies relacionadas que no han sido adecuadamente clasificadas taxonómicamente, y que pueden tener un alto potencial de genes de resistencia a algunas de las más importantes enfermedades. El aprendizaje de estas técnicas ha sido una herramienta muy útil que se seguirá aplicando para el mejoramiento de las especies.

En la Unidad de Biotecnología, se destacan los trabajos realizados para la caracterización genotípica de la colección de café que tiene la Institución y que hasta ahora no ha sido apropiadamente utilizada debido a la falta de información sobre la diversidad genética disponible. Para ello, se inició un programa con la colección de cafés de Etiopía (*Coffea arabica*), utilizando los marcadores genéticos RAPD para detectar polimorfismos. Preliminarmente, los experimentos conducen a definir un protocolo para obtener amplificaciones reproducibles. La estrategia para analizar la diversidad disponible consiste en seleccionar patrones polimórficos en muestras reducidas (10 genotipos) y utilizarlos luego en un estudio más amplio. Los primeros resultados indican que cerca del 15% de los patrones revelan polimorfismo, pero solo el 5% de ellos genera productos reproducibles.

Finalmente, durante 1995 continuaron los estudios de transformación genética en banano, utilizando para ello la transferencia de ADN por el método de bombardeo de partículas. Actualmente las técnicas para ello han sido puestas a punto, siendo la siguiente etapa la regeneración de las plantas transgénicas en el campo.

2. Area de Fitoprotección

Para los trabajos en Manejo Integrado de Plagas (MIP) que llevó a cabo el Area de Fitoprotección, los cultivos más importantes fueron los cultivos no tradicionales de exportación, tales como brócoli (*Brassica oleraceae*), arveja china (*Pisum sativum*) y cucúrbitas (*Cucurbita* spp.), vegetales

como tomate (*Licopersicum esculentum*), papa (*Solanum tuberosum*), repollo (*Brassica oleraceae* Var. Itálica) y chile (*Capsicum* spp), granos básicos como maíz (*Zea mais*) y arroz (*Oriza sativa*) y perennes como café (*Coffea* spp), plátano (*Musa* spp) y banano (*Musa* spp); en tanto que las principales plagas o enfermedades que fueron objeto de investigación y asistencia técnica fueron la mosca blanca (*Bemisia tabasi*), el picudo del banano (*Cosmopolites sordidus*), la broca del café (*Hypothenemus hampei*), el joboto o gallina ciega (*Phyllophaga* spp.), la caminadora (*Rottboelia cochinchinensis*), el arrocillo (*Echinocloa colona*), la sigatoka negra (*Mycosphaerella fijiensis*) en el banano, la pudrición de la mazorca del maíz (*Fusarium* spp. y *Giberella* spp.) y los nemátodos agalladores (*Meloidogyne* spp). A continuación se presentan algunos de los trabajos más sobresalientes en la investigación.

El control táctico más importante en el control de la Sigatoka negra en el banano y en el plátano es el uso de fungicidas. Sin embargo, la aparición de resistencia a los fungicidas y la falta de nuevos productos ha estimulado la búsqueda de opciones. El control biológico de patógenos utilizando microorganismos antagónicos, se considera también como una opción para reducir la contaminación del aire causada por los pesticidas. Se han seleccionado algunas cepas del *Basillus cereus* y *Serratia marcescens,* que son efectivos agentes de control para este hongo. No se encontraron diferencias significativas entre el control dado por los fungicidas y el dado por los microorganismos. A tasas de aplicación de 10^7 cfu/ml, la recuperación de *S. marcescens* de las hojas lavadas fue de 10^5 cfu/ml después de 15 días. El mejor inóculo en la producción de microorganismos se obtuvo con la solución nutritiva. Los surfactantes comerciales tienen una menor acción de fijación de los microorganismos a la hoja, que el agua o la solución nutritiva cuando se aplica por aspersión a las hojas del banano. Los substratos aplicados al follaje muestran efectos positivos en el crecimiento de la bacteria antagónica.

El hongo *Beauvaria bassiana*, como enemigo natural, ha mostrado ser una buena opción para reducir los daños que causa el picudo (*C. sordidus*) en el plátano. El efecto de diferentes formulaciones y métodos de aplicación de *B. bassiana* sobre la mortalidad del picudo, mostró que todas las suspensiones probadas que incluyeron el uso del 10, 15 y 20% de aceite con una concentración del hongo de 5×10^8 conidios por mililitro, causaron el 100% de mortalidad, mientras que las formulaciones control, sin hongos, causaron una mortalidad que osciló entre el 17 y el 36.5%.

Otra de las plagas de gran importancia económica en América son las larvas del género *Phyllophaga* o gusanos blancos. Se estima que en América Latina son causa de pérdidas en las siembras de maíz de hasta US $ 135 millones cada año. Los métodos tradicionales de control se basan en el uso preventivo de insecticidas del suelo, muchos de los cuales tienen toxicidad para el hombre y características indeseables para el medio ambiente y su efectividad no es apropiada. Una cepa de *Beauveria bassiana* se ha identificado y seleccionado, por su altísima virulencia, como microorganismo para el control de la especie más importante, la *Phyllophaga menetriesi.* Durante 1995, en una prueba en la cual larvas de gusano blanco fueron bañadas con agua que tenía una suspensión de 10^8 conidios por ml, se encontraron sepas que podían matar un 25% más larvas que la mejor segunda y un 117% que la mejor tercera, después de cinco a ocho semanas de la aplicación, llegando a niveles de mortalidad superiores al 90%. Durante 1996, estas cepas seleccionadas serán evaluadas en el campo.

La caminadora (*Rottboelia cochinchinensis*) es una maleza ampliamente difundida en América Central, América del Sur y el Caribe, que causa serios problemas en las plantaciones de maíz, frijoles (*Phaseolus vulgaris*), arroz de secano, sorgo (*Sorghum* spp.) y caña de azúcar (*Saccarum officinarum*) por su alta competitividad con el cultivo y su alta capacidad reproductiva, llegando a causar pérdidas que se han estimado entre el 45 y el 64% de la productividad si no es controlada. Durante 1995 se inició la validación de un sistema de cultivo de maíz en Guanacaste, Costa Rica, donde el sistema incluyó el uso de maíz híbrido, un herbicida pre-emergente y la siembra intercalada de la leguminosa *Mucuna* spp. En dos de los sitios donde se validó el sistema (Coralillo y Arado), los rendimientos del maíz fueron significativamente mayores que los rendimientos del agricultor, en tanto que en el tercer sitio (Palmira), donde se utilizó la variedad de maíz local, los rendimientos fueron similares. Sin embargo, la reducción de las poblaciones de caminadora observada en los lotes con *Mucuna* , hacen esperar una disminución importante en el uso de herbicidas para la cosecha de 1996.

Desde 1991, el CATIE, conjuntamente con el INTA de Nicaragua, ha venido desarrollando una tecnología para el manejo de plagas, basada en el uso de los hongos entomopatogénicos *Beauveria bassiana* y *Metarhizium anisopliae*. Como resultado de estos esfuerzos colaborativos, se tiene ahora un método práctico para aislar y preservar las líneas de hongos, y actualmente la colección contiene líneas promisorias para el control de varias plagas como la broca del café (*Hypothenemus hampei*), la palomilla del repollo (*Plutella xylostella*), el picudo del plátano (*Cosmopolites sordidus*), el picudo del algodón (*Anthonomus grandis*), el picudo del chile (*Anthonomus eugenii*) y el joboto o gallina ciega (*Bemisia tabasi*). Se cuenta también con un método simple para la producción en masa de este hongo, basado en material biológico suministrado por el laboratorio. Durante 1995, se validó la efectividad de este hongo para controlar diferentes plagas en Nicaragua . Alrededor de 135 agricultores optaron por aplicar este hongo basados en conteos y observaciones, con resultados exitosos en el control de la broca del café, el picudo del algodón y del banano y en la palomilla del repollo (un total de 250 ha con un promedio de cuatro aplicaciones). Técnicos nicaragüenses fueron entrenados en la producción comercial de este hongo y las mujeres de algunas cooperativas, también fueron entrenadas en su multiplicación durante este año.

En Nicaragua, en el mismo contexto de la colaboración descrita en el párrafo anterior, se propuso una serie de métodos para evaluar las plagas y el control de malezas en las plantaciones de café, con el fin de que el agricultor pueda tomar decisiones basado en estos métodos. Durante 1995, esta metodología se promovió entre más de 100 técnicos y 1,000 productores en diferentes partes del país, la cual comprendió un método para evaluar la composición de la población de malezas en el campo y las decisiones acerca de su manejo y otro similar para las plagas. Aunque ya se han identificado varios grupos de técnicos y productores que están empleando estas técnicas, es necesario continuar con un seguimiento sistemático para determinar las necesidades de capacitación para una adopción masiva.

Finalmente, debe destacarse como un punto relevante, la publicación del libro "Plagas invertebradas de Cultivos Tropicales con énfasis en América Central", el cual constituye un apoyo básico para la identificación de los insectos que constituyen las plagas más importantes para los cultivos de la Región.

3. Area de Agroforestería

Gracias a la colaboración brindada por DANIDA, mediante el apoyo a la Coordinación del Area, ha sido posible ir integrando con mayor eficiencia, las actividades del Area en un programa capaz de lograr transferir sus resultados a los clientes de los países, que abarca y desde decisores políticos hasta líderes de los agricultores. La cooperación financiera brindada por DANIDA y otras agencias como la BMZ/GTZ de Alemania y el CIID del Canadá, permitió el desarrollo de estas actividades.

La investigación durante 1995 mostró resultados importantes en todos los campos de la agroforestería.

El estudio de plantación de árboles maderables en cercos vivos analizó los datos arrojados por cinco especies que se plantaron en diferentes sitios del Area de Talamanca en Costa Rica. Expresando los resultados en m^3/km de cerca, a la edad de cinco años, *Acacia mangium* experimentó 60, *Cordia alliodora* 46, *Eucalyptus deglupta* 104, *Tectona grandis* 64 y *Terminalia ivorensis* 104. Con estos resultados fue posible concluir que en estos sitios, con precipitaciones de más de 2.500 mm anuales no es recomendable plantar *A. mangium* por la mortalidad causada por el hongo *Rosellinia* spp. a las raíces. Es destacable que algunos agricultores colaboradores ya han cosechado árboles comerciales de siete a ocho años de edad y la tecnología está siendo aplicada por agricultores en Talamanca (Costa Rica), Bocas del Toro (Panamá) y de la Costa Norte de Honduras.

Estudios realizados en Turrialba, mostraron que el uso de hasta un 50% de sombra de *Erythrina poeppigiana* en el café (Caturra y Catimor), no afecta la producción del grano. Sin embargo, existió una reducción del rendimiento del 30 al 40% cuando la radiación se redujo más del 30%, pero los granos del café producido bajo sombra fueron más grandes y saludables. Por esta razón, al ajustar los rendimientos para contabilizar las pérdidas de granos dañados de los lotes sin sombra, desaparecen las diferencias. Esto permite recomendar el uso de una disminución de la radiación en los cafetales del orden del 40%, bajo condiciones similares a las de Turrialba.

La continuación de la investigación del uso de forrajes provenientes de árboles y arbustos continuó a un ritmo acelerado. Así, en el estudio de ocho ensilajes de forrajes arbóreos se encontró que dos de ellos, el de morera (*Morus* spp.) y el de chicasquil (*Cnidosculus aconitifolius*), superaron la calidad nutricional de las gramíneas y leguminosas de especies de climas templados, al mostrar digestibilidades *in vitro* de 68 y 73% y contenidos de proteína cruda de 17 y 23%, respectivamente.

Pruebas de producción de leche con vacas no mostraron diferencias significativas al sustituir el concentrado comercial suplementado por morera fresca, siendo las producciones logradas de 13.6 y 13.2 kg de leche/animal/día. Sin embargo, el análisis de beneficios netos parciales favoreció el uso de la morera, al estimarse estos en US $ 2.84 y $ 3.29/animal/día, respectivamente.

La concentración de proantocianidinas mostró diferencias significativas entre cinco proveniencias de *Gliricidia sepium* y entre muestras de diferentes épocas (baja y alta precipitaciones), pe-

ro el contenido de cumarina varió solo entre proveniencias. La concentración de cumarina tiene un efecto negativo en el consumo voluntario de las especies arbóreas, por parte de los animales. Los dos compuestos estudiados tienen un poder discriminatorio para determinar la heterogeneidad genética entre el germoplasma de la especie.

Resultados obtenidos en fincas de productores de leche en la zona Atlántica de Costa Rica (región húmeda), mostraron que los rendimientos de leche se incrementaron entre 1 y 2 litros/vaca/día, al suplementar forraje de poró (*Erythrina* spp.) en el período de menor precipitación (diciembre-abril), cuando existe un déficit de forrajes por la disminución de la humedad en suelos de rápido drenaje. Esto permitió la disminución del uso de concentrados, favoreciendo la economía de los productores.

B. PROGRAMA MANEJO INTEGRADO DE RECURSOS NATURALES

El Programa Manejo Integrado de Recursos Naturales incluye las Areas de Manejo de Cuencas Hidrográficas, Manejo y Silvicultura de Bosques Tropicales, Manejo y Conservación de la Biodiversidad y Economía y Sociología de la Producción y la Conservación.

1. Area de Manejo de Cuencas Hidrográficas

Las acciones y resultados del Area de Manejo de Cuencas durante el año 1995, estuvieron constituidas por la intervención del Proyecto RENARM/Cuencas, Convenio CATIE-ORSTOM, las actividades de la Unidad de Sistemas de Información Geográfica y las de la Unidad de Agrometeorología. Las principales acciones corresponden a Educación, Capacitación y Asistencia Técnica.

Dentro de las actividades de proyección destacan principalmente la consolidación del Laboratorio de Sistemas de Información Geográfica como un módulo regional de investigación y entrenamiento en el manejo de proyectos de conservación de los recursos naturales. Esto por cuanto la cantidad de eventos de capacitación tienen una gran demanda, realizándose por primera vez un curso internacional financiado completamente por los participantes, que provinieron de los países del Area y de Argentina, Ecuador y Bolivia.

La elaboración de los planes de manejo y rehabilitación de diferentes cuencas hidrográficas en los países miembros es uno de los más importantes resultados del Area. Estos incluyeron:

Rehabilitación de la Cuenca del Río Las Cañas, El Salvador.
Rehabilitación de las cuencas de los Ríos Nueve Pozas y Cerro Colopeca, Honduras.
Rehabilitación de las cuencas de los Ríos Humuya y Yure, Honduras.
Modelación Hidrológica del Río Caldera, Panamá.
Proyecto de Reforestación del Area Costera del Lago de Nicaragua, Nicaragua.
Rehabilitación de la Cuenca Alta del Río Virilla, Costa Rica.

Modelación Hidrológica e Hidráulica del Río Tuis, Costa Rica.
Modelo operativo de la Reserva de Arenal, Costa Rica.

Varias actividades bajo la modalidad de "buy-ins" y contratos, constituyeron otros logros importantes para el Area, ya que ellos contribuyeron a consolidar el Laboratorio de Sistemas de Información Geográfica. Estas actividades comprendieron principalmente entrenamientos en servicio, construcción de bases de datos geográficas, servicios de sensores remotos y asistencia técnica. Las instituciones que demandaron estos servicios fueron en El Salvador, el Proyecto IICA/MAG, en Nicaragua los Proyectos IICA/GTZ y OLAFO, en Honduras la Escuela Agrícola Panamericana (El Zamorano), de Italia el Proyecto TREES/ESA y de Brasil el Proyecto SUDENE.

2. Area de Silvicultura y Manejo de Bosques Tropicales

El año 1995 fue un año de transición para tres de los seis proyectos forestales del CATIE. Dos grandes, el Proyecto "Madeleña" (financiado por USAID/ROCAP y FINNIDA), y el Proyecto "Producción en Bosques Naturales" (financiado por USAID) llegaron a su fin en diciembre. Por otro lado, empezaron dos proyectos más pequeños sobre el manejo de bosques naturales, con fondos bilaterales de USAID en Guatemala y Belice. También, se concretó otro proyecto grande de transferencia de tecnología sobre el manejo de bosques naturales en Nicaragua y Honduras, con fondos de COSUDE y se generaron otras ocho propuestas, la mayoría aún bajo consideración por los donantes, para asegurar la continuidad de las acciones importantes en el campo forestal a partir de 1996.

A pesar de toda esta transición, el Area Forestal del CATIE ha tenido un alto impacto en los países de América Central en 1996. Los logros realizados por los proyectos forestales en cuanto a extensión y capacitación se reportan en la sección de EDECO. A continuación, se destacan los logros más importantes en el campo de la investigación para cada proyecto.

Proyecto Madeleña (Diseminación del Cultivo de Arboles de Uso Múltiple)

A través de los últimos 15 años, el Proyecto Madeleña estableció 350 experimentos y más de 14,000 parcelas permanentes, con el objetivo de definir las mejores opciones silviculturales para las diferentes zonas de América Central. En 1995, se hizo un esfuerzo grande conjuntamente con científicos en los países, para concluir los análisis de los últimos 50 de estos experimentos, y de ellos y otras fuentes de información, se preparó un total de 62 publicaciones. Un 80% de estas publicaciones se orientaron a una audiencia compuesta mayormente por extensionistas, que exigían la información para aconsejar mejor a sus clientes, mayormente los pequeños y medianos agricultores, en cuanto a asuntos silviculturales. La mayoría de las otras publicaciones fueron preparadas para revistas o reuniones científicas internacionales.

Algunos de los temas más importantes en 1995, estaban relacionados con la calidad de sitio para varias especies forestales, técnicas de manejo de rodales ya establecidas y los aspectos económicos de la producción forestal.

Durante 1995, el IUFRO (Unión Internacional de las Organizaciones de Investigación Forestal), otorgó a uno de los miembros del equipo científico de Madeleña, un reconocimiento como uno de los diez mejores jóvenes investigadores forestales en el mundo. Recibió este honor por el desarrollo de una base de datos para almacenar y organizar una gran cantidad de información procedente de los experimentos de Madeleña, conocida como MIRA, que además puede ser accesada por los miembros de la Red Madeleña.

Otro logro importante ha sido la consolidación de las comisiones de investigación forestal en cada país; un paso iniciado por Madeleña y muy importante para asegurar que las investigaciones forestales apropiadas sigan siendo coordinadas e impulsadas en el futuro.

Mejoramiento Genético de Arboles Forestales

Las actividades de mejoramiento genético forestal destacan los esfuerzos por encontrar procedencias de árboles de caoba (*Swietienia macrophylla*) con resistencia al ataque de *Hypsipyla grandella*. Esta polilla pone sus huevos en la yema terminal de las plantas y luego las larvas las destruyen, arruinando la forma del árbol para propósitos comerciales. Sin embargo, en experimentos realizados por el CATIE se ha detectado diferencias significativas en suceptibilidad a esta polilla entre procedencias. Actualmente, en colaboración con el Scotland's Institute for Terrestial Ecology (ITE), el CATIE desarrolla una actividad en toda el área para coleccionar semillas y reproducirlas por cultivo de tejidos para obtener árboles madre. Por su parte, el ITE está caracterizando el ADN de este germoplasma, utilizando las técnicas de RAPD. Existe un amplio espectro de posibilidades de colaboración de otras instituciones interesadas en integrarse en la solución del problema de la polilla.

Los ensayos clonales iniciados con *Gmelina arborea*, una de las especies de árboles de más rápido crecimiento en el mundo y con *Cedrela odorata*, especie muy similar a la caoba, constituyen otros dos grandes avances en la genética forestal. Estos ensayos respectivos han sido útiles para la identificación de genotipos con óptimas características de crecimiento y resistencia a la polilla (*Hypsipyla*).

Lo más importante del trabajo de mejoramiento realizado en el CATIE son los ensayos de prueba de progenies medios hermanos, que han sido establecidos para 17 de las especies más cultivadas en América Central. En 1995, se evaluaron los resultados de cada uno de estos ensayos y siete de ellos fueron convertidos en huertos semilleros, eliminando los árboles inferiores para dejar únicamente los mejores individuos de las mejores familias. Se espera que los árboles que eventualmente desciendan de las semillas de estos huertos semilleros, crecerán entre un 20 y un 30% más rápido que los árboles provenientes de semillas no mejoradas de las mismas especies y también tendrán mejor forma.

Semillas Forestales

En el Proyecto de Semillas Forestales (PROSEFOR), durante 1995, se avanzó significativamente en el fortalecimiento de los bancos de semillas existentes en la Región, incluyendo Repúbli-

ca Dominicana. Esta acción es de suma importancia si se considera que en 1995, se estima que aproximadamente 25 000 ha fueron reforestadas en los países de América Central. El suministro de semillas de calidad apropiada es el objetivo principal de este Proyecto. En este año se lograron establecer 147 rodales semilleros nuevos de 40 especies con orientación del proyecto. Otra actividad importante ha sido la capacitación de los técnicos de los bancos de semillas, en cuanto a los procedimientos internacionales de certificación, colección, almacenamiento y distribución de semillas.

Otro logro significativo ha sido la acumulación de una gran cantidad de información sobre las mejores técnicas de colectar, almacenar y usar semillas de un gran número de especies forestales tropicales. Esta información se ha derivado de ensayos pequeños y puntuales realizados por el Proyecto o por medio de la literatura mundial. En 1995, este Proyecto escribió o tradujo 44 publicaciones necesarias para mejorar el uso y disponibilidad de semillas para plantaciones forestales en América Central.

Producción en Bosques Naturales

El Proyecto Producción en Bosques Naturales (PBN), hizo varias contribuciones significativas para mejorar el manejo de bosques naturales a nivel regional, especialmente en Costa Rica, Guatemala y Nicaragua. Su papel principal fue mostrar que el manejo de bosques tropicales húmedos y de baja altitud, era técnicamente factible, económicamente atractivo, ecológicamente sostenible y socialmente aceptable, bajo una gama de condiciones.

En 1995, hubo un esfuerzo muy significativo, por parte de este Proyecto, en asociación con las autoridades políticas forestales, cuyo resultado llevó al desarrollo de requisitos mucho más simplificados para planes de manejo y a la vez, aceptables para los gobiernos de Guatemala, Nicaragua y Honduras.

También, en algunos de los bosques naturales que el Proyecto ha estado asesorando por más tiempo, y donde han tenido más intervenciones silviculturales, se realizaron estudios de caso para documentar los costos, beneficios y otros aspectos que inciden sobre la viabilidad de un intento de manejar dichos bosques naturales en forma sostenible. Globalmente, las conclusiones han sido que si el dueño (un individuo, una comunidad, una empresa) desea manejar muchos tipos de bosque húmedo (pero no todos) en forma sostenible, sí puede hacerlo, y será económicamente atractivo, siempre que se sigan los lineamientos técnicos recomendados por el Proyecto.

Proyecto Silvicultura de Bosques Naturales (COSUDE)

Este Proyecto hizo grandes avances en sus estudios para determinar la dinámica de los bosques naturales intervenidos, tanto de bosques primarios como de bosques secundarios, en un esfuerzo para definir cuáles intervenciones serán las más apropiadas. Con este fin, se monitorearon 41 parcelas permanentes grandes (de una hectárea), para determinar el crecimiento de todos los árboles de más de 10 cm de diámetro, y más de 600 parcelas permanentes pequeñas (5m x 5m), para determinar su vegetación arbórea, brinzales y latizales.

También se hizo un esfuerzo especial para analizar los datos provenientes de ocho años de investigación intensiva en bosques secundarios, que estaban siendo manejados y convertir esta información en publicaciones. Un resultado es que se puede aumentar entre uno y tres veces el crecimiento de los árboles de especies comerciales, liberándolos de la competencia de árboles dominantes pero no comerciales adyacentes. Para efectuar esta liberación se encontró, en otros estudios, que una mezcla del 15% de Roundup (Glyfosato) inyectado en el tronco, es muy eficaz para matar los árboles competidores, y no presenta problemas para el medio ambiente. Otro hallazgo es que se puede predecir la productividad futura de algunas especies comerciales en ciertos tipos de bosques naturales, con la medición de ciertas propiedades físicas y químicas del suelo, tales como pH y fósforo disponible, y el porcentaje de arcilla.

Finalmente, en 1995, se inició el proceso de escribir un libro definitivo sobre el manejo de bosques naturales en el neotrópico. En este libro se pretende captar los mejores pensamientos de unas 25 autoridades más destacadas sobre este tema tan importante para el porvenir de dichos bosques.

3. Area de Manejo y Conservación de la Biodiversidad.

Los campos más importantes que cubre esta Area Técnica comprenden la producción y el manejo de los humedales, los productos no maderables del bosque, la explotación racional de los productos maderables, la etnobotánica y el manejo de las áreas protegidas y zonas de amortiguamiento. Dos importantes Proyectos (OLAFO y Manejo de Manglares), la contribución importante de la WWF y el presupuesto básico del Centro, brindan el soporte a estas importantes actividades.

Las actividades de transferencia de tecnología son un elemento importante del Proyecto OLAFO que tiene acciones en Costa Rica, Guatemala y Panamá. En cooperación con las instituciones nacionales se han puesto en práctica nuevas alternativas para los agricultores, con el fin de incrementar sus ingresos, tratando de detener el avance de la frontera agrícola. De esta forma, trabajando en Guatemala con la Comunidad de San Miguel, en la zona del Petén, donde el 80% de las familias vive de la explotación de los bosques naturales, se han hecho grandes esfuerzos para lograr su explotación racional. Durante 1995, se cosechó un área de 180 ha, con un rendimiento de 1.5 m^3/ha. A pesar de los relativos bajos rendimientos, esta actividad .complementaria a sus sistemas de producción agrícola, representa un incremento de un 350% en el salario diario que perciben los productores. Se han organizado grupos de productores para mejorar las prácticas de recolección y comercialización de la miel de abeja, las cuales, medidas en comparación al salario promedio de la zona, han incrementado en un 40% sus ingresos. Durante este año, se inició la introducción de módulos de producción de cabras, los cuales han empezado a rendir hasta 1.6 kg. de leche/día a las familias que normalmente no tenían acceso a la leche fresca. Finalmente es importante resaltar que la introducción de la práctica de plantar *Mucuna* spp. en los cultivos de maíz tradicionales y que en 1995 ya es aplicada por el 50% de los productores, ha tenido un impacto en reducir hasta en un 30% el avance normal de la frontera agrícola.

En Costa Rica, en la zona de Talamanca, la introducción de prácticas de manejo forestal en las fincas ganaderas, ha significado un rendimiento promedio de madera de 23 m^3/ha, siendo

la alternativa más competitiva en la región. Estudios realizados en la zona, han mostrado que el manejo de los bosques provee un 14% de incremento sobre el salario promedio de la zona. También en Costa Rica, pero en los manglares de Térraba-Sierpe, la cosecha de leña de mangle se ha incrementado acorde con los planes de manejo; en efecto, la Cooperativa Coopemangle ha pasado a producir de 200 sacos de carbón mensuales a 1,000 sacos a finales de 1995.

En Panamá, en el Valle del Teribe, se inició en 1995 un programa para recuperar las plantaciones de cacao, con un grupo de 11 agricultores, que para final del año ya se había triplicado. Los resultados de este programa se esperan para 1996.

Durante 1995 continuaron los esfuerzos de investigación en la identificación de nuevas especies no maderables del bosque y en la caracterización de las ya identificadas que son objeto de posible utilización en forma comercial. Así, estudios etnobotánicos en la región del Valle del Teribe en Panamá, han conducido a identificar 83 especies con sus usos tradicionales. Entre las especies ya identificadas, los estudios en *Quasia amara*, un arbusto con características de biocida natural, han determinado que su crecimiento natural es en bancales (parches), que requiere alta humedad pero exigente de suelos drenados, necesita de la luz para su regeneración y que la mayor concentración de biocidas se acumula en los troncos de mayor diámetro. La especie *Chamadorea* spp., una planta ornamental de gran belleza, se ha determinado que menos de una cuarta parte de la población es cosechable, que las plantas femeninas reproductoras son solamente entre el 1 y el 4% de la población, que únicamente entre el 15 y el 20% de las hojas de la planta son cosechables y que se requieren de cuatro a seis meses para producir hojas maduras en condiciones de su hábitat natural. En el caso de *Desmoncus* spp., un bejuco cuyas fibras son utilizadas para la fabricación de artesanías, la metodología para identificar la estructura de la población productiva; únicamente un 14% de la población es cosechable, con rendimientos de 1 km de fibra/ha y la liana requiere de c uatro años de crecimiento para alcanzar la madurez. Estos resultados han proporcionado información básica para el diseño de planes de manejo apropiados para el uso sostenible del recurso.

Trabajando en tres tipos de ecosistemas, los proyectos han realizado investigación aplicada para determinar el uso sostenible, tanto de los productos maderables como de los no maderables del bosque y los efectos residuales de las prácticas de extracción de madera sobre los recursos vegetativos no maderables.

En la Reserva indígena de Kekoldi, en Costa Rica, que se encuentra en la región Atlántica del país, de 120 ha bajo manejo solo el 25% de ella es productiva. Debido a la variabilidad ecológica, se definieron diferentes sistemas silviculturales de manejo para dos tipos vegetativos encontrados. Basados en seis años de rotaciones, se logró una producción sostenible de 1,800 kg de *Quasia amara*/año, indicando que esta planta puede ser manejada como complemento de las actividades de extracción de madera.

En San Miguel, Petén, Guatemala el bosque dado en concesión a la Comunidad por el Gobierno, está compuesto en un 60% por 10 especies que actualmente no tienen valor comercial. Dada la escasez de maderas preciosas disponibles, la búsqueda de mercados para las maderas no

tradicionales debe ser reforzado. Con el plan de manejo actual de la foresta, se ha detectado un incremento anual de los diámetros de los árboles menor a lo esperado, siendo el mismo entre 1.9 y 2.9 mm. Como resultado de la alocación de cortes asumida, los planes de manejo deben ser ajustados para reflejar el crecimiento real de los árboles en Petén, y en San Migue,l en particular.

En Nicaragua, en el manglar de la zona de Héroes y Mártires, se seleccionó una comunidad de cosechadores de leña en forma experimenta,l para realizar la explotación de los recursos disponibles. Desde la perspectiva económica y técnica, son posibles las prácticas de extracción controlada de mangle. Sin embargo, en el caso seleccionado, el manejo sostenible basado en la organización comunal, no fue viable, debido a las condiciones sociales y culturales de la población. Adicionalmente, las regulaciones aplicadas a los otros tipos de bosques y su planificación, no son aplicables a los manglares debido a los altos costos de control impuestos por el Estado y al bajo precio pagado por la leña. Debido a estas limitantes, fue necesario redefinir las regulaciones, basándolas en el centro de un área y no en árboles individuales.

Las actividades desarrolladas en el campo de la conservación y manejo de áreas protegidas, el Centro pone especial énfasis en la capacitación de técnicos de las instituciones nacionales y en la elaboración de planes de manejo de áreas específicas.

Destacan en este aspecto las consultorías realizadas durante 1995, entre ellas el estudio de la organización administrativa de la Dirección de Areas Protegidas, Pesca y Fauna de Nicaragua, la de lineamientos para el desarrollo de la Planificación de Areas Silvestres Protegidas de Honduras, con particular énfasis en las áreas de amortiguamiento y la elaboración de un plan global para el establecimiento del Area de Conservación del Pacífico Central en Costa Rica.

4. Area de Economía y Sociología de la Producción y la Conservación

Durante 1995, el Area de Economía y Sociología de la Producción y la Conservación se abocó a elaborar y organizar la Maestría con énfasis en Economía Ambiental y Sociología, la cual empezaría con diez estudiantes en enero de 1996, para lo cual fue preciso establecer un Plan de Trabajo para ese año y para 1997. Este proceso incluyó la elaboración del pensum y los programas de los cursos específicos.

Paralelamente, la elaboración de propuestas para proyectos específicos fue otra de las tareas prioritarias. De esta manera se elaboraron siete propuestas que han sido sometidas a diferentes donantes, entre las que destacan la sometida al Banco Interamericano de Desarrollo para becas del Programa de Maestría en Economía; la sometida a la Unión Europea para el análisis económico de las políticas fitosanitarias de Centro América, en la que participan como colaboradores la Universidad de Hanover (Alemania), la Imperial University of London (Inglaterra) y la Escuela Agrícola Panamericana (El Zamorano) de Honduras.

Por encargo de la Dirección General, se elaboró para la Junta Directiva CATIE, el documento de Política del Género en el CATIE, el cual representa un análisis de la situación actual y sugiere el curso de las acciones a seguir durante los años venideros.

El uso del método de valoración contingente para determinar las tarifas de ingreso a los parques nacionales de Costa Rica, fue uno de los trabajos de investigación más importantes llevados a cabo por técnicos del Area. El establecimiento del cobro de estas tarifas por parte del Gobierno de Costa Rica suscitó una gran polémica, ya que fueron impuestas empíricamente. El estudio utilizó la metodología de valoración contingente para determinar la buena voluntad de pago por parte de los visitantes al Parque Nacional del Volcán Poás y al Parque Nacional de Manuel Antonio (playas), considerando los visitantes locales y extranjeros. Considerando los servicios ofrecidos por cada uno de estos Parques, se determinó que los visitantes locales estaban dispuestos a pagar US $ 11 y 13 en el Volcán Poás y Manuel Antonio, respectivamente, mientras que los visitantes extranjeros estaban dispuesto a pagar $ 24 y 14 en esos mismos sitios. Estas tarifas de buena voluntad estaban muy por encima de las tarifas que se cobraban en el momento.

Se condujo otra investigación para hacer la valoración económica y productiva de los componentes forestales e hidrológicos de la explotación de un robledal de altura bajo intervención silvicultural. El estudio consideró la valoración del agua de dos formas: convertida en energía hidroeléctrica y usada ecológicamente, lo cual implicó el uso de diferentes valoraciones para el mismo producto. El estudio se hizo conjuntamente con el Proyecto de Bosques Naturales financiado por COSUDE. Se determinaron los Valores Actuales Netos (VAN) y las relaciones beneficio costo (B/C) de cada situación, considerando la producción de madera a dos tasas de extracción (20 y 30% del área basal de los árboles) y del agua. Las relaciones B/C obtenidas cuando se valoró solo la madera fueron de 2.17 y 2.38 para los tratamientos de 20 y 30%, respectivamente. El máximo valor de este índice (3.18) se obtuvo cuando se valoró el agua para uso ecológico en el tratamiento de 30%.

Finalmente, se destaca el estudio realizado para determinar los factores socioeconómicos que influenciaron la adopción de tecnologías de Manejo Integrado de Plagas en la producción de tomate en Costa Rica. Para ello se seleccionaron 60 productores de tomate de las localidades de Grecia y Valverde Vega, área considerada como la mayor productora del país. Se trató de medir la adopción de dos tecnologías desarrolladas y transferidas por el Proyecto MIP del CATIE entre esos agricultores, las cuales estaban referidas al control de la mosca blanca (*Bemisia tabaci*) consistente en la protección de viveros y el manejo del trasplante y el control de los gusanos de la fruta (*Heliothis* spp. y *Spodoptera* spp.), mediante el método de muestreo para la toma de decisión de aplicación de insecticidas. Las tasas de adopción encontradas fueron de 50% y 40% para cada una de las tecnologías, respectivamente. El estudio consideró ocho variables para analizar los motivos por los cuales los agricultores no adoptaron con mayor entusiasmo las tecnologías. Variables como la pertenencia a una organización comunitaria, el sistema de siembra tradicional, la experiencia previa del agricultor con la adopción de nuevas tecnologías, el número de años que el agricultor ha sembrado tomate en la misma manera, el acceso al crédito, la disponibilidad de contratar mano de obra o el tamaño del área cultivada, no tuvieron impacto estadísticamente significativo en los niveles de adopción. El estudio concluye que los productores que tienen las áreas más grandes, con menor tendencia a la adopción y que debido a la cantidad de mano de obra requerida por unidad de área para la implementación de al menos una de las tecnologías, es la principal causa de la no adopción. El estudio considera que la difusión realizada por medio de visitas, panfletos y lotes demostrativos fue adecuada y su incremento podría no tener impacto mayor en los niveles de adopción observados.

C. PROGRAMA DE EDUCACION PARA EL DESARROLLO Y LA CONSERVACION (EDECO)

El Programa de Educación para el Desarrollo y la Conservación, procura especializar y entrenar recursos humanos a nivel de Posgrado, desarrollando habilidades y conocimientos para promocionar e implementar prácticas de manejo, uso y conservación de los recursos naturales en el Trópico Americano. El Programa incluye las Areas de Posgrado, Capacitación y Comunicación e Informática.

Entre los logros más importantes durante 1995, se destacan la consolidación y el fortalecimiento interno del Programa, lográndose establecer los Planes de Acción para el período 1995-1997, que fueron aprobados por la Junta Directiva. Igualmente, se revisaron las normas y regulaciones de los estudios de Maestría, se elaboraron nuevas directrices para la elaboración de las propuestas de tesis por parte de los estudiantes de Posgrado, se aprobó el nuevo Programa de Doctorado en Ciencias Forestales y en Sistemas Agroforestales, se incrementó substancialmente la red de computación y comunicación electrónica entre las diferentes Unidades del Centro, se dieron pasos importantes en la automatización de los servicios que ofrece la Biblioteca Conmemorativa Orton y se incrementó significativamente el número de suscriptores que pagan las revistas publicadas.

Financieramente, se logró un importantísimo apoyo por parte de DANIDA para fortalecer la Educación superior, por un monto de US $ 2.5 millones, con el cual será posible la contratación de siete profesores de tiempo completo y ofrecer un número importante de becas en el período 1996-2000. Otros apoyos logrados fueron con el CIM de Alemania, para la contratación de un experto en Agroforestería y otro en Biometría, un programa conjunto con las Universidades de Alberta y Laval del Canadá, con financiamiento del CIDA para desarrollar intercambios académicos a nivel de la Maestría en Agroforestería. Finalmente, en forma conjunta con el CIAT, y con apoyo financiero del Banco Interamericano de Desarrollo, se financió el curso de investigación y desarrollo para el uso sostenible de las tierras agrícolas, el cual se ofrecerá en el período 1995-1996.

REDCA (Red Regional para la Cooperación en la Educación Superior, la Investigación en Agricultura y Manejo de los Recursos Naturales) es una de las principales instancias de proyección de las actividades educativas del CATIE, por lo que durante 1995 se realizaron esfuerzos para fortalecer sus acciones y consolidar el liderazgo del CATIE. El CATIE fue reelecto en la Secretaría Ejecutiva por un nuevo período de dos años, hasta 1997. Se ofrecieron y financiaron cursos en colaboración con los Comités Nacionales de Guatemala, Nicaragua, República Dominicana, México y Costa Rica y se realizaron once intercambios horizontales. Se realizó la IV Reunión del Comité ejecutivo en Puebla, México y la V Reunión en Santo Domingo, República Dominicana, con la presencia de 60 delegados de todos los Comités Nacionales.

Para iniciar el Programa de Doctorado en el año 1996, se realizaron esfuerzos importantes que culminaron con la firma de sendos convenios con las Universidades Estatal de Colorado y de Florida, quienes auspiciarán los Doctorados en Ciencias Forestales y Agroforestería, respectivamente. También, con gran éxito se inició el proceso de admisión a este programa, con amplia participación de candidatos de los países de América Latina y España.

A nivel de Maestría, el proceso de admisión se realizó con 318 candidatos que presentaron solicitudes, de los cuales fueron admitidos 113 y 43 recibieron algún tipo de asistencia financiera por parte de CATIE u otros donantes, 75% de los países miembros. Seis estudiantes se incorporaron al Programa con financiamiento propio o de donantes que los apoyaron sin la participación del CATIE. Por primera vez, para la admisión de la clase 95-96 se ofrecieron dos exámenes de admisión en diferentes fechas y simultáneamente en todos los países de América Latina y el Caribe. En el Cuadro 16 de la página 106, se presentan los resultados del proceso de admisión desde 1992, a la fecha.

En el Area de Capacitación, se realizaron esfuerzos importantes en la descentralización de las actividades, en el fortalecimiento de alianzas estratégicas con instituciones nacionales para el ofrecimiento de estos cursos y en la actualización de los contenidos. Se realizaron en total 270 actividades a las cuales asistió un total de 6,365 participantes. Estos eventos de capacitación se clasifican en el Cuadro17 de la página 108.

El 75% de las actividades de capacitación se llevó a cabo en los países miembros, mientras que tan solo el 20% se realizó en Turrialba y el 4% en otros países no miembros. El número de eventos de capacitación se incrementó en relación con 1994, al pasar de 222 a 270. Paralelamente, el número de participantes también se incrementó de 5.659 en 1994 a 6365 en el año de 1995. En el Cuadro 19 de la página109, se presentan las actividades de capacitación por países de origen de los participantes, el número de estudiantes de ese país y los días-estudiante, como medida de la longitud de los cursos que atendieron.

En la Unidad de Informática, se lograron grandes avances durante 1995. Se incrementó de 120 a 200 el número de microcomputadoras unidas a la red interna del Centro, red que permite el uso del correo electrónico y el acceso a INTERNET. Se ha instalado también el acceso remoto a la red por vía de módem, lo que permite ingresar al sistema desde cualquier punto. Se han puesto a disposición de los usuarios de INTERNET, servicios de información institucionales por medio de los servicios WWW y Gopher. Por otra parte, se elaboró el sistema automatizado para la Oficina de Recursos Humanos, que ahora cuenta con un nuevo sistema de control para el personal y un nuevo sistema para el pago de planillas. También se han mejorado otros sistemas existentes, como el SIIF (Financiero), SAP (Administración de proyectos), IDETEC (Escuela de Posgrado), entre otros.

Durante 1995, la Biblioteca Conmemorativa ORTON, atendió 13.497 consultas de usuarios, distribuidos de la siguiente manera:

Estudiantes	8,694
Personal Técnico	718
Administradores	1,154
Visitantes	2,931

Entre estos se circularon 85.690 documentos, se prestaron para consultar fuera de la Biblioteca 20.490 documentos, se realizaron 882 búsquedas bibliográficas y se reprodujeron 510.858 fotocopias.

La Biblioteca continuó con el proceso de automatización. En este sentido se definió que la mejor opción era adaptar el Programa Micro CDS/Isis, desarrollado por la UNESCO y utilizado por la mayoría de las grandes bibliotecas, con lo que se favorecía el intercambio de información de manera homogénea. El trabajo ha consistido en ir adaptando el programa a las necesidades de la Biblioteca. Por otra parte, la instalación del Programa Ariel para la transmisión electrónica de documentos vía INTERNET, ha brindado la oportunidad de recibir información con imágenes, agilizando el intercambio de información con otras bibliotecas, especialmente las de los Estados Unidos de Norteamérica.

En cuanto a su actualización, con apoyo del presupuesto básico y otros proyectos (Holanda), se ha mantenido las suscripciones de 203 publicaciones periódicas y 111 monografías. Se recibieron por intercambio o donación, 9,250 revistas y 4,847 libros. Las adquisiciones implicaron una erogación de US $ 76,256.

El CATIE continuó con la publicación regular de las tres revistas institucionales: Revista MIP (Manejo Integrado de Plagas), Revista Forestal Centroamericana y Revista Agroforestería en Las Américas. En cuanto a la producción editorial del CATIE, sus técnicos produjeron un total de 369 publicaciones durante 1995, entre las que se incluyen las tesis de Maestría (54).

ANNUAL REPORT

WHAT IS CATIE?

CATIE is an international, non-profit civil association. Its main purpose is research, higher education and outreach in agricultural sciences, natural resources and related subjects in the American tropics, with emphasis on Central America and the Caribbean.

HISTORICAL BACKGROUND

CATIE's origin dates from the foundation of the Interamerican Institute for Agricultural Sciences (IICA) on October 7, 1942.

From its beginnings, the institute's mandate has been research and education in agricultural sciences within the American tropics. In 1960, its General Directorate moved from Turrialba to San Jose. Teaching, training and research in agriculture, livestock production and forestry were kept on in Turrialba.

The Turrialba base was transformed into the Center for Education and Research (CEI). Between 1960 and 1969, the training of Latin American personnel in the Center was strengthened, making this decade the most important stage of IICA's Postgraduate Studies Program. The CEI subsequently became the Tropical Center for Education and Research (CTEI) in 1970. It was still dependent on IICA until 1973 when it became an autonomous entity as the Tropical Agricultural Research and Higher Education Center (CATIE), and continued its emphasis on education at post graduate level with research as a support activity for advancing agricultural production technology.

IICA by then had transformed into the Interamerican Institute for Cooperation on Agriculture, with emphasis on technical cooperation, policy, trade, and integration.

On September 1991, the governing body of CATIE was modified to an independent, self-perpetuating Board of Directors and a Council of Ministers from member countries, which would oversee the interests of the countries in the Center's strategic plans and activities.

CATIE's MANDATE AND MISSION

CATIE's mandate was established in Chapter 1, Clause 1 of the Constitutional Contract approved by the Inter-American Board of Agriculture (IABA).

Within the framework of this mandate, CATIE's mission is to:

Stimulate and promote research and higher education in agricultural and related sciences for development, conservation and sustainable use of natural resources in the American tropics to improve the well-being of mankind.

OBJECTIVES

The Center's general objective is to:

Establish and generate research, education and technical cooperation programs which contribute to the solution of socioeconomic and agroecological problems in the American tropics regarding the sustainable development of agricultural and forestry production, natural resource management, conservation and development for the benefit of the community.

Specific objectives:

a. To generate and validate technological practices for agricultural production and natural resource management which are economically feasible, socially and culturally acceptable and environmentally sustainable.

b. Prepare professionals at postgraduate level to contribute to the development of knowledge and execution of programs conducive to the solution of the socioeconomic and agroecological problems in tropical America.

c. Promote proficiency in technological practices developed through institutional collaboration and diffusion to end users.

d. Disseminate the information generated and stimulate the adoption of new technological practices.

MEMBERS

CATIE membership may be full or associate. Current full members are the Governments of Belize, Brazil, Costa Rica, Guatemala, El Salvador, Honduras, Mexico, Nicaragua, Panama, Venezuela, The Dominican Republic and the Interamerican Institute for Agricultural Cooperation (IICA).

The following may be associate members of CATIE: Governments of countries that are not IICA members, international governmental and non-governmental organizations, international centers and private organizations whose objectives are compatible with those of the Center and with the prior approval of the Board of Directors.

Currently, there are no associate members of CATIE, although a plan is being formulated to instigate a search amongst countries outside the American continent, businesses, non-governmental organizations and international organizations for associate members.

ORGANIZATION

The governing bodies of CATIE are:

a) The Inter-American Board of Agriculture (IABA), which acts as the Center's General Assembly, comprising all the Ministers of Agriculture of the American continent; b) The Council of Ministers, made up of the Ministers of Agriculture and/or Natural Resources and Environment from the member countries, acting to safeguard the interest of the countries; c) The Board of Directors, which acts as the instrument of higher management, is autonomous and self-perpetuating and includes the Executive and Finance, and Academic and Scientific Committees; d) The Directors General's Office.

Costa Rica presides over the Council of Ministers and the Director General of CATIE acts as *ex-officio* Secretary.

The Board of Directors is made up of four eminent scientists or academics from the international community, four distinguished scientists or successful businessmen from the member countries, one eminent person appointed by IICA and one eminent scientist elected by the IABA, both acting in their personal capacity. Board members hold office for three years with the possibility of re-election for a further term. The Director General acts as *ex-officio* Secretary of the Board.

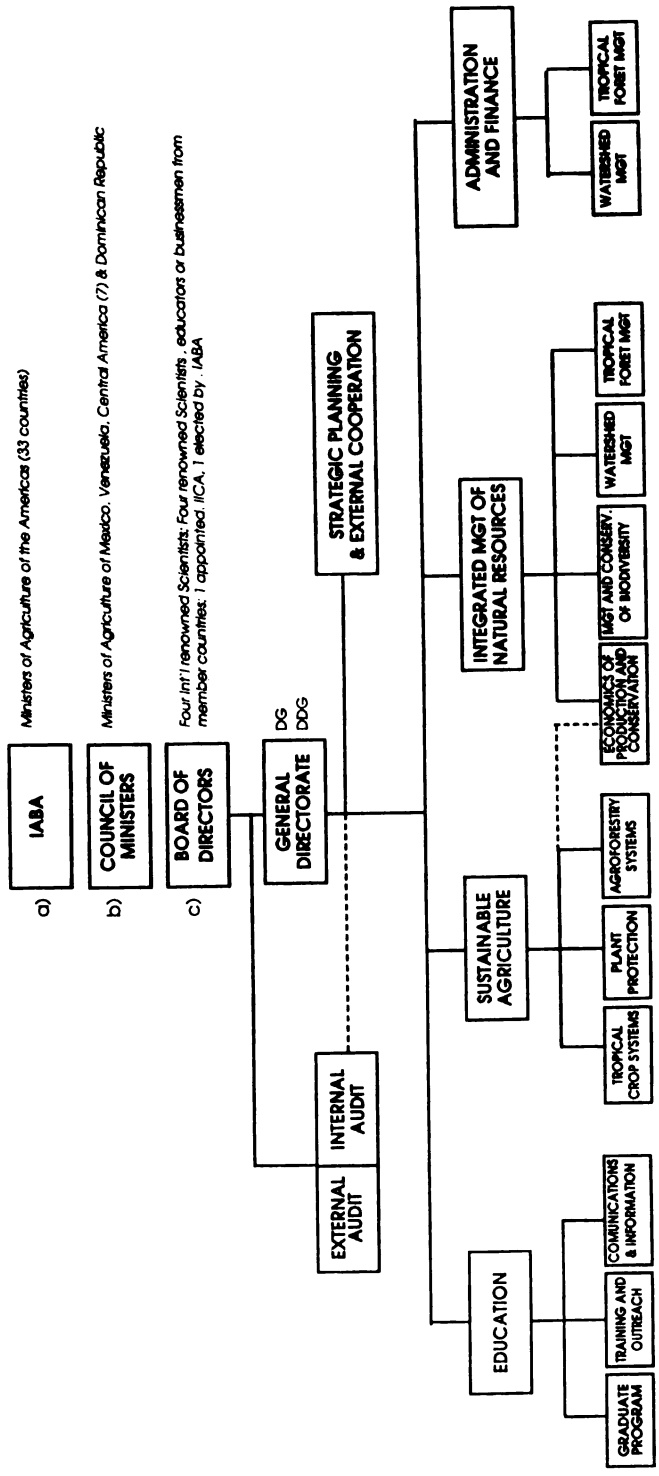
CATIE is directed by the Director General, who acts as its Chief Executive Officer, is elected by the Board of Directors and ratified by the Council of Ministers. The post has a term of up to five years, and the Director General may be re-elected once.

The Director's Office includes the Deputy Director General, appointed by the Director General.

To carry out its objectives, the Center currently has one Education Program and two Research Programs (Sustainable Tropical Agriculture and Integrated Management of Natural Resources), the Strategic Planning and External Cooperation Office, and the Directorate of Administration and Finance.

The following organization chart gives a more detailed view of the Center's organization.

CATIE ORGANIZATION



I.

RESEARCH, VALIDATION AND TRANSFER ACTIVITIES

"Resolving global problems through local solutions with regional impacts, and ample institutional and communal participation"

SUSTAINABLE TROPICAL AGRICULTURE PROGRAM (PATS)

Introduction and Objective:

The triple challenge of poverty, hunger and environmental degradation, continue to be major issues of concern for the Center as we move towards the 21st century. Food demand will double.

In order to meet this challenge, agricultural research will continue to play an important role in contributing to the improved management of natural resources and production systems. Efforts continue in the consolidation of strategic alliances in order to strength the food and nutrition systems of national partners to respond to local needs.

PATS is pushing ahead in influencing policy frameworks that favor our research and development initiative at the regional and national program level. Agriculture has become sidelined in the agendas of traditional sponsors by concerns for the environment, declining commodity process and the expected impact from free trade.

As the budget tightens, the program is looking to new and more cost-effective ways to address its agricultural research problems. There is increasing emphasis on shifting more research responsibility to national program partners.

The program's objective is:

> *To generate, validate and promote technological options, which will improve productivity of cropping systems in a manner that will sustain the natural resource base and cause a reduction in social and market pressures on ecosystems in the American Tropics.*

Program areas and lines of research

The program believes that both sustainability and productivity must be linked by maintaining an interdisciplinary approach. For this reason the areas of focus include:

Agroforestry and Watershed Management
Plant Protection
Tropical crops systems

Funding

The Sustainable Agriculture Program (PATS) was able to make progress based on the level of funding available. Core budget provided a large portion of the budget in Tropical Crops Area. However, of the $ 4.3 millions Program budget, the other two Areas, Plant Protection and Agroforestry expended mor than 80%, wich came primarly from project funds. The Program buget is shown in Table 1.

Table 1. Financing of the Sustainable Agriculture Program during 1995. In US $

ITEM	CORE BUDGET US $	PROJECT BUDGET US $ (*)	TOTAL US $
Program Directorate	214,813	---	214,813
Tropical Crops Area	540,967	128,628	669,595
Plant Protection Area	46,963	2,664,891	2,711,096
Agroforestry Sist. Area	121,461	615,635	737,096
TOTAL	**924,204**	**3,409,154**	**4,333,358**

(*) Details of Projects in Table 31 , page 135

Program Achievements:

Advances in 1995 brought the program a step further towards its desired goal. Significant noteworthy achievements included:

Integrated Pest Management Measures:

Promising fungal pathogens for the biological control of *Phyllophaga* sp., a common pest of economic importance in the region, have been identified and are undergoing field testing.

The technology for biological control of Black Sigatoka (*Mycosphaerella fijiensis*) has been refined and similar efforts have been advanced for the control of white flies(*Bemisia tabasi*). This research effort involved the participation of regional researchers and extensionists. A workshop on Augmentative Biological Control in Tropical and Subtropical Americas was hosted by the program and future research strategies drawn up.

Desirable genes from germplasm collection:

Biotechnological approaches elucidated germplasm resource relationships and facilitated the comparison of phytogenetic resources from one source with another. Molecular analysis confirmed the integrity of this variability, when a random sample of 100 tomato accessions from the germplasm collection from CATIE and similar number from AVRDC were compared.

Several accessions of legumes (*Vigna* spp), root crops (*Dioscorea* spp.) and peppers, (*Capsicum* spp.) were evaluated under field conditions for several growing seasons. Accessions with varying levels of resistance to major diseases were selected for advance yield trials.

Strengthening National Research Capability:

One of the main aims of CATIE is to strengthen national research systems and increase absorptive capacity by means of structured training, information exchange and other outreach activities in the member countries. In order to fulfill this aim the Tropical Crops Area has over the past year addressed the issue of screening for improved varieties, which will be components of more efficient farming systems in the region. The ultimate goal is to assist national programs' capabilities to meet their research needs.

The task of meeting the commitment to strengthen national programs in the region is becoming more challenging with reducing funds for agricultural research. However, in some countries this deficiency is fulfilled through buy-in arrangement as is the case with Belize, Nicaragua and other countries in the region. Such buy-in arrangements has enabled the Area to meet some research planning, management and diagnostic training and germplasm needs in these countries. Through such special arrangements the Ministries of Agriculture base funding for research was supplemented; it also provided opportunities for institution building and development through specialized training.

In 1995 the Ministry of Agriculture of Belize and UNICAFE from Nicaragua gave very special emphasis to increasing their capacity for Integrated Pest Management. In the case of Belize the specific priorities identified were:

Integrated Pest Management for peppers, tomatoes, cabbage and melons.

Introduction of improved genetic material in root crops, legumes, peppers and tomatoes and plantains.

Preparation of extension bulletins.

Series of specialized in-country training and in-service training events at CATIE.

Biotechnology techniques for national programs.

For UNICAFE much efforts were put on integrated management of pests, especially nematodes and weeds in coffee.

These initiatives have convinced policy makers that adopting such technologies are cost-effective ways of reducing farm inputs. Using this strategy, an urgent need to strengthen the national programs in specialized research areas on high priority crops was met. Because of the component of specialized training of scientific personnel, these contributions and interventions will remain and increase institutional capacity. Another important benefit of this strategy is the rapid and effective transfer of improved component production technologies from the Center for trial and adoption by farmers in their respective ecologies.

The collegial interaction and cooperative spirit that existed between the center scientists and the counterpart national scientists was very catalytic in consolidating national research and extension efforts. Four counterpart scientists from Belize (entomologist, pathologist, agronomist and tissue culture technician) participated in intensive on-the-job training at CATIE. This was then followed by joint participation of CATIE´s scientists and national counterpart scientists as resource persons in in-country training and testing of new technologies with farmer participation. Several of these interactive processes which took place allowed for a gradual devolution of the Center scientists and a complete take over by well trained and competent counterpart researchers. Besides ministry personnel in extension and research, this project also trained staff from NGO´s, leaders from farmers groups and agents from the pesticide control board.

This technique has had significant and rapid impact on Integrated Pest Management in Belize and Nicaragua. Farmers are applying their new knowledge, resulting in reduced production costs for pesticides and a cleaner environment. It also attracted the participation of many other interest groups and private organizations.

The Ministry of Agriculture has taken a major initiative to expand root crop, plantain and legume production in Belize. It has made the commitment by installing infrastructure and inviting technical backstopping from CATIE as well as improved varieties of plantains, root crops and legumes introduced in tissue culture form. This provided another opportunity for CATIE to get its improved technology demonstrated on farmers' fields and see how it performs under local conditions.

Similarly, in Nicaragua, researchers and farmers have adapted new technologies in Integrated Pest Management to reduce input cost and obtain more effective control measures for coffee pests, especially nematodes and weeds. In both cases, linkage is maintained between Center scientists and counterpart scientists and farmers. This highly interactive process has proven very effective for the scientists, donors and the farmers. There are now more than 5,000 farmers applying these technologies in the production of several crops. More users are now aware of pesticide toxicity, their impact on the environment and proper use of such pesticides. There are certainly clear changes of attitudes towards the use of IPM because of training, on-farm trials and demonstrations. This strategy, within the RENARM framework, has strengthened the participation of more than a hundred institutions and individual participants in the Plant

Protection Network. The other important impact of this initiative is the overall institutional change in the National Programs as reflected in an overwhelming increase in students conducting MSc thesis research in the Integrated Pest Management Unit of the Area.

These two examples have proven successful and had significant impact due to the following:

Compatibility of percieved priority needs of the countries with the relevant research of the Center.
Commitment of the governments, institutions and donor (USAID).
Technical backstopping from CATIE.

Efforts are underway to repeat this success in the transfer of other technologies developed at CATIE.

TROPICAL CROPS AREA
(Integrated Crop Management)

Introduction

At the end of 1995, the Tropical Crops Area at CATIE reviewed its position within the Center's new Research and Institutional Development framework. The current conditions in the region continue to change rapidly and these factors have repeatedly emphasized the importance of food security, safe guarding natural resources and the environment and at the same time underline the urgent need to revitalize the food and agricultural systems.

In order to adequately deal with the new paradigm of increasing consumption as the region strives for competitive and sustainable agriculture, the area has moved ahead to consolidate four units: Biotechnology, Integrated Pest Management, Phytogenetic Resource Characterization and Resource Crop Management. Within the framework of a consolidated approach the area laid special emphasis on activities that would enhance production and competitiveness. These applied research activities included the study of improved crop management for greater efficiency, massive multiplication rates, genetic evaluation and characterization, Integrated Pest Management with special focus on microbial control of pests.

Based on the prevalent area structure during 1995, the most important research results are presented under the Biotechnology Unit and the Phytogenetic Resources Unit.

Biotechnoiogy Unit

Modern Biotechnology consist of a group of tools that utilizes the foundations of biology in order to improve the quality of human life.

In the Biotechnology Unit we are developing activities in research, training, teaching and technology transfer applied to the preservation of genetic resources, genetic improvement, plant protection and forest management. This Unit has concentrated on basic research to develop methodologies for the propagation, preservation and genetic improvement of high economic value species. Table 2 shows the main research topics and their applications.

Table 2 Main research topics and their applications developed by the Biotechnology Unit in 1995.

Research Topics	Application
Micropropagation by apex culture	Coffee (*Coffea spp.*), Banana (*Musa* spp.),
Micro cuttings	Peach Palm (*Bactris gasipae*),
Zygotic embryos	Forest trees, Fruit trees
Somatic embryogenesis	Coffee, Banana and Plantain (*Musa* spp.)
Cell suspensions	Forest trees
Haplomethods	Coffee
Androgenesis	Banana
Gynogenesis	
Cryopreservation	Coffee, Banana
Apex, embryos, callus	
Preservation (germplasm)	Banana and Plantain
	Roots and Tubers
	Coffee
	Orchids and Vanilla
Molecular biology	Cocoa (*Theobroma cacao*)
Genetic mapping	Coffee
Evaluation of genetic diversity	
Genetic transformation	Musa

Improving polymerase chain reaction procedures for coffee germplasm evaluation

IICA / PROMECAFE, CATIE and French Cooperation (CIRAD, ORSTOM and MAE) disseminated a coffee breeding program for increasing the genetic basis of cultivated varieties in Central America. All varieties distributed in Central America or in selection deviate from a very few number of wild coffee-trees. As a consequence, the cultivated material presents a homogeneous agronomic behavior and major defects such as susceptibility to the main pests and dis-

eases (nematodes, berry borer, berry anthracnose) and adaptation to intensive cultural methods.

Until now, the contribution of genetic resources to Arabica breeding has been very reduced because of the lack of information on the organization of available genetic diversity. In 1995 a genotypical evaluation was begun of the genetic diversity available in CATIE field germplasm for the regional breeding program.

The generation of RAPDs

Molecular markers based on DNA sequence variation have proved extremely effective tools for distinguishing between closely related individuals. Since the advent of PCR (Polymerase Chain Reaction) technology, several methods have been developed that use amplified DNA sequences as molecular markers. The RAPD (Random Amplified Polymorphic DNA) markers are the most useful markers generated by PCR because of low cost and fast analytical process. They have been used for many topics in plant breeding programs such as diversity evaluation, relationship studies, fingerprinting, varietal control, gene identification and genetic map establishment. Although RAPDs are simple, their results are sometimes controversial because of difficulties in repeating some amplification products.

The protocol for generating RAPDs in the CATIE laboratory is derived from the original protocol described by Williams et al. (1990). Preliminary assays led to an optimization of the relative concentration of some PCR components. Genomic DNA is isolated using a protocol developed in the laboratory.

Prospects for the regional breeding program

After having established procedures for RAPDs generation, the first step of the molecular program consists of the selection of primers which detect polymorphism. It is carried out by analyzing a reduced number of individuals representing a large part of the preserved diversity. Preliminary results showed that about 15 % of tested primers revealed polymorphism, but only 5 % generate reproductive products. The second step of the molecular program will be the use of selected primers for evaluating the diversity available in CATIE germplasm. More than 40 RAPDs are required for a reliable estimation of genetic distance between groups.

The results awaited for the regional breeding program are as follow:

- determination of the structure of genetic diversity available within the species *C. arabica*,
- estimation of the genetic distance between wild and cultivated material,
- characterization of genetic resources conserved in CATIE germplasm.

Use of RAPD (random amplified polymorphic DNA) molecular markers in cattle adapted to humid tropic conditions

RAPD molecular markers were used to study genetic polymorphism in Romosinuano and Criollo Lechero Centroamericano cattle breeds in herds in Turrialba, Costa Rica.

Materials and methods

Work consisted of establishing the protocols necessary to extract and amplify DNA, as well as detecting polymorphism. Animals with minimum blood ties within each herd were selected. For the Romosinuano breed (R), a total of 19 weaned calves were considered, assuming that they had the best character fixing of the breed, since they were products of crosses. For the Criollo Lechero Centroamericano cattle (C), however, all the animals were taken into account, since the population was reduced to only 12 animals of different ages. Ten unrelated Jerseys (J) were used as the comparison breed. DNA was extracted from all of them, but only six received the amplified version.

The extraction were made from blood samples from the jugular vein and treated with an anti-coagulant and preserved in refrigeration during processing. Samples were processed according to the established process after modifying known protocols, testing different volumes of sample to attempt to minimize costs. The DNA amplification process was established from the classic process and that which is used at CATIE for coffee DNA studies.

Information obtained was coded as a binary variable (0 = absent, 1 = present) in a double entry table (individuals-RAPDs) from which genetic distance matrices between individuals were calculated, using Jaccard and Simple Correspondence coefficients in the SAS statistical package and the Genetic Distance generated from an electronic spreadsheet. Data transformation allowed the application of a conglomerate analysis to identify individuals, as well as its validation through discriminate analysis. Later the input of the classification was obtained from identified markers through canonical discriminate analysis.

Results

The extraction protocol showed its efficiency by obtaining an average DNA yield of 72 µg/ml blood, higher than that reported by the original protocols. No significant effect of the breed was seen for this variable. The most efficient volume used was 5 ml. Cost per sample obtained was rather low (< US $ 4).

The method used to amplify DNA was efficient, the major problems being the determination of Taq-polimerase (0.85 u) and primer (0.4 - 0.45 µM) concentrations. Fifty-four primers were tested of which 23 (40 %) were polymorphic. Eight of the polymorphic primers produced 34 polymorphic RAPDs, with an average of 4.25 polymorphic RAPDs per primer.

The conglomerate analysis, conducted for each of the genetic distance matrices calculated from the coefficients mentioned previously, led to similar results:

GROUP 1 = 19R + 2C,
GROUP 2 = 6C,
GROUP 3 = 4C + 6J.

The discriminate analysis showed the reclassification of the individuals, regrouping them thus:

GROUP 1 = 14R + 2C + 2J,
GROUP 2 = 5C + 1R + 2J,
GROUP 3 = 4R + 5C + 2J.

These results showed that group formation, relative to single-breed groups, was not outstanding. The reclassification changes could be explained by the reduced number of RAPD markers used for the analysis. Nevertheless, the origin of the studied cattle should be considered. The Romosinuano herd was the product of inbreeding with animals belonging to the same group, while the Criollo Lechero Centroamericano breed showed the effect of a greater genetic flow, due to artificial insemination with semen from diversified sources, used for the reproductive management.

Finally, a canonical discriminate analysis showed that 11 RAPDs contributed significantly to group constitution. Seven RAPDs were highly significant ($p < 0.01$). The variability summarized by the canonical variables CAN1 and CAN2 was 71 % and 29 %, respectively. The canonical correlation values for significant RAPDs varied between 0.35 and 0.94. The CAN1 variable discriminated the group 2 and the CAN2 variable separated groups 1 and 3. Negative and positive canonical correlation values of each marker were used for characterizing the formed groups.

Conclusion

These results showed the potential of RAPD markers to identify genetic groups, for short and medium term management and conservation of genetic resources.

Additionally, the identification of genes that govern economically and biologically important quantitative characteristics for genetic animal improvement, is a long-term goal in which DNA markers play an important role.

Transformation of banana embryogenic cultures through biolistic Techniques

Conventional improvement of banana is long and complex because of the sterility of the triploid cultivars currently grown. Genetic engineering and gene transfer are opening up new prospects for the improvement of bananas. Mastering embryogenic cell suspension and somatic embryogenesis for the genus *Musa* is an important tool for the development of non-conventional breeding programs.

Particle bombardment is an efficient method for delivery of DNA into plant cells. This method is especially beneficial for those plants like bananas, which appear to be a poor host for *Agrobacterium*, which is a natural vector used for gene transfer to plants. It also may offer other advantages over *Agrobacterium*-mediated transformation such as the use of more simplified plasmid constructions, elimination of the false positive due to *Agrobacterium* persistence in the host tissue and simplified transformation protocols.

Our study considered *Musa* AAA cv "Grand Naine" and cv. "Gross Michel". One part of the work consisted in the evaluation of different concentrations of glufosinate for selecting transgene cells. Another part was to determinate transient expression levels and stable transformation. Transgenic plant regeneration represents the next step in our research work.

Genetic transformation was done using Biolistic techniques (helium-driver particle gun and microprojectiles). The target consisted of the adventitious somatic embryos obtained from male flowers in embryogenic cultures in a temporary immersion system at an early stage of the exponential growth stage.

Parameters which can be varied to optimize the bombardment system are numerous: acceleration force, target distance, vacuum conditions and promoters. In CATIE, the best transit expression of ß-glucoronidase gene (GUS) was obtained in both cultivars 'Grande Naine' and 'Gross Michel' using the enhanced 35S promoter (pCaMV2) in comparison with ubiquitine (pUGC1) and Actin (p0021). We recorded scores of 400 to 800 blue spots per shooting.

A stable expression was achieved 5 weeks after transformation using the GUS gene with the cultivars 'Grande Naine' and 'Gross Michel'.

To select transformed cells, we used the pBar gene and the selective herbicide agent Glufosinate or 'BASTA'. 15 days after transformation, somatic embryos were subjected to selection in BASTA 5 mg/l for two months in the SIT system. Subsequently, they were regenerated on a semi-solid germination medium containing BASTA 5 mg/l. Only 0.25% of the embryos resulted in the formation of plants. These plants are currently under acclimatization for further DNA analysis.

Resource Crop Management Unit

Crop Interactions in Mixed Cropping System

Intensive production of minor crops in association with long season crops is usually considered of little importance. However, the use of short season low input, stress tolerant crops in mixtures, offers many opportunities. Such mixed crop arrangements can improve productivity during stress periods, reduce weeding cost for long season crops, improve land use and contribute to food security and availability and the economic sustainability of farmers.

In order to better understand the plant interactions in different crop combinations and to facilitate the improvement of the farming system, comparative tests of different crop mixtures were undertaken.

Sweet potato (*Ipomoea batatas*)/cowpea (*Vigna unguiculata*) mixture test

In most rain-fed but dry subhumid areas of the region, short season drought tolerant crops could be grown either as a secondary crop in a long cycle crop or together as a primary mixed crop for that season. These crops -sweet potato and cowpea- can become an important source of cash income and employment opportunity in farm production.

New technologies supported by improved varieties are yet to be introduced to these stressed areas. The sweet potato-cowpea crop mixture can play a significant role in providing food security with minimal inputs. This combination is also a useful tool as a model in understanding the various crop interactions as affected by density, growth habit compatibility and competitive ability. This model also allows for the study of the optimal utilization of induced beneficial genetic effects from this interaction.

In many areas where the sweet potato-legume mixture is practiced crop densities are usually kept high. Most farmers have indicated that such practices are used in order to minimize weeding and to ensure a secure harvest. This experiment was established in order to clarify which factors were associated with productivity.

In an on-station trial at CATIE using equivalent farm densities for comparison, several factors were measured which could account for productivity. This pilot trial had cowpea accessions planted in plots 8 x 5 m in densities of 40,000 and 66,700 plants/ha. Samples were taken at regular intervals to measure leaf area index, indices of relative growth rate and land equivalent ratio.

Based on these results, important agronomic characteristics were observed. At higher density, sweet potato increased yield and overall efficiency compared to lower density plantings (Fig 2). There was a marked effect of plant response to shade effects. Light interception accounts for much variability in plant growth and development. This data showed that growth

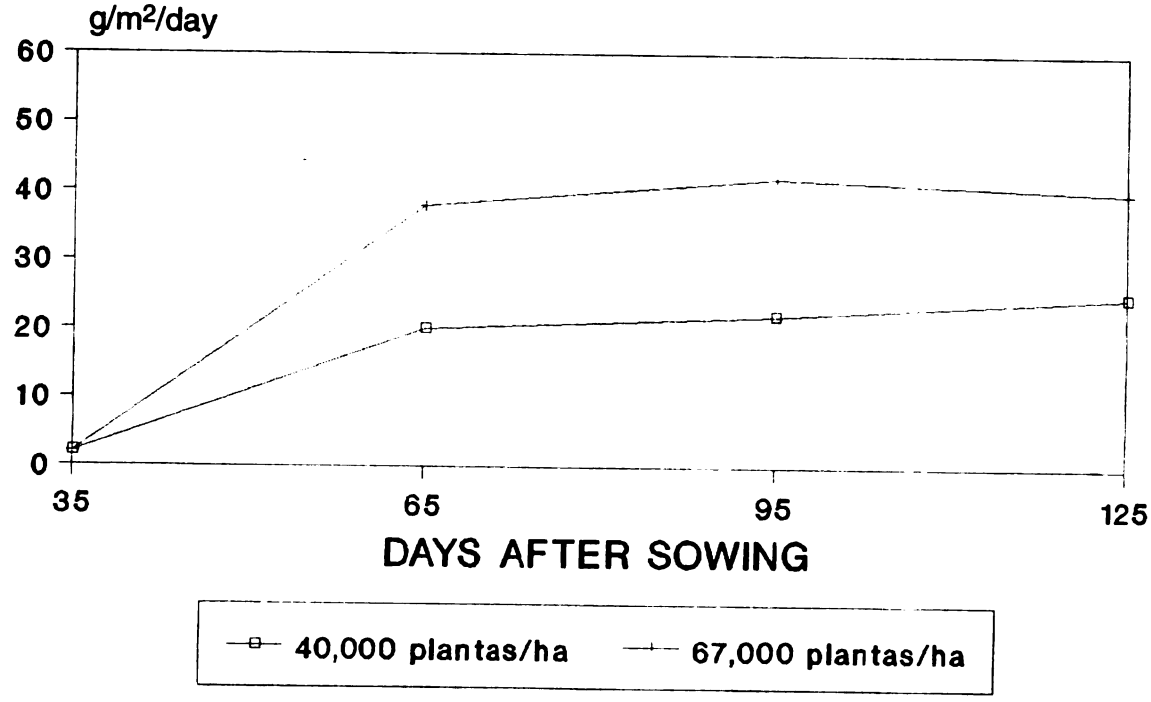


Fig. 2. Dry matter ratio cowpea-sweet potato: alternate rows. CATIE, 1995

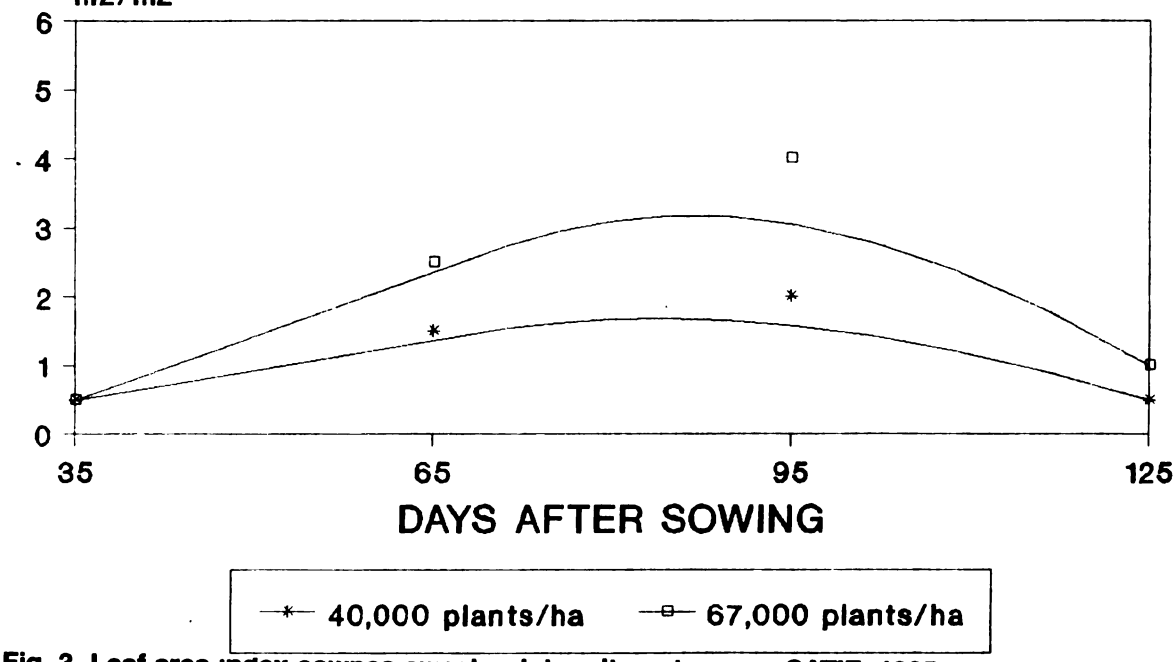


Fig. 3 Leaf area index cowpea-sweet potato: alternate rows. CATIE, 1995

rate increased as density increased. This could be due to the effect of physiological stimulation of the source-sink relationship indicating genetic potential of the crops to respond to light stress or shade. The effect of shade on canopy photosynthetic efficiency may be an important consideration for selection. Other characteristics of interest for which selection could be applied is that of vigorous and early establishment as indicated in the leaf area index (Fig. 3).

The land equivalent ratio (LER) indicates that higher density planting can certainly be a viable measure for increasing productivity (Table 3).

A similar test with cassava and yam bean indicated that yam bean when intercropped with cassava had a significant yield reduction for the varieties used. Nevertheless, the overall productivity of the mixture was higher than in monocropping. This is the result of competition for light between cassava and yam bean.

Table 3. Yield and land equivalent ratio (LER) of *Vigna unguiculata* and *Ipomoea batatas* in three intercrop systems and monoculture. CATIE 1995.

SPACING	0.50 x 0.50 m			0.30 x 0.50 m		
CROP SYSTEM	Vigna unguiculata kg/ha	Ipomoea batatas kg/ha	LER	Vigna unguiculata kg/ha	Ipomoea batatas kg/ha	LER
Vigna + Ipomoea in the same row	445	17,900	1.28	520	18,200	1.60
Vigna + Ipomoea in alternate row	467	15,900	1.20	559	19,900	1.74
Vigna one row , Ipomoea two rows	217	18,500	1.10	159	18,300	1.04
Monocul-tures	1,115	20,400	-	637	23,200	-

Phytogenetic Resources Conservation Unit

Increasing emphasis and focus is being placed on the need to preserve and characterize plant germplasm with the aim of improving the data base on such material as well as to bet-

ter exploit their genetic potential. The Tropical Agricultural Research and Higher Education Center (CATIE) has a wide range of plants collected from Mesoamerica (Table 4). Included in this collection is a broad genetic base in peppers (*Capsicum* spp.), tomatoes (*Lycopersicom esculentum*), cucurbits (*Cucurbitaceae* spp.), coffee (*Coffea* spp.), cacao (*Theobroma cacao*), tropical and subtropical fruits with high potential.

Table 4. Inventory of annual and perennial species preserved at CATIE. Genetic Resources Unit, 1995.

ANNUALS	ACCESSIONS	PERENNIALS	ACCESSIONS
Grains	**692**	**Fruits**	**1,007**
Amarantos (*Amaranthus* spp.)	267	Anona (*Annona* spp.)	37
Crotalarias (*Crotalaria* spp.)	25	Peach palm (*Bactris gasipaes*)	537
Maiz (*Zea mays*)	400	Nance (*Byrsonina crassifolia*)	23
		Citrics (*Citrus* spp)	20
Leguminous	**24,822**	Lichi (*Litchi chinensis*)	10
Cannavalia (*Cannavalia ensiformis*)	16	Zapote (*Pouteria, Manilkara, Chrysophillum*)	313
Beans (*Phaseolus* spp.)	24,578		
Cowpea (*Vigna ungiculata*)	175	Guayaba, cas (*Psidium* spp.)	67
Alado beans (*Psophocarpus* spp.)	19		
Lablab (*Dolichos lablab*)	34	**Tropical crops**	2,685
Vegetables	4,202	Coffee (*Coffea* spp.)	
1,768			
Tomato (*Lycopersicon* spp.)	457	Cocoa (*Theobroma cacao*)	707
Peppers (*Capsicum* spp.)	1,284	Achiote (Bixa orellana)	30
Ayote (*Cucurbita* spp.)	2.138	Macadamia (*Macadamia* spp.)	24
Calabaza (*Lagenaria siceraria*)	145	Plantain (*Musa* spp.)	56
Tomato (*Physalis* spp.)	84		
Naranjilla (*Solanum quitoense*)	94	**Forestry**	300
		80 species	300
Roots & tubers	**550**		
Jícama (*Pachyrhizus* spp.)	163	**Botanical gardens**	**433**
Sweet potatoe (*Ipomoea batatas*)	145	'Cabiria 1' (101 species)	163
Cassava (*Manihot esculenta*)	169	'Cabiria 7' (188 species)	277
Taro (*Dioscorea* spp.)	73		
Miscellaneous	**162**	**Miscellaneous**	**203**
TOTAL			**35,056**

One of the objectives of CATIE is to cost effectively maintain a representative core collection of this germplasm on a long-term basis. With the advent of an established global network of regional and international germplasm banks, the need for proper identification has become essential for comparison on a global scale. Advances in agricultural biotechnology has made this possible.

Through a collaborative effort between four institutions, CATIE, the University of Wisconsin, AVRDC and CIRAD/ORSTOM, molecular marking techniques were used on both plants and animal germplasm to assess and understand the variability and relationships between accessions at the Center and their relationship with others. This initiative is the first of its kind in comparing germplasm accessions between different conservation banks. It will add to the knowledge of material at data banks and form the basis for complementary exchange.

This research collaboration has two major thrusts:

- Measure the extent of variability and similarity within and between different germplasm banks.

- Develop the capacity at CATIE to implement and continue to characterize the germplasm resource through manpower training.

The application of molecular marking techniques using RAPD to characterize and compare genetic resources at a germplasm bank was being undertaken at the University of Wisconsin for beans and tomato. In an effort to harness this available expertise to improve on the data base of the tomato collection, a collaborative arrangement was initiated. This included exchange visits and training in the first instance. At a later stage, the procedures and conditions were agreed upon for the exchange of samples of tomato for growing out and extracting DNA.

A random sample of 100 tomato accessions from the germplasm collection and a similar number from AVRDC were sent to the University of Wisconsin for analysis and comparison. The outcome of this evaluation is shown in Fig. 4. The result showed that while there was some limited overlap, the two germplasm collections are quite complementary to each other.

The encouraging result of this finding stimulated the institutions to extend this technique to peppers. Again, the University of Wisconsin, in collaboration with CATIE compared a sample of pepper collections from CATIE with commercially grown peppers in the US. The result of this comparison is shown in Fig. 5. This exercise revealed that a sample of CATIE's collection demonstrated a rich genetic diversity and indeed has some related species that may not yet have been adequately classified taxonomically and may have high potential for resistant genes.

In a bold move to extend the use of this technology, an attempt was made to work out the genetic relationship of the cattle population at CATIE. Using the RAPD molecular markers, the genetic relationship between Romosinuano, Criollo Lechero Centroamericano and Jersey

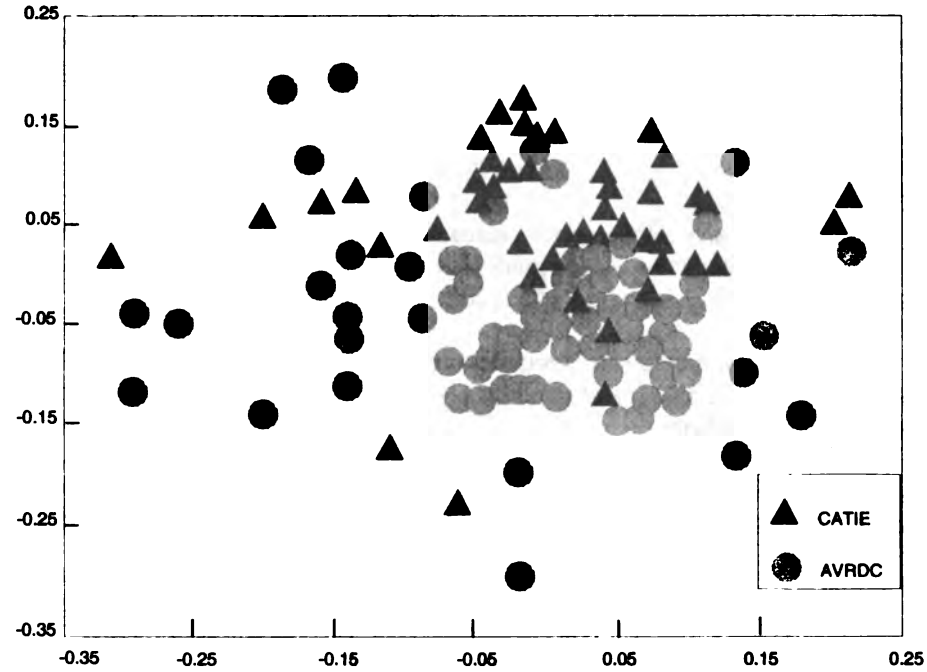


Fig. 4 MDS plot of tomato genetic diversity among germplasm accessions from CATIE and AVRDC.

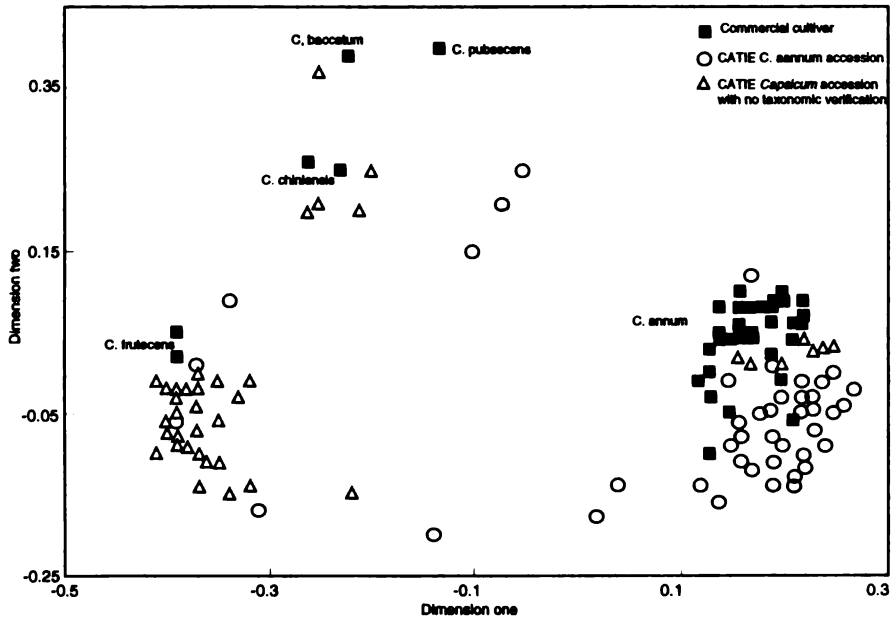


Fig. 5 MDS plot of pepper genetic diversity among germplasm accessions from CATIE and commercially grown peppers in the US.

cattle breeds was analyzed. The results showed that the conglomerate analysis and the genetic distance matrices conducted for each of the group led to similar results.

Group I = 19R + 2C
Group II = 6c
Group III = 4c + 6J

The discriminate analysis showed the reclassification of the individuals, regrouping them to: these results showed the potential of RAPD markers to identify genetic groups for short and medium term management and conservation of genetic resources.

The use of this approach to clarify relationships between populations in both plants and animals is in compliance with the area's stated policy of ensuring that biotechnology is used to upgrade its plant genetic resources activity.

This work reveals that more research will be needed to clarify the taxonomic relationship of the close relatives of the germplasm species in collection. This information also allows CATIE to share a new and larger authoritative data-base on individual lines in an internationally accurate and standardized format.

Exploration for new resistance genes at CATIE's germplasm bank

A key factor that can contribute to increased productivity and effective integrated pest management is host-plant resistance. The process of discovering these genes is often a long process involving systematic evaluations involving entomologists and pathologists. In order to more optimally use the germplasm available to us, several screening activities were undertaken.

Peppers (*Capsicum* spp.), tomato (*Lycopersicom esculentum*) and cucurbits (*Cucurbitaceae* spp.)

Peppers are in high demand throughout this region as well as having a high export potential. However, because of limited varieties with resistance to prevalent diseases and pests, their production is usually associated with high pesticide use. In order to set the stage for the evaluation of the complex of problems which plague the production of these crops, field test were conducted to assess the potential variability for disease and pest resistance.

From these studies new resistance may become available for use in a variety of ways. Identify the frequency of particular genes for resistance.

Based on the result of these evaluations (Fig. 6), there is very little variability. Arising from this study came the recognition of the importance of the continuing evaluation of the different accessions in order to establish the level of diversity for resistance.

The rise and fall of yam production in the region is clear evidence of the host-pathogen coevolutionary interaction. Therefore, any test or screening that can detect preexisting resistance that

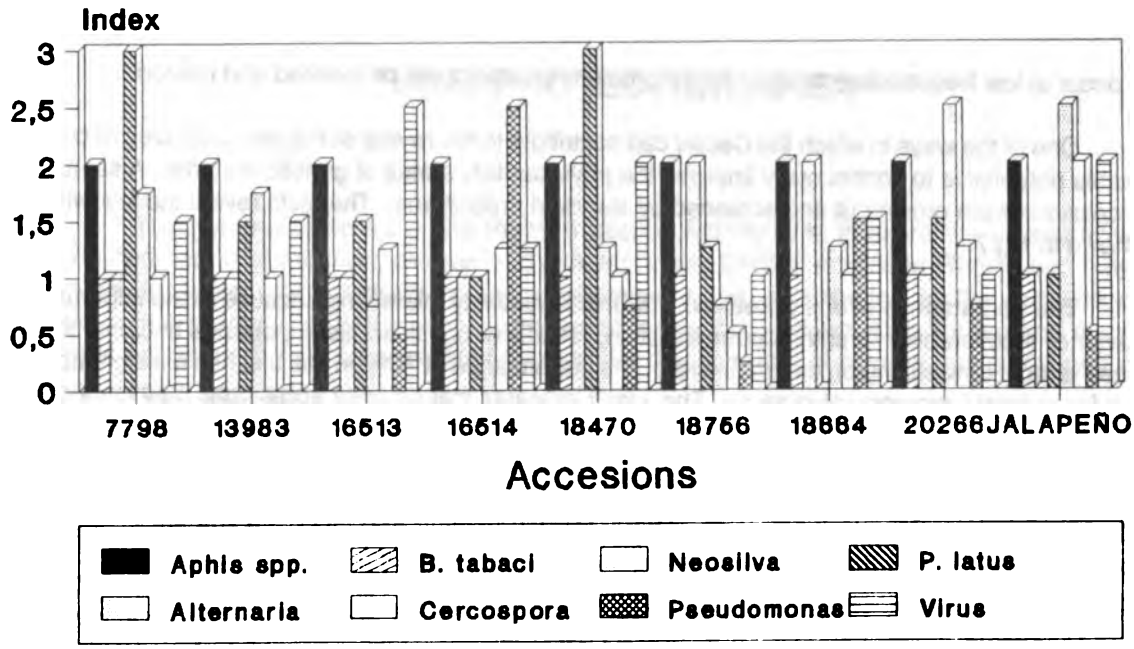


Fig. 6 Reaction of *Capsicum* spp. accesions to some pests and diseases CATIE. Costa Rica. 1995.

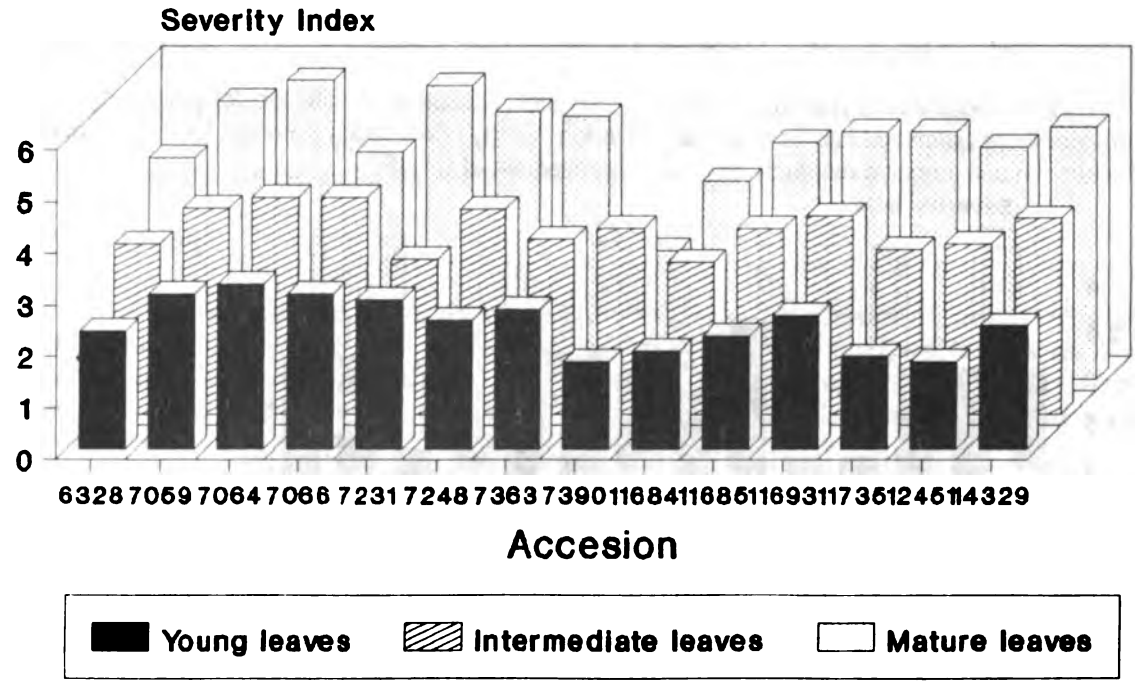


Fig. 7 Anthracnose in Dioscorea spp. accessions. CATIE. Costa Rica. 1995.

may occur at low frequencies can gain future prominence and could be isolated and utilized.

One of the ways in which the Center can contribute to the revival of this declining crop of considerable potential is to continuously improve the phytosanitary status of genetic material. A sample of accessions were grown-out and screened by standard procedures. The tests reveal the following as shown in Fig.7.

The performance of one accession, 7390, is particularly interesting because of the important behavior of recoverability to anthracnose infection. This is of considerable importance because this disease is most devastating on mature leaves. The performance of 7390 in this trial has a major implication for varietal improvement in yams. This result indicates that different accessions may have different mechanisms in their response to this disease.

The response of pumpkins to two devastating diseases, mildew and viruses, also shows low level of frequency for resistance (Fig. 8). The accession number 8003 was the line showing best response. This indicates that a broader base germplasm needs to be evaluated.

Another strategic disease of economic importance is that of *Moniliophthora roreri* in cacao. This disease can cause up to 100% fruit loss in an orchard. the cost of its control is high and variable.

Again, an ideal way to control the disease could be through host plant resistance. This would be easily adapted by limited resource farmers. Based on the results of preliminary screening of 300 accessions from the germplasm, 5 clones have shown promising levels of resistance.

Using Quantitative Trait Loci technology, the identification of specific loci for resistant genes to *Phytophthora palmivora* has been made. This technology offers much potential for its continued application in collaborative research on cacao improvement at CATIE.

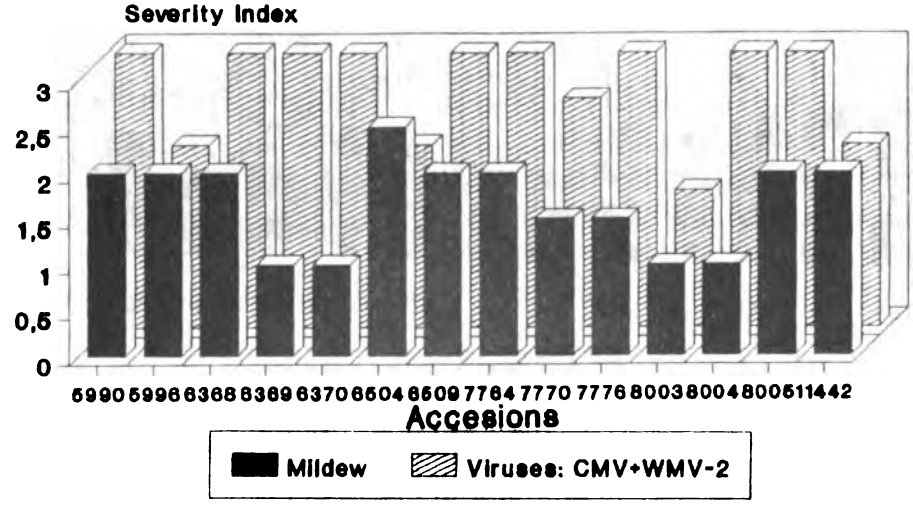


Fig. 8. Reaction to viruses and mildew in *Cucurbita moshata* accessions. CATIE. Costa Rica. 1995.

PLANT PROTECTION AREA

The general objective of the Plant Protection Activity is to improve the economic well-being and health of the men, women and children in the Central American Region by: helping farmers increase crop productivity and economic returns; contributing to the production of residue free produce for national consumers and for export; and reducing human and environmental exposure to harmful pesticides through the development of environmentally sound pest management practices.

Donors, work lines and beneficiaries

Donors

The Plant Protection Area was highly dependent on external sources of funding in 1995. The USAID financed the Regional IPM/RENARM project which gave technical support to the postgraduate school in the IPM activities. Besides research, technical assistance training and information services were offered by CATIE through the Project.

The activities in research, development and IPM implementation were supported in Nicaragua by NORAD/SIDA through the CATIE/INTA Nicaragua IPM project.

NRI/ODA has contributed to the development of activities on biological control of insects, pathogens and weeds of importance in the area. The mission of the Project is to develop microbial control technologies and training and technical assistance support.

Work Lines

The main target crops for IPM were: non-traditional export crops as broccoli (*Brassica oleraceae*), snow peas (*Pisum sativum*), cucurbitas (*Cucurbitae* spp.), vegetables as tomatoes(*Lycopersicom esculentum*), potatoes (*Solanum tuberosum*), cabbage (*Brassica oleraceae* Var. Italica) and peppers (*Capsicum* spp.), basic grains as maize (*Zea mais*), rice (*Oriza sativa*) and perennial crops as coffee (*Coffea* spp.), plantain (Musa spp.), bananas (§spp.).

The most important pests, included in research, technical assistance and implementation activities were: whitefly (*Bemisia tabasi*), banana weevil (*Cosmopolites sordidus*), coffee borer (*Hypothenemus hampei*), whitegrubs (*Phyllophaga* spp.), itchgrass (*Rottboelia cochinchinensis*), "jungle rice" (*Echinocloa colona*), banana black sigatoka (*Mycosphaerella fijiensis*), maize cob rot (*Fusarium* spp. and *Giberella* spp.) and knot nematodes (*Meloidogyne* spp.).

Beneficiaries

The vast majority of beneficiaries from CATIE's Plant Protection Area educational/training, research and outreach activities are reached indirectly, through the improved knowledge and capacities for IPM experimentation and training/extension of the para-technical, technical and decision making personnel of collaborating/beneficiary institutions/organizations in the member countries.

Direct beneficiaries include university professors, students, researchers, extension agents and other categories of technical and para-technical personnel that were reached through our M.Sc. Degree and Non-Degree Training Programs and our IPM Information and Communication and Technical Assistance Programs.

TECHNICAL HIGHLIGHTS

Diagnosis and agroecological surveys of agricultural pest in Central America

Errors in pest diagnosis result in higher management costs and increased environmental pollution. The Plant Protection Area has promoted accurate diagnosis and agroecological surveys for the main pests and crops in Central America. Geographical distribution of the broccoli (*Brassica oleraseae*) disease "Club root" *(Plasmodiophora brassicae*), and a survey to determine the seasonal abundance in snow pea of the leaf miner (*Liriomyza huidobrensis*) and the fungus *Leptosphaerulina americana* were undertaken during 1995 in Guatemala. These findings have improved pest management decisions.

Pest identification, as a part of diagnosis, is fundamental to IPM activities. This year an inventory of insect pests was published, "Plagas invertebradas de Cultivos Tropicales con énfasis en América Central". This publication is a basic support for insect pest identification. Growers have been trained in whitefly taxonomy in Nicaragua, since this is a key pest in vegetables. Four insects from the Hymenoptera order were identified as biological control agents.

Biological control of pests of bananas and plantains

1. The main tactic for the control of Black Sigatoka in bananas and plantains is the use of fungicides. However the appearance of fungicide resistance and the lack of new products have stimulated the search for alternatives. Biological control of pathogens through antagonistic microorganisms is considered a promising alternative to air pollution caused by pesticides and to meet farmers need to compete in the market for non-residual products.

   Field trials undertaken by researchers on the RENARM project, have shown that selected strain of *Bacillus cereus* and *Serratia marcescens* are effective control agents of this fungus.

In the field, under conditions of severe disease pressure, there were no significant differences between the control given by fungicides and the microorganisms. At application rates of 10^7 cfu/ml, recovery of *S. marcescens* from leaf washings was 10^5 cfu/ml after 15 days. The best inoculum in production was obtained in nutrient broth. Commercial surfactants have a lower attachment action than water or nutrient broth when sprayed on the banana leaves. Substrates applied to the foliage showed positive effects on antagonistic bacteria growth.

2. The fungus *Beauveria bassiana*, as a natural enemy, has shown to be a good option for reduction of black weevil damage in plantain. The effect of different formulations and application methods of *B. bassiana* on *C. sordidus* mortality showed that all the suspensions with *B. bassiana*, that is 10, 15 and 20 % oil plus a fungus concentration of 5×10^8 conidia per milliliter caused 100 % *C. sordidus* mortality, while the control formulations, without fungus, caused mortality between 17 and 36.5 %. Suspensions of *B. bassiana* with 15 % oil, can reduce fungus concentrations tenfold and obtain greater than 95 % mortality.

Biological control of whitegrubs (*Phyllophaga*) with fungi

Larvae in the genus *Phyllophaga* (Col: Scarabaeidae) are whitegrubs that cause serious losses to a wide range of crops in most parts of the Americas. Damage is caused by third instar larvae feeding on the roots, weakening and frequently killing the plants. In maize alone, losses to whitegrubs in Latin America have been estimated at $135m every year. The one or two-year life cycle, the unpredictable, patchy and seasonal nature of outbreaks, and the soil dwelling habit of the larvae, contribute to farmers' frequently not attempting to control or to their delaying measures until they are no longer effective or economically justifiable. Where control is attempted, currently recommended methods rely heavily on preventive insecticide use, many of which have undesirable human toxicity and environmental characteristics, and even these methods are not effective in some crop situations.

A highly virulent strain of the naturally occurring fungus, *Beauveria bassiana*, has been identified as a promising microbial control agent for one of the most important whitegrub species, *Phyllophaga menetriesi*: this species is a serious problem from Mexico to South America. During 1995, researchers in the Microbial Control Unit, in an attempt to select an even more effective fungus, evaluated 48 monospore isolates of this highly virulent strain in laboratory bioassays. As Figure 9 shows, in tests in which larvae were dipped in a water suspension of 10^8 conidia ml^{-1}, they were able to identify monospore isolates that killed 25% more second instar larvae and 117% more third instars after five and eight weeks respectively. The best of these isolates will undergo field testing in 1996.

Biological control of cob rot and weed management in maize

1. Stalk and cob rot caused by *Fusarium moniliforme* is a worldwide problem in maize growing areas, especially under tropical conditions. Apart from considerable yield losses under cer-

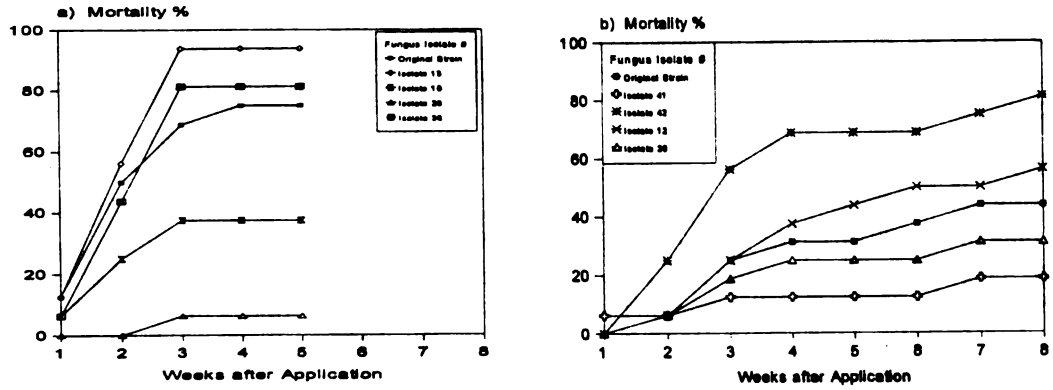


Fig. 9 Mortality curves for *Phyllophaga menetries* whitegrub larvae treated with monospore isolates and the original P0084 strain of *Beauveria bassiana*: a) second instar larvae; b) third instar larvae.

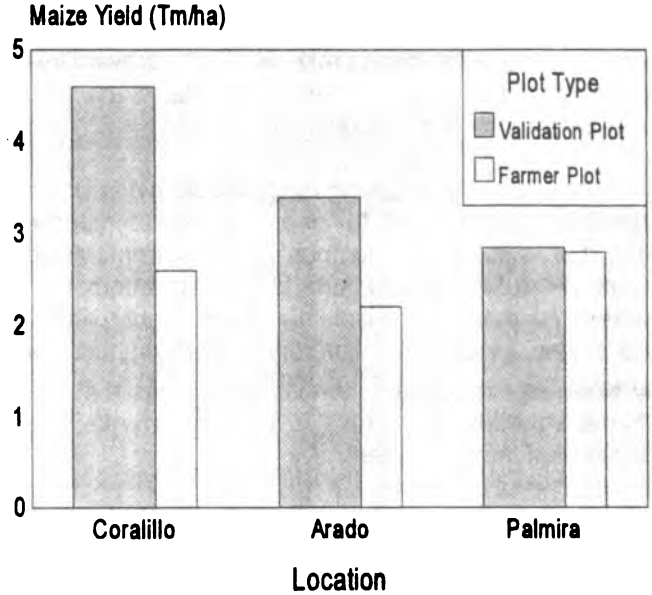


Fig. 10 Better maize yields in the firt year of validation of improved weed management practices, Guanacasta, 1995

tain conditions, the pathogen also causes accumulation of toxic substances in maize grains. This year special emphasis has been given to the fumonisin, a group of toxins known to be highly toxic to animals and human beings. A fumonisin survey carried out in 1995 in Costa Rica showed, that among 34 maize samples from different geographical regions, the fumonisin content varied considerably, from 3.9 ppb to level of 15 ppm in the most contaminated samples.

The 1996 research will be carried out in order to develop a biological control strategy based on the application of antagonistic fungi. The fungi that are being tested for antagonism, all originate from different plant and soil material from Costa Rica. This research will focus on the development of a screening method suitable for estimating the antagonistic effect of the applied isolates using polyclonal antibodies.

In addition, a genetic characterization of selected isolates of *F. moniliforme* based on fumonisin production, pathogencity, vegetative compatibiility and mating population is being made.

The research is financed by DANIDA , Denmark, and carried out in collaboration between The Royal Veterinary an Agricultural University of Copenhagen and CATIE.

2. Itchgrass (*Rottboellia cochinchinensis*) is a widespread weed species in Central and South America, and also in the Caribbean. It is a major problem in maize, beans, dryland rice, sorghum and sugarcane where it is a highly competitive weed with a high reproductive capacity. In the seasonally arid area of the Pacific Northwest of Costa Rica, itchgrass causes 45-64 % crop losses if not controlled, and the costs of control can limit planting areas for small and medium-size farmers. In previous years, researchers on the NRI project investigated integrated weed management tactics for this weed in maize based cropping systems. In 1995 the practices they developed began validation at three sites in Guanacaste, Costa Rica.

   The validation plots were established in growers fields in Corralillo, Arado and Palmira. Grain yields were substantially higher at the first two locations in the validation plots compared to growers plots (Fig. 10). In this first year, validation plots include an improved maize hybrid, use of a preemergence herbicide and interplanting of the cover legume, velvetbean (*Mucuna* sp.). In Palmira, where a local variety was planted, yields were similar in both plots. Reductions in the itchgrass populations are expected to allow less use of herbicide and increased reliance on suppression by the cover legume in 1996.

SEED BIOLOGY AND CONTROL OF A HERBICIDE-RESISTANT WEED IN UPLAND RICE

The annual grass, *Echinochloa colona*, is a major weed of rice throughout the tropics. Propanil, a relatively inexpensive herbicide, has been widely used to control this weed for many years, but continued reliance on this chemical has lead to the evolution of resistance in many

places. Weed scientists working with the NRI project have found resistant populations of *Echinochloa* in every country in Central America, especially in upland rice and on farms with long histories of rice growing and Propanil use. Loss of effectiveness of such an important component of rice cultivation can have serious economic impacts and has lead to increased herbicide use as farmers apply more and more in an attempt to achieve control.

In experiments designed to test management strategies for propanil-resistant populations of this weed, it had been shown in the Parrita, in the Pacific Zone of Costa Rica, that, compared with current farmer practices, in-crop infestations can be reduced by integrating pre-planting control of the first generation of *Echinochloa* seedlings (e.g. with glyphosate), preemergence application of pendimethalin and, if necessary, fenoxaprop-ethyl applications in late postemergence. In 1995, the longer term benefits of targeting the first seedling generation during Year 1 became evident, with lower pre-plant seedling populations being found in plots treated this way. The importance of continuing to manage the resistant population was highlighted by studies that showed that, even after 10 months burial, 30% of *Echinochloa* seed is latent but still viable, and that some populations are developing resistance to fenoxaprop-ethyl .

Reduction in whitefly borne geminivirus damage in tomatoes through cultural practices

1. Tomato producers in Costa Rica primarily use direct sowing, which exposes seedlings to whitefly-borne geminiviruses early on. In other Central American countries, seedlings are transplanted without a ball root, causing them severe post-transplant stress. It is desirable to keep tomato seedlings in seedbeds covered with nets for at least 30 days, avoiding such stress. CATIE's researchers have succeeded in that approach, using inexpensive newspaper cups to grow geminivirus-free and high-quality seedlings. This method is currently being validated and promoted by extension agents and NGO's in several Central American countries.

2. Previous research efforts at CATIE demonstrated that living soil covers, as well as silver plastic ones, interfered with whitefly's abilities to locate tomato plants. Two large on-farm trials were carried out in 1995 for transplanted tomatoes, testing "cinquillo" (*Drymaria cordata*, Caryophyllaceae) and silver plastic covers. Both reduced whitefly adult numbers and significantly delayed virus dissemination, giving rise to yields as high as 22 t/ha.

3. In the greenhouse, different levels of soil fertilizers (N-P-K), applied to transplanted tomatoes according to the crop's nutrient absorption curve, reduced the severity of the tomato yellow mosaic disease (caused by geminiviruses transmitted by the whitefly *Bemisia tabaci*). Treatments with high levels of phosphorus were most notable, resulting yields as high as 1162 g/plant (25.5 t/ha)

IPM technology development and implementation for Nicaraguan bananas, and poor coffee and tomato producers

1. Participative implementation of integrated pest management in coffee, tomatoes, bananas and plantains, cabbage and cotton:

   During 1995, members of the CATIE-INTA/MIP project funded by NORAD, combined their efforts with extensionists from different NGO's and state and private institutions to work with small producers in the implementation of ecological pest management in priority crops. Through a participative working system, these groups of specialists, extensionists and producers diagnosed their plant health problems, prioritized the problems to be handled, conducted practical training in pest management, tested some options in comparative plots, collected data on pest incidence and maintained open communication to learn about the pests and be able to make better decisions in time to control them more effectively.

   This activity covered seven work areas for coffee, 27 areas for tomatoes, and seven areas for bananas and plantains (see Table 5).

   During this period it was observed that participative implementation work in pest ecology provides producers and extensionists with new visions and tools to analyze the situations, strengthens open discussion and facilitates decision making. In the years to come, the consolidation of these work areas will be fundamental as starting points for mass production of pest management implementation based on knowledge and better decision making by producers and extensionists.

2. Use of entomopathogenic fungi for pest management

   Since 1991, the CATIE-INTA/MIP (NORAD) project in Nicaragua has been working with ten national and regional institutions to develop pest management technology based on the use of the entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae*.

   As a result of these collaborative efforts, there are now practical methods to isolate and preserve fungus strains, and presently there is a collection containing promising strains to control various insect pests as coffee borer (*Hypothenemus hampei*), diamond back moth (*Plutella xylostella*), banana weevil (*Cosmopolites sordidus*), cotton boll weevil (*Anthonomus grandis*), pepper weevil (*Anthonomus eugenii*) and white grubs (*Phyllophaga* spp). Also there is a simple method for mass production of these fungi based on local inputs, and an efficient low-technology fungus multiplication method based on biological material given out by the laboratory. During 1995, the effectiveness of these fungi to control different pests in Nicaragua was validated (see Table 6). Approximately 135 producers opted to apply these fungi based on counts and observations with successful results to control the coffee borer, the cotton boll weevil, the banana weevil and the diamond back moth (a total of 250 ha with an average of 4 applications). Technicians were also trained in the commercial production of these fungi, and women from cooperatives were trained in low-technology multiplication this year.

Table 5. Participative implementation in the ecological management of pest in Nicaragua during 1995.

Crops	Groups	Management Plots	Meetings	Technical Personnel		Producers
				Male	Female	
Coffee	10	16	44	33	20	650
Tomatoe	7	30	57	34	12	470
Musa	7	8	28	50	5	130
Cabbage	1	6	8	4	3	60
Cotton	1	10	5	8	4	30

Table 6. Validation use of entomopathogens in the management of different pests in Nicaragua

Crop	Pest Key	Testing _Area (ha)	Producers	Collaborating Institutions
Coffee	Borer	160	60	AGROCAFE PRODECOOP UCA's
Cabbage	Diamond Back Moth	28	22	UCA-Miraflor INTA
Plantain	Weevil	18	30	INTA
Cotton	Weevil	25	23	UNAN-León GTZ

3. Simple methods for producers to count coffee pests

Based on several years' research work, members of the CATIE-INTA/MIP (NORAD) in Nicaragua proposed a series of coffee pest count methods to assess the field situation and to make better decisions based on these observations.

During 1995, the use of these methods was promoted to 100 technicians and 1000 producers in different parts of the country. A method to assess the weed composition in the field and another to make decisions about weed management, as well as an integrated count of insect pest and disease incidence and another to diagnose the plantation's productivity should be mentioned.

Various groups of technicians and producers are already using these pest count methods to obtain precise information about pest incidence in their plantations to be able to make wiser decisions.

A systematic monitoring is necessary for a while so that producers and technicians become accustomed to using these counts to describe the situation and later base their decisions on this data.

IPM support of the non-traditional exports in Central America

Broccoli and snow pea are two important non-traditional export commodities for Guatemala. However, to be accepted in the USA, these crops need to be free of pesticide residues. The MIP/ICTA/CATIE/ARF project has dealt with this challenge through the training of 3235 growers. Pamphlets has been sent to extensionists and farmers to keep them informed about IPM and pesticide restrictions. These activities have resulted in more accurate pest diagnosis and management with a more rational use of pesticides on broccoli and snow pea.

The rapid expansion of non-traditional exports in Central America has highlighted the region's chronic problems of poor regulation of pesticide use and misuse. Importing countries, which strictly enforce pesticides regulations within their own borders, expect foreign producers to play by the same rules, and this has created a demand for up to date information on these often rapidly changing requirements.

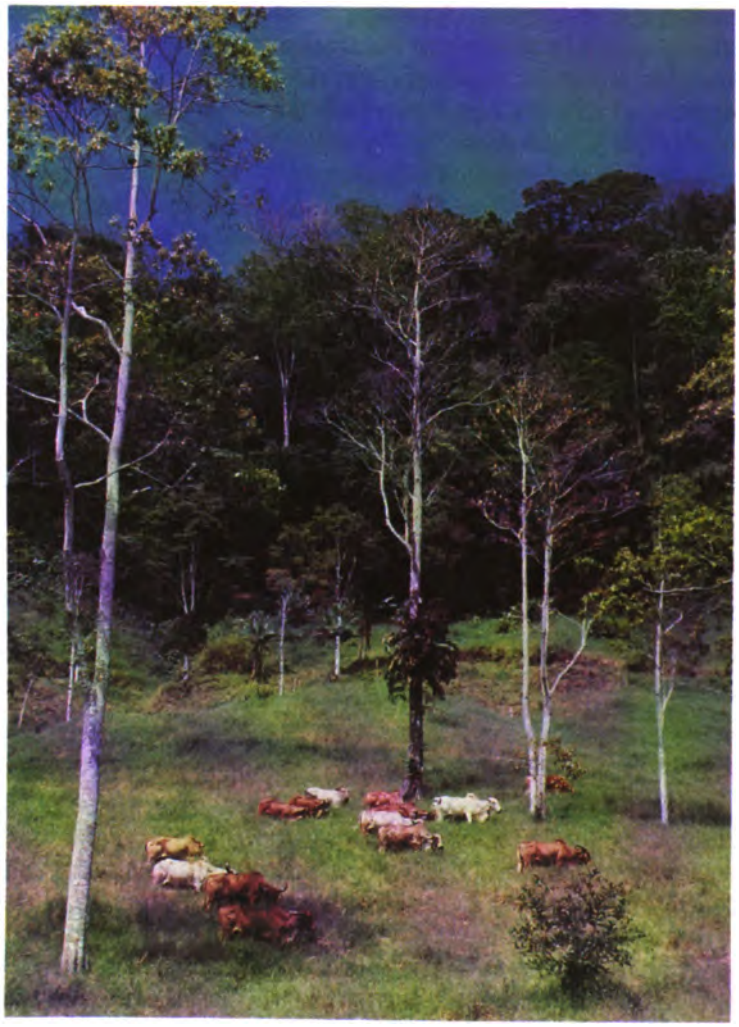
The Pesticide Tolerances Bulletin is a quarterly publication in Spanish, directed at growers and exporters of non-traditional agricultural products, that lists the pesticides permitted by the United Stated Environmental Protection Agency (EPA) by crop, and their respective residue tolerances. In 1995, more than 2500 single-crop bulletins were distributed to 160 subscribers. The Crop Protection pesticide specialists are responsible for the Bulletin and for answering requests for information, mainly on pesticides registered for specific crops, residue tolerances, and changes to the registration status of particular pesticides. The EPA supported these activities by providing the Crop Protection Unit with regular updates of their Pest Bank database containing pesticide information.

Agroforestry Systems Area

This section covers the activities of the Technical Unit "Development of Agroforestry Systems", previously the "Area of Agroforestry Systems", which was fused with the Technical Unit "Watershed Management" in September 1995 to form the "Area of Watersheds and Agroforestry Systems". Since the two units functioned independently for most of the year, they are presented separately in this annual report.

The following sub-sections present a selection of the most important activities and results obtained in 1995. One of the achievements during the year was to integrate the different groups and sources of funding. Hence the information in this report is not divided according to the source of funding. Nevertheless the different organizations and programs which have both supported specific activities and facilitated the coordination of planning and resources deserve special mention.

Firstly the support of DANIDA (Denmark) to the coordination Unit was essential in the process of successfully combining the existing "consortium of projects" into more efficient inte-



grated program. DANIDA also provided a significant part of the resources which were used to build up the capacity of the agroforestry area to transfer information to its diverse set of clients: i.e. from politicians to farmer leaders. BMZ/GTZ (Germany) was the pillar of the efforts to establish training and technical assistance activities in Honduras, Nicaragua, Costa Rica and Panama and the technical publications supported by this agency are reaching an audience throughout Latin America. IDRC (Canada) made a significant contribution to the resources required for investigation (home gardens; silvo-pastoral systems).

Outreach

One of the principal activities has been the preparation of publications in Spanish, with an emphasis on documenting and distributing the results of medium-long term CATIE research to Latin America technical staff. The GTZ (German supported) project made an outstanding contribution with six new booklets in its Transfer of Technology series.

There was also a significant increase in events designed to transfer knowledge to and from collaborating national institutions; not just training activities but also seminars, workshops, joint planning meetings and technical missions to member countries. For example assistance was provided to Guatemalan collaborators to validate the use of fodder trees for goats and cattle. In total 75 events have been held, mostly jointly organized with national projects or organizations, and 2132 participants have benefited. Assistance has also been provided in the preparation of bilateral proposals; e.g. to the Kuna indigenous people of Northeast Panama.

CATIE seeks to concentrate its efforts on selected topics where the institute has in-depth

experience and results to offer, including methodologies. An example, where strategic alliances are being developed, is with the national coffee institutions of the Central American countries in order to transfer our knowledge on coffee shade management and help our partners generate new sustainable technologies. Integration of CATIE's activities with those of our partners is also being promoted through the distribution of a data base on Agroforestry Projects in Central America and the Dominican Republic, and of an Annotated Bibliography of all of CATIE's publications on agroforestry. The first of a series of meetings, planned for each of the collaborating countries in order to distribute this information on computer diskette and to plan agroforestry activities, was held with representatives of 15 Costa Rican projects.

The structure of the USTED methodology for land use evaluation is explained in CATIE's 1994 Annual Report. In addition to publishing earlier results, work in 1995 focused on: (1) the upscaling of the methodology towards the regional level, i.e., to make USTED operational for the Atlantic Zone as a whole; (2a) initiating crop data collection and (2b) producing a soil inventory in the province of Guanacaste, to implement and test USTED in a region with significantly different bio-physical and socio-economic conditions than the Atlantic Zone; (3) improving the sustainability-related factors in USTED. A number of projects both within and outside Costa Rica are making use of the data bases which have been generated.

Research

Introduction of timber trees on small farms in the tropical humid lowlands

Line plantings: A combined analysis of the growth data, recorded for five timber species (three replicates of three species on 12 sites) planted in single lines around farm boundaries, gave the following results for total stem volumes (m^3/km) at age 5 years: *Acacia mangium* 60, *Cordia alliodora* 46, *Eucalyptus deglupta* 104, *Tectona grandis* 64, *Terminalia ivorensis* 104. The growth of *C. alliodora*, *Eucalyptus deglupta* and *Tectona grandis* were satisfactory. *T. ivorensis* and *A. mangium* are not recommendable for sites with a rainfall of 2500 mm or more per year and alluvial soils because of mortality caused by root rot, mostly due to *Rosellinia* sp. The collaborating farmers have already harvested commercial trees (dbh>40 cm; aged 7-8 years) and the technology is being adopted by farmers in Talamanca, Costa Rica; Bocas del Toro, Panama, and on the North coast of Honduras.

Established cocoa plantations: The existing shade canopy of 4-6 year old cocoa (*Theobroma cacao*) plantations can be easily and cheaply replaced by the same timber species planted at 204 trees/ha. The commonly used traditional shade species *Inga edulis*, which only produces firewood, was the least successful in competing with the existing shade and rapidly providing a new protective canopy for the cocoa.

New cocoa plantations: When these species were planted in new cocoa plantations (278 trees/ha), total stem volume growth rates were between 9 and 18 m^3/ha/year for *Tabebuia rosea*, *Terminalia ivorensis* and *Cordia alliodora*. The productivity of *T. ivorensis* was again reduced by high mortality rates. Cocoa production did not differ among shade species.

Table 7. Effects of poro (*Erythrina poeppigiana*) shade on coffee production in Turrialba, Costa Rica.

	SHADE TREATMENTS				
	No Shade	Poro pruned (twice/yr.)	Poro pollarded (thrice/yr)	Shade cloth (50%)	Unpruned poro
Harvest 94/95					
Caturra (61)	64[1] (100[2])	55 (85)	51 (80)	48 (75)	39
adjusted[3] (69)	56[1] (100[2])	54 (96)	45 (81)	46 (82)	39
Catimor (76)	77 (100)	65 (84)	64 (83)	--	59
adjusted (89)	66 (100)	64 (98)	58 (88)	--	59
Harvest 7-11/95					
Caturra (52)	59 (100)	54 (90)	54 (90)	55 (93)	31
adjusted (59)	53 (100)	53 (100)	48 (91)	54 (101)	31
Catimor (62)	59 (100)	48 (82)	58 (99)	--	37
adjusted (73)	50 (100)	48 (95)	52 (105)	--	37

1 fanegas (256 kg) calculated assuming 5000 plants per hectare
2 percentage with respect to no shade treatment
3 percentages of diseased or shriveled coffee were subtracted.

Mixed plantain-cacao plantations: *C. alliodora* planted at wide spacing (12x12m) in combinations of cocoa and plantain gave exceptionally high growth rates with 26 m^3/ha at age 5 years from 69 trees/ha.

Studies of shade trees in coffee plantations

In Turrialba, Costa Rica, up to 50% shade of *Erythrina poeppigiana* over *Coffea arabica* var. Caturra and Catimor did not affect coffee production. However, there was a yield reduction of 30-40% when radiation was reduced to less than 30%. Coffee berries from shaded plots were larger and healthier, and weed growth was less. When yields were adjusted for processing losses due to berry damage in unshaded plots (e.g. 15% losses due to *Cercospora coffeicola*) there was no significant difference between moderate shade and full sun plots (Table 7). An homogenous shade pattern with 40-60% radiation is recommended for this sub-optimal coffee zone (altitude 600-900 masl).

In another experiment in the same zone, coffee production without shade was higher than under a mixed shade of *Cordia alliodora* and *Erythrina poeppigiana* but the difference was proportional to the higher bush density in the unshaded plots (7215 vs. 4780 bushes/ha). The coffee bean defect known as "empty bean" was lower under shade and the conversion factor for berries to dry beans was higher. An extrapolation of eight years of data to a 20 year cycle, showed that there are clear financial justifications (cost benefit ratio; return to labor) for small farmers, using limited capital and family labor, to continue the traditional practice of incorporating timber trees within the coffee shade strata (Table 8).

Studies of forage trees

Research on fodder trees/shrubs involves several sequential steps: a) identification of woody perennials used as fodder in Central American farms; b) screening of species with high nutritional quality; c) evaluation of animal response (palatability, consumption, milk or meat production) to selected fodder species; d) agronomic experimentation (propagation, planting density trials, pruning, etc.) with selected species.; and e) determination of anti-qualitative compounds, silage, etc. of selected fodder species.

Studies with eight woody species, previously selected as sources of fresh forage for goats and cattle, showed that they produce superior silage to that obtained from temperate gramineous and legume species. The best results were obtained with Morera (*Morus* sp.) and Chicasquil (*Cnidoscolus aconitifolius*) with *in vitro* digestibility of 68 and 73%, and crude protein of 17 and 23% respectively (based on dry weights).

Milk production of grazing cows was not significantly affected when a commercial concentrate supplement was replaced by Morera (13.6 and 13.2 kg/day/animal respectively).

However the partial net benefit ($2.84 and $3.29/day/animal, respectively) favors the use of Morera as a supplement. Promising results were also obtained with higher productivity animals, when a commercial supplement was partially replaced by Morera.

Table 8. Financial indices for the *Coffea arabica* cv caturra agroforestry system with different densities of *Cordia alliodora* assuming a 20 year production cycle. In Costa Rican currency.

Tree density (*C. alliodora*/ha)	Gross margin ¢/ha	Internal rate of return (%)	Benefit/cost ¢/¢	Return to labor ¢/day
0	5,274,884	73.2	1.8	3104
100	4,076,924	66.3	2.2	3463
200	3,499,743	59.0	2.1	3718
300	2,904,050	51.1	2.0	3894

The potential of these fodder trees for goats was again demonstrated by significant increases in milk production when the level of *Hibiscus rosa-sinensis* was increased in a diet based on king grass (*Pennisetum purpureum x P. typhoides*). *H. sinensis* offered at 1.0 to 2.7% of live weight gave an increase of 1.4 to 1.8 kg/animal/day of milk.

Proanthocyanidin concentration showed significant differences between five provenance of *Gliricidia sepium* and between season (high and low precipitation) but coumarin content varied only between provenance. Coumarin concentration has a negative effect on voluntary intake. The two compounds had discriminatory power to detect genetic heterogeneity between *G. sepium* germoplasm.

Agroforestry systems with annual crops

Research with annual crops in agroforestry systems during 1995 was carried out by M.Sc. students in three long-term experiments, on two contrasting soil types. In the first experiment, mineral N levels were higher in the plots receiving organic amendments, including nitrogen fixing trees (*Gliricidia sepium* and *Erythrina poeppigiana*), although the effect of the amendment lasted less than 40 days.

In the second experiment on an Acrudoxic Melanudand soil, with very low nutrient status and 15-35% slope, a mulch of *Mucuna deerengiana* was found to be as effective as alley farming or a mulch of pruning in maintaining crop yields and reducing erosion. Liming increased crop yields but did not improve tree growth and reduced accumulation of nitrates at depth.

The third experiment, originally set up to measure the interaction of three different tree species with different varieties of corn and beans, was modified to measure the effects of plowing and different bean populations on the performance of beans in alley farming systems. When

unseasonably heavy rains followed bean planting, as occurred in January, the soluble nitrates were leached below the rooting zone of the beans so that less N was available to the beans in the ploughed plots later in the season. As a result, plowing had a negative effect on bean production in the first planting and a positive effect on the second planting (Table 9). In all cases, alley farming had a positive effect on bean yield. Bean yields were lowest with *Calliandra calothyrsus*, possibly because it had the greatest canopy width and slowest decomposition rates of the three species despite having the highest biomass production.

Table 9. Effect of associated tree, tillage, and seeding density on bean production and tree canopy width.

	Bean yield-January planting (kg ha^{-1})	Bean yield-May planting (kg ha^{-1})	Width of tree canopy (m)-May, 1995	Width of tree canopy (m)-August, 1995
Associated tree				
C. calothyrsus	1134 A	1356 A	9.08 A	5.14 A
G. sepium	1182 A	1423 A	3.80 B	2.86 B
E. poeppigiana	1364 A	1290 A	9.80 A	5.72 A
Treeless control	595 B	953 B		
Plowed, pruning incorporated	972 B	1339 A		
No plowing	1167 A	1172 B		
160,000 pl ha^{-1}	966 B	1173 B		
200,000 pl ha^{-1}	1173 A	1337 B		

Note: values followed by the same letter do not differ significantly at $P<0.05$.

Silvopastoral systems in the tropical lowlands

Improved grasses (*Bachiaria brizantha* and *B. humidicola*) and legumes (*Arachis pintoi*) produced up to 30 t(DM)/ha/year. Liveweight gains on these pastures were five times greater than those obtained under traditional pasture systems in the humid tropics. This shows that livestock production can be intensified and therefore fragile areas can be released for reforestation.

Living fences of *Erythrina* and *Gliricidia* species. managed with three pruning/year, produced 2.4 kg DM/tree/year of high nutritive value (IVDMD = 60%; CP = 23%). Milk yields and liveweight gains of animals grazing unimproved pastures were increased significantly with the supplementation of foliage from these tree species.

An economic evaluation concluded that even though replacing the native vegetation with a mixture of *B. brizantha* and *A. pintoi* is very profitable, the same mixture in combination with two legume trees (*Erythrina berteroana* and *Gliricidia sepium*) is not.

On-farm results showed that milk yields were increased by 1-2 l/cow/day with the supplementation of poro (*Erythrina* species.) in the period of low rainfall (Dec.-April) when there is a deficit in forage supply because of a moisture deficit in these rapidly draining soils. This permitted a reduction in the amount of concentrates used to supplement dairy cows.

From the above results, it is concluded that improved silvopastoral technologies offer alternatives for increasing the economic efficiency of livestock production in the Atlantic Zone.

INTEGRATED MANAGEMENT OF NATURAL RESOURCES PROGRAM (MIREN)

The Integrated Management of Natural Resources (MIREN) Program is faced with the challenge of finding ways to protect the environment while, at the same time, finding ways to provide food and resources for the ever growing human population of Central America and member countries.

The general objective of MIREN is:

To generate, validate and promote appropriate technologies for natural resource management, conservation and sustainable use, with the social sectors that are involved.

In 1995 MIREN implemented program plans and activities in CATIE's member countries in the Areas of Tropical Forestry (both tree planting and management of natural forest), Watershed Management, Biodiversity Management and Conservation and Economics of Production and Conservation.

Funding

A large proportion of the MIREN budget is for project area funding. Of the $ 7.5 million Program budget 6.5% is from core budget. The Program budget es shown in table 10.

Table 10. Financing of the Integrated Management of Natural Resources (MIREN) during 1995.

ITEM	CORE BUDGET U.S. $	PROJECT BUDGET U.S. $ (*)	TOTAL U.S. $
Program Directorate	244,229	----	244,229
Tropical Forest M&C Area	105,075	3,832,965	3,938,040
Watershed Mgmt. Area	---	898,452	898,452
. Biodiversity M&C Area	72,658	2,308,747	2,381,405
Econ. and Soc. P&C Area	56,192	---	56,192
TOTAL	478,154	7,040,164	7,518,318

(*) Details of Projects in Table 31 , page 136

Each of these Program Areas are discussed in greater detail below.

Tropical Forest Management and Silviculture Area

1995 has been a year of transition for many projects in CATIE's Forestry Area. The large Madeleña Project (USAID/FINNIDA financed) and the Production in Natural Forests Project (USAID financed) both concluded on a strong note in December. British funding for a Forest Tree Improvement Project and for Forest Ecology studies was also drawing to a close as the year ended. On the other hand, new funds became available for a second natural forest management project with Swiss (COSUDE) funds, and one new scientist position and three assistant scientist positions have become available in natural forest management as a result of additional core funding from Denmark, Sweden and Switzerland. There have also been two important buy-ins from bilateral USAID in Guatemala and Belize.

As a result of concern for the large drop in funding for CATIE forestry projects (the 1996 budget is slightly under 50% of the 1995 budget), and aware that there is a huge demand for services in the forestry sector, considerable effort was spent on the development of novel proposals which could use some of the skills already developed at CATIE. Themes for these proposals include (a) forestry extension network (10 proposals) (b) recuperation of degraded lands, (c) the construction of a biological corridor, (d) carbon sequestration, (e) monitoring of natural secondary, silviculturally treated forests, (f) development of *Hypsipyla* resistance in the Meliaceae, (g) the COSUDE (Transforma) natural forest management project, and (h) a project to foment the development of plantation-based forest industries. About one fourth of these projects have been approved or look very promising, one-fourth have been rejected by the intended donor and one-half remain in the pipeline. In spite of the generally negative financial transition for the Forestry Area in 1995, the year itself was enormously productive. Highlights for each of the six projects in the Forestry Area are presented in the next section.

It should also be recognized that professionals from the Forestry Area also contributed substantially to CATIE's Graduate School, teaching approximately one-third of the courses and supervising approximately one third of all students. The exact nature of this contribution is explained in the section in this report on the Graduate School. Similarly, the contribution which the forestry area made in training, both in the countries of Central America and at headquarters, is quantified in detail in the training section of this report.

MADELEÑA - Dissemination of multiple use trees.

In its 15th and final year, the Madeleña Project continued to put major emphasis on transmitting the technical information it had generated on the best silvicultural options to small farmers throughout much of the Central American isthmus. As in previous years, the emphasis was on the training of the extensionists of the 38 collaborating governmental and non-governmental organizations in the aspects of tree growing that their clients, the small farmers, request. In 1995, the

number of extensionists that had been trained in the Madeleña network rose to 850 (up from 700 the year before) with the project providing over 5000 man/woman days of training through 71 separate training events. All but five of these training events were in the countries (i.e. not at headquarters).

The number of farmers directly assisted by extensionists trained by the project rose to 26,500 (up from 14,000 the previous year), and as a result of farmers imitating farmers who are already planting trees, the number of farmers now planting trees in Central America is now well over 100,000.

As opposed to previous years of the project, 1995 training events often had a heavier emphasis on stand management and marketing of forest products. These aspects are essential for generating optimal returns on tree farming and are therefore essential to the sustainability of tree planting practices. To help facilitate the aforementioned training events and to leave the best technical results and thoughts of Madeleña researchers at the disposition of extensionists in the future, the project published an additional 62 articles in 1995.

Some key themes that were developed in various publications includ stand dynamics in the tropics, site indexing for fast growing industrial species and the economics of growing thees on small farms. Furthermore, in a marathon effort to wrap up all outstanding experimental trials for the 6 to 10 most promising species in each country, a 70 to 120 page compendium of undocumented research findings was produced for each of the six Central American countries by both Madeleña staff members and counterpart researchers in the collaborating organizations. It should be mentioned that the data used in preparing these *compendia* came from measurements of thousands of sample plots in silvicultural experiments which had been installed and dutifully measured by the projects network of collaborating organizations (mainly the national forest services or their equivalents). The measured data had then been stored in the MIRA (Management of Information about Tree Resources) data bank system. The exercise in 1995 involved expert returning to each of the countries for about one month and working with local foresters and scientists (mainly from universities) to analyze and synthesize all of the experiments which had to do with each of these 6 to 10 "most promising" species. Obviously these *compendia* will be of enormous use to various stakeholders in the future to determine the best silvicultural options in the different areas of Central America.

A highlight of 1995 was when a researcher from the Project recieved an award from IUFRO (International Union of Forest Research Organizations) as one of the 10 top young forest scientists in the world. He received this recognition mainly for his development of the MIRA data base.

In 1995 heavy emphasis was also placed on consolidating the forestry research commissions that the Madeleña project had helped initiate in each country, and on securing the continuance of the Madeleña network itself, albeit with a much stronger emphasis at the national level.

Tree improvement project

CATIE's Tree Improvement Project conducts four main lines of research. These will be listed in turn, along with the most significant results for each line of research.

Exploration, characterization and conservation of forest genetic resources

Swietenia macrophylla, the big leaf mahogany, is a fast growing species for the lowland tropics with high value wood. However, it usually does not grow well in most parts of the world under plantation conditions because it is extremely vulnerable, at the seedling and sapling stages, to a medium-sized moth, *Hypsipyla grandella*, which ruins the form of the tree for commercial purposes.

Earlier research by CATIE's tree improvement project had shown that there was significant variation in susceptibility to *Hypsipyla* attack between a few provenance of *Swietenia macrophylla*.

Current research is being done in collaboration with Scotland's Institute for Terrestrial Ecology (ITE). CATIE is making a Central America-wide collection of seed and/or leaf tissue from several hundred mother-trees. The ITE is characterizing the DNA of this germplasm using Random Amplified Polymorphic DNA's. There is considerable scope for future collaborative research with a world-wide consortium of research institutions interested in finding an integrated solution to the *Hypsipyla* problem.

Development of clonal silviculture appropriate for small and medium farmers

Research continued on the miniature, low-cost greenhouse that CATIE helped pioneer in previous years; as a result, a large number of tropical tree species commonly used in Central America plantations can now be reproduced cheaply and easily through rooted cuttings.

Identification and development of improved forest germplasm

Clonal trials were initiated both for *Gmelina arborea*, one of the fastest growing trees in the world, and *Cedrela odorata*, a close relative of *Swietenia macrophylla* with many of the same attributes and problems. The ability to conduct such clonal trials will significantly enhance the ability to identify genotypes with optimal growth characteristics and resistance to *Hypsipyla*, for these respective species.

A most important part of the tree improvement work at CATIE is the first generation half-sib progeny tests that are being conducted for 17 of the most commonly planted tree species in Central America. In 1995, the results of each of these tests were evaluated and seven of the tests were converted to forward selection seedling seed orchards by eliminating all but the best individuals of the best families. Trees grown from seed produced in these orchards will be approximately 20 to 30% faster growing than trees grown from unimproved seed of the same species, and will also have better form.

Dissemination, demonstration and education in the techniques of forest genetics

Although there were many short courses for the genetics team throughout the year, the major education event was the "V International Short Course in Improvement and Conservation of Forest Genetic Resources". The leader of this project also authored or co-authored nine publications in 1995; four of these were accepted by Silvae Genetica.

PROSEFOR - Tree Seed Project

Needs for tree seed are high among organizations collaborating with CATIE in tree planting. In 1995 trees were planted on approximately 25,000 hectares of land throughout Central America. The supply of a genetically adequate quality of the huge amount of seed needed for this reforestation is of principal concern to the PROSEFOR Tree Seed Project.

In 1995, the PROSEFOR Tree Seed Project made considerable progress on two fronts. It strengthened the national tree seed banks in each Central American country and the Dominican Republic, and it selected an additional 147 stands for the production of tree seed from 40 different species. Of these, 28 have been thinned leaving only the best 100 to 200 phenotypes per hectare to produce seed for future generations (this may result in modest genetic gains).

The project also sought to improve the national seed banks in all seven countries by bringing up their operational procedures so that they are in line with the international standards for seed certification, collection, storage and distribution.

The other mechanism relied upon for information transfer was the writing of 44 publications. Some of these publications were translations and adaptations of useful documents on forest seed which had previously existed only in English. Others dealt with explaining the forest tree seed situation in Central America, while still others explored the possibility of collaborating to produce seed that, as yet, cannot be supplied in sufficient quantity.

Production from Natural Forests (USAID/RENARM)

This projects specific objectives were to:

1. Demonstrate that the management and silviculture of the lowland tropics forest (primary, intervened and secondary) is technically feasible, financially profitable, ecologically sustainable and socially acceptable;

2. Improve the technical capacity of counterpart organizations to sustainable manage the natural forest;

3. Generate, validate and disseminate appropriate technologies for the management and silviculture of natural tropical forests;

4. Contribute to the improvement of a policy framework which favors and supports the management of the natural forests of the Central American Region.

In order to meet these objectives, this project conducted and published 15 research papers and held 15 intensive short courses which collectively trained 238 technicians and extensionists in such things as improved harvesting techniques, how to prepare simplified management plans and stand growth monitoring. One of the major objectives of this project is to enable the development of management plans for natural forests which will enable forests to produce valuable commercial timber while continuing to perform their initial ecological and environmental functions *ad infinitum.* These management plans must not be so complicated legally problematic that they turn forest owners off to the idea of developing management plans for their forests in the first place.

The other major thrust of this project has involved the fine tuning of silvicultural interventions in these forests being managed for sustained timber production. This has been done by closely monitoring selective timber harvesting practices to determine which are least damaging to the residual woody vegetation. Growth of trees in the residual forest both following harvest

and liberation cutting was carefully measured using permanent sample plots and an efficien,t project-developed, computer program "SEMIFORE" was used to store, process and analyze the vast quantities of growth data that were generated from these measurements. In many forests, skillful silvicultural interventions have been found to about double the growth rate of the commercial species growing through the lower diameter classes to a commercial size, but there is significant variance and only by measurement in permanent sample plots can yields for future harvests be accurately predicted.

Because this was a USAID/RENARM project, many of the mainstream activities of this project were shut down in September of 1995. However, two USAID bilateral buy-ins have required the ongoing services of many of this project's personnel for training in forest management and for monitoring growth in liberated and non-liberated secondary forests in Guatemala and Belize, respectively.

Silviculture of Natural Forests, Project (COSUDE/ODA/DGF/CATIE)

The three objectives of this project are as follows:

1. Determine the ecological, socioeconomic and technical background information required for the development of sustainable management techniques for natural forests.

2. Develop and then validate operations for the management of natural forests which incorporates this background information.

3. Transfer through training, teaching, publications and scientific interchanges, the use of sustainable natural forest management systems.

Several significant advances were made towards achieving these objectives in 1995:

Several important results were obtained in the quest to achieve these objectives. One of the salient research findings was that commercial species growing in one treated primary forest approximately doubled their diameter growth (from 0.5 cm/year to 0.9 cm/year) following a liberation thinning. As a result of these thinning, the populations of non-commercial species of large dimensions were reduced, but species richness of trees in the sapling stage were unaffected.

In another research effort, the main factors which affect harvesting operations (e.g. forest structure and composition, site and cultural, economic, industrial and political factors) were assessed to determine why traditional logging practices in the region are highly destructive and to explain the more benign pre-harvesting, harvesting and post-harvesting practices being promoted by CATIE.

In some novel thesis research, it was determined that soil characteristics such as percent clay, available phosphorus, manganese and organic matter can be used to explain 79.5% of the variation in dominant height of Vochysia ferruginea growing in natural secondary forests.

But the research is far from over. Must already existing permanent sample plots continued to be measured in 1995 and, in addition 41 large permanent sample plots (each one hectare in size) and over 600 small (5m. x 5m.) sample plots were established to help monitor the growth of large trees (over 10 cm. in diameter) and small trees, respectively, following different levels of silvicultural intervention.

Another important experiment initiated has to do with documenting the impact of liberation and improvement thinning of young sapling and pole-sized commercial forest species which have come in on abandoned pasture sites. The baseline studies for these research were completed in 1995.

In order to share the results of these research and expand their impact, several activities took place. Chief among these were the organization and the participation in over 20 training courses in forest management (one of these was in Bolivia), the organization and advance of a major book to be written by 30 authorities on management of natural forests in the neotropics and the creation of a second COSUDE project "TRANSFORMA" which aims at sharing natural forest management techniques with forest technicians in Nicaragua and Honduras.

WATERSHED MANAGEMENT AREA

Introduction and Objectives

The Watershed Management Area has a multi-disciplinary focus in the planning and management of natural resources and Biodiversity within watersheds. The activities of the Unit involve the evaluation of biophysical and socioeconomic variables at the farm and watershed levels of analysis, while accounting for related effects at the watershed level. The goal of the Unit is to create the conditions where public and private institutions in CATIE member countries can generate, transfer, and apply appropriate technologies that promote the sustainable use of natural resources.

The Area is promoting social and cultural harmony, appropriate technologies, rehabilitation of degraded lands and immediate solutions that have both direct and indirect benefits to small hillside farmers.

The main objective is to:

Identify, develop, and disseminate effective techniques for the rehabilitation and management of watersheds. The principal strategy to accomplish this involves working at farm level through participatory and extension activities involving both relevant institutions and local farmers.

Two main fields of expertise of the Watershed Management Technical Unit are being developed:

Watershed Rehabilitation.

With emphasis on the rehabilitation of small hillside farms and production systems, this Unit has generated appropriate mechanisms for institutions responsible for watershed planning and the improvement of deteriorated areas. This has involved researching, validating, evaluating, and diffusing technological practices that promote the appropriate use of natural resources in compliance with identified requirements such as sustainable agriculture and ecosystem stability.

The main objectives of this field are to:

1. Generate appropriate mechanisms for institutions in CATIE member countries to conduct watershed planning and actions to improve deteriorated land areas. The main emphasis is to promote the rehabilitation of hillside farming areas.

2. Generate, validate, evaluate, and diffuse technological practices involving the appropriate use of natural resources in compliance with identified requirements such as sustainable agriculture in fragile areas.

3. Promote technical assistance and training required for the establishment of demonstrative areas in member countries as well as the strategies to obtain required financial resources for

such projects.

4. Research and promote strategies to guarantee the continued operation of watershed rehabilitation efforts.

5. Promote intervention strategies at the field level that involve both extension and research activities in order to find solutions to the ecological and socio-economic problems in member countries.

6. Ensure the continued presence of watershed management activities through continued involvement and participation in the CATIE MSc. graduate program.

Geographic Information Systems (GIS).

This field includes a center for the collection of digitally stored GIS and remote sensing data. This GIS center provides data processing and other GIS services to users on demand, and is involved with the teaching of GIS technology as a support tool for the planning, management and monitoring of natural resources and agricultural activities in the member countries. Currently, CATIE has one of the best GIS labs in the region for training and research to satisfy the training and service demands of member countries.

The Geographic Information Systems (GIS) Unit of the RENARM/Watershed Management Project completed many achievements in 1995 which are expected to improve watershed management activities in the CATIE member countries. In addition to participating in graduate teaching and research activities, the Unit provided technical assistance and/or GIS data to various projects within CATIE (MADELEÑA, OLAFO, BOSQUES NATURALES, MEJORAMIENTO GENETICO FORESTAL), as well as to several institutions in CATIE member countries (MICUENCA/CARE and FAUSAC in Guatemala; CNFL, IGN, DGF and RECOPE in Costa Rica; PROMESA project and IICA/MAG in El Salvador, IICA/GTZ and the Ministry of Agriculture in Nicaragua). A collaborative research project was finished related to RADAR technology with the University of Sherbrooke. To promote the financial independence of the GIS Lab development activities such as training, technical assistance were encouraged under the "sale of services" modality. Finally, several project proposals have been written with the aim of generating additional external research and training funds.

Institutional achievements

- The GIS laboratory and center (international experts and state of the art equipment and technology) was consolidated for research, training and applied natural resource management projects. This has included numerous international training events in the GIS laboratory at CATIE, as well as many visits to member countries where on-demand GIS training and/or assistance was provided.

- Contributions have been made to the CATIE M.Sc. program in the form of courses taught by staff in the Watershed Management Unit and by assistance provided to Watershed Management graduate students conducting research for theses and special topics in CATIE headquarters and member countries.
- The completion of watershed management activities and implementation or projects in CATIE member countries with particular emphasis on GIS applications in hillside agricultural areas.

- Several activities of the order of "buy-ins" and contracts were carried out in El Salvador (IICA/MAG), Nicaragua (IICA/GTZ and OLAFO project), Honduras (Agriculture Pan-American School "El Zamorano"), Italy (TREES/ESA project) and Brazil (SUDENE). These activities were related mainly to "of the job" training, geographical database construction, remote sensing services and technical assistance.

- For the first time the International GIS Course was completely financed by the participants. There were participants from the Central American countries, Argentina, Ecuador and Bolivia.

Table 11 below showes the number of direct beneficiaries of Unit activities.

Table 11. Number of direct beneficiaries of Unit activities (by country)

COUNTRY BENEFICIARIES	NUMBER OF DIRECT BENEFICIARIES
PANAMA	71
COSTA RICA	48
NICARAGUA	5
EL SALVADOR	30
HONDURAS	43
GUATEMALA	21
JAMAICA	18
DOMINICAN REPUBLIC	29
BRAZIL	3
ECUADOR	1
ARGENTINA	1
BOLIVIA	1
TOTAL	**271**

Technical accomplishments of the projects

The main accomplishments of the RENARM/Watershed Management Project in 1995 included member country watershed rehabilitation and planning projects, graduate training, and geographic information system activities.

Watershed Rehabilitation and Planning Projects

The Projects maintained a leadership role in the region through the continuation and follow-up of numerous watershed rehabilitation programs and activities in the region. This included technical assistance, training, post-graduate education, and the strengthening of counterpart national institutions with both financial and human resources in order to continue watershed management activities at the field level. More specifically, implementation and follow-up work was continued on ten watershed management plans, four new watershed management plans were introduced, and GIS systems were introduced to five national institutions.

Specific watershed plans and projects impacted by the Project in 1995 included:

- Rehabilitation of Las Cañas River Watershed, El Salvador
- Rehabilitation of Nueve Pozas and Cerro Colopeca Rivers Watershed, Honduras
- Rehabilitation of Humuya and Yure Rivers Watershed, Honduras
- Hydrologic Modeling of Caldera River, Panamá
- Reforestation Project of the Coastal area of Lake Managua, Nicaragua
- Rehabilitation of Río Virilla Upper Watershed, Costa Rica
- Hydrologic and Hydraulic Modeling of Tuis River, Costa Rica
- Operation Modeling, Arenal Reservoir, Costa Rica
- Rainfall simulation research for soil erosion and hydrodynamic characterization in Costa Rica.
- Study of solar radiation in plantain crop systems.
- Relationship between soil surface and air, its influence in the development of plantain diseases.

Achievements of the above watershed plans and projects have been described in publications, conference presentations, masters theses and internal CATIE documents.

BIODIVERSITY MANAGEMENT AND CONSERVATION AREA

This Area includes management of protected areas, wetlands management, ethnobotany and the management of buffer zones in protected areas. It seeks natural resource management alternatives to benefit the inhabitants, above all ethnic groups, that live in such areas.

It includes sociological, socioeconomic and cultural studies, environmental education and rural economic studies based on the biodiversity. This area of work has two technical units: Conservation for Development and Protected Areas Management

Biodiversity Management and Conservation Unit

This Unit undertakes its work on the basis of two very large projects financed by the Swedish Government which (OLAFO Project) and Danish Government (Mangrove Project).

The Project for Conservation and Sustainable Development in Central America (OLAFO) is a regional project based at CATIE, Turrialba with demonstration areas in the Peten, Guatemala, the mangroves of Heroes y Martires in Nicaragua, Talamanca in Costa Rica, and the Teribe Valley in Bocas del Toro, Panama.

The project for the Wise Use of Mangrove Resources is also based at CATIE, Turrialba, with demonstration areas in the mangroves of Estero Real, Nicaragua, and Terraba Sierpe, Costa Rica.

Objectives

OLAFO: Rural community groups in demonstration areas have validated models of production systems based on the sustainable use of forest and other traditional agricultural components, with the support of national institutions that have acquired the ability to diffuse the models.

Mangroves Project: Mangrove natural resources in Estero Real and Terraba Sierpe are being used in a sustainable manner by local populations. A higher level of awareness about the importance of adequate use and conservation of mangroves exists at the regional level.

Funding

OLAFO, whose donor agencies include Sweden (SIDA), Norway (NORAD), and Denmark (DANIDA), had a total 1995 budget of $1,671,743, of which 100% was executed. Of the 49 OLAFO staff members, 64% are located in the demonstration areas. OLAFO finished its second phase in December 1995.

The Mangroves Project, funded by DANIDA, executed its budget of $604,750 by 91%. The project is based in mangrove ecosystems of Estero Real, Nicaragua, and in Térraba Sierpe, Costa Rica. Approximately three-quarters (73%) of the staff members are located outside of headquarters.

General activities

Validation

The OLAFO/Mangroves projects worked towards validating alternatives to the traditional production systems found in the different demonstration areas. The following activities were carried out in 1995:

- honey production in mangroves and sub-tropical ecosystems
- mangrove charcoal production
- low technology shrimp farming
- iguana pet production
- improved fallow management with green manure
- agroforestry modules with goats
- timber management
- mangrove tannin production
- rehabilitation of cocoa and citrus stands

Research Work Lines

The major lines of research carried out in 1995 are listed below:

- Non-timber forest products: *Desmoncus spp., Chamaedorea spp., Zamia skinneri, Reinhardtia gracilis, Quassia amara, Ryania speciosa, Carludovica palmata, Manilkara zapota*
- Tree and shrub forage: *Leucaena spp.*, Chaya (*Cinedosculus spp.*), tabaquillo (*Aegiphila montrosa*).
- Diversified forest management (timber and non-timber forest products)

- Marketing non-traditional products
- Economic evaluation of ecosystems
- Evaluation of production system sustainability indicators
- Social research for the promotion of community organization

Outreach

Diffusion of project experience was carried out in the following manner:

- Organizational group strengthening, administration, legalization, revolving funds, production processes, transformation and commercialization
- Public and private institutional strengthening in the management of natural ecosystems (education, technical assistance)
- Diffusion and motivation through technical meetings, demonstration events, and publications

OLAFO highlights

Validation

Improvements or introductions of new alternatives to traditional production systems were under validation in Guatemala, Costa Rica, and Panama in 1995. In Guatemala, the natural forest management activity provided benefits to approximately 80% of the families in San Miguel. The harvest of a 180 ha area yielded 1.5 m3/ha of wood in 1995. Despite relatively low yields, this activity is complementary to their traditional agricultural production systems and, in comparison with the average wage paid to an agricultural worker in the region, allowed them to increase their daily wage by 350% in 1995.

Rural communities were organized in groups to improve honey harvesting and commercialization practices. As a result of their efforts they received a daily wage about 40% higher than the average rate.

There were approximately 5 goat modules in production in 1995, producing on average 1.6 kg of milk/day for families which normally do not have access to fresh dairy products.

To reduce the amount of forest felled to plant corn crops, green manure was intercropped with corn in 1995. Seeking to increase the amount of time spent in a given parcel, about half of the farmers in San Miguel planted *Mucuna spp.* A 30% decrease in the advance of the agricultural frontier is estimated as a result of these preventative actions.

In Costa Rica, forest management practices on a cattle ranching farm in Talamanca yielded about 23 m3/ha of wood in 1995. Comparing this activity with the returns to labor of cattle ranching, the most competitive alternative in the region, studies showed that forest management provided a 14% higher daily wage rate. Forest management is complementary to traditional livestock production activities.

In the mangroves of Terraba Sierpe, COOPEMANGLE, a fuelwood collecting cooperative multiplied its production rate by five times with its entrance into the national charcoal market. They are producing 1000 sacks of charcoal a month, compared to 200 per month produced for the local market in previous years.

In the Teribe Valley, a program started to recover cocoa plantations began with 11 farmers at the beginning of 1995 and tripled by year end.

Research

Among the research lines mentioned above, significant findings have been made in the areas of non-timber forest vegetative resources at the species and component levels, the impacts of timber harvesting on vegetative non-timber forest resources, production system sustainability and social research. The highlights from 1995 are described below.

Non-timber forest species

An ethnobotanical study was carried out to identify the extent of the productive biodiversity available in the Teribe Valley, Panama. Of the 83 species identified, their traditional uses and processing were defined. Ethnobotanical studies are useful as tools for selecting species to include in diversified forest management plans.

Characteristics such as distribution, availability of harvestable material, and growth rates, were defined for *Quassia amara*, a small shrub with natural biocide characteristics, *Chamadorea spp.*, an ornamental plant, and *Desmoncus spp.*, a vine whose fibers are used to make handicrafts. In particular, it was determined that *Q. amara* is distributed in patches, requires moist yet well drained soil conditions, direct light for regeneration, and concentrates biocide in larger diameter trunks. Research carried out on xate (*Chamadorea spp.*) revealed that less than a quarter (23%) of the population is harvestable, and that female reproductive plants represent only 1-4% of the population. Only 15-20% of the plant's leaves are harvestable, and it requires 4-6 months to produce mature leaves in natural forest conditions. In the case of bayal (*Desmoncus spp.*) a methodology was developed to identify productive population structure. Only 14% of the population was harvestable (1 km fiber/ha) and the vine required 4 years of growth to reach maturity. These research results provide valuable information required to design management plans for the sustainable use of the resource.

Diversified forest management

Working in three different types of ecosystems, the projects are carrying out applied research to determine the sustainable use of both timber and non-timber resources, and the residual effects of timber harvesting practices on non-timber vegetative resources.

Atlantic tropical forest

A management plan for the sustainable use of *Q. amara* was developed in 1995. Of the 120 ha under management in the Kekoldi Indigenous Reserve only 25% of the area is productive. Due to ecological variability, different silvicultural management systems were defined for two vegetative types found. Based on six year rotations, a sustainable harvest rate of 1800 kg of primary material was set. Research indicates that *Q. amara* can be managed as a complement to timber extraction activities.

Sub-tropical forest

Results from the initial selective timber harvests in the community concession indicate that 60% of the forest corresponds to relatively few (10) species, which are not commercially valuable. Given the lack of precious species available, the search for markets for non-traditional timber species needs to be reinforced. Annual mean diameter increments were lower than expected, ranging between 1.9-2.9 mm. As a result the allowable cut assumed in management plans must be adjusted to reflect the real growth rates in the Peten and in the San Miguel concession in particular.

Bayal was not seriously affected by timber harvesting practices. While the number of xate plants and quantity of harvestable foliage was affected by the harvest, the patches opened up by the harvest increased the available light, and decreased by one third the time required for a leaf to mature. With respect to silvicultural systems, the biological feasibility of timber and non-timber forest resource production was demonstrated. These results provide guidelines for diversified management plans.

Mangrove forest

A selective experimental community fuelwood harvest was carried out in the Nicaraguan demonstration area of Heroes y Martires. From a technical and economic perspective, controlled harvesting practices are possible. Nevertheless, sustainable forest management based on communal organization is not feasible given the local population's social and cultural conditions. In addition, the regulations applied to broadleaf forest control and planning are not applicable in the mangroves due to high operating costs of control imposed by the state and the low price paid for fuelwood. As a result of these limitations, it is necessary to redefine regulations, basing them on control of an area rather than on individual trees.

Evaluation of production system sustainability

A methodology was developed to evaluate the sustainability of mangrove production systems. Ecological indicators related to water (pollution, water flow conservation), soil (shoreline erosion) and vegetation (cover density, harvest level) were defined. With respect to social criteria, indicators were developed to measure the meeting of basic necessities, level of organi-

zation, community self management, and access to capital. These indicators make it possible to evaluate the sustainability of natural resource management actions in mangrove ecosystems.

Social research

A methodology was developed and proven to help design natural resource management actions which are based on the community's perceptions of their reality. A participatory methodology was developed to characterize coastal area production systems. The methodology is easily understood, inexpensive, identifies limitations in productions systems, and considers both the families' and project technicians' interests.

Together with The Costa Rican Institute of Social Studies of Population (IDESPO), a methodology was created to measure poverty in rural communities. It is participatory, measures the relationship between poverty and the environment, and takes into consideration gender differences.

Outreach

Local Groups Strengthened

A total of 155 families benefited from project activities in 1995. In Guatemala, 30 families participated in the community concession of San Miguel and their organization related to timber management activities was strengthened. The Committee of San Miguel was recognized by the President of the Republic of Guatemala in a formal ceremony for their contribution to the development of sustainable agriculture as pioneers of the community forest concession in Guatemala.

In the neighboring community of La Pasadita made up of approximately 70 families, the proposal for their communal forestry management plan was presented to CONAP.

In León Nicaragua, a shrimp producers' cooperative was legalized, benefiting approximately 15 families. In the Kekoldi Indigenous Reserve in Costa Rica, the production and marketing of handicrafts with non-traditional fiber (*Cardulovica palmata*) benefited approximately 10 families. In the community of San Rafael in Talamanca, the group organized around the ornamental plant nursery was strengthened, affecting approximately 10 families. In Terraba Sierpe, the improved national marketing strategy positively affected Coopemangle's management capacity (12 families), and its related women's group manages its bakery without project support (8 families).

Cooperation with public/private organizations

A total of 42 institutions worked with OLAFO/Mangroves technicians and beneficiaries. The type of cooperation varies according to the activities carried out with each of the following institutions.

a) National counterparts working closely with technicians on technical activities included MARENA/PNDR in Nicaragua, INRENARE in Panama, and MAGA-FORPETEN in Guatemala. In the case of Guatemala, the counterpart took a pivotal role in participating and promoting project activities to decision makers and other institutions in the area.

b) Professionals, students and faculty from the following institutions strengthen their technical capacities in demonstration areas and, at the same time, provide support to project activities. Institutions which were involved in the demonstration area in Nicaragua included MEDEPESCA, the Agrarian National University (UNA) and Central American University (UCA).

In Panama, the Ministry of Agricultural Development (MIDA) and the Peace and Justice Service (SERPAJ) coordinated with technicians in the sale of handicrafts, and the University of Panama assisted in research activities.

In Guatemala, CONAP, the national institute for protected areas, worked closely on regulation issues with the project, while the University of San Carlos, Guatemala (USAC), the Agricultural Technical School (ENCA) and the Peten University Center (CUDEP) participated in research investigations.

c) Projects which benefited institutions included the proposal for the management of *Zamia skinneri* in Costa Rica, which was approved by CITES (Convention on the International Trade of Endangered Species). The legalization of the National Wetland Development Association of Terraba Sierpe (ADEHUTES) was achieved with project input. The wetland management plan for Terraba Sierpe was elaborated jointly between the Ministry of Environment and Energy (MINAE), the Ministry of Public Education (MEP), the National Geographic Institute (IGN), the Cooperative Movement, the International Union Conservation Network (IUCN), and the CATIE/Mangrove Project.

Cooperation with CATIE Technical Units

The OLAFO/Mangrove Projects participated in activities and coordinated projects with professionals from the Natural Forest Management Unit and in the Forage Resources Unit. Technical assistance in complementary areas are both given and received among these areas.

Protected Areas Unit

Education is one of the most important activities in this Unit. Four courses were given in support of the Master's Program: Natural Area Planning, Conservation Biology, Protected Areas Management and Wildlife Management. Among training activities the XVII International Protected Areas Course was the most important event and it was held from April 17 through May 19

Projects implemented

The final report for the IGUANA FOUNDATION technical assistance project was prepared, including a situation diagnosis of core areas in the "Pacifico Central" Conservation Area in Costa Rica, as well as the guidelines for the overall plan, and local community development plans.

The Community Integration in Buffer Zone Conservation Project was designed and implemented as a technical assistance effort for the Central Pacific Conservation Area. The final reports describe the current situation of the communities in critical areas and propose a package of conservation and development projects that will guide the establishment of a sustainable development program.

These reports illustrate the integration of region wide and critical site planning principles as a means to promote conservation and development, the principle objective of CATIE's participation.

Project proposals

The Unit continued promoting the development of a regional protected areas training strategy. A significant effort was also made with the staff al North Carolina State University (NCSU) developing a proposal for a joint training program in specific aspects of protected areas management.

Efforts were also made to promote CATIE's potential as the site for a Latin American Environmental Education Course. This three month course would be financed mainly by WWF. Contacts have been made to receive technical support from Strathclyde University in Glasgow, where the course has been given during the past 3 years.

Funding proposals for the XVIII International Protected Areas Course were submitted to and funded by WWF and UNESCO. The course will be held in April and May of 1996.

WWF-CATIE coordination in Research

WWF contributed to the realization of the XVII International Course in Protected Areas Management, held from April 15 to May 19, 1995. Given the importance WWF attaches to the formation of human resources, it accomplished an analysis on training needs in natural resources followed by a workshop involving the main training organizations in Central America. The results of the analysis and workshop were used to design a proposal, recently approved by COSUDE, to support training programs of various institutions including CATIE over a three year period.

Also, during the III trimester, 1995, WWF led the Masters course on Protected Areas

Management, which involved a field exercise to evaluate the carrying capacity of the Sendero de la Reserva Iguana in Costa Rica.

Acknowledging CATIE's experience in tropical forest management, WWF is supporting the process of preparing a book on these theme. The first step involved a workshop, held at CATIE on June 21st. to 23ed., 1995, in which the book's co-authors and other experts participated in the design an revision of the proposed book. This is similar to the process WWF supported with CATIE regarding Simplification of Natural Forest Management Plans in Central America.

WWF personnel served as advisors for two graduate students. Also provided financial support for two Masters' degree theses and continues to provide technical support to three others students.

ECONOMICS AND SOCIOLOGY OF PRODUCTION AND CONSERVATION AREA.

General Objective of the Area:

With its initial work in this area, CATIE is introducing a more extensive and permanent contribution to the development of the American tropics, helping to discern the socioeconomic, cultural and management factors that affect the sustainable and environmentally sound management of agricultural production and natural resources.

By means of a close collaboration with the other technical/ biophysical areas of CATIE and with permanent counterparts in the member countries the development and dissemination of economically and socially appropriate alternative practices is guaranteed. Furthermore, this technological contribution will not oppose or be diminished by economic, social and gender, cultural, institutional and administrative constraints.

Specific Objectives of the Area:

- To identify and analyze the socioeconomic and gender factors and issues that influence and determine sustainable development in Tropical Agriculture and Natural Resources Management.

- To promote a holistic approach in the design and implementation of strategies and actions aimed to foster the development of Tropical Agriculture and Natural Resources utilization, so that the end-user level technological contributions are fully compatible with the socioeconomic, management and gender realities of such users.

- To establish strategic alliances and conduct relevant projects with institutions and organizations with similar interests and complementary strengths.

Lines of Work Started during 1995:

The general lines of works of the Area that were started or continued during 1995, in post-graduate level education, research, technical cooperation and training were:

- Evaluation of the economic and social feasibility of technological alternatives such as new species and varieties, cultural and management practices, pest control, mechanization, etc., including its impact on production and productivity, family income, spending patterns, consumption and savings, nutrition and health, levels of employment, etc.

- Market studies on products as well as inputs and factors of production, with special emphasis on the analysis of environmentally relevant factors such as pesticides.

- Analysis of natural resources use patterns, and studies about the decision-making processes within rural homes, communities and at the micro-regional level; including their relationship with and impact on the development of agricultural and livestock production, natural resources degradation and the environment; with special emphasis on the analysis of the role of women in the decision making.

- Development and adaptation of methodologies to determine the value of natural resources and the environment and the socioeconomic evaluation of the environmental impact of productive activities, including the identification and measurement of the external costs and/or benefits that result from these.

- Analysis, design and evaluation of agricultural, environmental and natural resources management and foreign trade policies and their impact on agricultural production activities, the management of natural resources and the degradation of the environment.

- Development and adaptation and evaluation of methodologies for working with ethnic groups, and for the recovery of traditional, indigenous and rural people's knowledge; as well as gender analysis techniques.

- Development, adaptation and evaluation of participatory methods for the development and dissemination of sustainable agriculture and natural resource management practices.

- Identification and analysis of social aspects that can be useful in the design of a successful sustainable and environmentally sound agriculture and natural resource management strategy; such as the organization of the communities for agroforestry production, the association of women groups for carrying out productive activities, the recovery of local knowledge and experiences to stimulate the scientific investigation, etc.

Main achievements during 1995

Management, Administration and Institutional Strengthening:

- The elaboration of a Work Plan for the Economics and Sociology of Production and Conservation Area for the years of 1996 and 1997.

- The organization of an Emphasis on Environmental Economics and Sociology within the Master's Degree Program of CATIE which started with ten students in January of 1996.

- The preparation and presentation to the Honorable Council of Ministers of CATIE of the proposal "Postgraduate Studies in Environmental Economics and Sociology in CATIE" that will be submitted to the Interamerican Development Bank for the possible financing of 44 scholarships to be equitably divided among qualified students from the member countries.

- Elaboration and presentation to a meeting within the INCO-DC Program of the European Union of the research proposal titled "Economic Analysis of the Phytosanitary Politics of Central America" for an amount close to US $600,000. The project would be implemented under the leadership of CATIE in cooperation with the University of Hanover (Germany), Imperial College, University of London (Great Britain) and the Pan-American Agricultural School (El Zamorano/Honduras), over a three-year period.

- Negotiation of an agreement with the Swiss Agency for International Development (ASDI) to take charge of the implementation of its Environmental Economics Program for the Central American Region, starting in October 1995. This program has as a general objective increasing the level of knowledge and capabilities needed in Central America to make better founded decisions about environmental management.

- Preparation and presentation of the proposal "Training and Extension in Community Forestry" to the Kellogg's Foundation with the general objective of contributing to the reduction of rural poverty and the rate of degradation of natural resources, by means of a rural participative development based on community forestry and agroforestry.

- A more ambitious version of this project, which includes the creation of a Regional School of Community Forestry and Agroforestry on the "La Lola" farm (property of CATIE), has also been prepared and will be presented to groups of potentially interested donors in the near future.

- A project proposal for the creation of a "Center for the Collection, Analysis and Dissemination of Socioeconomic Information" to offer services to the member countries of CATIE was prepared in collaboration with scientists of the "Land Tenure Center" of the University of Wisconsin, USA and will be presented to groups of potentially interested donors in the near future.

- The project proposal "An Information Network for the Promotion of Forestry Plantations and Industries in Central America" was prepared in coordination with the Tropical Forest Management Area, and presented to the Canadian PAR (Programa de Apoyo a Iniciativas Regionales para Centro America).

- The elaboration of the document about "The Gender Policy of CATIE", commissioned by the Office of the Director General, was coordinated and supported. This presents and analyses the current situation and suggests the course of action to follow over the coming years.

Outreach

The following are relevant outreach activities carried out by the Area's personnel, or in which they were involved or cooperated during 1995:

- Participation in the Costa Rican National Committee for Environmental Accounting.

- Participation in the World Congress "Taking Nature Into Account" sponsored by the European Economic Community and the "Club of Rome".

- Collaboration with the Government of the Republic of Nicaragua in the preparation of a plan to restructure the "Fundacion Nacional de Desarrollo Agropecuario", and in the elaboration of the project pre-proposal "Desarrollo Sostenible para el Volcan Mombacho y Areas Circunvecinas a la Ciudad de Granada".

- Collaboration with the Agroforestry and Watershed Management Area in the implementation of the seminar/workshop: "Environmental Management of the South Watershed of the Lake of Managua"; conducted in the city of Managua, Nicaragua.

- Participation in the world-level Committee of Experts of the United Nations that will prepare a Manual of Environmental Accounting, the use of which will be promoted by this organization beginning in 1997.

- Participation in the Latin American Seminar "Integrating the Gender Perspective in Participatory Forestry Development", conducted in Cuenca, Ecuador, from October 3 to 6 of 1995.

- Collaboration in writing the chapter on Environmental Macroeconomics for the book on "Perspectives on Ecological Economics" that is being prepared by the Interamerican Society of Ecological Economics.

Research Projects

The following research projects were carried out or initiated by specialists of the Economics and Sociology of Production and Conservation Area during 1995:

- An economic analysis of the plant protection policies of Costa Rica; with an emphasis on their effects on the pest management practices utilized in the coffee production systems.
- Evaluation of participatory techniques for the transfer of IPM technologies to tomato producers in Grecia and Valverde Vega, Costa Rica.
- Production and economic valuation of the hydrological and forest components of a mountain oak forest under silvicultural intervention.
- Analysis of the social and economic factors that affect land use in the southern watershed of Lake Managua, Nicaragua.
- Evaluation of the relation between land use changes, natural resource degradation and environmental contamination of the southern watershed of Lake Managua, Nicaragua.
- Monitoring and analysis of the adoption and dissemination patterns of soil conservation and water management practices, and of the socioeconomic factors that affect such patterns in the "Rio las Canas" watershed, El Salvador.
- Long term cost-benefit analysis of the soil conservation and water management project in the "Rio las Canas" watershed, El Salvador.
- Evaluation of the needs and strategies for training in the management and administration of community forestry and agroforestry initiatives in Central America.

Select Research Advances

The following three abstracts were selected from the research projects listed in the section above:

Use of the Contingent Valuation Method for Determining Entrance Fees to National Parks in Costa Rica

The purpose of this study was to determine whether the contingent valuation method (CVM) could be used to determine visitors willingness to pay (WTP) for two different national parks in Costa Rica. Specifically, WTP estimates for future visits to the Manuel Antonio and Volcan Poas National Parks with improved resources and services, were obtained for both resi-

dent and foreign visitors. Mean WTP values among resident visitors to the Manuel Antonio Park (an ocean/beach site) were US$ 13 and $11 for the Poas Park (a mountain/volcano site), while the WTP for visitor's was US$ 14 for Manuel Antonio and US$ 24 for Poas. With the exception of foreigners at the Manuel Antonio park, all of these WTP estimates are considerably higher than the actual entrance fees being charged at these parks.

It was also determined that proposed entrance fees (BID) was the only explanatory variable to influence visitors WTP for the Manuel Antonio Park, while both fees and the knowledge of the recent entrance fee debate in Costa Rica influenced WTP values of residents visiting Poas. Finally, fees, quality of services and resources, and the origin and sex of foreign visitors all had a statistically significant influence on their WTP values for the Poas Park. This study has demonstrated a useful methodology to determine visitors' WTP values for entrance to different types of national parks, as well as an indication as to what factors influence such WTP values.

Production and Economic valuation of the hydrological and forest components of mountain Oak Forest under silvicultural Intervention.

The research was carried out in the experimental area of Villa Mills, Siberia, belonging to the Natural Forest Silviculture Project (CATIE-COSUDE). The area is located in the North East of the Talamanca Mountain Range (Costa Rica) at altitude between 2,600 and 2,800 meters above sea level. Financial indicators (VAN and B/C), for the silvicultural treatments 20% and 30% of basal area extraction, valuing only wood production are $174504 and 2.17 for the 20% treatment, the 30% treatment is $256797 and 2.38, respectively.

Adding water production to the financial analysis and valuing it as another product from the forest at two monthly tariffs for water (4 and 1,6 dollars) and the excess in two uses (hydroelectric energy and ecological use) VAN and B/C equal to $436565 and 3.14, the same treatment at a tariff of $1,6 and hydroelectric use was $199417 and 2,26; same tariff and ecological function gives VAN and B/C equal to $432937 and 3.13.

The treatment; 30% extraction of basal area (tariff of $4, hydroelectric use), VAN and B/C equal to $300840 and 2.53 (tariff of $4, ecological use) Van and B/C equal to $489156 and 3.18, the same treatment at tariff of $1,6 and hydroelectric use the Van and B/C was $297212 and 2.52; same tariff and ecological function VAN and B/C equal to $485528 and 3.17.

Socio-Economic Factors Influencing the Adoption of IPM Technologies for Tomato Production in Costa Rica

Sixty farmers from six different communities in the Grecia and Valverde Vega counties, located in the main tomato producing area of Costa Rica, were involved in this study. The impact of three widely used extension tools, talks, written materials and demonstrative plots, was evaluated for their effectiveness in transfering of two specific integrated pest management (IPM) technologies: the use of protected seed beds and transplanting for the management of the white flies (*Bemisia tabaci*), and the implementation of sampling and decision criteria for the control of

the tomato fruit worms (*Heliothis* spp and *Spodoptera* spp). A Collateral effort to quantify the impact of 12 key socioeconomic variables on the levels of adoption of these two technologies was conducted.

The statistical method of "seemingly unrelated poisson regression", which is a type of multiple equation "count" procedure, was used for the analysis; since it has been reported in the econometrics literature as very appropriate for cases such as this where the dependent variables do not exhibit a normal and continuous distribution but measure instead a few "levels" that have a well defined ordering.

Statistically meaningful differences (at the 99.5%) were found on the average adoption rates for the two technologies, which were estimated at 50% and 40% respectively. However, despite their high cost, it could not be demonstrated or even established that there was a remote possibility that the use of written materials in addition to the talks, or of demonstrative plots as a complement of the last two had any effect on the observed levels of adoption.

Key socioeconomic variables, such as belonging to a community organization, the cropping system traditionally used, the previous experiences with the adoption of new technologies, the number of years that the farmer had been growing tomatoes in the same manner, access to credit, the economic situation of the farm family, the availability of hired labor and the size of the area grown with tomatoes, were found to have an important and statistically significant impact on the adoption levels, as it is observed in the following table:

Table 12. Magnitude and statistical significance of the impact of key socioeconomic variables on the rate of adoption of two IPM technologies for tomato production in Grecia and Valverde Vega, Costa Rica.

Variable	Level of Significance	Magnitude of Impact
Belonging to a community organization	95%	85-140%
Previous adoption of new technologies	95%	90-130%
Cropping systems utilized	95%	30-50%
Number of years growing tomatoes	90%	(15-25%)
Access to credit	98%	90-165%
Economic resources available	90%	(20-40%)
Availability of hired labor	98%	80-120%
Size of the area grown	90%	(40-60%)

The negative impact of the variable "number of years growing tomatoes" is attributed in this instance to the inertial effect that tradition and habit could have on the adoption of new technologies; but in the case of the variable "economic resources available" it is harder to explain. It is believed that the fact that farmers that were growing larger plots had a lower tendency to adopt

was also due to the high level of labor per unit area that was required to implement at least one of the two technologies offered.

On the other hand, it is interesting to note that other socioeconomic variables that are usually cited as important in the determination of adoption rates for technological innovations; such as the farmer's educational level (which was quite variable in this sample), whether or not the farmers have had previous working relations with technicians and extensionists, their age, and the type of land tenure; did not show even a slight statistical probability or inclination to have any effect on such levels of adoption in this specific situation.

II.
EDUCATION ACTIVITIES

"Empowerment of people through knowledge; strengthening of organizations through human resource development and technical cooperation"

EDUCATION FOR DEVELOPMENT AND CONSERVATION PROGRAM (EDECO)

The Education Program aims to specialize and train human resources at the graduate level, developing abilities and knowledge to promote and implement sustainable natural resource management and conservation practices in the American Tropics. The Graduate School, now with more than 1200 graduates throughout Latin America and the rest of the world, is the oldest in Latin America devoted to sustainable agriculture and the management and conservation of natural resources.

The Program is also responsible for the coordination of REDCA, a network of institutions, including universities and research centers, devoted to agriculture and natural resources management, which now has over 120 members.

After presenting general information for program activities, a more detailed report is presented separately for each of the Areas comprising the Program, *i.e.* Graduate Studies, Training and Outreach, and Information and Communication.

Main Achievements

The Program's main achievements during 1995 concerned the following issues:

- Internal consolidation and strengthening
- Development of alliances and outreach
- Advances in the Ph.D. Program
- Development of automated integrated administrative systems

Internal Consolidation

Significant achievements were made in consolidating the organization and management, and in strengthening program activities.

- The 1995-1997 Education Program Action Plan was completed and approved by the Board of Directors.
- The Graduate Studies and Training Technical Committee made a complete revision of the Standards and Regulations of Graduate Studies.
- Guidelines were developed for writing thesis proposals and for the administration of the Graduate School.
- CATIE's computer network and electronic communication resources were substantially increased.
- Advances were made in the automation of Library Services and in bibliographic data bases.
- The number of subscribers to the three Journals published by CATIE increased.

Funding
Several proposals were prepared, submitted and negotiated with relevant donor agencies.

Some proposals presented in 1994 were approved.

- A proposal to DANIDA for strengthening Higher Education for the amount of US$ 2.500.000 was approved. Five full time professors and a number of scholarships will be funded by this proposal during the 1996-2000 period.
- A proposal to CIM/Germany requesting financial support (topping up) for hiring an expert in agroforestry and an expert in biometry was approved.
- A proposal, in conjunction with Laval University and the University of Alberta, Canada, for US$ 375.000, was approved by the Canadian International Development Agency (CIDA), to develop a Master's Program in Agroforestry in Canada and to foster academic exchange.
- A proposal for ECU 56.000 was presented to the European Union, ALFA Program, to plan future joint educational activities with European and Central-American universities in the areas of Forestry and Agroforestery.
- A proposal for US$ 37.600 was presented to WWF/EFN to finance training activities in the area of natural resources conservation and management.
- A proposal was presented to the Kellogg Foundation to finance training courses in the area of Community Forestry.
- A proposal to organize a course on Research and Development for Sustainable Agriculture Land Use in conjunction with CIAT, was presented to the International Development Bank. A total amount of US$ 177.000 was approved for a two year period (1995-1996).
- A proposal for US$ 150.000 to organize a course on Women and Development was presented to JICA.

Table 13 shows the entire Program Budget for 1995.

Table 13. EDECO Program Budget for 1995, including all sources of funding

ITEM	CORE BUDGET US $	PROJECT BUDGET US $*	TOTAL US $
Program Directorate	265,788		265,788
Graduate Studies Area	70,155,	404,920	475,075
Training Area	118,217	468,625	586,842
Communication & Information Area	454,875	576,733	1,031,608
- Computer Center & Biometic Unit	(252,954)		(252,954)
- Library & Documentation	(105,840)	(218,794)**	(324,634)
- Design & Printing Unit	(62,293)		(62,293)
- Public Relations	(33,788)		(33,788)
- Journals***		(357,939)	(357,939)
TOTALS	**909,035**	**1,450,278**	**2,359,313**

* Detail of Projects in Table 31, page 135.
** Includes $ 123.482 as IICA's contribution.
*** Includes Agroforestry in the Americas Journal, Central America Forestry Journal and IPM Journal

Development of alliances and outreach

Networking: Major efforts were made in thes Area to strengthen the activities of REDCA (Regional Network for Cooperation in Higher Education and Research in Agriculture and Natural Resources Management), and to consolidate the leadership of CATIE.

CATIE was re-elected to hold the Executive Secretariat of REDCA for a new two-year period (September 1995-September 1997).

The University College of Belize joined REDCA, becoming the first institution in this country to be a member of the network. Efforts will now be directed at organizing a National Committee.

Four training courses and a workshop were organized in cooperation with the National Committees and the Executive Secretariat of REDCA. These activities took place in Guatemala, Nicaragua, Dominican Republic, Mexico and Costa Rica.

Eleven horizontal exchanges between institutions belonging to the REDCA network in the area of *curricula* development were organized by the Executive Secretariat. The courses, workshop and exchanges received financial support from the Government of Holland, under project DSO CR003602.

The X General Assembly of REDCA and the V Meeting of the Executive Committee took place in September, in the Dominican Republic, with the attendance of 60 delegates. Strong support was received from the National Committee and IICA's Office in Santo Domingo. The IV Meeting of the Executive Committee took place in Puebla, Mexico.

Agreements were signed between CATIE and the University of Florida and CATIE and Colorado State University to develop cooperative Ph.D. programs.

An *Addeum* to the 1994 agreement between the Universidad Nacional of Costa Rica and CATIE was signed to implement joint educational programs and to obtain recognition of CATIE's diplomas at a national level.

Negotiations began to establish joint regional Master's programs between CATIE and three national universities.

A meeting for former students entitled 'Encounter with Turrialba' was held at CATIE's headquarters in March 1995. Financial support from the German agency DAAD was crucial to the organization of this meeting.

Ph.D. Program

The Board of Directors approved the initiation of doctoral programs during its 8th Ordinary Meeting held in May 1995.

An agreement with Colorado State University to collaborate in a joint Ph.D. program in Forestry was signed in July 1995. A similar agreement was signed in December 1995 with the University of Florida to collaborate in a Ph.D. program in Agroforestry.

A Doctoral Committee composed of six faculty members was nominated. The recruitment of candidates was started and, by the end of the year, provisional admission had been granted to seven candidates in the Forestry Ph.D. program and six candidates in the Agroforestry Ph.D. program.

Two scholarships for doctoral studies were approved by the Swiss Government, under COSUDE's Natural Forest Management Project.

Classes are scheduled to start in April 1996 at CATIE's headquarters. Coursework at the cooperating university will start in August 1996 for the two semesters. The program will have a minimum duration of three years after completion of the M.Sc. degree.

New Automated Administrative Systems

At the request of the Administration, new integrated administrative systems were developed to automate administrative processes, improving the efficiency and accuracy of different administrative procedures.

The new systems, developed under ORACLE and accessed through the central computer network, provide support to the administration, in particular to the Human Resources Unit, Maintenance Unit, and accounting services.

GRADUATE STUDIES AREA

Graduate studies began at CATIE in 1946 with the first Master degree awarded in July 8, 1947, to a Mexican professional. The Graduate School with its almost 50 years of continuous work, is the oldest one in the fields of agriculture and natural resources management.

The Graduate Studies Area administers the School maintaining its leadership and relevance in the formation of human resources at M.Sc. and Ph.D. level.

Enrollment in 1995 suffered to some extent from the effects of the reduced number of fellowships traditionally provided by the AID/RENARM projects. However much of the short fall was picked up by contributions from FUNDATROPICOS *i.e.* CATIE's own foundation resources.

Of the 318 individuals that requested admission, a total of 113 were admitted and 43 received some form of financial assistance either from CATIE or a number of donors.

Of the candidates that requested admission, 75% came from member countries. In 1943 only 44% of admission requests were from member countries.

The 1995-1996 class

The average cost per student in 1995 continued to be around US$ 32.000 for the two year period, including tuition and stipend.

The fellowships portfolio was substantially more diversified than in previous years. The major donors were Holland with eight fellowships and Germany (DAAD) with five. Six of the studentswere self-financing.

Table 14 shows a summary of the major sources of funding, nationality and area of interest of the 1995/1996 class. As can be observed the major areas of interest of the class were tropical forest management, silviculture, and Biodiversity management and conservation.

Table 14. Source and amount of scholarships funds during 1995 at CATIE's graduate studies program

SOURCE	CLASS 94-95		CLASS 94-95		TOTAL
	No.	US$	No.	US$	
I. Bilateral Agreement/countries					
USAID/BRAZIL	1	16.190			16.190
II. National Institution funds					
CONACYT-MEXICO			1	15.190	15.190
INIFAP-MEXICO	1	16.190			16.190
CORDEP-BOLIVIA	1	16.190			16.190
EMBRAPA-BRAZIL	3	48.570	1	15.190	63.760
SEFORVEN-VENEZUELA	1	16.190			16.190
CHIXOY- GUATEMALA			2	30.380	30.380
CONICIT- COSTA RICA			1	15.190	15.190
SWISS EMBASSY			1	15.190	15.190
"INDIO HATUEY" EXPERIMENTAL STATION, CUBA			1	15.190	15.190
III. Scholarships given by CATIE's grant projects					
NATURAL FOREST (RENARM)	5	80.950	1	15.190	96.140
WATERSHED MANAGEMENT	8	129.520			129520
IPM	4	64.760			64.760
OLAFO PROJECT	2	32.380	2	30.380	62.760
PROCEFOR			1	15.190	15.190
CATIE/MUTIS-SPAIN			1	15.190	15.190
CATIE/MAG			1	15.190	15.190
FUNDATROPICOS			2	30.380	30.380
IV. Scholarships sponsored by cooperating countries and administrated by CATIE					
NETHERLANDS	9	145.710	9	136.710	282.420
DAAD-GERMANY	5	75.250	5	75.250	150.500
ODA-UNITED KINGDOM	5	80.950	3	45.570	126.520
V. Others					
FAO	2	32.380			32.380
KELLOG	1	16.190			16.190
MUTIS-SPAIN/IICA	2	32.380			32.380
IICA			3	45.570	45.570
MUTIS-SPAIN/OWN RESOURCES			2	30.380	30.380
PROCAFOR			1	15.190	15.190
STUDENTS's OWN RESOURCES			5	75.950	75.950
TOTAL	**50**	**803.800**	**43**	**652.450**	**1,456.270**

Note: 50% of these totals are returned to students to housing, board and personal expenses

Following the same trend observed in 1994, a very small number of applications were received in 1995 for the Master's Program in Tropical Crops. The 1995 enrollment confirms the prediction that the interest in tropical crops is disappearing and that a movement towards natural resources is taking place.
Table 15 shows a list of the courses taught in the academic year of 1995, their professors and number of students per course.

Table15. Courses Taught at the Graduate School during the Academic Year of 1995

Course	Professor	Students	Credits
First Quarter			
Statistics	Pedro Ferreira	43	4
Introduction to Agricultural Economics	Juan Aguirre	43	3
Ecological Basis for Sustainable Production	Bryan Finegan	43	3
English	Ileana Villalobos	43	0
Utilization and Management of Scientific Literature	Laura Coto	43	0
Dasometry	Daniel Marmillod	31	2
General Genetics	Marikis Alvarez	5	2
Introduction to Integrated Pest Management	Octavio Ramírez	8	3
Land Use Planning and Management	JFaustino/HSolís	10	3
Second Quarter			
Experimental Design	Pedro Oñoro	30	3
Administration and Management of Agricultural Research	Juan A. Aguirre	16	3
Natural Resources Economics	Steven Shultz	20	3
Agrometeorology	Francisco Jiménez	5	3
Plant Anatomy and Physiology	NVásquez/MGutiérrez	8	3
Genetic Resources	Jorge Morera	3	3
Insect Management	Luko Hiljé	7	3
Diagnostics IPM I	Elkin Bustamante	7	3
Ecological Basis of Silviculture and Agroforestry	Bryan Finegan	30	3
Dendrology	Luis Poveda	11	2
Agroecosystems	José Arze	10	3
Conservation Biology	Roberto Vides	11	3
Introduction to Environmental Sociology	Jan Karremans	3	3
Hydrology and Hydraulics	Hernán Solís	6	3
Planning of Natural Spaces	José Luis Villa	12	3
Community Participation and Organization	Alejandro Martínez	16	2

Course	Professor	Students	Credits
Third Quarter			
Rural Development	Fernando Ferrán	9	3
Sampling Techniques	Pedro Ferreira	25	2
Introduction to the Dynamics of Agroforestry Systems	José Arze	1	3
Crop Systems	Marikis Alvarez	6	3
Weed Management	BValverde/IGarita	7	3
Diagnostic IPM II	Daniel Coto	7	3
Agroforestry Systems	Eduardo Somarriba	10	3
Soil and Water Conservation	Jorge Faustino	9	3
Management of Geographic Information Systems	SVelásquez/LUgalde	21	3
Management of Wildlife	Dagmar Werner	11	3
Management of Protected Areas	Miguel Cifuentes	13	3
Forest Plantation Silviculture	LUgalde/WVasquez/GGalloway	13	3
Forest Economics	Juan A. Aguirre	18	3
Genetic Improvement I	Jorge Morera	4	3
Forage Evaluation Systems	María Kass	3	3
Marketing of Forest and Non-Forest Products	Luis Bianco	9	3
Fourth Quarter			
Sustainable Management of Tropical Soils	Donald Kass	10	3
Plant Disease Management	Elkin Bustamante	7	3
Economics of Plant Protection	Octavio Ramírez	7	3
Watershed Management	Hernán Solís /Jorge Faustino	5	4
Identification, Design and Evaluation of Forest and Environmental Projects	Juan A. Aguirre	7	3
Extension and Communication	B. Ramakrishna/Carlos Rivas	6	3
Biodiversity Policy and Legislation	Tannia Ammour	10	3
Ecology and Management of Coastline Ecosystems	Tannia Ammour	10	3
Natural Forest Silviculture	Frank Wasdsworth	14	3
Forest Management	José J. Campos/Juan Flores	13	3
Genetic Improvement II	Jean V. Escalant	2	3
Agroforestry Systems II	Ibrahim Muhammad	8	3
Diagnostics and Design of Agroforestry Systems	Luis Camero	8	3
Women, Development and the Environment	Cecilé Fassaert	3	3
Conservation and Improvement of Forest Genetic Resources	Jonathan Cornelius	3	3
Biological Control	Manuel Carballo	6	2

Major achievements of 1995

- For the first time the Admission examination was offered simultaneouly at two different dates in all the countries of Latin America and the Caribbean.
- The new gender admission policy was revised and applied.
- The first students were admitted to the M.Sc. program in Environmental Economics and Sociology. The Graduate Studies and Training Technical Committee approved the new Master's Program in Environmental Economics and Sociology in July 1994. Of a total of 32 applications received in 1995, 14 students were admitted in 1995 and nine will enter this new program in January 1996.
- There was a substantial increase in the number of students completing their degree requirements in 24 months, compared 1994 when there were only 2 and in 1995 when there were 27.
- The Inter-American Development Bank included CATIE in the list of institutions that can beme beneficiaries of the Japan/IDB fellowships program for the Northern Hemisphere.
- Strategic Alliances were made with the Universidad Centro Occidental Lisandro Alvarado of Venezuela to develop a joint MSc program in the Area of Horticulture and the Universidad Nacional of Costa Rica and the Universidad Nacional Agraria of Nicaragua to develop a joint MSc program in the areas of trade and problems related to plant and animal export.
- Creation of a Doctoral Committee and admission of 10 students to the Ph.D. program to begin in 1996.
- A thorough revision of the *pensum* of the MSc programs was began. A proposal for the creation of professional M.Sc. programs was presented to the Graduate Studies and Training Committee. The principal goal of these programs is to prepare the participant to enter into a professional career without necessarily pursuing further formal education. It is a non research oriented MS.
- Organization of the Graduation and Commencement Exercise. A formal Graduation Ceremony was organized for the first time in the history of the institution. Development of the Formal Attributes of the Degree: the new Cap and Gown of the Graduate, using the official colors of blue and white.

Table 16. Application and selection process of the M.S. students in the last four years.

YEAR	APPLICATIONS RECEIVED	STUDENTS ADMITED	STUDENTS ON THE PROGRAM
1992	238	49	42
1993	264	102	50
1994	312	113	43
1995	317	170	53
TOTAL	**1.113**	**434**	**188**

TRAINING AREA

The general objective of training at CATIE is to promote and make possible the acquisition of knowledge and the development of new abilities within the context of a specific area of knowledge.

Most training activities are carried out in short term courses. These courses are designed and implemented in the light of CATIE's research and development strategies. Strategic alliances with other institutions and organizations such as REDCA frequently open up interesting possibilities for collaborative training and mutual benefits.

During 1995 CATIE's training activities were focused to follow three basic institutional strategies:

- Decentralization of training events in favor of the member countries
- Strengthening strategic alliances with institutions and organizations, and
- Upgrading the technical content of the courses

CATIE's technical programs both at headquarters and outside, collaborate in the identification, design and implementation of short-term courses. The content of these courses respond to the demand for training by national institutions of CATIE's member countries.

In 1995, 270 training events for 6365 participants were held both at headquarters (23%) and in the member countries (75%). Of this total, 78 events were short courses (strategic and specials) with 1762 participants. There was also a total of 192 other training events such as in-service training, technical assistance, conferences, field days, field practices, workshops and technical visits, in which a total of 4603 persons participated.

To promote and disseminate information about training at CATIE, 1,000 information posters, 10,000 brochures, and 5,000 information sheets were distributed during this year to different Latin American institutions. The training events were also posted in electronic information networks such as Gopher, WWW and Email.

The number of events, students, duration and the student-days index, per type of activity carried out in 1995 are summarized in Table 17. The majority of these activities were workshops and conferences. With regard to courses, there were more special courses (65) than strategic courses (13), and consequently the amount of time spent on special courses expressed in terms of the student-days index is greater (9572) than for strategic courses (7065).

Table 17. Training activities by type of event. 1995.
(Number of events, students, duration (days), and student-days)

TYPE OF EVENT	EVENTS	STUDENTS	DURATION (days)	STUDENT-DAYS
In-Service Training	34	174	742	2094
Technical assistance	8	55	49	545
Strategic courses	13	194	366	7065
Conferences	40	1261	53	1534
Special courses	65	1568	411	9572
Field days	15	378	24	425
Field practices	7	211	8	244
Workshops	79	2015	285	7934
Technical visits	9	509	23	593
TOTAL	**270**	**6365**	**1961**	**30006**

Table 18 shows the number of strategic courses offered during 1995, duration (days), number of students, student-days and the number of countries from where the participants came.

Table 18. STRATEGIC COURSES. 1995.

(Number of days, students, and countries of origin)

COURSE	DURATION (days)	STUDENTS	STUDENT/DAYS	COUNTRIES
Environmental Impact Analysis	11	18	198	8
Sustainable Agriculture	89	25	2225	15
Protected Areas	35	23	805	15
CDS/ISIS Databases	12	10	120	6
Forestry Extension	11	16	176	5
Forestry Genetic Improvement	26	11	286	8
Programming with SAS	5	7	35	4
Information Management	12	11	132	8
GIS	19	12	228	7
Silviculture & Forest Management	40	16	640	8
Agroforestry Systems	82	24	1968	15
Projects Evaluation	12	6	72	4
Community Forestry	12	15	180	7
TOTAL	**366**	**194**	**7065**	

Table 19 shows in detail the countries of origin of the participants, the number of students and time allocated to each country, expressed in terms of student-dayss.

Table 19. Training activities by country. 1995.
(Number of students and student-days)

COUNTRIES	STUDENTS	STUDENT-DAYS
ARGENTINA	6	94
BELIZE	26	680
BOLIVIA	16	495
BRAZIL	34	1472
CANADA	42	47
CHILE	7	202
COLOMBIA	255	739
COSTA RICA	1799	6600
CUBA	6	178
ECUADOR	188	2173
EL SALVADOR	432	2058
UNITED STATES	42	149
EQUATORIAL GUINEA	8	361
GUYANA	589	2496
HONDURAS	736	3146
JAMAICA	20	488
MEXICO	21	495
NICARAGUA	726	3978
PANAMA	634	1780
PERU	70	607
PARAGUAY	2	68
DOMINICAN REP.	170	724
VENEZUELA	134	574
OTHER COUNTRIES	402	402
TOTAL	**6365**	**30006**

Activities at headquarters

Twelve strategic courses, 9 of them corresponding to special courses, 22 in-service training, 1 conference and 9 workshops were conducted in Turrialba. A total of 1073 people have been trained in 56 events with an estimated total duration of 1164 days.
Table 20 shows training activities carried out in Turrialba during 1995. From a total of 13,803 student-days, strategic courses accounted for 6889 of them.

Table 20. Training activities by type in Turrialba. 1995.
(Number of events, students, duration (days), and student-days)

TYPE OF EVENT	EVENTS	STUDENTS	DURATION	STUDENT-DAYS
In-Service Training	21	35	594	1018
Strategic courses	12	178	355	6889
Conferences	1	21	4	84
Special courses	9	155	154	4188
Field days	3	67	3	67
Workshops	9	215	53	1155
Technical visits	1	402	1	402
TOTAL	**56**	**1073**	**1164**	**13803**

Training activities carried out by Areas and specific projects in Turrialba are shown in Table 21.

Table 21. Training events by type in Turrialba. 1995.
(Number of events, students, duration (days), and student-days)

PROJECTS	EVENTS	STUDENTS	DURATION	STUDENT-DAYS
Protected Areas	11	23	244	759
Library	1	42	33	327
Biodiversity	5	48	35	1060
Biotechnology	4	449	158	677
Training	6	75	45	4840
Watershed Mgment	3	76	154	747
Tropical Crops	9	2	208	164
Economics	1	51	82	678
Inf. Systems	4	36	54	494
Madeleña	4	80	46	400
IPM	1	30	5	149
Natural Forest	4	16	19	640
Prosefor	1	2	40	41
Agroforestry	2	143	41	2827
TOTAL	**56**	**1073**	**1164**	**13803**

Activities in member countries

Training activities conducted outside Turrialba, mainly in CATIE's member countries through specific projects, provided training for 4785 participants in a total of 204 events, for a total time commitment of 13657 student-days. The main training activities were: 1 strategic course, 53 special courses, 13 in-service training, 36 conferences, 68 workshops. Table 22 and Table 23 show the number of events, students, duration and student-days, by type of training, and by activities of the areas and projects in the member countries.

Table 22. Training activities by type in member countries. 1995. (Number of events, students, duration (days), and student-days)

TYPE OF EVENT	EVENTS	STUDENTS	DURATION	STUDENT-DAYS
In-ServiceTraining	13	139	148	1076
Technical assistance	8	55	49	545
Strategic courses	1	16	11	176
Conferences	36	1016	46	1226
Special courses	53	1323	247	5084
Field days	10	303	14	330
Field practices	7	211	8	244
Workshops	68	1615	204	4785
Technical visits	8	107	22	191
TOTAL	**204**	**4785**	**749**	**13657**

Table 23. Training events by project in member countries. 1995. (Number of events, students, duration (days), and student-days)

PROJECTS	EVENTS	STUDENTS	DURATION	STUDENT-DAYS
Biotechnology	17	31	37	151
CONAP	3	106	9	133
Watershed Mgment	4	187	7	876
Economics	11	15	89	30
GTZ	1	736	2	1273
Madeleña	27	1483	56	4812
IPM	65	804	208	1294
Prosefor	34	339	75	948
Agroforestery	14	562	74	1146
Prosibona	10	194	44	513
REDCA	4	99	42	1020
Silviculture	14	229	106	1461
TOTAL	**204**	**4785**	**749**	**13657**

Training activities in Turrialba compared to activities carried out outside Turrialba are shown in Figures 11, 12 and 13.

Seventy-five percent of the training events have been conducted in member countries, 20% at Turrialba headquarters and only 4% in other countries. Similarly, the majority of the students are from member countries (75%). Nevertheless, when the student-day index is considered, the figures are similar for activities in Turrialba and in member countries, because course length in Turrialba ranges from one to twelve weeks compared to the length of events in the countries that varied from only one day to two weeks.

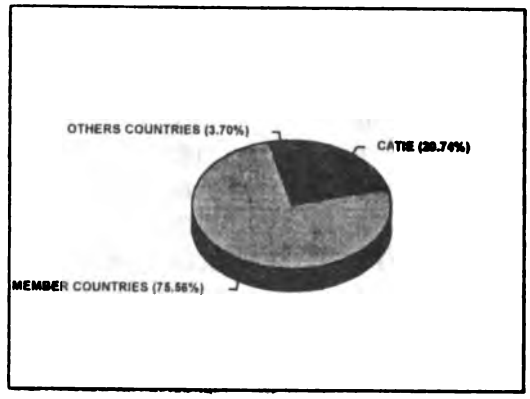


Fig. 11. Training events 1995

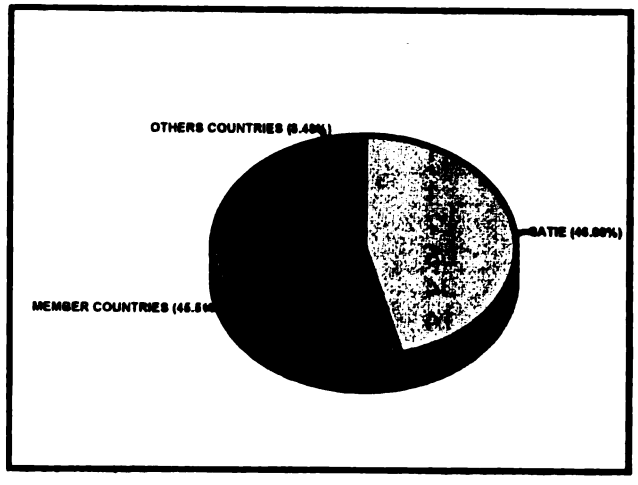


Fig. 12. Students-Day 1995

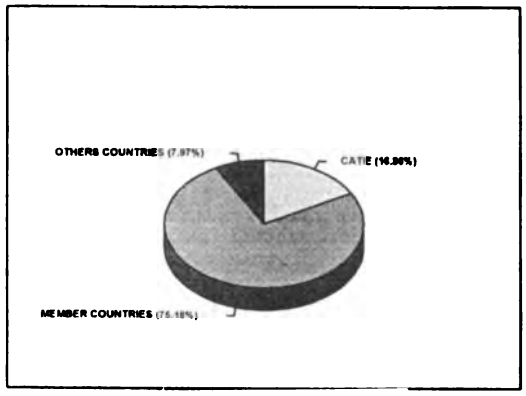


Fig. 13. Students 1995

Main achievements in training

- The number of training events increased from 222 in 1994 to 270 in 1995.
- More professionals trained this year (6,365) compared with 1994 (5,659)
- Promotion, as measured by the number of printed materials posted increased from 5,000 brochures and 1,500 information sheets distributed in 1994 to 10,000 brochures and 5,000 information sheets distributed in 1995.
- Use of the Internet network (regular Email plus Gopher and WWW browsers), to inform worldwide about training events managed by CATIE
- Design and successful implementation of the First International Graduate Course on Sustainable Land Use in collaboration with CIAT and IICA.

COMMUNICATION AND INFORMATION SYSTEMS AREA

Within the framework of this Area, the Program aims to communicate research results and link research with the teaching process. In addition, data banks containing the results of research in tropical agriculture and natural resources management are kept both to have at hand the most recent advances at world level in these fields and also to make any results from CATIE's research available to national institutions in the member countries.

Three scientific journals are published to communicate research results: The Central American Forestry Journal, Integrated Pest Management, and Agroforestry in the Americas. The Area also includes the administration of the Orton Memorial Library, the most complete in agricultural sciences and natural resources in Latin America and the Caribbean.

To accomplish its objectives, the Area operates two different Units: the Computing and Statistical Services Unit and the Communication Unit.

Information Systems and Statistics Unit

This Unit provides support to the administration and to the programs regarding the development and maintenance of information systems, soft-ware, hard-ware and statistical analysis of data.

Budget execution

The Unit was assigned a basic budget of US$ 233,415 for the year 1995. However it should be mentioned that additional funds were generated by the unit through information (i. e. data base) and communication services and short training courses.

Achievements

Electronic communications and networks

During 1995 the number of computers connected to the CATIE network was increased from 120 to 200. The network offers access to Internet services such as electronic mail, information search and remote access to computers abroad. With respect to financial aspects, there was a significant reduction in expenditures due to massive use of electronic mail which substituted to a large extent for the use of telephone, fax and telex.

Remote access was offered via modem to electronic communication which permitted users to log-in from any local away from the campus via the telephone line.

In addition, information on CATIE was made available to the public through the WWW and Gopher Servers, as well as server for files. The implementation of CATIE's Gopher and Home-Pages was a major achievement of 1995.

Training was conducted in 1995 for editors, and Library personnel , to teach the basic tools that are needed to offer CATIE's journals in an electronic format.

For the first time, some teaching materials were distributed to the students via the computer network. This effort will continue in the coming years to provide greater accessibility and faciletate making changes and additions to existing materials.

Training courses in electronic mail, navigation of Internet and creation of pages in the WWW were offered to 110 persons. Various courses for microcomputers such as Word for Windows and Qpro were offered to a total of 100 participants.

Biometry

Three graduate courses were offered: Statistics, Experimental Design and Sampling Techniques. A regional training course on applications of SAS statistical software was offered and a new SAS Manual was published using Dutch funds.

Systems development and maintenance

Several administrative systems were created or improved during 1995. A major contribution was the development of new integrated administrative systems to automate the Human Resources Office and keep track of maintenance and other services, and the development of a new Payroll system. These new systems were developed under Oracle and may be accessed through the central network.

Advances were also made in modernizing and improving existing systems such as SIIF (Finances Administration), SAP (Projects Administration), IDETEC (Graduate School) and IDETEC (Agricultural technology data base).

Communication Unit

Orton Memorial Library

During 1995 the Orton Memorial Library developed important activities to encourage consultation of existing collections as well as to efficiently serve users *in situ* and at the hemispheric level.

Coordination of activities and projects implemented in the Center, by the different information areas favor their development and impact on products and services offered.

Users:

13,497 library users were served as follows:

Students	8,694
Technical Personnel	718
Administrators	1,154
Visitors	2,931

Circulation: 85,690 documents

Home loan: 20.490 documents

Inter-library loan: 364 documents

Bibliographic searches 882 with 89,605 records (See Table 1)

Telephone requests: 6,356

Remitance to other information sources: 158 documents

Reproduction of documents: 510,858 pages

Selective dissemination of Forestry information: 111 users

Automation

The use of new technologies for services and information processing, is definitively giving a new focus on activities developed by the Orton Memorial Library and Documentation Centers, giving them an advantage in the region in this field.

Administrative processes:

It was decided that the bibliographic data bases established at CATIE, should remain within the Micro CDS/Isis Program developed by UNESCO and used by the majority of agricultural and related libraries, because of the information exchange with countries in the region and training programs offered by the Library and Documentation Centers.

Different applications for the automated publications loan control under Micro CDS/Isis were evaluated. The application developed in Argentina, in which the necessary adjustments are being made to meet the institution's needs, was chosen.

Transmission of documents system:

With the installation of Ariel, the document transmission system via Internet, the library is now able to receive information with images. This has facilitated document exchange, especially with libraries in the United States. The Orton Library was the first library in the region to operate this system.

Data Bases:

Because of the current need for information in our Center to be accessible to a greater number of users worldwide, the Unit participated in the Colima and IICA Project to edit a compact disk with the agricultural data bases produced in Latin America. This contribution will assit those institutions in the region which require access to information, but which still lack technological facilities such as hard disk space and access to the Internet.

Equipment:

Computer hardware was improved with the acquisition of a scanner to use the Ariel system. A new server with 2GB on the hard disk and 32 MB ram memory were also installed allowing an amplification of bibliographical data bases produced by the Library and Documentation Centers.

Evidently, the use of consultation material on CD is growing, resulting in a need to improve existng equipment. For this reason, a multi-user CD tower was acquired.

To update obsolete hardware, two personal computers with multimedia were bought. This will assit graduate students and short course participants to consult special material.

Acquisition of bibliographic sources:

Publications were acquired in three ways: through purchases, exchange and donation

203 periodicals and 111 monographs were pruchased.

9,250 periodicals and 4,847 books were received by exchange or donation.

To purchase bibliographic material the following budget was allocated:

Basic budget	US$ 45,600.00
Netherlands Project	US$ 20,000.00
Other projects	US$ 10,656.47
	US$ 76,256.47

Data bases:

Orton:

The Orton data base is updated continuously. New documents were processed, and basic collections such as CATIE M.Sc. theses were complete automated. 6,584 new records were introduced. Presently the Orton data base has 54,173 records.

Interise:

Information was collected for the Central American Environmental Studies Directory, a joint project with IUCN and IIED. This directory includes a bibliographic data base, which will be distributed by diskette or printed copies and a directory of institutions dedicated to the development of environmental projects.

Revis:

REVIS is a data base that contains periodical publications with updated records received in the Library (5,762 records).

Publications produced:

- Agroforestería en CATIE: bibliografía parcialmente anotada. Versión preliminar
- Bibliografía sobre Bosques Naturales en CATIE
- Bibliografía sobre Producción y Manejo de Bosques Naturales Tropicales
- Boletín de Canje y Donación

- Boletín de Documentos Recién Ingresados a la BCO
- Directorio de Unidades de Información y Organismos de Enlace de Extensión
- Hoja Divulgativa RIBRENAC (4 ediciones)
- Manual de procedimientos RIBRENAC
- Metodología para el ingreso de información a las bases de datos
- REDCAFE: servicio de información bibliográfica (2 ediciones)
- Resúmenes de las tesis de grado sobre silvicultura y agroforestería en CATIE: 1982 - 1995.

Diffusion

The bibliographic services are diffused through the different communication media available in the institution and also through the elaboration and distribution of material such as brochures (Library, INFORAT, Short courses), posters, RIBRENAC and folders.

The service's promotion was conducted through various training activities at the Center and in other institutions on a national and international level by means of information networks: RIBRENAC, AGLINET and REDCA.

Table 24. Documents requested to Orton Memorial Library from different regions during 1995

REGION	Sending	Documents
AFRICA	55	92
CENTRAL AMERICA	6839	8491
NORTH AMERICA / EUROPE	653	1230
LATIN AMERICA	2939	4901
CARIBBEAN	600	938
ASIA / OCEANIA	90	183
TOTAL	11176	15835

Agroforestry in the Americas Journal

Agroforestry in the Americas is a quarterly technical journal edited in Spanish, concerning tropical agroforestry in the Americas. Publication started in 1993 as a project under the Coordination of Agroforestry Systems Area of CATIE, with technical and economical support from DANIDA, Denmark. The same year, the International Center for Research in Agroforestry (ICRAF-Kenya), joined this effort through an important economic and technical collaboration, that has been maintained since then.

The main purposes of this journal is to meet the Spanish language agroforestry information needs of researchers, professors, extentionists, community leaders and decision makers of the Americas and provide a tool for dissemination and discussion of scientific and technical activities promoted by CATIE and other agroforestry -related institutions of the Region.

The 3.256 readers registered during 1995 -from America as well as other Regions of the world- make this journal an excellent opportunity for the promotion, transfer, implementation, development and evaluation of agroforestry in the Region.

The first issue of this technical quarterly journal was published in August, 1994, and today there are five more printed issues, with 4000 copies each. The content covers a wide geographic range and diversity of topics. Sixteen articles were published during 1995, of which 12 were research updates, four were extension experiences and two interviews with outstanding Latin American agroforestry scientists. In addition, it included and editorial section, news, upcoming events and book reviews with a total distribution of approximately 15,000 copies.

One important task that was conducted during this year was the identification of potential readers with 1,100 new subscribers registered by the end of 1995. Promotion of the journal was started via Internet. Different advertising strategies were developed including a poster (500 copies) and brochure (1000 copies), wich were distributed throughout the Region.

In addition, exchange agreements were obtained with 44 regional institutions for materials including journals and books. Cooperation agreements with the journal "Bosques, árboles y comunidades rurales" (FAO/IRDC; Latin American edition) and with the agroforestry team of IUFRO were reached during the second semester. As a result, each issue will include one page describing the activities of these groups.

To date, the Agroforestry in the Americas journal has been distributed free of charge. In the future, options will be sought that make journal more independant and relevant to the countries that receive it.

Table 25 shows distribution of the journal among contries.

Table 25. Distribution of the Agroforestry of the Americas Journal during 1995.

COUNTRY	QUANTITY
Costa Rica	680
Guatemala	154
El Salvador	84
Nicaragua	192
Honduras	223
Panama	165
Belize	21
Venezuela	106
Dominican Rep.	112
Mexico	308
Ecuador	241
Other L.A. countries	1.639
Other countries	402
ICRAF	885
TOTAL	**5.212**

Central American Forestry Journal

The Central American Forestry Journal (Revista Forestal Centroamericana, RFCA) is a quarterly technical practical publication dealing with renewable natural resources, rural development and environmental issues. It is a forum for discussion and for the exchange of technical information in these fields as well as a means of integrating the regional forestry sector, targeting people working in different sectors related to conservation, management and utilization of natural resources. A particular importance is given to the integration of the forestry sector in the local economy on a sustainable social, economic and ecological basis.

During 1995, the Project RFCA, which is part of the Central American Forestry Program (PROCAFOR) financed by the Government of Finland, has continued its successful implementation. Its importance was recognized in September by the Central American Association of Forestry Professionals (Asociación Centroamericana de Profesionales Forestales) as well as by the Central American Chamber of Forest Enterprise Managers (Cámara Centroamericana de Empresarios Forestales). Part of the success is due to the National Commissions which collaborate in getting editorial material from the different countries as well as in getting subscriptions and distributing the Journal widely in the Region.

Four thousand copies of each of four issues were published during 1995. Each issue included a poster of different native tree species. The main subjects were the search for balance in the relationship between mankind and the natural resources (RFCA 11), commercialization of forest products and services (RFCA 12), biodiversity (RFCA 13) and community forestry (RFCA

14). In total, 34 formal articles were published: 13 in the section on technical communication, 13 in the section on experiences and 8 in the section on opinions. Moreover each issue included an editorial and a section on current trends, events, publications and letters to the editorial staff.

At the end of 1995, the number of paying subscribers was 927, out of which 85% are from Central America, 10% from other Latin American countries and 5% from industrialized countries. The main office as well as members of the National Commissions and libraries sold more than 1 500 single issues. Additional issues were sent free of charge to libraries, collaborators and on exchange base or for publicity to different institutions. In total 12 036 issues were distributed.

The expenditures totaled US$ 190 000 and the revenues generated by the Project US$ 29 000, funds available for future activities. 42% of the revenues were earned by subscriptions, 36% by announcements and 9% by selling individual issues.

PAYED SUBSCRIPTIONS BY AREA
DECEMBER 31, 1996

AREA	CONTRY	TOTAL
AFRICA		4
ASIA AND OCEANIA		2
CENTRAL AMERICA		
	BELIZE	3
	COSTA RICA	271
	EL SALVADOR	237
	GUATEMALA	87
	HONDURAS	65
	NICARAGUA	59
	PANAMA	65
TOTAL	**CENTRAL AMERICA**	**(787)**
EUROPE		33
NORTH AMERICA		17
SOUTH AMERICA		84
AN ANTILLES		
TOTAL		**927**

The Integrated Pest Management Journal

The IPM Journal is published and distributed by the Plant Protection Information and Communication Center as part of the IPM/RENARM Project.

This Journal falls within an essential strategy for natural resources conservation, health and sustainable agricultural production.

The IPM Journal is the only scientific forum in Latin America and the Caribbean that specializes in reviewing, editing and disseminating integrated pest management research methodologies, studies and results. Through this Journal, over 30 articles selected from the pool of work conducted in the region, reach an average of 1000 plant protection specialists every year. Authors include CATIE experts, but most are technicians from other international and regional centers and institutions or national level programs such as those of the ministries of agriculture, universities, private and semi-private foundations and organizations. Furthermore this Journal publishes short technical notes, information about u p coming training opportunities, such as short courses, seminars and workshops, congresses, etc. Each issue included a Technical factsheet addressing specific plant protection problems or issues in key crops, and the Bulletin "Whitefly Update". The IPM Journal was published quarterly during 1995 including numbers 35, 36, 37 and 38, indicating its continued demand for over nine years. To date this Journal is supported by the IPM/RENARM Project and is free of charge.

Other Services and Publications

Updating the databases of IPM Professionals, Specialists and Institutions in Central America continued during 1995. The updating of the Plant Protection Bibliographic data base continued, and around 1000 entries were revised and put in a standard format for easy management and retrieval.

The Informative Alerting Services reported the continued updating of mailing lists, as well as the production and dissemination of three issues of the quarterly "IPM Current Contents" (Páginas de Contenido MIP). 86,690 photocopies were prepared and mailed to meet 2,756 requests for information mainly from Central American users. Bibliographic and non-bibliographic information needs included 2,472 requests on plant protection aspects answered by mail, telephone or in person.

9,576 copies of the "IPM journal", "IPM Current Contents", and other CATIE publications, books, proceedings, and series in plant protection were distributed. 576 folders with promotional material about the Plant Protection Area and information services were handed out.

The book "Inventory of invertebrate pests of annual and perennial crops in Central America" was published and is under promotion and distribution. The bibliographic search and revision of

literature to support the second edition of the book "Invertebrate pests of annual crops in Central America" has been continued.

Twelve "IPM Guides" for farmers have been revised and published, including:
- Suggestions for integrated insect and disease management in tomatoes.
- Suggestions for integrated insect and disease management in cabbage.
- Suggestions for integrated insect and disease management in peppers.
- Handling pesticides safely.
- Suggestions for preventing insects, diseases and weeds attacking crops.
- How to use agricultural practices to control insects and diseases in crops.

Several extension pamphlets and brochures such as "Taltuza", "Gusano del fruto del tomate", "Usemos MIP en papa" and "Usemos MIP en tomate" and posters for extension-oriented presentations were prepared.

Promotional material about Plant Protection information services as well as on the different publications edited by this Area were included in CATIE's Gopher; which can be accessed through INTERNET. Mechanisms to also include the IPM Data Bases in INTERNET are being analyzed.

The promotion and sale of plant protection publications and information services was a continued process with activities such as updating and distribution of brochures announcing the different services.

The strengthening of information sources continued; including the selection and acquisition of new printed and electronic bibliographic materials, as a basis for updating and expanding the services offered.

Highlights

The "1995 CONICIT Prize" for **Publishing in Science and Technology** was granted to CATIE's Plant Protection Information and Communication Center. This Information Center was worthy of this prize for several reasons: The Center covers the entire technical information cycle with high quality printing, from books to translations and databases, thus facilitating the spread and transference of knowledge. The literature production of the Center has significantly contributed to regional and national agriculture. Its literary material coincides with the universal policies of sustainable development.

The IPM magazine will be included in the most important agricultural data bases such as CAB, AGRIS and AGRICOLA.

Subscriptions were being sold at the end of the year. Table 26 shows the current distribution of the journal and other publications.

Table 26. Distribution of the Integrated Pest Management Journal and other IPM publications during 1995, by countries.

COUNTRY	IPM JOURNAL	OTHER IPM PUBLICATIONS*
Costa Rica	1207	1394
Guatemala	430	865
El Salvador	288	542
Nicaragua	384	772
Honduras	204	397
Panama	240	384
Belize	50	206
Venezuela	46	275
Dominican Rep.	65	103
Mexico	60	191
Ecuador	28	48
Other L.A. countries	270	685
Other countries	215	415
TOTAL	**3.307**	**6.287**

* IPM Bulletins, Current Contents, Guides, Pamphlets and Brochures

III.
STRATEGIC PLANNING AND EXTERNAL COOPERATION

The Strategic Planning and External Cooperation Office was created in 1994. The objective of the Office is to update and follow up the implementation of CATIE's Strategic Plan (1993-2002).

The Office is also responsible for all external cooperation on a day to day basis, including donor relations, formulation and negotiation of project proposals, fund raising, government relations, consultancies, and corporate image with our peers, and with the international community.

The main activities of the Office during 1995 are shown in Table 27

Table 27. Main activities of the Strategic Planning and External Cooperation.

DATE	ACTIVITY
January-December	Core budget support. Elaboration/negotiation of projects and consultancies.
January-December	Institutional strategic planning and alliances.
January-April	Coordination and production of the Institutional Development Plan.
April, November, December	Donor Support Meetings.
May-July	Strategic planning meetings and review of CATIE's strategic plan.
July-August	Coordination, Minister's Meeting
August-November	Supervision, Work Plan 1996-1997.
December	Design of the monitoring system of the Institutional Development Plan and Work Plans.

Plan and Work Plans.

In order to carry out main educational and research activities, CATIE received during 1995 funds from different countries. We wish to thank all the govemments and people involved that contributed to the development and conservation of the American tropics. Table 28 shows contributions by country.

Table 28. Contributions to CATIE research and education activities by country, 1995

COUNTRY	CONTRIBUTION Amount US$
Canada (IDRC, CIDA)	85,593
Denmark (DANIDA)	2,144,481
Finland (FINNIDA)	542,530
France (Ministry of Foreign Affairs and CIRAD)	35,118
Germany (GTZ, BMZ)	396,898
Japan (JICA)	101,365
Netherlands (Ministry of Foreign Affairs)	605,668
Norway (NORAD)	1,273,963
Sweden (SIDA)	666,605
Switzerland (COSUDE)	232,000
United Kingdom (ODA, NRI)	358,435
United States of America (AID)	4,385,227
Other Institutions (WWF, IPGRI, BID-CIAT, IUCN, CIFOR, European Community)	707,836
TOTAL	**11,535,719**

Table 29 shows in detail all the new projects that were successfully negotiated during 1995

Table 29. Projects successfully negotiated, 1995

PROJECT	SUBJECT	DONOR	TIME FRAME	COUNTRY	MILLIONS US $
Natural Forest Silviculture, Phase III (PROSIBONA)	Research and management of natural forest	COSUDE	1996-1998	Costa Rica	2.500
FUNDATROPICOS	Institutional endowment fund	COSUDE	1995	Costa Rica	2.500
Support to CATIE's core budget	To contribute to the implementation of the Institutional Development Plan, 1995-2002	ASDI/SIDA	1995	Costa Rica	0.698
Support for the Master's Programme	To support the education of Master's Degree candidates in tropical agriculture and management of natural resources in the Central American Region.	DANIDA	1995-2000	Costa Rica	2.770
Renovation of the Agroforestry Project CATIE/GTZ	To research agroforestry practices of cacao with shade	GTZ	1995-1997	Costa Rica Panama Honduras	0.822
CATIE/Chixoy-Guatemala Project	Extension system at farm level of the watershed	BID	1995-1997	Guatemala	2.200
Agricultural Research Project for the tropics of Bolivia	To elaborate the terms of reference	BID/CIAT	1995	Bolivia	1.200
Conservation for Sustainable Development in Central America Project (OLAFO), Phase II	To study the utilization of non-timber forestry products with the participation of the community	ASDI/ NORAD/ DANIDA	1996-1998	Costa Rica Guatemala Nicaragua Honduras	2.000
CATIE/CONAP Project	To elaborate the forest management guides of Petén	USAID	1995-1996	Guatemala	0.350
Conservation and use of plant genetic resources in Mesoamerica through horizontal cooperation (REMERFI)	To conserve and use the native plant genetic diversity of Mesoamerica in a sustainable and complementary way	GTZ	1996-2000	IICA, REMERFI, Panama, Costa Rica, Nicaragua, Honduras, El Salvador, México	0.866
Contract IICA-GTZ/CATIE	To train two professionals at a basic level in Geographic Information System (GIS)	BID: IICA-GTZ	1995-96 6 months	Nicaragua	0.023

PROJECT	SUBJECT	DONOR	TIME FRAME	COUNTRY	MILLIONS US $
Nicaraguan IPM Project, Phase II	Agricultural specialists, technicians, teachers, and small and medium farmers of Nicaragua will have an increased capacity to generate, modify, and use pest management technologies which are more appropriate environmentally, economically, and socially	NORAD	1995-1998	Nicaragua	2.700
MISCELLANEOUS (*)					1.498
TOTAL					**19.305**

(*) WWF, CIFOR, UICN, IICA-PRIAG, ODA, SIDA, USAID, CEE, IPGRI, UNESCO AID, IUFRO, CIID-WWF.

During 1995 almost fifty new agreements were signed with different member countries' institutions to achieve a large variety of goals and needs where CATIE can play a very important roll as a leader institution in agricultural development and natural resources conservation. Table 30 below, shows in detail such agreements.

Table 30 Signed institutional agreements with CATIE in 1995

AGREEMENT	OBJECTIVE	TIME FRAME
Collaboration Agreement between MAG/IICA/CATIE/AYA	To rehabilitate the damaged infrastructure caused by the earthquake of Limon and give a higher coverage of potable water supply	May, 1995
Agreement between FIAS/CATIE	To carry out joint research, training, extension and technical assistance activities in order to fulfill national priorities at rural community level.	Nov., 1995 Dec., 2000
Cooperation Agreement between la Universidad Autónoma "Gabriel René Moreno", Santa Cruz, Bolivia/CATIE	To establish cooperation for the development of activities of mutual interest in natural resources and sustainable development in the areas of education, training, research, extension and diffusion	June, 1995 June, 2000
Cooperation Agreement between UMSNH/CATIE	To establish a cooperation for the development of activities of mutual interest in natural resources and sustainable development in the areas of education, training, research, extension and diffusion	June, 1995 June, 2000
Cooperation Agreement EI/CATIE	To establish framework of cooperation direct and indirectly for whatever activities considered of mutual interest	May, 1995 Indef.
Agreement between RSMAS/CATIE	To establish framework of cooperation for whatever activities considered of mutual interest.	May, 1995 May, 1998
Technical Cooperation Agreement between AEK/CATIE	To establish a framework for a joint technical and scientific cooperation in order to promote, negotiate and execute plans and projects to the development and conservation of Kuna Yala region in Panama.	April, 1995 June, 1995
Cooperation Agreement between CRU/CATIE	The purpose is the join development of research projects.	Jan., 1995 Jan., 1998
Agreement between NORAD/CATIE	To increase knowledge about Integrated Pest Management (IPM) among farmers (women included), technical high school and university students and institutions in Nicaragua and among specialists, technicians and extentionists in other Central American countries.	July, 1995 July, 1998
Agreement between INTA/CATIE	For the execution of the IPM Project	Nov., 1995

AGREEMENT	OBJECTIVE	TIME FRAME
Letter of Understanding between DGPSA-MAG/CATIE/ INTA-MIP/NORAD	For the execution of join activities of the IPM Project, Phase II	July, 1995 July, 1998
Letter of Understanding between MIP/EAP/ COSUDE/CATIE/ INTA-MIP/NORAD	For the execution of join activities of the IPM Project, Phase II	July, 1995 July, 1998
Letter of Understanding between UNICAFE/CATIE/INTA-MIP/NORAD	For the execution of join activities of the IPM Project, Phase II	July, 1995 July, 1998
Letter of Understanding between UNAN-León/CATIE/INTA-MIP/NORAD	For the execution of join activities of the IPM Project, Phase II	July, 1995 July, 1998
Letter of Understanding between UNA/CATIE/INTA-MIP/NORAD	For the execution of join activities of the IPM Project, Phase II	July, 1995 July, 1998
Letter of Understanding SIMAS/CATIE/ INTA-MIP/NORAD	For the execution of join activities of the IPM Project, Phase II	July, 1995 July, 1998
Agreement between UAW/CATIE	To up date and modify the Agreement signed by both Institutions in May 22, 1986	April, 1995 Dec., 1997
Contract BID/UNEPROCH/CATIE	To execute activities of forestry extension in the Rio Chixoy watershed	August, 1995 August, 1997
Memorandum of Understanding between WWF/CATIE	To establish a cooperative framework between CATIE and WWF for activities of mutual interest and in accordance with the nature of the objectives.	July, 1995 July, 2000
Memorandum of Understanding between MAG/IICA/CATIE/FAO	Preparation of the IV International Technical Conference in Fitogenetic Resources, to be held in Leipzig, June 17-23, 1996	July, 1995 June, 1996
Implementation Letter Nº 34 USAID/CONAP/ CATIE	To elaborate the forest management guides of Peten	June, 1995 June, 1998
Teaming Agreement CHIMONICS/ CATIE	To submit a proposal to the Agency for International Development in response to the USAID/Guatemala RFP PROARCA.	Dec., 1995

AGREEMENT	OBJECTIVE	TIME FRAME
Memorandum of Understanding between CHEMONICS/ CATIE	Outlines a framework of collaboration for provision of technical assistance, training and policy dialogue on sustainable development, natural resources management and conservation, and agriculture in Latin America and the Caribbean.	March, 1995
Letter of Understanding between EARTH/CATIE	To establish the basis that will manage the collaboration of CATIE in the recruitment of students for the EARTH in the mandate area of CATIE	April, 1995 March, 1996
Letter of Understanding between UNDP/CATIE	To establish a cooperation framework for the development of activities of mutual interest in the region, in accordance with the nature of the objectives.	June, 1995 June, 2000
Agreement between BID/IPGRI/CATIE	To financially contribute to activities of genetic resources of Sapotaceas native fruits	July, 1995 July, 1996
Letter of Understanding between FUNDACION NATURA/CATIE	To establish a cooperation framework for the development of activities of mutual interest in Panama, in accordance with the nature of the objectives.	April, 1995 April, 2000
Letter of Understanding between FAUSAC/CATIE	To coordinate and strengthen efforts for a better interchange of forest and renewable natural resources information at Central American level	March, 1995 Dec., 1995
Letter of Understanding between WWF/PAF-CA/CATIE	To follow the simplification of management for the natural forest in Central American	March, 1995 Dec., 1995
Interchange Letter UICN-ORMA/CATIE	To realize through the Forest Conservation Area the realization of non-timber forestry product activities (July 17-21, 1995	July, 1995
Agreement for Scientific and Technical Cooperation between NCSU/CATIE	To establish a series of interactions between the two participating universities in areas of mutual interest.	August, 1995 August, 2000
Agreement between INRENARE/ CATIE	To develop the Agroforestry Project CATIE/GTZ (Transference and extension of agroforestry technology)	August, 1995 July, 1997
Cooperation Agreement between COSUDE/CATIE	Institutional endowment fund	Nov., 1995 Dec., 2000
Agreement between AFE-COHDEFOR/ CATIE	Research, training and technical assistance cooperation to the developing countries	Feb., 1995 Feb., 1996

AGREEMENT	OBJECTIVE	TIME FRAME
Agreement between SIDA/CATIE	For the implementation of the Institutional Development Plan	June, 1995 Dec., 1995
Agreement between CIFOR/CATIE	To establish a cooperation framework for the development of activities of mutual interest in Latin America and the Caribbean.	May, 1995 May, 2000
Agreement N°102-95 between MAGA/CATIE	Administrative support for the execution of the reorganization of the Agricultural Development National Bank	Dec., 1995 Dec., 1996
Agreement N°100-95 between MAGA/CATIE	Fruit plantations and industrialization of fruits and vegetables	Dec., 1995 Dec., 1997
Agreement N°99-95 between MAGA/CATIE	Technical and administrative operation of the Chixoy Project	Dec., 1995 Dec., 1997
Agreement N°98-95 between MAGA/CATIE	To edit and put into operation the agricultural statistical system of USPADA	Dec., 1995 Dec., 1997
Cooperation Agreement between CODEFORSA/ CATIE	To give technical assistance and the necessary training for the application of appropriate silviculture interventions in natural forestry in seven demonstrative farms in the North Huetar Region of Costa Rica	1995-1996
Contract N° 7974/R1/SD between the International Atomic Energy/CATIE	Effect of terbufos on anapanteles marginiventris, a non target parasitoid of fall armyworm (Spodopter frugiperda).	August, 1995 July, 1996
Contract between AGREVO/CATIE	To realize research in resistance to the fenoxaprop-etilo herbicide	January, 1995 January, 1996
Contract of Service between DGEA-MAG/IICA/CATIE	To buy two satellite images LANDSAT TM.	May, 1995 120 days
Contract between UNESCO/CATIE	XVII International Protected Area Course, CATIE.	March, 1995 Sept., 1995
Letter of Understanding between MARENA/CATIE	Extension of the Agreement between both institutions (December, 1995) for the implementation of the Nicaraguan IPM Project, Phase II	July, 1995 Dec., 1995
Memorandum of Agreement between USDA/CATIE	To provide support for cooperative scientific and technical activities in agriculture.	Oct., 1995 Dec., 1995
Letter of Understanding between CIFOR/CATIE	To prepare a bibliography on natural forest management in the American tropics.	May, 1995 May, 1996

Table 31. Budget of current projects during 1995, in US $.

PROJECT	DONOR	BUDGET
EDUCATION FOR CONSERVATION AND DEVELOPMENT PROGRAM		
Strengthening Institutional Capacities	The Netherlands	605,668
Agroforestry International Course	JICA, Japan	101,365
Bibliography on natural forest management C.A. Interaise	CIFOR	6,150
Agricultural Research for the Tropics of Bolivia	IUCN	30,000
	BID-CIAT	177,180
SUSTAINABLE TROPICAL AGRICULTURE PROGRAM		
Tropical Crops Area		
Banana Genetic Improvement-MUSA		
Yam Bean Jicama	E.U.	42,081
Sapotáceas	E.U.	33,237
Integrated Crop Management of Vegetables and Tropical and Sub-tropical Fruits	IPGRI	9,310
	USDA	44,000
Plant Protection Area		
Integrated Control of Echinochloa Colonum Weeds (Integrated Management of Itch Grass)	NRI-UK	50,997
Pathology (Microbial and cultural control)	NRI-UK	87,868
Entomology (Microbial control of Phyllophaga)	NRI-UK	68,463
IPM in Nicaragua	NRI-UK	58,487
RENARM/Plant Protection (includes Buy-Ins)	NORAD	874,000
Nematodes	AID/G-CAP	1,489,958
	CIRAD	35,118
Agroforestry System Area		
Agroforestry Coordination Unit		
Agroforestry Coordination-Phase VI	DANIDA	218,737
Goat Agroforestry	GTZ	343,512
Forestry-Agroforestry Technical Assistance FORESTA	GTZ	53,386
Research and Training in the Atlantic Zone	P.W./AID	32,945
Home Gardens	WAU	47,500
Agrosilvopastoral Systems	IDRC	23,975
Development of Graduate Programs in Agroforestry	IDRC	43,143
	IDRC	18,475

PROJECT	DONOR	BUDGET
INTEGRATED MANAGEMENT OF NATURAL RESOURCES PROGRAM		
Tropical Forest Management and Silviculture Area:		
Forestry and Agroforestry Research and Training (P1)	FINNIDA	332,928
Central American Forestry Journal (P3)	FINNIDA	209,602
RENARM/Natural Forest Management	AID/G-CAP	916,982
RENARM/Dissemination of Multiple Use Trees	AID/G-CAP	1,107,922
Forest Research and Training-Phase VI	COSUDE	232,000
Forestry Seeds in Central America (PROSEFOR)	DANIDA	749,300
ODA Tree Improvement	ODA	92,620
Maya Biosphere	AID	110,622
Assessment of Genetic Diversity	NERC	80,989
Watershed Management Area:		
RENARM/Watershed Management	AID/G-CAP	682,798
Chixoy Forestry Extension	BID	215,654
Biodiversity Management and Conservation Area:		
Wise Use of Mangrove in Costa Rica and Nicaragua	DANIDA	615,093
WWF Project Coordination	WWF	45,735
Management of Forests in Central America	WWF	20,000
Conservation for Sustainable Development in Central America (OLAFO II)	SIDA	666,605
Conservation for Sustainable Development in Central America (OLAFO II)	NORAD	399,963
Conservation for Sustainable Development in Central America (OLAFO II)	DANIDA	561,351
TOTAL		**11,535,719**

Table 32. CATIE's Associated Principal Staff (APS) assigned by different countries and institutions

COUNTRY OR INSTITUTION	Nº OF APS	COUNTRY OR INSTITUTION	Nº OF APS
Denmark	1	Switzerland	3
Finland	3	United Kingdom	3
France		United States of Ameirca	1
CIRAD *	4	World Wildlife Fund	3
ORSTOM	1	INIBAP	1
Germany	1	IUCIN **	1
Netherlands **	5	CIFOR	1
Sweden	1	**TOTAL**	29

* One of the scientists is 50% paid by CATIE's Core Budget
** Three scientists have 20% of time assigned to CATIE

Table 33 Shows an estimate of the contributions received through the strategic alliances with donor institutions and wich include the staff of table 32 above.

Table 33. Counterpart contributions of strategic allies during the period 1992-1995, in US$ thounsands

INSTITUTION	1992	1993	1994	1995
CIRAD-France	600	850	850	850
IPGRI / INIBAP	150	150	150	150
NRI-United Kingdom	250	300	250	250
COSUDE-Switzerland	495	495	495	495
GTZ-Germany	500	400	400	400
ODA-United Kingdom	200	200	200	200
UA-Wageningen-The Netherlands	45	45	70	70
DGIS-The Netherlands	150	150	150	300
MAE-France	90	90	90	100
WWF-US.	140	140	200	250
ORSTOM-France	150	150	250	300
FINNIDA-Finland	—	180	300	300
Penn State Univ./ACRI	—	125	125	75
ICRAF	—	—	25	30
ISNAR	—	—	20	50
CIFOR	—	—	30	125
IUCN	—	—	25	25
U.Laval / U.Alberta-IDRC	—	—	—	35
Veter. Med. Univ. - Denmark	—	—	—	50
U. of Winsconsin	—	100	100	100
TOTALS	**2770**	**3375**	**3730**	**4230**

Table 34 shows the total investment in research, graduate education, trainning and outreach during 1994 and 1995 considering the estimate of contributions received as strategic allies as presented in table 33 above.

Table 34. Total investment in research, graduate education, training and outreach, during 1994 and 1995, in US $ thousands.

DESCRIPTION	1994	1995
Core budget	5,613	5,667
Projects	11,170	10,980
Strategic alliances	3,730	4,230
TOTALS	**20,513**	**20,877**

IV. FINANCING

Summary of Accounting Activities and Policies

CATIE is a legal, international, non-profit institution. CATIE was founded in 1973 and in 1983 a new contract was signed for an additional twenty year period.

CATIE's resources originate from regular incomes, agreements and productive activities. It's financial management information has been into five funds, according to their purpose and source (independent or consolidated financial statements): Basic Activities Fund, Trust Fund, Retirement Fund for Principal Professional Staff, Plant Fund and Agricultural Activities Fund. The accounting records and financial statements are expressed in US dollars (US$).

As shown in table 35, total revenues during 1995 were US$ 16,647,938.09 and total expenses US$ 15,966,977.73. This let a positive balance of US$ 680,960,36 as an excess of revenues over expenses.

Table 35. Income and Expense balance up to December 31, 1995. (US$)

INCOME	US $
Membership	1,811,700.00
Technical Support Service	128,065.99
Teaching Activities	537,689.26
Productive Activities	1,705,353.04
Logistical and Administrative Support	1,234,481.06
Exchange differences	51,099.11
Other Incomes	199,191.12
Subtotal	5,667,579.58
Trust Funds Income	10,980,358.51
Total Income	**16,647,938.09**
EXPENSES	
Director Office and Senior Management	634,189.29
Administration and Services	1,057,342.30
Technical Programs	1,915,343.26
Productive Activities	1,120,676.17
Depreciation	259,068.20
Subtotal	4,986,619.22
Expenses in Trust Funds	10,980,358.51
Total Expenses	**15,966,977.73**
Income - Expenses Surplus	**680,960.36**

The next table 35 shows the combined statements of assets, liabilities and fund balance until December 1995. It is notable that during this period CATIE has canceled the total liability with the Retirement Fund for Principal Staff.

Table 35. Asset. liability and balance combined statement of funds to December 31, 1995. (US $)

ASSETS	US $
Current Assets	
Cash	1,866,223.59
Negotiable assets	2,437,607.52
Document and account receivable	
CATIE's members	226,561.54
Other entries	423,945.10
Total account receivable	**650,506.64**
Inventories	301,913.59
Expenses paid in advance	26,030.93
Total current assets	**5,282,282.27**
Building, machinery and equipment	3,119,389.22
Member long term account receivable	1,268,235.40
Other assets	4,273.61
Funds of account receivable	2,735,128.44
TOTAL ASSETS	**12,409,308.94**
FUND LIABILITIES AND BALANCES	
Current liabilities:	
Document and account payable:	
Account payable	353,893.94
In Trust Funds	949,475.78
Accrued expenses	97,490.15
Supplies	87,625.07
Total current liabilities	**1,488,484.94**
Long term liabilities:	
Account payable funds	2,735,128.44
Social benefits	83,606.93
Deferred credits other liabilities	650,000.00
Total long term liabilities	**3,468,735.37**
TOTAL LIABILITIES	**4,957,220.31**
Fund statement	7,452,088.63
TOTAL LIABILITIES AND WORK FUNDS	**12,409,308.94**

V. ADMINISTRATION

The main objective of the Administration Area has been to raise efficiency, by increasing, in quality and quantity, all the institutional services and updating the administrative procedures and strategies.

During 1995, the Administration Area focused its efforts in achieving a significant reduction in costs as shown in table 36. We notice that no reduction was obtained in some items because new equipment was purchased such as new weapons for guards and a new electronic system of bar codes to control inventories

Table 36. Expenditures comparison of the Administration Area during 1994 and 1995

ACTIVITY	1994	1995	Difference %
Administration Leadership	106,053	44,521	-58.02 %
General Services Unit	22,594	19,197	-15.03 %
Archives and Telecommunications Unit	15,061	17,090	13.47 %
Security Unit	104,337	104,182	- 0.15 %
Supplier Unit	75,161	88,888	18.26 %
Productive activities:			
Vehicle Rent	268,563	146,764	-45.35
Lodging	138,887	125,381	- 9.72
International Club	69,716	77,362	10.97
TOTAL EXPENDITURES	**800,372**	**623,385**	**-22.11**
REAL DIFFERENCE		**176,987**	

At the same time, an income increase up to 13.25% was obtained on the Area's productive activities as it is shown on table 37.

Table 37. Income comparison between 1994 and 1995

PRODUCTIVE ACTIVITY	1994	1995	Difference %
Vehicle Rent,	174,106	196,792	13.03
Lodging	447,624	510,752	14.10
International Club	93,098	102,006	9.57
TOTAL INCOME	**714,828**	**809,550**	**13.25**
REAL DIFFERENCE		**94,722**	

FUNDATROPICOS (CATIE FOUNDATION)

The 1995 budget of the support fund sponsored by "FUNDATROPICOS" was the equivalent of US$ 558,145 to execute the institutional physical plant maintenance program, according to the purposes of the Foundation. Table 38 shows the balance of the use of funds. We notice that for the first time, two postgraduate scholarships were funded with this budget.

Table 38. Maintenance Expenditure Plan Execution as of December (Amounts in US$)

Activities	New Budget	Executed to December	Balance
PERMANENT ACTIVITIES			
Basic Services	25,484	25,484	0
Basic Maintenance of Residences	53,640	53,640	0
Basic Maintenance of Buildings	30,855	30,854	0
Green Area Maintenance	11,837	11,836	0
Maintenance of UPF Vehicles	19,915	19,914	0
Tools and Equipment	5,264	2,564	0
SPECIAL ACTIVITIES			
Renovation Fire Extinguishers	5,000	5,000	0
Renovation Parking lots	4,694	4,694	0
Renovation Greenhouse	294	294	0
External Painting of Apts. 90	9,143	9,142	0
Repair Audit			0
Maintenance Soil Laboratory	1,500	1,500	0
Remodel PATS Director Office			0
Maintenance Training Classrooms	475	475	0
Remodel Computer Room			0
Relocation basketball court			0
Lodging conditioning	4,450	4,450	0
Renovation Farm installations	10,551	10,551	0
Student Apartments	18,753	18,753	0
Transportation Repair	1,149	1,149	0
Renovation Main Building	5,574	5,574	0
Paint Irazu Apts.	4,885	4,885	0
Abaca 3 Residences	6,808	6,808	0
Painting Biotechnology Building	9,797	9,797	0
Paint Computer Center	4,643	4,643	0
Wood purchased	18,715	18,715	0
Residence 4 Abaca	1,032	1,032	0
Fundatropicos' property expenditures (surveyance)	3,585	1,032	(734)
Incidental Expenses	8,642	7,522	1,120
OPERATIVE SUBTOTAL	**263,985**	**263,607**	**379**
PERSONNEL			
Professional Support Staff	19,623	19,624	
Administrative Staff	30,260	30,260	
Support Staff (Maintenance)	110,520	110,518	
Field Workers (Maintenance)	63,961	63,961	
Audit	5,405	5,405	
Student Scholarships	58,483	58,503	
Other Professional Services	5,908	6,306	(400)
PERSONNEL SUBTOTAL	294,160	294,537	(400)
TOTAL BUDGET	**558,145**	**558,165**	**(20)**

FARM ACTIVITIES

Coffee

During the 1995-1996 crop period, the coffee production was 2,134 fanegas, which was similar to the 1994-1995 crop that was 2,221 fanegas. But the total value of the crop decreases from US $ 362,000 to US $ 195,000 because of the international prices. Table 39 shows the historical net income of the activity since 1992.

Sugar cane

The sugar cane farm increased plantings of sugar cane up to more than 200 ha.. In 1992 the sugar cane harvest was 1.101 tons, during 1993, 3,126 tons, during 1994, 6,647 tons in 1995, 12,251 tons. Sugar cane harvest fulfilled the commitment made in the 1994 report which were 12,000 tons. For 1996 the expectation is to harvest 18,000 tons. During 1995 equipment for harvest and carrying sugar cane to the mill was acquired for an amount of US $ 111.600. Table 39 shows the historical net income of the activity since 1992.

Livestock Farm.

During 1995 the dairy and creamery achieved production of 347,748 kg of milk. Little less than the production achieved in 1994, as a result of a stronger genetic selection in the dairy herd. A reduction of cows resulted in an increase of milk production per cow, in fact, this production shows an increase from 8.7 to 9.9 kg. of milk per cow per day comparing 1994 vs. 1995. As heifers are becoming cows, during 1996 a commitment of 400,000 kg. of milk is expected from the farm. Total net income (milk and meat) from this activity is shown in Table 39 .

Forestry Farm.

Since 1992, a total of 52.5 ha were reforested in CATIE's farms. *Pinus tecunumani* (20.6 ha), *Pinus caribaea* (5.8 ha), *Eucaliptus grandis* (21.6 ha) and *Eucaliptus deglupta* (4.5 ha) represented the 58,350 trees planted. Part of the forestry activity included thinning and pruning which generate a net income as shown in Table 39 .

Table 39. Historical net income of CATIE's farm activities. Net income with and without investments, shown in US$.

	1992	1993	1994	1995
INCOME				
Agric. Products	137.792	167.053	577.152	445.714
Livest. Products	203.812	239.484	196.908	221.529
Foret. Products	45.651	61.539	35.375	64.305
EXPENSES				
Agric. Products	171.854	254511	458.069	469.215
Livest. Products	258.552	238.661	200.822	123.038
Foret. Products	27.013	53.006	29.428	30.728
NET	**(70.627)**	**(78.102)**	**101.116**	**108.567**
NET **	**165.269**	**176.082**	**221.685**	**357.623**

** Net without farm investments.

EXTERNAL AUDITING

Athur Andersen & Co. S.G. were the independent Auditors during 1995. Their report of the combined statements of financial position of CATIE for 1995 was very satisfactory as stated on page 3 of the official report: "the combined financial statements referred to above present fairly, in material respects, the financial position of the Tropical Agriculture Research an Training Center (CATIE) as of December 31, 1995 and 1994 and the results of its activities and its cash flow for the years then ended, in conformity with generally accepted accounting principles".

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XIII. GLOSSARY OF INSTITUTIONAL

ABBREVIATIONS

ACRI	American Cocoa Research Institute
AHP	Angostura Hydroelectric Project, Costa Rica
APPTA	Small Producers Association of Talamanca, Costa Rica
APROSAM	San Miguel Producers Association, Guatemala
AUW	Agricultural University of Wageningen, the Netherlands
AZP	Atlantic Zone Program, AUW/CATIE
BCO	Orton Memorial Library, CATIE
BLSF	Latin American Forestry Seed Bank, CATIE
BMZ	Ministry of Cooperation of the Federal Republic of Germany
CATIE	Tropical Agricultural Research and Higher Education Center
CEL	Electric Commission of Rio Lempa, El Salvador
CEMAPIF	Small Industry Forestry, Management and Utilization Center, Nicaragua
CIAT	International Center for Tropical Agriculture
CIDA	Canadian International Development Agency
CIFOR	Center for International Forestry Research
CIM	Intergovernmental Migration Committee
CIRAD	International Agricultural Research and Development Center of France
CNFL	National Light and Power Company, Costa Rica
CODEFORSA	San Carlos Commission for Forestry Development, Costa Rica
COHDEFOR	Honduran Corporation for Forestry Development
CONACYT	National Science and Technology Commission, Mexico
CONCAFE	National Coffee Council, Nicaragua
CORBANA	Banana Development Corporation, Costa Rica
CSU	Colorado State University
DAAD	German Academic Exchange Service
DANIDA	Danish International Development Agency
DGF	Forestry Directorate General, Costa Rica
DIECA	Costa Rican Sugarcane Growers' Organization
DIGEBESA	General Direction of Agricultural Services, Guatemala
EDECO	Education for Development and Conservation Program, CATIE
EMBRAPA	Brazilian Agriculture Research Corporation
EU	European Union

FAO	U.N. Food and Agriculture Organization
FHIA	Honduran Agricultural Research Foundation
FINNIDA	Finnish International Development Agency
FUNDATROPICOS	CATIE's Foundation
GIS	Geographic Information Systems, CATIE
GTZ	German Agency for Technical Cooperation
IABA	Inter American Board of Agriculture
ICRAF	International Center for Research in Agroforestry
ICTA	Agricultural Science and Technology Institute, Guatemala
IDB	Interamerican Development Bank
IDRC	International Development Research Center of Canada
IICA	Inter American Institute for Cooperation in Agriculture
INFORAT	Tropical American Forestry Information and Documentation Service, CATIE
INIBAP	International Network for Improvement of Banana and Plantain
INIFAP	Forestry and Agroforestry National Research Institute, Mexico
INRENARE	Institute of Renewable Natural Resources, Panama
INTA	National Institute for Agricultural Technology, Nicaragua
IPGRI	International Plant Genetic Resource Institute
IPM	Integrate Pest Management Project, CATIE
ISNAR	International System for National Agricultural Research
ITC	INIBAP's Transit Center
ITCR	Technological Institute of Costa Rica
IUCN	International Union for the Conservation of Nature
JICA	Japanese International Cooperation Agency
MAE	French Department of Foreign Affairs
MAG	Ministry of Agriculture and Livestock, Costa Rica
MAGA	Agriculture, Livestock and Food Ministry of Guatemala
MARENA	Natural Resources and Environment Ministry, Nicaragua
MBR	Maya Biosphere Reserve, Guatemala
MICI	Commerce and Industry Ministry, Panama
MIREN	Integrated Management of Natural Resources Program, CATIE
MIRENEM	Natural Resources Ministry of Costa Rica
MUT	Multiple Use Trees Project, CATIE
NARMAP	Natural Resource Management and Protection Project, Belize
NATURA	European Network of Agricultural Universities
NFTA	Nitrogen Fixing Tree Association
NGO's	Non-governmental Organizations
NORAD	Norwegian International Development Authority
NRI	Natural Resources Institute, United Kingdom
ODA	Overseas Development Administration of the United Kingdom
OIRSA	Regional Organization for Animal and Plant Sanitary Protection
OLAFO	Conservation for Development Project, CATIE
ONS	National Seed Office, Costa Rica

ORSTOM	French Institute of Scientific Research for Development Cooperation
OUI	Inter-American Organization of Universities
PASE	Program for Advising and Follow-up of Alumni, CATIE
PATS	Sustainable Tropical Agriculture Program, CATIE
PBN	Production from Natural Forests Project, CATIE
PRIAG	Regional Research in Basic Grains Project
PROCAFOR	Central American Forestry Program
PROMECAFE	Coffee Network in Central America, Mexico and the Dominican Republic
PROSEFOR	Forestry Seed Project, CATIE
PROSELVA	Project for Conservation of Peten Forests
RAFA	Agroforestry in the Americas Journal
REDCA	Regional Network for Cooperation in Higher Education and Research in Agriculture and Natural Resources
REDCAFE	Regional Network for Coffee Bibliography
RENARM	Regional Environmental and Natural Resource Management Project
RFCA	Central American Forestry Journal, CATIE
RIBRENAC	Regional Network for Natural Resources Bibliography, CATIE
SBN	Silviculture of Natural Forests Project, CATIE
SDC (COSUDE)	Swiss Development Cooperation
SIDA	Swedish International Development Authority
U N	United Nations
UCA	Universidad Centroamericana
UCR	University of Costa Rica
UJCV	Universidad Jose Cecilio del Valle, Honduras
UNA	National University of Costa Rica
UNAH	National University, Honduras
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPEB	Union of Banana Exporting Countries
URCOCAM	Regional Union of Shrimp farming Cooperatives
USAID	United States Agency for International Development
USDA	US Department of Agriculture
WWF	World Wildlife Fund

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