ANNUAL REPORT FOR PROJECT BP-1

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IMPACT ASSESSMENT

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CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

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PROJECT BP1: IMPACT ASSESSMENT

PROJECT DESCRIPTION

Project BP-1: Impact Assessment

Objective: To generate information that helps guide the allocation of CIAT resources, assists NARS in priority setting, improves the quality and efficiency of the Center's outputs, and indicates the returns to stakeholders' investments.

Outputs: Improved information and analysis for estimating the magnitude and distribution of the benefits of agricultural and natural resource management research. Appraisals of the acceptability, adoption, and impact of selected CIAT outputs. Improved capacity at CIAT and NARS for estimating, monitoring, and measuring the impacts of research.

Gains: Improved allocation of resources can increase the rate of return on investment in agricultural research. Project target is 2%.

Milestones:

1998 Review of adoption and impact of CIAT outputs prepared. Benefits of two CIAT projects estimated. Two field studies on technology adoption and acceptability conducted.

1999 Two field studies on technology adoption and acceptability conducted. Patterns of poverty in LAC analyzed. Expected benefits of social capital outputs of two CIAT projects estimated.

2000 Project monitoring system linked to estimates of impact assessment. Two field studies on technology adoption and acceptability conducted.

2001 Guidelines on methods of impact assessment for resource management research developed. Expected benefits of two CIAT projects estimated. Two field studies on technology adoption and acceptability conducted.

Users: The information and models developed in this project will help research planners in NARS and the CGIAR with decisions on resource allocation. Stakeholders will be able to measure expected returns to investment in agricultural and resource management research.

Collaborators: *Field studies on technology adoption and acceptability:* NARS in Latin America, Asia, and Africa. *Methodology development and strengthening of NARS:* IFPRI, IICA, and the University Javeriana *Use of outputs:* IDB, NARS in Latin America, Asia, and Africa.

CGIAR system linkages: Improving Policies (100%). Participates in the CGIAR Impact Assessment and Evaluation Group and contributes to the Tropical America Ecoregional Program.

CIAT project linkages: Works with all CIAT projects to appraise benefits and monitor impact.

PROJECT WORKBREAKDOWN STRUCTURE

Project BP-1: Assessment of Past and Expected Impact of Agricultural Research

Project objective

To generate information that helps guide the allocation of CIAT resources, assists NARS in Priority setting, improves the quality and efficiency of the Center's outputs, and Indicates the returns to stakeholders' investments

Outputs	**Databases and methods developed to improve the *ex ante* assessment of the benefits of agricultural and natural resource Management research**	**The expected contribution of CIAT's outputs to economic growth, poverty alleviation, And sustainability Estimated**	**The acceptability, adoption, and impact of CIAT outputs analyzed**	**Systems for monitoring and evaluation as integral components of agricultural research developed**
ACTIVITIES	• Compile and organize basic data sets, including research activities and costs, biophysical conditions, production systems, commodity markets (in collaboration with IFPRI). • *Revise existing consumer surplus* models for assessing the economic benefits of research (in collaboration with IFPRI). • Identify and adapt novel techniques for extending the economic analysis to include nonmarket outputs (in collaboration with the University of Wageningen).	• Analyze current development trends to assess potential consequences of CIAT's research portfolio (linked to all other CIAT projects). • Formulate research investment scenarios to estimate magnitudes and patterns of expected benefits from CIAT outputs (linked to all other CIAT projects).	• Revise literature on historic adoption and impact of CIAT outputs. • Conduct field studies on acceptability and adoption of CIAT outputs (in collaboration with INIAP, CORPOICA, EMBRAPA-CNPMF, and Nestlè Corp.)	• Assist CIAT project leaders in the use and implementation of a monitoring and evaluation system (linked to all other CIAT projects). • Use information from project monitoring and evaluation systems to improve projections of expected impact. • Contribute to strengthening regional and national systems for research prioritization (in collaboration with IFPRI, IICA, and IDB Regional Fund for Research).

LOGFRAME PROJECT BP1

NARRATIVE SUMMARY	MEASURABLE INDICTORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Goal: To contribute to the alleviation of hunger and poverty in tropical developing countries by applying science to the generation of technology leading to lasting increases in agricultural output while preserving the natural resource base.	• CIAT outputs make contribution to increase food availability, poverty alleviation, and improved management of natural resources.	• Reports of external reviews, donors, and national institutions. • Indicators of food production and natural resources. • Impact assessment studies.	• Sustained funding to CIAT • No external shocks fundamentally worsen food availability, poverty or natural resources
Purpose: To generate information that helps guide the allocation of CIAT resources, assists NARS in prioriting setting, and documents the returns to stakeholder investments.	• Information used by CIAT BOT, MT, Project Managers. • NARs assisted in priority setting. • Returns to investment documented.	• Minutes of BOT, MT, projects. • Published CIAT plans. • Reports of NARS. • Published impact studies.	• Decision maker openness to utilize information. • Adequate funding for Project BP1.
Output 1: Capacity to assess expected impact of research developed.	• Databases used in planning and Project development. • New methods used in planning and project developments.	• CIAT mid-term and strategic plans. • CIAT Project documents. • Publications	• Decision makers' openness to use data and information.
Product 1.1: Data bases for research planning developed.	• Data bases available.	• Project web site. • CIAT internal network. • Publications.	• Adequate support of CIAT information systems. • Access to data sets.
Product 1.2: New methods for assessing research impact developed.	• Improved consumer surplus model available. • New methods for assessing impact of NRM research developed. • New methods for assessing impact of research producing institutional innovation or information	• Publications	

LOGFRAME PROJECT BP1

NARRATIVE SUMMARY	MEASURABLE INDICTORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Output 2: Expected impact of potential CIAT research outputs appraised.	• Ex-ante impact of CIAT projects estimated. • Ex-ante impact of new research alternatives estimated.	• Publications	• Collaboration of other CIAT projects.
Product 2.1: Conditions affecting potential future returns to research outputs identified.	• Prevailing trends affecting LAC agriculture monitored. • Future scenarios developed.	• Publications	
Product 2.2: Impacts of research outputs simulated.	• Projections of future impact available.		
Output 3: Past impact of CIAT research understood.	• Estimates of acceptability, adoption, or impact of selected CIAT outputs estimated.	• Publications	• CIAT outputs utilized by partners.
Product 3.1: Field studies of selected cases of impact undertaken.	• Field studies conducted.	• Publications	
Product 3.2: General patterns of impact understood	• Synthetic reviews of impact executed.	• Publications	
Output 4: Institutional capacity for estimating, monitoring, and evaluating research impacts strengthened.	• CIAT has coherent of estimating, monitoring and evaluating impact.	• CIAT plans and documents. • External reviews.	• Commitment of entire CIAT community
Product 4.1: CIAT projects' planning, monitoring and evaluation system assisted.	• Adequate monitoring procedures in CIAT projects. • Specific support activities documented.	• Project plans and reports. • Annual reports; external reviews.	• CIAT projects define their outputs.
Product 4.2: NARS' planning monitoring, and evaluation systems assisted.	• NARS planning procedures and reports. • Specific support activity documented.	• NARS documents and reports. • Annual reports.	NARS assign priority to this activity.

1998 HIGHLIGHTS

Output 1. Product 1.1

- Databases made available on Internet, linked to other relevant sites, and registered in major search engines. Databases include agricultural production, trade, prices, land use, population, exchange rates and agricultural inputs. (Linked to all CIAT projects and Information and Documentation Unit).
  Sections 1.1 and 1.2 in this report.

Output 1. Product 1.2

- Consumer surplus model of ex-ante benefits improved to permit multi-market analysis, dis-adoption of technologies, probability of research success, and price trends. (Linked to projects IP1, IP2, IP3, IP4, IP5, SB2).
  Section 1.3 in this report.

- Framework based on economics of information developed to analyze impact of CIAT projects with non-technological outputs (Linked to projects PE3, PE4, SN1, SN3).
  Section 1.4 in this report.

Output 2. Product 2.1

- More rapid growth in productivity found for CIAT crops - beans, cassava, rice, beef and milk - then for most other commodities in Colombia, suggestive of impact of CIAT technology. (Linked to projects IP1, IP3, IP4, IP5).
  Section 2.1.A. in this report.

- Competitiveness appears to be highest in Latin America for export plantation crops, above median for milk, rice and beans, and below median for beef and cassava. (Linked to projects IP5, PE4, PE5).
  Section 2.1.B. in this report.

- Relation between cattle and deforestation in Latin America is strongly influenced by interest rates, foreign exchange regime, infrastructure development, and land tenure. (Linked to projects IP5, PE4, PE5).
  Section 2.1.C in this report.

Output 2. Product 2.2

- Post doctoral fellow recruited to work on this output full time in 1999 (Linked to all CIAT projects).

Output 3. Product 3.1

- Releases of CIAT germplasm by NARS 1967-1998 found to continue at high rate, to be changing in composition over time, and to be complementary to NARS own growing breeding output. (Linked to IP1, IP2, IP3, IP4, IP5, SB2).
  Section 3.1.C. in this report.

- Awareness of impact of CIAT rice and beans research promoted through articles carried by Financial Times, Reuters, EFE, IDB in house magazine. (Linked to Communications Unit and IP1 and IP4).
  Section 3.1.B. in this report.

Output 3. Product 3.2

- Adoption of improved pastures in Caqueta Colombia found to have doubled from 1986 to 1997, from 26% to 58% of pasture area, and to be associated with a decrease in deforestation. (Linked to projects IP5, PE5).
  Section 3.2.B. in this report.

- Dry cassava agroindustry in Ceara Brazil produced benefits that reached small farmers and women, but additional enterprise development services shown to be critical success factor. (Linked to SN1).
  Section 3.2.C. in this report.

- Farmer participatory research methods in Colombia found to increase quantity and diversity of farmer research as well as lead to identification of rapidly adopted improved technology. (Linked to IP1, SN3).
  Section 3.2.D. in this report.

- Components of IPM adopted for control of white fly in Colombia, but impact constrained by non-adoption of complete IPM package. (Linked to IP1, PE1).
  Section 3.2.A. in this report.

- Benefits of adoption of improved cassava varieties in Colombia in 1996 alone estimated to exceeded $US2,300,000. (Linked to IP3).
  Section 3.2.F. in this report

Output 4. Product 4.1

- CIAT Project capacity for internal impact assessment enhanced through organization of annual review workshop. (Linked to all CIAT projects).

- Basic principles of guidelines for assessing impact of NRM outlined. (Linked to projects PE2, PE3, PE4, PE5, SN1, SN3).
  Section 4.1.A. in this report.

Output 4. Product 4.2

- Students trained from three LAC Universities.

- **OUTPUT I: DATABASE AND METHODOLOGIES**

1.1 Data Base Development - *J. A. García*

Durante el año 1998 el proyecto BP1 continuó realizando esfuerzos tendientes a mejorar los sistemas de información ya implementados, particularmente en lo que respecta a la cantidad, la calidad y la disponibilidad de datos claves que son necesarios para llevar a cabo los diferentes estudios de evaluación de la investigación realizados por el propio proyecto, por otros proyectos del CIAT o por otras instituciones o investigadores colaboradores.

Actualizaciones

La Base de Datos socioeconómicos de América Latina y el Caribe dispone de información desde el año 1961 de fuentes como FAO, USDA, FMI y World Bank, y aglutina datos referentes a comercio, producción, precios, uso de la tierra, población, tipo de cambio, riego, maquinaria y fertilizantes entre otros. Esta base de datos fue actualizada incorporando para la mayoría de dichas series datos correspondientes al año 1996. Las series de datos referentes a producción de cultivos fueron actualizadas con información del año 1997.

La Base de Datos de Colombia fue actualizada con las series de datos relacionadas a continuación:

Variable	Unidad	Serie
Capital Agropecuario	$ 1975	1953-1994
Empleo Agropecuario	Número de Personas	1950-1994
Educación Rural Primaria	000 Alumnos	1970-1995
Educación Rural Secundaria	000 Alumnos	1970-1995
Área en Cultivos Transitorios	000 HA	1970-1995
Área en Cultivos Permanentes	000 HA	1970-1995
Área en Café	000 HA	1970-1995
Fertilizantes	000 MT	1970-1995
Gasto en Investigación (Sector Privado)	Millones $ 1985	1970-1995
Gasto en Investigación (Sector Público)	Millones $ 1985	1970-1995
Potencia Promedia (Tractores)	HP/Tractor	1970-1995
Tractores Importados	Número	1970-1995
Tasa de Inflación	%	1960-1996
Tasa de Interés Real	%	1970-1995
Inversión en Vías Rurales	Millones $ 1985	1970-1995
PIB Agropecuario	Millones $ 1975	1950-1995
PIB Agrícola (con Café)	Millones $ 1975	1975-1995
PIB Café	Millones $ 1975	1975-1995
PIB Pecuario	Millones $ 1975	1975-1995
PIB Total	Millones $ 1975	1975-1995
Presupuesto HIMAT	$ Corrientes	1971-1995
Presupuesto ICA	$ Corrientes	1971-1995

1.2 Web Page Development - *J. A. García*

1.2.A. Mejorando la disponibilidad de las Bases de Datos vía Internet

Teniendo presente que mecanismos sencillos de acceso a una base de datos probablemente motivarán a los usuarios a dar una mayor y mejor utilización de la misma, se hizo énfasis en mejorar la disponibilidad tanto a nivel local CIAT como a nivel de usuarios externos al CIAT, vía Internet. Para ello se desarrollaron programas de interacción con el usuario escritos en Microsoft FrontPage que permiten una fácil y sencilla definición de la consulta a realizar.

En cuanto al acceso de nuestras bases de datos vía Internet, está disponible toda la información almacenada en la base de datos de Colombia (Ver Figura 1) y lo referente a Tasa de Cambio, Desempleo e Indice de Precios al Consumidor (Fuente: Fondo Monetario Internacional), variables éstas almacenadas en la base de datos socioeconómicos de América Latina.

Como pretendemos que antes de finalizar el año el usuario pueda también visualizar en forma gráfica mucha de la información almacenada en nuestras bases de datos, se realizó una búsqueda en el mercado de software por productos diseñados para trabajar independientemente de la plataforma Internet disponible y capaces de proveer la manera más sencilla de agregar gráficas dinámicas a un sitio "Web" utilizando para ello datos almacenados en cualquiera de los manejadores de bases de datos más comunes en la actualidad.

Los resultados de la búsqueda nos llevó a seleccionar el producto Chart FX Internet Edition mediante el cual se pueden desarrollar aplicaciones-Internet que permiten generar una gran variedad de gráficas, las cuales pueden ser editadas y modificadas por el usuario a su propio gusto en tiempo real. Este producto además, es 100% independiente del navegador (browser) y del sistema operacional, y puede extraer datos de todos los sistemas manejadores de bases de datos más populares.

Por otra parte y dado que también se pretende que la consulta pueda hacerse tanto en idioma español como en inglés y que los resultados puedan visualizarse en forma de gráfico, se realizaron los ajustes a las diferentes tablas de la bases de datos para que ello sea posible.

Colaboradores:

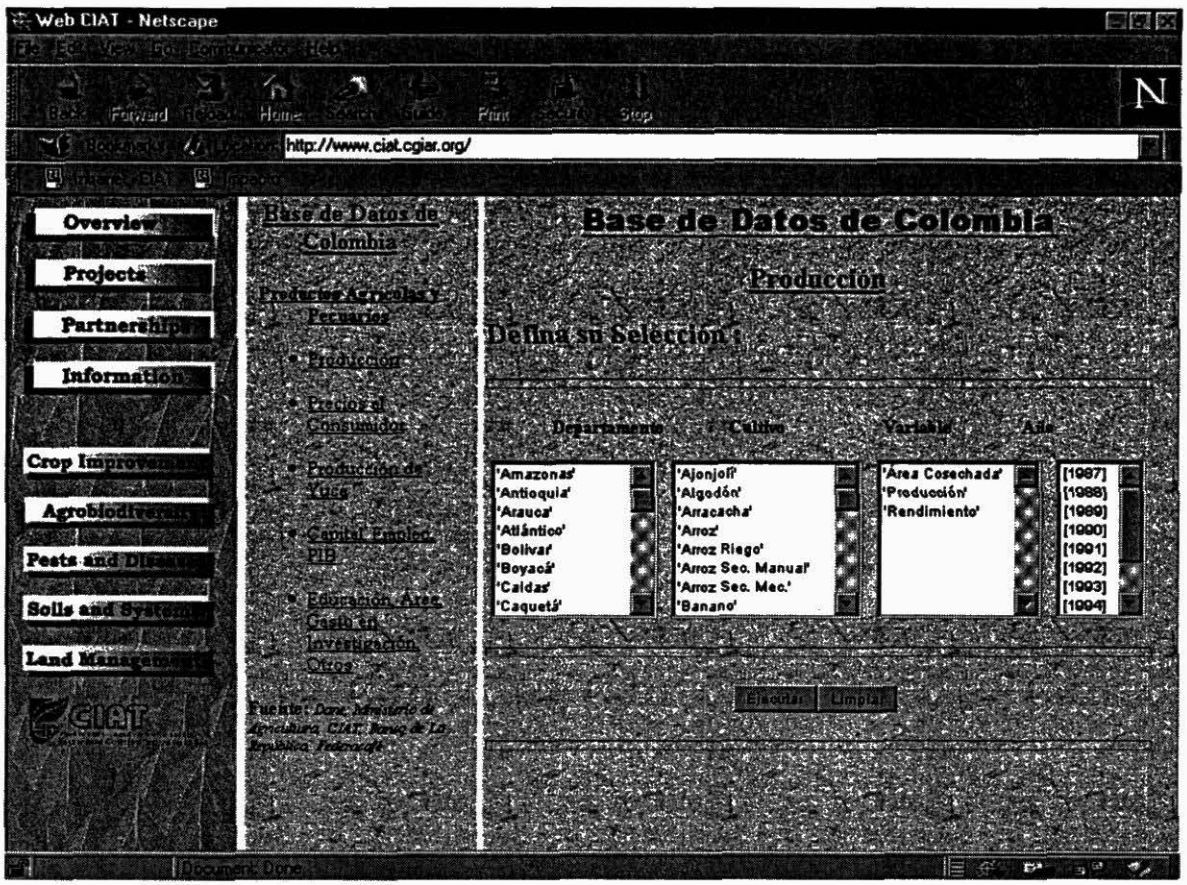
- Carlos Saa

1.2.B. Fuentes de datos (Otros Sitios de Interés)

Teniendo en cuenta la dificultad y lo costoso que puede ser mantener actualizadas nuestras bases de datos y que la mejora tanto en la cantidad como en la calidad de los datos obtenidos depende de la identificación de fuentes importantes que puedan suministrarnos rápidamente información actualizada de interés, hemos ubicado en Internet una serie de sitios "Web" en varios de los países de América Latina que pueden sernos de utilidad en un futuro.

Las fuentes mencionadas se relacionan en el Web de Impacto y pueden ser consultadas en la dirección http://www.ciat.cgiar.org/inslinks/enlaces.htm. (Ver Anexo-1)

Figura -1



1.2.C. Trends in CIAT Commodities 1998

Utilizando el sistema automático de generación de reportes implementado en la base de datos socioeconómicos de América Latina se generaron los cuadros correspondientes a los Trends 1998 los cuales están disponibles en el Home Page de Impacto (http://www.ciat.cgiar.org/inslinks/mainmenu.html) para los productos Arroz, Frijol, Carne, Leche y Yuca.

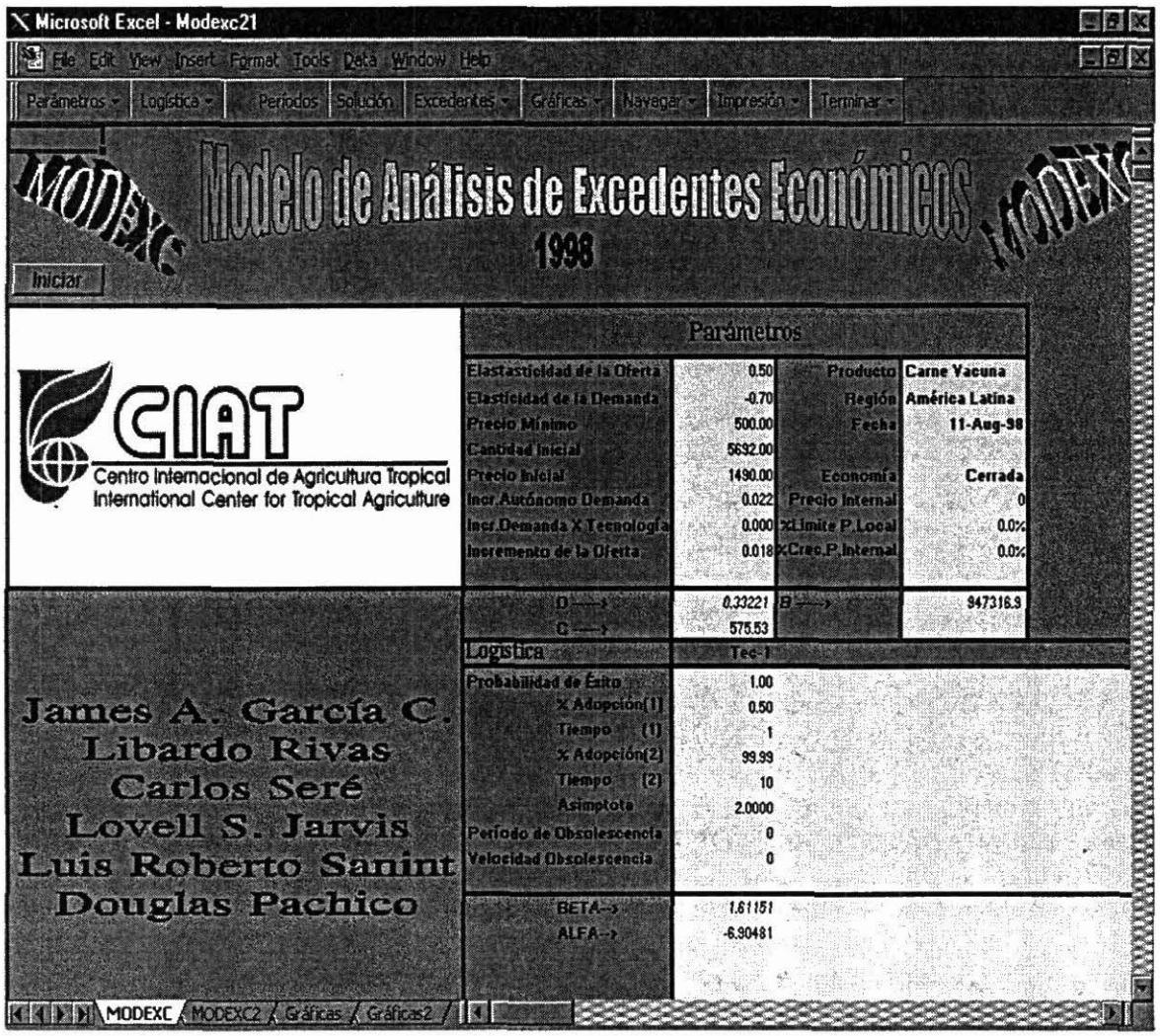
1.2.D. Disponibilidad de Modelos (MODEXC)

Utilizando Microsoft Excel de Microsoft Office 97 y haciendo uso de las facilidades disponibles tanto en lo que se refiere a hoja de cálculo, su capacidad de graficación y de seguridad, así como también de su disponibilidad y facilidad de programación en VBA (Visual Basic for Applications) se implementó el Modelo de Análisis de Excedentes Económicos (MODEXC) el cual estaba disponible a los usuarios en Lotus 1-2-3.

MODEXC trabaja utilizando un menú principal propio de la aplicación y diferentes submenús, los cuales presentan diversas opciones que activan procedimientos implementados para llevar a cabo actividades específicas. Estos menús están diseñados de tal manera que permiten un fácil uso del modelo por parte del usuario, pues éste solo tiene que limitarse, después de señalar una opción, a suministrar respuestas adecuadas a las preguntas desplegadas por el modelo.

En esta última versión, el modelo puede manejar simultáneamente tres mercados que interactuan y se afectan entre sí, lo cual significa un importante aporte para los futuros estudios que se realicen con el propósito de evaluar el potencial de nuevas tecnologías. Esta nueva versión permite también discriminar los excedentes tecnológicos esperados para el consumidor, el productor y el total que son atribuibles a cada una de las tecnologías analizadas.

De la misma manera, el modelo lleva un registro de los valores de "K" correspondientes a cada una de las tecnologías. Cabe señalar que otra característica importante del nuevo modelo es que éste permite la entrada y salida de tecnologías en diferentes momentos de tiempo y utilizando diferentes velocidades de obsolescencia o de desaparición.



En el Home Page de Impacto se encuentra disponible una versión tanto del manual como de la aplicación de MODEXC que permite el análisis de excedentes tecnológicos considerando un único mercado (http://www.ciat.cgiar.org/inslinks/modexc.htm). Próximamente ésta última versión de MODEXC (con 3 mercados) estará también disponible vía Internet tanto en idioma español como en inglés.

Detalles sobre la conceptualización teórica del modelo son descritas en el punto 2.1.B del presente informe.

Staff involucrado:

- James A. García
- Libardo Rivas

1.3 Modelo de Excedentes Económicos: MODEXC - *L. Rivas-J.A. García*

Durante 1998 se continuó el desarrollo y mejoramiento del Modelo de Excedentes Económicos (MODEXC), un esfuerzo de CIAT a través de varios años. El trabajo se concentró en dos áreas: a) Aspectos conceptuales y teóricos y b) Uso empírico del modelo.

- Se avanzó en el desarrollo teórico de MODEXC, al pasar de un esquema de un solo mercado en equilibrio, a otro de múltiples mercados que se relacionan a través de procesos de sustitución – complementariedad, bien sea en la producción o en el consumo.

- Dado que el proceso de investigación & desarrollo tecnológico es continuo en el tiempo, y se observa que nuevas tecnologías permanentemente reemplazan a las antiguas, se implementó en el modelo el concepto de obsolescencia - desadopción tecnológica, para simular el proceso de entradas y salidas de tecnologías a los sistemas de producción.

- Se produjo una nueva versión, revisada y actualizada, del manual para el usuario.

- Se colocó tanto el modelo como su manual a disposición de los usuarios a través de Internet.

Aspectos conceptuales y teóricos

1) **Múltiples mercados**. El desarrollo teórico más importante fue el paso de un esquema de un único mercado de las antiguas versiones de MODEXC, a uno de múltiples mercados que se vinculan entre sí, a través de las relaciones de sustitución y complementariedad tanto en el consumo como en la producción. La nueva versión de MODEXC permite incluir hasta tres mercados, por ejemplo se puede trabajar simultáneamente con los mercados de carne vacuna, leche y aves. Los dos primeros pueden estar vinculados por relaciones de sustitución en producción entre carne y leche, lo cual es muy frecuente en los sistemas de doble propósito del trópico bajo. Los mercados de vacuno y aves pueden estar relacionados a través de la sustitución en el consumo, hecho comprobado empíricamente en varios países latinoamericanos. Los mercados de leche y aves pueden no estar relacionados.

Las formas funcionales de las ecuaciones que describen los mercados son:

$$1)\ D_a = (1+\Omega_a)^t \beta P_a^{\eta_a} \prod_{i=b}^{n} P_i^{\lambda_i}$$

$$2)\ S_a = (1+\theta_a)^t C_a K1_a \left(P_a K2_a - \frac{M_a}{K3_a} \right)^{d_a} \prod_{i=b}^{n} P_i^{\gamma_i}$$

$$3)\ D_a = S_a$$

Siendo D_a la cantidad demandada en el mercado A

S_a la cantidad ofrecida en el mercado A

P_a el precio propio del mercado A

λ_i, γ_i Elasticidades de sustitución – complementariedad en consumo y en producción.

P_i Precios esperados en los otros mercados, calculados según un esquema de rezagos distribuidos del tipo Nerlove 1958)

$\Omega, \theta, \beta_a, C_a, d_a, \eta_a, K1_a, K2_a, K3_a$ son términos constantes.

2) **Función de producción de tecnologías**. Se implementó en MODEXC el concepto de desadopción tecnológica. Las versiones previas del modelo trabajaban con múltiples tecnologías que entraban a los mercados en diferentes momentos en el tiempo, pero no existía la posibilidad de que dichas tecnologías fueran reemplazadas por otras, en la medida en que las primeras se tornaran obsoletas. El modelo se mejoró en el sentido de introducir el concepto de obsolescencia, que implica desadopción y sustitución de unas tecnologías por otras.

Consideramos que este enfoque se aproxima mejor al concepto teórico de función de producción de nuevas tecnologías, donde los recursos destinados al desarrollo tecnológico, generan a lo largo del tiempo un flujo permanente de nuevas opciones tecnológicas y en los sistemas de producción se observa un proceso continuo de entrada y salida de tecnologías.

3) **Probabilidad de éxito de la investigación**. Se incluyó explícitamente dentro del modelo, como un parámetro, la probabilidad de éxito en el proceso de investigación y desarrollo de cada tecnología considerada individualmente. Esto permite que el modelo exprese directamente los beneficios tecnológicos como valores esperados.

4) **Tendencias de los precios internacionales**. Para el cálculo de los excedentes económicos en condiciones de mercado abierto, se incluyó la posibilidad de considerar cambios en los precios internacionales a través del tiempo, mediante la inclusión de un factor de tendencia, que refleja la evolución esperada de los precios internacionales del mercado que se evalúa. Las anteriores versiones asumían un precio internacional constante a lo largo de todo el período de evaluación.

5) **Excedentes económicos discriminados por tecnología**. El modelo está en capacidad de estimar los beneficios atribuibles a cada tecnología considerada individualmente. Anteriormente tal estimación debía efectuarse por fuera de MODEXC.

6) **Manual de MODEXC**. Se produjo un a nueva versión del manual de MODEXC revisada y actualizada.

1.4 Methods—Social Capital - *N. Jonhson*

- Completed a critical review of the social science literature on the concept of social capital.
- Proposed a general framework for analyzing the impact of projects designed to increase social capital. The framework is based on the economics of information and its implications for the efficiency of resource allocation.
- Reviewed methodologies for assessing impact within the proposed framework.

In late 1997, a new project was begun in BP-1 to develop a framework for analyzing the impact of CIAT research on strengthening the institutional and organization capacity of local communities to manage natural resources. Community resource management is a new and important area of research, both within and outside of the CGIAR, and it presents challenges to the existing methods of evaluating agricultural research projects. Addressing these challenges is the goal of this project, entitled, "Institutional and market development for community management of hillside watershed resources."

Social capital is thought to play a critical role in a community's ability to organize itself and manage its resources cooperatively. Generally defined in terms of community cohesiveness, norms and customs, or trust, social capital has gained considerable currency among development researchers and practioners. Several empirical studies have suggested that social capital plays a critical role in development (eg Putnam, 1994), and these results have sparked a great deal of research attempting to replicate and explain them. Despite these efforts however, a common operational definition of social capital has not emerged, and the implications of social capital for projects and policies to stimulate development are not clear.

In order to get a better understanding of social capital and how it might be useful at the project level, an extensive review of the literature was undertaken in early 1998. The goal was to examine conceptual and empirical studies to identify common patterns and processes that could lead to a better understanding of exactly how social capital works.

Based on the results of the literature review, the conceptual framework of the economics of information was suggested as an appropriate conceptual framework for understanding how social capital effects individual decision making, as well as individual and social welfare. Social capital can essentially be seen as a mechanism for managing and transmitting information among individuals in a community.

Social relationships transmit all sorts of information. Facts and opinions are transmitted directly between individuals. More subtle information about social norms and accepted behavior are also conveyed through social interaction, and individual reputations are formed that way. Social relationships are clearly not the only means of conveying information, but under certain circumstances they may be the most efficient. While in developed countries it may be all too easy to electronically access information about a person's economic history or creditworthiness, in other areas economic decision must be based on a person's reputation alone. Similarly, there are often high information costs associated with monitoring and enforcement of regulations, for example environmental standards and practices. Alternative methods that involve resources users directly in the design and implementation can be more effective in the long run. In these types of situations, social relations can constitute a valuable economic resource.

In economic theory, the cost and reliability of information have important implications for welfare. Information problems can lead to market failures, where resources are used inefficiently and total output and welfare suffer. Better information can lead people to make better individual decisions, which translate into a more efficient allocation of total resources in the economy. A more efficient allocation implies that the value of total output is higher.

At the project level, this implies that the value of a project designed to improve information via increasing social capital can be measured in terms of an increase value of output generated by the resource reallocation. This value can be estimated both *ex ante* and *ex post*. Within CIAT, economists are using this framework to estimate ex ante impact of local organizations for natural resource management. Rivera and Estrada use a programming model to estimate the impact of water users associations in a Colombian watershed. Johnson uses opportunity cost and contigent valuation measures to estimate the value of improving a community's ability to manage potable water supplies in Nicaragua (see section 2.2A of this report).

The framework of information economics also suggests other more qualitative methodologies for evaluating impact. The framework provides a logical process that links a problem and its consequences to a project and its impacts. The logical chain can not only provide the basis for a well-targeted cases study, it can also suggest indicators which could be used to see whether the different links in the logical chain are holding. Case studies and indicators are particularly useful in understanding and evaluating the process through which it was achieved rather than the overall value of the impact.

Funding:

- Rockefeller Foundation

ANEXO-1 : Relación de Fuentes de Datos Socioeconómicos, vía Internet, de Países de América Latina

Argentina

Secretaría de Agricultura, Ganadería, Pesca y Alimentación	http://siiap.sagyp.mecon.ar/default.htm
Encuesta Nacional Agropecuaria 1995 – Evolución de las existencias de Bovinos, Ovinos y Caprinos por provincia (1993-1995)	http://siiap.sagyp.mecon.ar/censos/retotal.htm
EXISTENCIAS DE GANADO	http://siiap.sagyp.mecon.ar/bases/existen.htm
SAGP y A-SIIAP Ganadería Series Históricas de Precios	http://siiap.sagyp.mecon.ar/ganado/ganado.htm
FAENA TIPIFICADA	http://siiap.sagyp.mecon.ar/bases/ftipanu.htm
INDEC – Instituto Nacional de Estadística y censo	http://www.indec.mecon.ar/default.htm
IMF DSBB Argentina:Index of Data Categories	http://dsbb.imf.org/country/argcats.htm
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Colombia

IMF DSBB Columbia:Data Categories	http://dsbb.imf.org/country/colcats.htm
CEDEBASE – Uniandes	http://cedebase.uniandes.edu.co/
DANE	http://www.dane.gov.co/
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Bolivia

INE - Instituto Nacional de estadística	http://www.ine.gov.bo
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Brasil

Institute of Geography and Statistics (IBGE)	http://www.ibge.gov.br/
Institute of Geography and Statistics (IBGE)	http://www.ibge.gov.br/english/e-home.htm
IBGE - Indicadores Conjunturais	http://www.ibge.gov.br/informacoes/indices/M-ind.htm
Instituto CEPA / Santa Catarina	http://www.icepa.com.br
Bem-vindo ao site SIAGRO	http://www.siagro.com.br/
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Chile

U.S. Embassy Santiago, Chile, Foreign Agricultural Service	http://www.rdc.cl/~usemb/fas-stat.htm
Estadísticas de la Agricultura Chilena	http://www.minagri.gob.cl/minagri/cuadros/esta.html
Directory of pub/Estadisticas_de_la_Agricultura/ Variables_Macrosectoriales	ftp://ftp.minagri.gob.cl/pub/Estadisticas_de_la_Agricultura/ Variables_Macrosectoriales/
INE - Instituto Nacional de Estadística	http://www.conicyt.cl/servidores/INE/tabla1.htm
IMF DSBB Chile:Data Categories	http://dsbb.imf.org/country/chlcats.htm
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Ecuador

Instituto Nacional de Estadísticas - INE	http://www4.inec.gov.ec
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Guatemala

INE-Instituto Nacional de Estadística - República de Guatemala	http://www.gua.gbm.net/ine
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

México

Secretaría de Agricultura Ganadería y Desarrollo Rural	http://www.sagar.gob.mx/cea.htm
INSTITUTO NACIONAL DE ESTADISTICA GEOGRAFIA E INFORMATICA	http://www.inegi.gob.mx/paginamenu.html
U.S. Agricultural Trade Office México	http://www.atomexico.gob.mx/
IMF DSBB Mexico:Index of Data Categories	http://dsbb.imf.org/country/mexcats.htm
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Paraguay

DCEA - SINTESIS ESTADISTICA	http://www.una.py/sitios/mag/dcea/
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Perú

PERU - Instituto Nacional de Estadística e Informática - INEI	http://www.inei.gob.pe
Estadística Agrarias	http://www.minag.gob.pe/MINAG/estadistica/estadistica.html
IMF DSBB Peru:Index of Data Categories	http://dsbb.imf.org/country/percats.htm
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

República Dominicana

Oficina Nacional de Estadística y Censos	http://www.estadistica.gov.do
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Uruguay

Instituto Nacional de Investigación Agropecuaria	http://www.inia.org.uy
Servicios INIA	http://www.inia.org.uy/servicios.html
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

USA

South America	http://mann77.mannlib.cornell.edu/data-sets/international/89024/4
World Agriculture: Trends and Indicators	http://mann77.mannlib.cornell.edu/data-sets/international/89024/
(USDA) Mann Library Gateway	http://usda.mannlib.cornell.edu
USDA- National Agricultural Statistics Service Data Products	http://www.usda.gov/nass/pubs/dataprd1.htm
ERS Products and Services--Data Bases	http://151.121.66.126:80/Prodsrvs/dataprod.htm
BEA Home	http://www.bea.doc.gov/
FAS Home Page	http://www.fas.usda.gov
BICO Export / Import Search Function	http://www.fas.usda.gov/scriptsw/bico/bico_frm.idc
IMF DSBB United States:Index of Data Categories	http://dsbb.imf.org/country/usacats.htm
Gopher USDA Economics and Statistics System	gopher://usda.mannlib.cornell.edu

Venezuela

Ocei-Oficina central de Estadística e Informática	http://www.ocei.gov.ve
Inter-American Development Bank	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

Varios

Basic Socioecomomic Data (The REGION)	http://www.iadb.org/statistics/socioe.htm
Agriculture in Latin America - LANIC	http://lanic.utexas.edu/la/region/agriculture/
OECD-Organisation for Economic Co-operation and Development	http://www.oecd.org/
IMF Dissemination Standard Bulletin Board (Subscribing Countries)	http://dsbb.imf.org/country.htm
International Monetary Fund Home Page	http://www.imf.org/
CEPAL	http://www.eclac.cl/index.html
FAOSTAT Database Collections	http://apps.fao.org/lim500/agri_db.pl
Census Bureau: Statistical Agencies (International)	http://www.census.gov/main/www/stat_int.html
Economic Research Service--Other Sites	http://151.121.66.126:80/Othrsite
World-Wide Web Servers: Summary	http://vlib.stanford.edu/Servers.html
Latin World - Latin America on the Net	http://www.latinworld.com/
OAS: Gophers and Webs of the Americas	http://www.oas.org/EN/MSTATES/gopher2.htm
BID - BASIC REPORT	http://database.iadb.org/INT/_BRPTNET/brptpubframe.htm

OUTPUT II: EX-ANTE IMPACT ASSESSMENT

2.1 Análisis de Tendencia

2.1.A. Productividad de la agricultura en Colombia - *L. Rivas, G. López*

- En el desenvolvimiento histórico de la agricultura del país se distinguen claramente tres fases. La década del 70, caracterizada por elevadas tasas de crecimiento de la producción y la productividad. Los 80 con bajos índices de crecimiento de la producción y estancamiento de la productividad y los años 90, época de cambios y reformas, donde la producción y el uso de insumos declinan sustancialmente y la productividad atenúa en parte la reducción en el uso de insumos.

- Durante todo el período de análisis, 1990-1997, solo 5 productos agropecuarios, entre 27 considerados en este trabajo, fueron capaces de alcanzar altas tasas de crecimiento de su producción, por encima del 6% anual. Ellos fueron: Banano, flores, palma de aceite, maní y frutas. Se trata de productos exportables o con demanda asegurada para la agroindustria.

- La década actual marca una pronunciada reducción de las áreas sembradas y del empleo agrícola, una transferencia de recursos desde los cultivos temporales hacia los permanentes y un incremento sustancial en las importaciones de alimentos.

- Los índices Divisia de producción, insumos y productividad multifactorial (PMF) para el sector agropecuario colombiano del período 1970-1995 muestran que en términos agregados, la productividad multifactorial ha sido un factor importante en la expansión del producto agrícola total del país. Sin embargo, ello no ha sido suficiente para mantener un crecimiento alto y sostenido del sector agropecuario.

- Se ajustaron varios modelos econométricos para identificar los factores determinantes de los cambios en productividad. Resultan altamente significativas como determinantes de la PMF: a) La inversión en capital humano, b) La inversión en infraestructura física, vías y obras de riego y c) La tasa real de interés de los préstamos agropecuarios.

- Se anota que una gran dificultad para desarrollar esta clase de trabajos es la limitada disponibilidad de información estadística para el sector, lo cual imposibilita desagregar por regiones o cultivos, puesto que muchas de las cifras disponibles corresponden a simples estimaciones globales.

Resumen

Durante 1998 se concluyó el estudio de la productividad agregada de la agricultura de Colombia, que incluyó tres grandes temas: 1) Análisis de las tendencias generales del sector del sector agropecuario. 2) Estimación de los indicadores de productividad multifactorial para el período 1970-1995 y 3) Ajuste de modelos econométricos para identificar los factores determinantes de la productividad multifactorial (PMF).

En la medida en que avanza el proceso de crecimiento el sector agropecuario ha perdido importancia dentro de la estructura de la producción del país. A principios de los 60 su contribución al producto total era del 30%, hacia 1996 esa proporción se había reducido a 19%. No obstante debe acotarse que si el sector agrícola se evalúa como un sector ampliado, incluyendo sus vínculos con la agroindustria, su participación en el PIB crece sustancialmente.

La producción agropecuaria nacional alcanzó su mayor dinamismo en los 70 cuando el producto agrícola total creció al 4.3% anual frente a un crecimiento del producto total (PIB) del 5.3%. En los 80 la tasa de expansión del producto agropecuario declinó notablemente, 2.9% anual, y se redujo a solo1.8% en el período 1990-1997.

Pocos productos lograron mantener elevados índice de crecimiento de su producción durante el extenso período analizado, 1970-1997. Se destacan por su dinámica los cultivos de banano, frutas, flores, aceite de palma y maní, con tasas de crecimiento promedio anual de su producción por encima de 6%. En todos ellos el incremento de las áreas plantadas fue el principal determinante del crecimiento de la producción. La característica común a los productos de alto ritmo de expansión en el agro colombiano es que son exportables o que tienen alta demanda para procesamientos agroindustriales. En el otro extremo, destacándose por su bajo ritmo de crecimiento, se encuentran cultivos como ajonjolí, tabaco negro, algodón, cebada y fique, los cuales redujeron considerablemente sus áreas cultivadas.

Las reformas económicas e institucionales introducidos en la década del 90, para adecuar la economía nacional al nuevo orden económico mundial, han tenido enorme repercusión sobre el desempeño de la agricultura de Colombia. Se observa una acentuada reducción de la dinámica del sector y una recomposición de la producción en favor de los cultivos permanente o de plantación y en desmedro de los temporales, los cuales entre 1990 y 1997 redujeron su contribución al producto agropecuario del 22 al 15%.

Durante ese período las áreas en cultivos transitorios se redujeron en 800 mil hectáreas y las de cultivos permanentes se incrementaron en 300 mil. Las mayores reducciones de área ocurrieron en cereales, medio millón de hectáreas. Los cultivos permanentes que se destacaron por la expansión de sus áreas sembradas fueron caña de azúcar y café.

Aunque la liberación comercial permitió reducir los costos reales de algunos insumos como maquinaria, fertilizantes y agroquímicos, esto no alcanzó a compensar la pérdida de ingresos de los productores, originada en la caída de los precios reales recibidos por ellos. Varios analistas, entre ellos Ocampo y Perry (1995) y Sanint (1993) atribuyen el estancamiento productivo a una crisis de rentabilidad del sector, que derivó en sustanciales reducciones de las áreas cultivadas.

Todo este proceso ha tenido implicaciones negativas sobre la disponibilidad y la balanza comercial de alimentos del país. Las importaciones netas de cereales en el período 1990-1996 crecieron a tasas muy elevadas, en particular las de sorgo maíz y cebada. La balanza comercial de alimentos expresada en dólares constantes de 1990, cayó de un superávit de más de 300 millones en 1990 a un déficit de 400 millones en 1996. La pérdida de dinámica del sector agropecuario, ha conducido a una mayor dependencia del comercio para satisfacer el consumo doméstico.

A lo largo del período 1970-97 los rendimientos (producción/ha) fueron un factor importante en la expansión de los productos relacionados con el mandato global del CIAT: fríjol, yuca, arroz y ganadería vacuna. En todo el período evaluado el alza en los rendimientos contribuyó en más de una tercera parte (37%) al aumento de la producción de fríjol, en un 30% a la expansión de la producción de arroz y en mas de una cuarta parte (26%) al aumento de la producción ganadera (carne y leche). Aunque la producción de yuca muestra una marcada tendencia descendente debido a la contracción de las áreas sembradas, el alza en sus rendimientos ha contrarrestado en parte el efecto de la reducción de las siembras.

Se destaca que durante lo que va transcurrido de los 90, en los cultivos de yuca y fríjol el alza en rendimientos permitió observar tasas positivas de crecimiento de la producción, no obstante la caída de sus áreas cultivadas.

Basándose en trabajos previos, tanto metodológicos como empíricos, elaborados por Falconi, et al, 1995 y1996 y Alston, et al. (1995) se estimaron índices de productividad multifactorial del sector agropecuario del país, para el período 1970-1995.

Los tasas de crecimiento de los índices de productividad multifactorial, producción e insumos presentadas en el Cuadro 1, concuerdan en alto grado con las tendencias en producción y rendimientos descritas previamente. Una posible explicación a los incrementos de productividad observados en los 90, es que a raíz de la crisis de rentabilidad hayan salido del sector algunos de los productores más marginales, generando desempleo de recursos como tierra y mano de obra, permaneciendo en el sector aquellos con mayores índices de productividad y competitividad. Este es un aspecto importante desde el punto de vista de la eficiencia económica, no obstante desde la perspectiva de la equidad social, este hecho puede ser muy negativo en la medida que se deterioren, la oferta de alimentos, el bienestar de los productores mas pobres, el ingreso y el empleo rural.

Se efectuó un trabajo econométrico de ajuste de modelos de regresión para identificar los factores que explican los cambios de la productividad multifactorial. Se incluyeron cinco variables independientes: 1) Inversión anual en investigación agropecuaria, 2) Inversión anual en vías rurales y obras de riego, 3) Inversión en educación rural, 4) Tasa de cambio real y 5) Tasa de interés real de los préstamos al sector agropecuario

Cuadro 1. Tasas de crecimiento de los Indices Divisia de Producción, los Insumos y la Productividad Multifactorial del Sector Agropecuario. Colombia:1970-1995

Período	Producción		Insumos		Productividad Multifactorial	
	Tasa	%	Tasa	%	Tasa	%
1970-1979	4.1	100.0	2.4	58.5	1.7	41.5
1980-1989	1.6	100.0	1.6	100.0	0.0	0.0
1990-1995	0.2	100.0	-2.6	-1300.0	2.8	1400.0
1970-1995	2.9	100.0	1.2	41.4	1.7	58.6

Los mayores problemas para el ajuste de los modelos fueron: a) Alta colinearidad de las variables explicatorias. b) Información disponible con muy alto nivel de agregación, lo cual hace que los efectos del orden de región o producto se confundan y/o se neutralicen c) La deficiente base de información estadística, que impide trabajar a niveles menores de agregación y que no permite elaborar ciertos ajustes a los datos, como por ejemplo incorporar las variaciones en la calidad de los insumos a través del tiempo.

Para aliviar los problemas de colinearidad se utilizó el procedimiento de regresión de borde (Ridge Regression), que es un método econométrico de aproximación que reduce las distorsiones de las varianzas de los estimadores ocasionadas por la colinearidad.

Como factores explicatorios de las variaciones de la productividad multifactorial resultaron altamente significativas las inversiones en capital humano y en capital físico (vías y obras de riego) y la tasa de interés real para los préstamos agropecuarios. Las dos primeras variables a pesar de ser altamente significativas y presentar el signo esperado, muestran coeficientes de regresión muy bajos.

La tasa de interés real resultó altamente significativa y con un alto valor de su coeficiente de regresión, sin embargo su signo positivo no es muy claro, ya que aparentemente resulta contraintuitivo: A mayor tasa de interés mayor productividad. Lo anterior podría racionalizarse argumentando que el mayor costo del capital, conduce a un uso más eficiente de este recurso. De otro lado, el alza del costo de capital limita las inversiones en capital y tecnología de los pequeños y medianos productores, y puede tener un impacto negativo sobre la productividad. Lo anterior, sugiere que los efectos de los cambios en la tasa de interés sobre la productividad pueden tener diferente dirección, según, la región, el sistema de producción y el tipo de productor.

La variable inversión en investigación resulta poco significativa (p=22%). Es difícil encontrar efectos significativos de las inversiones en investigación sobre la productividad global, cuando se trabaja a niveles tan agregados, ya que muchos de los resultados de las inversiones en investigación son específicos a la región, producto o sistema de producción. También es necesario introducir los rezagos apropiados en la variable inversiones en investigación, para encontrar efectos significativos sobre la productividad.

Los resultados de este trabajo confirman las experiencias de otros intentos de ajuste de modelos econométricos para identificar los determinantes de la productividad global (Véase Misión de Estudios del Sector Agropecuario, 1990), que muestran que para mejorar los modelos es necesario estimarlos por producto, región, sistema de producción etc. El principal inconveniente para trabajar de ésta forma, es la dificultad para encontrar series históricas consistentes y confiables de insumos, precios, costos etc. que permitan calcular índices más desagregados de productividad multifactorial.

Si bien la productividad ha sido importante en el crecimiento agrícola nacional, ello no ha sido suficiente para lograr un alto y sostenido ritmo de expansión. Es necesario persistir en el empeño de incrementar la productividad de las actividades agropecuarias del país, para ello el desarrollo

tecnológico en rubros productivos seleccionados por su alto potencial, es estratégico para mejorar la productividad y la competitividad de la agricultura nacional.

Colaboradores:

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- César Falconi, ISNAR
- Gabriel López, Estudiante Universidad Javeriana, Bogotá.
- Miriam Cristina Duque, CIAT.

2.1.B. Competitividad de la Agricultura en las Américas - *R. Hertford, J. García*

Resumen

La literatura sobre competitividad relaciona conceptos e indicadores que son imprecisos, difíciles de medir y frecuentemente extraños. Se encuentran muchas definiciones acerca de qué es competitividad y cómo se puede medir efectivamente. Se adopta aquí una definición bastante simple: "Es la capacidad de sobrevivir como empresa a lo largo del tiempo". Por supuesto, para poder sobrevivir, la empresa tiene que ganar lo suficiente para atraer y compensar los recursos involucrados en la producción. Igualmente, las utilidades tienen que ser suficientes para que en un mundo cambiante la empresa pueda tomar las medidas necesarias para defenderse y renovarse. Un punto importante de resaltar es que, la competitividad se revela a través del tiempo y no en un solo punto de tiempo.

En concordancia con los requisitos para un mejor indicador, es decir, que sea sencillo, dinámico, comprensible, bien fundamentado teóricamente y que pueda ser fácilmente estimado, se propone utilizar el concepto de la "cuasirenta" que para una empresa es igual a los ingresos brutos menos los costos variables de la producción.

Para que una empresa sea competitiva debe exitosamente mantener sus cusasirentas sobre un período de varios años en el pasado y en el futuro. El pasado en este estudio incluye el período de tiempo 1984-95 y el futuro incluye 1995-2005.

La definición de las cuasirentas (CR) en cualquier año de éstos períodos es:

(1) $CR = PQ - TCV$

donde "P" es el precio del producto de la empresa recibido por el productor, "Q" representa la cantidad de producción y "TCV" es el total de los costos variables.

Los costos variables de la producción son costos que se pueden evitar si la decisión es la de no producir en un ciclo de la producción. Los insumos fijos, por otro lado, tienen costos que no se pueden evitar al dejar de usarlos durante un ciclo de la producción. Las utilidades son iguales a los ingresos brutos menos todos los costos variables y los fijos. A corto plazo, las cuasirentas corresponden al área entre la curva de oferta y el precio del mercado.

Cuando las "CRs" son negativas, el ingreso bruto no alcanza ni a cubrir los costos variables y por supuesto la empresa no es competitiva. Si las "CRs" son positivas, la empresa es competitiva y más competitiva será en la medida que el valor de las "CRs" sea mayor.

El interés generalmente se centra en las "CRs" de la empresa promedio en un grupo —por ejemplo pequeños vs grandes productores de un producto en una región particular— en lugar de las "CRs" de una empresa individual.

En éste estudio, el interés se enfoca en las "CRs" de la empresa promedio de un grupo de empresas que se dedican a la producción de diversos productos agrícolas y pecuarios en países de las Américas.

Teniendo en cuenta que las estimaciones del "TCV" para la empresa promedio en un grupo de empresas generalmente no están disponibles, (1) puede ser planteada como:

(2) $\mathbf{CR = PQ(1 - S)}$

donde "S" es la participación de los costos variables totales en los ingresos brutos.

Dada la no disponibilidad de las series de datos de "TCV" y si aceptamos que "S" probablemente se comporta razonablemente invariable a través de un buen período de tiempo, los cambios en las "CRs" se deberán principalmente a los cambios en el factor "PQ".

Desafortunadamente, series de datos sobre "PQ" generalmente no se encuentran disponibles para la empresa promedio de interés, por lo cual (2) es nuevamente definida como:

(3) $\mathbf{CR = PR\ (1 - S)T}$

donde "R" es el rendimiento promedio estimado de las empresas en una industria (una variable para la cual generalmente hay datos disponibles) y "T" es la cantidad promedio de tierra cultivada o cosechada por las empresas tenidas en cuenta en la estimación del valor promedio "R". (Para empresas dedicadas a la explotación de animales, "T" es expresado en términos del número promedio de animales)

Finalmente, las "CRs" son deflactadas a través del tiempo por el factor "W", definido como el producto del salario promedio anual para el sector industrial urbano por la tasa de empleo industrial urbano, lo cual nos lleva a:

(4) $\mathbf{CR^* = PR(1 - S)T/W}$

Esta transformación de (3) no solamente representa una solución al problema de deflactar las cuasirentas, sino que permite además la comparación entre países por cuanto "CR*" es un índice.

En este estudio "P", "R" y "W" varían a través del tiempo (1984-95) pero "S" y "T" se asumen razonablemente constantes debido a que, para muchas empresas incluidas en el estudio, solo fue posible obtener una única estimación cerca al año base del estudio, 1995.

El índice de competitividad para el período 1984-95 se calcula dividiendo el numerador de la expresión (4) capitalizado a 1995 (tasa de interés 10%) por el divisor "W" también capitalizado a 1995. El índice para el período 1995-2005 es igual a la relación del numerador de la expresión (4) descontado a 1995 y el denominador "W" también descontado a 1995.

Los datos para las variables "P", "R" y "W" fueron obtenidos de fuentes secundarias mediante el proyecto CIAT/IADB/IICA/IFPRI y los datos para "S" y "T" fueron obtenidos por colaboradores en 15 países de las Américas incluidos en el estudio —desde Estados Unidos en el norte hasta Argentina y Chile en el sur—. La obtención de datos se centró en 24 diferentes productos en aquellos países más otros 4 productos para los cuales se consiguieron datos en solamente un país. De los 15 países considerados y los 28 productos involucrados se generó finalmente información para 243 empresas.

El cuadro-1 muestra el ordenamiento de países con base en el indicador de competitividad calculado como promedio simple y promedio ponderado de los índices correspondientes a todos los productos de cada mercado nacional para el período de doce años, 1984-95. La ponderación utiliza la participación porcentual de los productos registrada durante el año 1995.

Ecuador, país que experimentó un rápido crecimiento de su sector agrícola en el período 1990-95 [ECLAC, 1997, p.19] muestra un valor del indicador dos a tres veces mayor que el valor mostrado por Venezuela, Colombia, Bolivia y Argentina.
Guatemala y Paraguay, entre los países que obtuvieron los más bajos valores del indicador de competitividad mostraron desempeños excepcionalmente pobres en el período 1990-95. [ECLAC 1997, p.19].

Al igual que Guatemala, sus vecinos del norte (Méjico y Estados Unidos) también obtuvieron valores bajos en el indicador de competitividad.

Aunque los valores promedios del indicador, para los 10 primeros paises, sugieren retorno aceptable a las inversiones hechas en agricultura, los valores obtenidos por los últimos 5 países del cuadro-1 son alarmantemente bajos.

Sorprende también observar, que los valores del indicador de competitividad ubica, con excepción de Perú, a los países de la Región Andina (Bolivia, Colombia, Ecuador y Venezuela) como una de las regiones más competitivas, en tanto que los países del Cono Sur (Argentina, Brasil, Chile, Paraguay y Uruguay) obtienen valores inferiores de competitividad destacando los muy bajos valores de Brasil y Paraguay.

Se observa igualmente que el comportamiento de los países, con base en el promedio de los primeros 5 mejores valores de competitividad en cada país, no cambia apreciablemente los resultados obtenidos con base en el promedio de todos los productos en cada país.

El Cuadro-2 presenta, para cada producto, los valores promedios del indicador de competitividad sobre todos los países y los valores promedios sobre los 3 mejores valores obtenidos por cada producto.

Los cultivos agrícolas que son comúnmente exportados e industrializados (Banano, Algodón, Uvas, Naranjas y Caña de azúcar) se ubican como productos altamente competitivos. El café que debería ser parte de este grupo, se muestra como la excepción al grupo; sin embargo, esto es consistente con la reciente eliminación del pacto mundial del café y las reducciones que siguieron en el precio internacional del producto.

Tres productos pecuarios (Huevos, Carne de pollo y Leche de vaca) se ubican inmediatamente después del grupo anterior; sin embargo, otros dos productos pecuarios (Carne de res y Cerdos) se ubican lejanamente por debajo de estos. El caso de los cerdos representa solamente una empresa nacional, los Estados Unidos, donde la mayoría de los valores de competitividad fueron bajos.

Entre los cultivos Hortícolas, el Tomate obtuvo el tercer más alto valor entre los 28 productos considerados en el estudio. La cebolla obtuvo también una posición respetable, mientras que otros tres productos hortícolas, que no son industrializados o comercializados en el mercado internacional frecuentemente (Zanahoria, Sandía y Lechuga) terminaron en posiciones muy inferiores en el ranking de competitividad.

Los principales cultivos de raíces de la región, Yuca y Papa obtuvieron valores diferentes que los ubican respectivamente en la parte inferior y en la parte media del rango de competitividad.

Al final de la distribución de competitividad se encuentra el Sorgo, la Cebada y la Avena. Claramente se confirma que estos han sido un grupo de productos adversamente afectados por la apertura comercial en la región. Por otro lado, otros cultivos de grano como Arroz, Fríjol seco y la Soya evidencian un nivel de competitividad superior al resto de productos de grano.

Los cuadros 3 y 4 presentan indicadores de competitividad en dos períodos de tiempo para país y para producto. El Cuadro-3 muestra que los niveles de competitividad, durante el periodo 1990-95, no disminuyeron como se esperaba para todos los países sino únicamente en 8 de los 15 países considerados en el estudio. Los primeros tres países del ranking, los cuales pertenecen a la Región Andina, mejoraron su posición en este período mientras que los últimos países, con los valores más bajos del indicador para todo el período, empeoraron su situación. En otras palabras, los países más competitivos lograron ser más competitivos y los países menos competitivos llegaron a ser menos competitivos.

El Cuadro-4 muestra que cerca de la mitad de los productos mejoraron sus niveles de competitividad a nivel de la región. Los dos productos con niveles más altos del indicador de competitividad durante 1984-89 fueron capaces de aumentar sustancialmente durante el período 1990-95. Poco movimiento se evidenció en los valores del indicador de competitividad para los productos con los valores más bajos durante el período 1984-89 (Lechuga, Cebada, Cerdos y Avena. Suave mejoría se registró para Café y Sandía).

Cinco productos con valores altos del indicador (Uvas, Algodón, Huevos, Carne de pollo y Cebolla) experimentaron, en los años recientes, deterioro en sus valores de competitividad. De los doce productos con niveles de competitividad inferiores a 1.0 en el período 1984-89, siete incrementaron su valor para el período 1990-95. En otras palabras, a nivel de producto hubo menos evidencia de que los más competitivos lograron ser más competitivos y los menos competitivos se volvieran menos competitivos.

El Cuadro-5 intenta ayudar a entender porqué el indicador de competitividad se comporta en forma diferente para los diferentes tipos de productos agrícolas. Para este propósito, los cultivos fueron clasificados, de acuerdo con los resultados del Cuadro-1, en siete grupos (No se consideraron los productos pecuarios para este fin). Los valores más altos y los más bajos de cada columna aparecen sombreados en el cuadro para llamar la atención sobre ellos.

Se observa que el alto nivel del indicador de competitividad de 1995 para Tomate es claramente el resultado de su alto valor por hectárea, además del hecho de que corresponde a empresa agrícola de mediana escala. Banano, Algodón, Caña de azúcar, Naranja y Uva son empresas de gran escala, lo cual es mayormente responsable por el alto valor de su indicador de competitividad.

Fríjol, Arroz y Soya son en promedio las empresas de mayor escala, pero debido a que sus valores por hectárea son bajos y sus relaciones costos variables sobre ingresos totales están entre las más altas, los valores del índice de competitividad fueron más bajos que los valores de los dos grupos anteriores.

Las empresas productoras de Papa son de tamaño mediano y el retorno por hectárea del cultivo está entre los más altos; pero la relación costos variables sobre ingresos que es en promedio la más alta de las empresas agrícolas hace que el indicador de competitividad no sea tan alto como podría esperarse.

Cultivos hortícolas consumidos domésticamente (Zanahoria, Lechuga y Sandía) evidencian alto retorno por hectárea y la más baja relación costos variables sobre ingresos pero la muy pequeña escala de sus operaciones los hace menos atractivos en términos de competitividad. En orden inferior de competitividad se encuentra el café dado su bajo retorno por hectárea.

Finalmente, Cebada, Avena, Sorgo y Trigo ocupan el último lugar debido a que sus costos son relativamente altos y sus retornos por hectárea son los más bajos.

Los resultados de este estudio son detallados en el documento "The Competitiveness of Agriculture in the Americas" por Reed Hertford y James A. García presentado en la conferencia sobre "El Papel Estratégico del Sector Rural en el Desarrollo de América Latina" llevado a cabo en Cartagena, Colombia del 8 al 10 de Julio 1998.

Colaboradores:

- IICA, BID, IFPRI, CIAT

Table 1 -- Average values (1984-95) of the competitiveness indicator for all enterprises, the top five, and the top ten in each country, eliminating three outlier observations

Country	Number of enterprises	Average values of the indicator			
		All Enterprises - Weighted Average	All Enterprises - Simple Average	Top 5 Enterprises - Weighted Average	Top 5 Enterprises/All Enterprises - Weighted Averages
Ecuador	16	32.58	20.29	65.14	2.00
Venezuela	18	15.37	9.06	30.29	1.97
Colombia	22	13.88	2.20	16.31	1.18
Bolivia	11	13.16	12.97	20.12	1.53
Argentina	14	11.19	11.24	17.54	1.57
Chile	18	8.46	7.99	17.45	2.06
Dominican Rep	18	7.49	8.36	15.38	2.05
Uruguay	15	4.18	2.17	5.52	1.32
Costa Rica	11	3.29	3.65	5.80	1.76
USA	14	1.80	1.57	3.71	2.06
Brazil (Sao Paulo)	16	1.30	0.98	2.04	1.57
Mexico	22	1.07	0.45	2.82	2.63
Guatemala	16	0.91	1.37	3.37	3.72
Peru	16	0.73	0.68	2.09	2.88
Paraguay	13	0.56	0.31	0.80	1.44

Table 2 -- Average values (1984-95) of the competitiveness indicator for all countries and the top three and top five by commodity, eliminating three outlier observations

Commodity	Number of Enterprises	Average values of the indicator			
		All Enterprises - Weighted Average	All Enterprises - Simple Average	Top 3 Enterprises - Weighted Average	Top 3 Enterprises/All Enterprises - Weighted Averages
BANANAS	9	21.91	9.93	40.42	1.84
SUGAR CANE	10	21.23	9.17	29.29	1.38
TOMATOES	13	8.09	10.05	18.69	2.31
TABLE GRAPES	1	7.29	7.29	7.29	1.00
SEED COTTON	11	6.58	5.32	7.13	1.08
ORANGES	9	4.90	11.50	17.63	3.60
HEN EGGS	8	3.94	30.89	64.93	16.49
CHICKEN MEAT	9	3.56	7.91	16.56	4.65
COW MILK,WHOLE,FRESH	13	3.24	5.70	13.72	4.23
ONIONS,DRY	11	2.69	2.92	6.68	2.48
RICE,PADDY	15	2.29	4.54	20.20	8.84
BEANS,DRY	13	2.23	2.80	18.78	8.42
SOYBEANS	10	2.13	4.47	11.52	5.40
POTATOES	13	1.78	3.29	11.20	6.28
MAIZE	14	1.50	2.35	18.54	12.33
GROUNDNUTS IN SHELL	1	1.37	1.37	1.37	1.00
BEEF AND VEAL	13	1.06	5.15	13.77	12.94
WHEAT	11	1.04	0.80	1.14	1.10
SORGHUM	10	0.98	2.70	8.47	8.66
TOBACCO LEAVES	8	0.96	1.26	3.16	3.29
CASSAVA	7	0.86	3.28	6.89	7.97
CARROTS	6	0.73	0.59	0.89	1.22
COFFEE,GREEN	10	0.68	0.79	1.78	2.61
WATERMELONS	3	0.66	0.66	0.66	1.00
LETTUCE	6	0.57	0.89	1.00	1.75
BARLEY	1	0.22	0.22	0.22	1.00
PIGS	1	0.12	0.12	0.12	1.00
OATS	4	0.07	0.11	0.07	1.01

Table 3 -- Average values of the competitiveness *indicator for all commodities* in each country, three time periods

Country	Average values of the indicator - All Enterprises Weighted and Simple Average for each period					
	1984-95		1984-89		1990-95	
Ecuador	32.58	20.29	23.71	26.09	33.57	19.36
Venezuela	15.37	9.06	9.19	5.57	15.92	9.71
Colombia	13.88	2.20	11.74	2.10	14.51	2.24
Bolivia	13.16	12.97	13.82	18.57	10.63	10.61
Argentina	11.19	11.24	31.19	27.57	11.06	10.51
Chile	8.46	7.99	9.16	9.16	7.88	7.39
Dominican Rep	7.49	8.36	7.54	7.65	7.62	8.64
Uruguay	4.18	2.17	5.99	3.18	4.05	2.11
Costa Rica	3.29	3.65	2.61	3.34	3.30	3.84
USA	1.80	1.57	1.41	1.65	1.71	1.45
Brazil (Sao Paulo)	1.30	0.98	1.82	1.23	1.30	0.98
Mexico	1.07	0.45	1.75	0.61	0.91	0.40
Guatemala	0.91	1.37	0.98	1.29	0.99	1.43
Peru	0.73	0.68	1.24	1.20	0.73	0.68
Paraguay	0.56	0.31	0.49	0.30	0.56	0.32

Table 4 -- Average values of the competitiveness indicator for all countries by commodity, three time periods

Commodity	Average values of the indicator - All Enterprises Weighted and Simple Average for each period					
	1984-95		1984-89		1990-95	
BANANAS	21.91	9.93	12.13	6.31	23.27	10.51
SUGAR CANE	21.23	9.17	18.85	9.82	22.63	8.88
TOMATOES	8.09	10.05	4.62	11.58	8.23	9.75
TABLE GRAPES	7.29	7.29	7.86	7.86	7.00	7.00
SEED COTTON	6.58	5.32	6.51	6.69	6.23	4.72
ORANGES	4.90	11.50	3.81	12.65	4.91	11.90
HEN EGGS	3.94	30.89	7.22	39.29	3.91	29.60
CHICKEN MEAT	3.56	7.91	7.21	10.56	3.40	7.47
COW MILK, WHOLE, FRESH	3.24	5.70	2.97	5.58	3.04	4.83
ONIONS, DRY	2.69	2.92	8.21	5.68	2.79	3.16
RICE, PADDY	2.29	4.54	2.17	7.19	2.27	4.48
BEANS, DRY	2.23	2.80	1.20	5.38	2.24	2.83
SOYBEANS	2.13	4.47	2.00	9.08	2.09	4.08
POTATOES	1.78	3.29	2.38	4.52	1.70	3.07
MAIZE	1.50	2.35	0.74	4.15	1.47	2.30
GROUNDNUTS IN SHELL	1.37	1.37	1.48	1.48	1.20	1.20
BEEF AND VEAL	1.06	5.15	0.72	5.64	1.09	5.40
WHEAT	1.04	0.80	0.91	2.17	1.00	0.78
SORGHUM	0.98	2.70	0.25	1.90	0.53	1.62
TOBACCO LEAVES	0.96	1.26	2.39	5.72	0.91	1.25
CASSAVA	0.86	3.28	1.18	3.44	0.82	3.31
CARROTS	0.73	0.59	0.66	0.53	0.79	0.62
COFFEE, GREEN	0.68	0.79	0.60	1.17	0.66	0.66
WATERMELONS	0.66	0.66	0.52	0.72	0.64	0.64
LETTUCE	0.57	0.89	0.61	0.85	0.60	0.92
BARLEY	0.22	0.22	0.22	0.22	0.21	0.21
PIGS	0.12	0.12	0.13	0.13	0.11	0.11
OATS	0.07	0.11	0.06	0.14	0.06	0.10

Table 5 -- The 1995 level of the competitiveness index compared with values of its determinants, S, T, and PR/W, weighted averages by crop commodity group

Commodity groups	S	T	PR/W	1995 Indicator level	Explanation
Bananas, Seed Cotton, Sugar cane, Oranges, Table Grapes	0.558	56.771	0.517	10.752	Large scale enterprises
Tomatoes	0.563	5.735	2.174	7.415	Highest value per hectare
Beans, Rice, Soybeans	0.635	70.700	0.110	2.299	Largest scale, but high costs and low gross returns per hectare
Potatoes	0.730	10.982	0.780	1.438	High value per hectare, medium scale, but highest costs
Carrots, Lettuce, Watermelons	0.503	4.550	1.139	0.797	Lowest cost-high value, but small scale
Coffee	0.531	6.193	0.146	0.548	Low value per hectare
Barley, Oats, Sorghum, Wheat	0.528	55.514	0.016	0.396	Large scale, but lowest value per hectare

S=Variable costs/gross returns ratio. T=Enterprise size (hectares). PR/W=Gross returns per hectare deflated by the employment-adjusted urban-industrial wage.

2.1.C. Tendencias de los procesos de deforestación y sus vínculos con la ganadería en América Latina - *L. Rivas*

- Los acentuados cambios en los patrones de uso de los suelos han propiciado significativas pérdidas de bosques en América Latina Tropical, las cuales en el período 1980-1990 superaban a las observadas en otras regiones en desarrollo como Asia y Africa. La información más reciente y confiable que cubre el período señalado, indica que las pérdidas acumuladas de bosques tropicales en la región se situaron en 74 millones de ha en ese período.

- Existe abundante literatura sobre el tema de la deforestación, no obstante persisten grandes vacíos en cuanto a su magnitud, distribución e intensidad geográfica y especialmente sobre las causas que la propician o la atenúan. Las cifras disponibles dan una idea general de problema, pero son deficientes al no identificar claramente el tipo de bosque que se pierde y la magnitud de los daños en los bosques intervenidos.

- Diferentes modelos globales de simulación indican que las tasas de deforestación en los próximos años tenderán a bajar, pero no por ello el problema pierde relevancia en América Latina, ya que continuará siendo de gran magnitud, de no mediar acciones políticas y tecnológicas que reviertan o suavizan la deforestación.

- No existe una explicación única y simple de la deforestación, hay consensos en relación con los agentes directos de ella, pero no en cuanto a las causas primarias o estructurales de la misma.

- El desenvolvimiento económico general, las políticas aplicadas, la competencia de las distintas actividades agropecuarias por los recursos productivos, modificaron los patrones de uso del suelo y propiciaron el avance de los cultivos comerciales intensivos en tecnología y capital en la tierras mejor ubicadas y de mayor productividad, desplazando a la ganadería hacia áreas marginales de bosques y sabanas. Por lo anterior, la relación ganadería – deforestación debe ser analizada dentro del contexto socioeconómico general.

- Los modelos de evaluación del impacto económico y ambiental de la deforestación muestran que para frenar sus efectos nocivos, se precisan herramientas de política económica y tecnológica. Pero que las primeras tienen mayor importancia relativa en lo pertinente al uso de los suelos y la conservación de los recursos naturales y el medio ambiente.

Resumen

Se efectuó una revisión bibliográfica y de información estadística sobre el tema deforestación y sus vínculos con la ganadería en América Latina Tropical. Este trabajo se resumió en una ponencia que se presentó en la Consulta de Expertos sobre Políticas para Producción y Manejo de Recursos Naturales organizada por la FAO en Brasilia en Mayo del presente año. El trabajo incluyó los siguientes tópicos: 1) La deforestación y su problemática, 2) Factores determinantes

de la deforestación, 3) Expansión ganadera y deforestación y 4) Política económica y tecnología en el contexto del cambio en los patrones de uso del suelo.

Se encontró que existe abundante material sobre el tema pero que aún persisten grandes vacíos de conocimiento sobre la magnitud y severidad del problema y sobre sus causas y consecuencias. La información disponible da una idea general del problema, pero aún es insuficiente para identificar y entender sus causas y su impacto económico y ambiental.
Las cifras más recientes y confiables se remontan al período 1980-1990 e indican que en América Latina Tropical, la pérdida acumulada de bosques tropicales llegó a 74 millones de ha. Una fracción muy importante de las áreas boscosas intervenidas, 52%, se destinó a usos efímeros, especulativos o ilícitos.

La literatura muestra evidencias de que el fenómeno de la deforestación tiene una dinámica muy variable espacial y temporalmente. En algunas zonas se observa que aunque los factores iniciales que propiciaron la deforestación tienden a desaparecer, otros nuevos la impulsan y el proceso continúa. En algunas otras la deforestación desaparece temporalmente para luego emerger con nuevos bríos.

La relación ganadería –deforestación debe estudiarse dentro de un contexto amplio que incluya el estilo de desarrollo y la dinámica de uso del suelo en el sector agropecuario en conjunto. El contexto macro y de política económica, que determinan el desarrollo vial, las tasas de interés y de cambio, la estructura de tenencia de la tierra y la distribución de ingreso, es la matriz de poderosas fuerzas que en definitiva determinan los patrones de uso de los suelos y los movimientos migratorios de la población

El desarrollo de tecnologías mejoradas y sostenibles tanto para los márgenes de bosque como para las zonas productoras consolidadas y de mayor productividad, parece ser esencial dentro de las estrategias para aliviar la presión sobre los bosques tropicales. No obstante es imperativo señalar que el desarrollo tecnológico, es necesario pero no suficiente para lograr este objetivo. Trabajos desarrollados por Smith et al. (1997) muestran la importancia relativa de la política y la tecnología cuando se trata de enfrentar problemas relacionados con el uso de los suelos y el medio ambiente. Por ejemplo, según Smith et al.(1997), en la amazonia brasileña la política resultaría cuatro veces más efectiva que la tecnología, cuando se pretende frenar la acelerada expansión de la frontera agrícola.

Es necesario mejorar la información existente sobre los procesos de deforestación, desarrollando sistemas de monitoreo que provean información permanente y detallada, sobre la magnitud de las áreas afectadas y la severidad de los daños, para entender mejor sus causas y efectos y estar en capacidad de diseñar estrategias apropiadas para enfrentarla.

2.2. Estimation of Impact

2.2.A. Community Management of Resources - *N. Johnson*

- Designed a *ex ante* impact analysis for improving community management of water resources in hillside watersheds.

- Completed data collection for the analysis.

Data collection was completed for an *ex ante* analysis of the impact of strengthening community management of potable water. The site for the study is the CIAT research watershed in San Dionisio, Matagalpa, Nicaragua. The study is being carried out jointly between BP-1 and PE-3, Community Management of Watershed Resources in Hillside Agroecosystems. It is designed to estimate impact of a PE-3 project as well as test a new methodology for valuing investments in community resource management (see section 1.4).

Potable water was identified by the community as one of their most pressing natural resource management problems. According to residents, water scarcity, inefficient distribution systems, and contamination combine to significantly reduce welfare for many people. The goal of the study is to estimate the magnitude and distribution of inefficient water management to see whether intervention is justified. Potable water is currently managed by local committees, so improving access to potable water would involve strengthening these organizations.

Various types of data were collected in order to compare and contrast the results under different estimation methods. The value of water will be measured in terms of 1) the opportunity cost of time spent bringing water from distant water sources, 2) the loss of income associated with water-borne diseases, and 3) residents own willingness to pay for better water supplies (contingent valuation).

In addition to comparing the final estimates that result from different valuation methods, the different methods will be compared in terms of their appropriateness for use by local communities to analyze their own resource management problems. Part of the goal of CIAT's research in this area is to identify methodologies and strategies that could be used by other people in other circumstances—especially by local stakeholders--to analyze similar types of problems.

Staff and Collaborators:

- Nancy Johnson

Funding Sources:

- Rockefeller Foundation, Swiss Development Corporation

OUTPUT III: EX POST IMPACT ASSESSMENT

3.1 Impact Reviews

3.1.A. Impact Briefs - *N. Russell, D. Pachico*

Improving Food Security

Rice Improvement for Latin America and the Caribbean

The challenge: In this century rice has gradually become the most important food grain in tropical America. The region's per capita consumption of this staple rose from 10 kilograms in the 1920's to about 30 in the 1990s. The displacement by rice of traditional staples, such as cassava and plantain, which are bulkier and more perishable, has been driven largely by rapid urbanization throughout the region. Rice is clearly a more convenient food for the approximately 70 percent of the population who now live in cities. Sustained improvement in the production of this crop is thus critical for food security in tropical America.

It is also vital for alleviating poverty in the region. About half of the people in Latin America and the Caribbean live below the poverty line, as defined by FAO. Food accounts for half of poor people's total expenditures, and 15 percent of what they spend on food in for rice. More efficient rice production in lowland irrigated areas offers the further advantage of reducing the pressure to expand cultivation of upland rice and other crops onto ecologically fragile land in the savannas and forest margins.

The product: In the mid-1960s, Latin America's entire rice area was planted to tall traditional varieties. Throughout the 1970s farmers rapidly adopted new semidwarf varieties developed by national programs and international centers. This was merely the beginning of a process that continues to the present. Over the last 25 years, national programs across the region have released, on average, a total of 10 new lowland rice varieties each year. A total of about 275 new varieties have been released, 90 percent of them targeted to flooded environments. About 39 percent of the varieties have come from crosses made at CIAT and 12 percent from IRRI crosses; some of the rest have progenitors from the international centers in their parentage. In general, each new variety represents significant improvement for at least one key trait, on top of the gains already achieved.

The impact: Modern semidwarf varieties now account for 93 percent of all flooded rice production, which represents 80 percent of Latin America's total output of this crop. In the irrigated rice areas, average yield increased from 3.3 tons per hectare in the mid-1960s to 4.6 tons in 1995. As a result, total rice production doubled during that period to about 20 million tons of paddy, making the region largely self-sufficient in rice. More efficient production has brought down the price of this staple by about 50 percent in real terms over the last three decades.

According to recent results from an ongoing study, consumers have been the main beneficiaries of technological change, receiving US$518 million per year since 1966. Producers in irrigated

areas have also captured large benefits, amounting to $437 million per year. These gains have been offset somewhat by losses in other rice production environments, mainly upland, rainfed areas.

Reducing Poverty

Cassava Starch Processing in Colombia

The challenge: Cassava provides food and a livelihood for roughly 120 million people in tropical America, where the starchy root crop originated. Traditionally, it has been considered a "poor man's crop," grown mainly for subsistence by small farmers in marginal environments. In recent years, though, the image of cassava has begun to change with the advent of new uses and markets. In addition to being consumed in fresh form, the crop has also become a component of animal feeds and a source of starch for a wide range of industrial products. As such cassava now offers small farmers, not just their next meal, but a reliable option for increasing their incomes.

The product: In the 1980s, CIAT and various national partners embarked on a search for ways to enable farmers to make a better living from cassava. This work was aimed particularly at farmers in marginal areas (characterized by poor soils and drought) where cassava is often one of the few crops that will grow. The product of this work was an integrated approach to cassava research and development, in which partner institutions work toward sustainable crop production in a given area, while simultaneously creating new or improved cassava products and markets.

One such project was established in Colombia's Cauca department, focusing on small-scale extraction of cassava starch for local markets. In 1989 various NGOs in that region joined CIAT and CIRAD, with financing from the French government, in an integrated project aimed at speeding the development of Colombia's cassava starch industry. Specifically, the project sought ways to improve the quality of the final product and to increase the efficiency of processing by improving equipment and procedures and by introducing and testing improved cassava varieties.

The Impact: A recent study divided the 208 starch processing operations in Cauca into three groups--low, medium, and high--according to their level of processing technology. Just over 15 percent of the units had adopted all or part of the improved technology introduced by institutions. The majority of processors (67 percent) were using technologies improved locally with institutional support. About 26 percent were processing roots of an improved variety with high dry matter content. Another 20 percent were mixing this variety with the best local variety.

Analysis of economic impact showed that from 1988 to 1996 the new technology had generated benefits valued at about US$25 million. Producers profited from the higher demand and somewhat better price for cassava roots, with benefits amounting to $6.4 million. Processors took an approximately equal share of the gains through reduced processing costs. The rest of the economic benefits accrued to industries that consume starch, because they were able to buy it at a lower cost. All these gains in turn benefited Colombian society by injecting cash into the economy and by generating employment. Given that the project cost about $8.9 million, its net benefits of $16.4 million represent an 80 percent internal rate of return.

Improving Food Security

Adoption of Climbing Beans in Rwanda

The challenge: Beans are grown on more than 3.5 million hectares in Africa, cultivated for subsistence and, increasingly, as a cash crop by poor farmers, mainly women. In Rwanda alone, 95 percent of all farmers grow beans, which provide 32 percent of all calories and 65 percent of all protein consumed in the country.

During recent decades high population density and land scarcity in Rwanda have given rise to extremely intensive production of beans and other crops on small plots. In the absence of sufficient organic and inorganic fertilizers, soils quality appears to be declining, and this poses a major threat to the country's food security. One warning sign of the problem was the emergence in the 1980s of a complex of bean diseases referred to collectively as "root rots." Serious outbreaks occur only in areas, like Rwanda as well as southwestern Uganda and western Kenya, where circumstances force farmers to exhaust the soil through ever more intensive cultivation. ***The product:*** In the early 1980s, CIAT began working with Rwanda's national bean program to test and improve experimental germplasm introduced from tropical America. The work has been funded by the Canadian, US, and Swiss governments. A prominent feature of this program was the participation of Rwanda's women bean farmers in the improvement scheme. Since the women tend to grow complex mixtures of beans, their early involvement in selection was considered essential for achieving wide adoption of new varieties.

One important finding on this work was that climbing beans of Mexican origin show market advantages over bush beans and local climbing varieties, especially in terms of yield and root rot resistance. They proved to be the ideal technology for a country where producing more food on less land is of the utmost urgency. Eventually, more than 20 climbing bean varieties were released. At first farmers complained about the need to use tall stakes, but with help from local NGOs they found a number of environmentally sound ways to obtain them.

The impact: During recent years CIAT staff have carried out a series of studies on the adoption of climbing varieties in Rwanda. In 1990, for example, six growing seasons after release of the variety Umubano, scientists observed and adoption rate of about 70 percent. The means yields of Umubano were 1.4 to 1.6 tons per hectare, compared to 0.8 to 1.0 tons for local climbing bean mixtures.

Then, in 1993 a nationwide survey showed that about 43 percent of Rwandan families were growing improved climbing bean introduced 5 years earlier. It was estimated that up to 20 percent of Rwanda's total bean area was sown to the new varieties. The study concluded that the use of improved climbing beans increased production by a much as 66,000 tons per year, generating extra income of about US$15 million.

In late 1995 a survey was conducted to monitor the impact of seed aid in Rwanda (under the Seeds of Hope project) after the genocide of 1994. Remarkably, the study found that, despite the violence, improved climbers were being grown by 48 percent of the bean farmers surveyed and accounted for a third of the bean seed sown.

Improving Food Security

Adoption of Improved Beans in Peru

The challenge: For many centuries common bean has been an essential part of the Andean zone'sdiet and culture. Here and throughout tropical America, the crop offers a protein-rich food that low-income families can afford. Beans are the fourth most important source of protein in tropical America, and as a source of calories, they surpass both potato and cassava. Beans also provide a livelihood for millions of small farmers, whose best hope for overcoming poverty is to produce food efficiently for expanding urban markets at home and abroad.

Until the early 1990s, production of this staple in the Andean zone as a whole was essentially stagnant, with rates of growth in yield and production lagging well behind population growth. The outlook for beans in the region was bleak, with trends in supply and demand pointing to large deficits by the year 2000.
The product: CIAT responded to this challenge in two ways; first, through an international bean improvement scheme that channeled improved germplasm to national programs around the world and, second, through bean networks in key production regions. These have provided national programs with a mechanism for sharing research results and responsibilities, and they have notably strengthened local capacity to solve problems in bean production. PROFIZA, the regional network for the Andean zone, was set up in 1988, with funding from the Swiss government.

As of 1996 the countries taking part in the network--Bolivia, Colombia, Ecuador, and Peru--had released 31 improved varieties. In addition to offering higher, more stable yields and good local adaptation, most of these varieties supplied genetic solutions to important disease problems in specific environments.

The impact: By 1995 bean production in the Andean zone had risen sharply, mostly as a result of higher yields. The annual rate of increase in production now exceeds the pace of population growth, with a resulting increase in per capita bean consumption.

A growing body of evidence from adoption studies in the Andean zone suggests that improved varieties have contributed importantly to those increases. For example, a 1996-97 study, in Peru's Cuzco department examined the adoption and impact of five new varieties that had been developed in the late 1980s through farmers participatory schemes. According to the study, 94 percent of farmers were growing new varieties. Moreover, these constituted 52 percent of the bean germplasm available, and they accounted for 64 percent of the total bean area. The study further determined that the combination of improved germplasm and higher plant densities boosted averaged yields by 110 percent from 1985 to 1996.

Protecting the Environment

Reducing Pesticide Use on Beans in Colombia

The challenge: In parts of Colombia, farmers have raised their incomes during the last two decades through intensive production of beans and other vegetables for urban markets. They have done so by adopting new varieties and practices, including pesticide application.

Unfortunately, though, a dangerous "chemical culture" has arisen in many rural communities. For fear of yield losses, farmers spray frequently and habitually, without accurate knowledge or assessments of the economic threat from insect pest. Indiscriminate use of chemicals has come to pose a serious threat to the environment and human health. And, ironically, it has made pest problems worse by destroying the natural balance between them and their natural enemies.

In the late 1980s, problems arising from total dependence on chemical controls became evident in the Sumapaz region, which supplies snap beans and other vegetables to markets in the nation's capital. Farmers were spraying snap beans about a dozen times during a growing season, roughly once a week.

The product: During the early 1990s, a pilot Project supported by CIAT and financed by IDRC began searching for ways to put chemical use on a more rational basis in Sumapaz. Through farmer participatory research, the Project developed an integrated pest management strategy for snap beans in the area, which consisted of six technologies, involving cultural, mechanical, and chemical controls.

The impact: In 1992 an adoption study showed high levels of adoption for at least some of the component technologies. Very few farmers accepted the entire IPM package. The most popular innovations were the cultural practices. Together with other measures, these enabled farmers to lower pesticide use by about 33 percent.

In 1996 a second showed that, although parts of the package were still in use, many farmers had abandoned them, and the average number of sprays per growing season had returned almost to its 1988 level.

The study put forward various explanations for this. For example, because snap beans prices vary greatly, farmers have a strong incentive to spray as a defensive measure to reduce the risk to their income. Another key consideration is that snap beans account for only 22 percent of farmers' total pesticide use in Sumapaz. Apparently, any effort to change the chemical culture there will have to deal with the whole farming system rather than a single crop.

3.1.B. Beans and Rice in Latin America - *A. van Schoonhoven, D. Pachico*

Tracking the complex modernization of Latin America rice and bean farming over the last three decades, a new study, compiled by the Colombia-based International Center for Tropical Agriculture (CIAT), reports today that production of rice has doubled between 1966 and 1995, and production of beans grew by 25 percent between 1983/85 and 1993/95. In some areas, bean

yields have grown by as much as 110 percent. CIAT is one of 18 agriculture centers sponsored by the Consultative Group for International Agricultural Research.

In addition to CIAT, sources of data for the report include the United Nations Food and Agriculture Organization (FAO), and national agricultural research programs of almost every country in Latin America and the Caribbean.

"Latin America has accelerated its rice and bean production over the past two decades with extraordinary speed, allowing millions of the region's poorest consumers to keep one of the world's most important pair of staple foods at the center of their diet," said Aart van Schoonhoven, Director of Genetic Resources Research at CIAT and author of the study. "The growth in rice and bean production has also allowed farmers in isolated areas to sell their products to urban centers in Latin America and even as far away as Japan. Furthermore, improved bean varieties are offering farmers in many destitute areas of the Andes of Bolivia, Colombia, and Peru with viable farming alternatives."

Rice Production

Rice supplies Latin America consumers with more calories than wheat, maize, cassava, and potatoes, and is consumed widely among Latin Americas, 70 percent of whom reside in urban areas. Over the also 30 years, national agricultural research programs across the region have released, on average, a total of 10 new lowland rice varieties each year, according to the CIAT report. In all some 300 varieties have been released. Nearly 40 percent of these varieties have come from crosses made at CIAT; 11 percent from the International Rice Research Institute (IRRI) in the Philippines; and the rest from national program in Latin America, Africa, and Asia. These modern, "semidwarf" varieties of rice today account for virtually all of rice production in Latin America.

CIAT economists have applied an "economic surplus model" to determine the steam of benefits to consumers and farmers of this improved rice production from 1966 to 1995. They have found that the new varieties and accompanying improvements in crop management increased the average rice yield in wetland areas from 3.3. tons per hectare in the mid-1960s to 4.6 tons (5.0 tons for irrigated rice) in 1995. Mainly as a result of the yield gains, total production doubled during that period to 20.6 million tons, making Latin America almost self-sufficient in rice. Meanwhile, the are planted to rice rose modestly, from 5.8 million hectares in the mid-1960s to 6.7 million in 1995.

"More efficient production of the crop on such a large sale has brought down its price by about 50 percent in real terms over the last three decades," said Douglas Pachico, PhD, Director of Impact Assessment at CIAT and an author of the Study. "As a consequence, consumers have enjoyed savings of US$518 million per year since 1966. Price savings have especially helpful to the poor, since the spend half of their total income on food, and rice accounts for 15 percent of their total food purchases."

Bean Production

Latin America is the most important bean-producing in the world; its 8 million hectares account for nearly half of global bean output. In contrast with rice, the crop is grown chiefly on small, non-irrigated farms in marginal environments, such as those characterized by steep, erosion-prone slopes and by low soil fertility.

National agricultural research programs in Latin America have released about 180 new varieties of beans, according to the report, based mainly on experimental lines developed at CIAT. Information provided by the national programs suggests that the new seed in now planted on at least 40 percent of Latin America's total bean-growing area. According to figures from FAO, over the last decade or so, total bean production in Latin America has risen 25 percent -- to 5.3 million tons in 1993-95 from 4.2 million tons in 1983-85. At the same time, total area in production has risen by only two percent -- to 8.1 million hectares from 7.9 million -- and the annual rate of growth in area has actually declined to -0.5 percent.

"Increase bean production has resulted mainly from higher yields," said Pachico. "The annual growth rate in beans yields is now about 2.7 percent compared to 1.9 percent a decade ago."

The increases in production have been even more dramatic in some parts of Latin American than in the region as a whole, according to the report. A 1996-97 study conducted by CIAT in Peru's Cuzco area examined the adoption and impact of five new varieties that had been developed in the late 1980s through farmer participatory schemes. According to the study, the new varieties constituted 64 percent of the total bean farming area. The study further determined that the combination of improved varieties and higher plant densities boosted average yields by 110 percent from 1985 to 1996. Other field studies from Bolivia, Colombia, and Ecuador have registered similar production increases.

"Modern production of beans has boosted incomes in rural areas, contributing to economic growth in Latin America across the board, "said van Schoonhoven. "Unlike some other traditional staples, the crop has fit rather easily into urban life and eating habits. This rapid growth in urban demand for beans, combined with improved bean production, has created new cash-earning opportunities for the small farmers who grow beans."

"However, the production increases in rice and beans crops need to be multiplied many times over if Latin America is to continue to provide sufficient food at reasonable prices for its burgeoning urban population," continued van Schoonhoven. " These gains are also important for reducing rural poverty. Expanding economic opportunities in areas already under cultivation is critical for reducing human pressure on Latin America's vast store of natural resources, especially its forests, biodiversity, and fresh water."

Funding for CIAT rice research has been provided by the United States and Colombia. Funding for bean research has been provided by the U.S., Switzerland, and Canada.

CIAT is a nonprofit, nongovernment research organization dedicated to alleviating hunger and poverty and to protecting natural resources in the tropics. It is one of the international centers of

the Consultative Group on International Agricultural Research, an association of nations and international agencies that funds research for development.

3.1.C. CIAT Germplasm - *N. Johnson, D. Pachico*

Introduction

Alleviating hunger and poverty through increased agricultural productivity has been at the heart of CIAT's mission since its foundation more than 30 years ago. The development and distribution of improved germplasm has been a central part of this effort. Improved germplasm of beans, cassava, rice and tropical forages from CIAT has reached farmers via national programs throughout the world.

During the past three decades, CIAT research has contributed to the development of 664 varieties that have been released by national agricultural research systems (NARS) in 51 countries worldwide in all continents (Figure 1). The availability of new germplasm has enabled farmers, depending on their circumstances and needs, to attain higher yields, suffer lower losses to pests and diseases, withstand soil and moisture constraints, and produce better quality crops.

Identification and release of improved germplasm is an essential first step in evaluating the impact of genetic resources research on agricultural productivity, alleviation of poverty and hunger, and a more sustainable use of natural resources. This paper summarizes current information on the release of improved genetic materials through CIAT. This information serves as an initial indicator of research performance and impact since it is through the release of new varieties to farmers that genetic research programs contribute to poverty reduction and increased agricultural productivity.

Since this paper gives only a partial and preliminary indication of impact achieved by CIAT research, it will be followed by future publications that will comprehensively document the extent of use of this germplasm and will attempt to assess its impact on agricultural production and human welfare. Moreover, improved germplasm is not the only output of CIAT's international research that impacts upon poverty, productivity and natural resources management. For example, CIAT has identified natural enemies of crop pests as well as beneficial micro-organisms that enhance crop performance. CIAT has developed improved research methods and decision support systems that contribute to enhanced management of natural resources. Scientific knowledge and training has contributed to national capacity to solve agricultural and natural resource management problems. Thus, documenting the release of improved germplasm from CIAT provides some indication of the impacts of CIAT research, but it does not give a comprehensive and complete picture of impact.

Broad Trends in Germplasm Releases

Ninety-eight percent of the germplasm coming from CIAT has been released by NARS in developing countries. Latin America and the Caribbean have been the biggest beneficiaries of releases of improved germplasm through CIAT (Table 1). Some 530 germplasm releases have occurred in this region, including all four CIAT mandated crops: beans, cassava, rice and tropical

forages. In addition, Africa has benefited from a large number of germplasm releases in beans, while there have been numerous releases of improved cassava in Asia. In fact, Asian releases of CIAT cassava germplasm outnumber those for Latin America. Available data on rice germplasm releases are restricted to Latin America and the Caribbean (LAC), CIAT's mandated region. While the vast majority of CIAT releases have gone to LAC countries, there is no doubt that some CIAT germplasm has found its way into varieties in other regions such as Asia and Europe. Forage releases have so far been heavily concentrated in the LAC region.

Brazil is the country that has released the largest amount of material from CIAT, with 120 germplasm releases, covering all CIAT crops (Table 2). Colombia is second with 46 releases, while Mexico ranks third with 37 releases, followed by Cuba with 34 releases. All these countries have released germplasm from all four of CIAT's mandate crops, with rice being the most frequent release. Ecuador and Panama also have released CIAT derived materials for all four crops- beans, cassava, rice and tropical forages.

Rice from CIAT has been released in 23 countries in LAC, thereby attaining almost total coverage of the region. Improved beans have been released in 39 countries world wide, including 18 in Latin America and 14 in eastern and southern Africa. CIAT cassava has been released in 8 Latin America countries and 6 nations in Asia. Forages have been released in 14 countries, 12 of them in Latin America.

Over time there has been an increase both in the number and also in the diversity of materials released coming from CIAT (Table 3). The total number of releases of genetic materials coming from CIAT risen five fold, from 58 during the 1970s to 311 in the 1990s.

During the 1970s, almost all the germplasm releases were of rice, as CIAT built on the gains of the previous rice research done at IRRI by testing, distributing and adapting new materials for LAC production conditions. During the 1980s the rate of release of rice germplasm accelerated as materials with better adaptation to Latin American conditions were developed in collaboration between CIAT and NARS. By the late 1970s, bean varieties developed in CIAT's own program were also being released in substantial numbers. During the 1980s bean releases caught up to rice, and during the 1990s there were more than twice as many bean releases as rice releases. In large part this is due to the fact that the greater diversity in bean production environments, systems, and market requirements demands more specialized varieties, each one of which covers a smaller area than would be the case for most rice releases. Because of this diversity it would take a larger number of bean releases to cover a given area than would be the case for rice.

By the 1990s practically all irrigated rice in LAC was covered in improved varieties. Nonetheless, taking into account that the data for the 1990s really only covers 7 complete years, the annual rate of release of new rice varieties with CIAT assistance appears as high in the 1990s as in the 1980s, even though the new varieties are often replacing previously released improved varieties. In contrast, in beans, the rate of releases of new varieties has continued to climb in the 1990s. In large part this is because many African countries have also begun to release improved bean varieties. Nonetheless, because of the relatively smaller areas covered in individual bean varieties, neither the total area in new bean varieties nor the percent of the area in improved varieties reaches the high levels attained in irrigated rice in LAC.

In the early 1980s releases began to emerge from CIAT's cassava and forages research, and these continued in the 1990s, with the number of cassava releases accelerating slightly in the 1990s. Initially the cassava releases were concentrated in Latin America, particularly in Colombia and Brazil. More recently, a growing number of cassava releases have been occurring in Asia, especially in Thailand, China, Indonesia and Vietnam.

NARS were particularly active in releasing forage germplasm in the 1980s, with Colombia and Brazil being the leading countries in this regard. Substantial areas are known to have been established with new forage germplasm in these countries. Because the diffusion of forages is much slower than in the case of annual crops, the adoption of some material originally released in the 1980s is still ongoing, lessening the pressure for further new releases of forages in these countries. More recently, forage germplasm releases have been increasing in Central America, especially in Costa Rica.

Table 3 also shows data on NARS releases of varieties which they developed without direct CIAT assistance or material input. CIAT may sometimes have played an indirect supporting role in developing these varieties, for example, through the development of breeding methods or the provision of technical assistance or training. Nonetheless, NARS breeders have had the full responsibility of developing these releases. Unfortunately, the available data may not be complete and thus may under-represent the level of NARS' breeding activity.

Nevertheless, it appears that NARS breeding of their own varieties has not significantly slackened nor been displaced by CIAT breeding. Table 3 shows, for example, that the number of releases of improved varieties developed solely by NARS without direct CIAT involvement has been steadily rising since the 1970s for both rice and forages. Likewise, the development of improved bean varieties without direct CIAT help actually grew from the 1970s to the 1980s. Comparing the 1980s to the 1990s, the number of bean varieties being released by NARS on their own remains at about 7 releases per year.

Consequently, these data suggest that CIAT breeding has complemented a growing NARS production of new varieties, rather than crowding out NARS efforts on their own initiative. The combined efforts of NARS working on their own and working in collaboration with CIAT has made available to farmers a great and increasing diversity of new germplasm options.

Types of CIAT-Assisted Releases

The release of improved genetic materials from CIAT can come from four basic sources. The first is through exchange of native materials or landraces from collections maintained by CIAT. At an early stage in crop improvement significant gains can typically be made through the exchange of native materials from one region to another. In this paper, such releases are called "germplasm accessions", which essentially consist of landraces selected over generations by farmers.

Secondly, improved materials can be obtained through exchange in a genetic improvement network. In rice, such network exchange drew principally on prior work of IRRI, but also of

national programs. In beans, network exchange has involved mainly the exchange of materials among NARS through networks that CIAT initiated.

Third, improved materials have emerged through CIAT's breeding programs. CIAT breeders develop advanced lines that are essentially finished products which can be utilized directly by NARS. CIAT also releases crosses, which are selected locally by national programs and then released as varieties.

Finally, national programs utilize as parents in their own breeding programs materials with desirable characteristics that have been developed by CIAT. In this case the NARS are producing the advanced lines while CIAT is providing an intermediate input in the form of parents.

The evolution of the types of materials released by CIAT is shown by decade for three crops in Table 4. Tropical forages are excluded because all the released materials fall into a single category, germplasm accessions. For the other three crops there is a remarkably consistent evolution in the types of materials released.

Initially the exchange of germplasm collection material is significant for both beans and cassava, but its importance declines strongly over time. This is because after the initial gains have been made from circulating existing materials, further gains can only be made through creating new variation through breeding. In the case of rice, this stage had already been fully exhausted by the time that CIAT began its rice research. Likewise, for rice and beans the circulation of materials from earlier international and national breeding work declines in importance over time.

Of increasing importance over time has been the development of advanced lines by CIAT. To a large extent this reflects the economies of scale of working with large germplasm collections to screen and recombine diversity for distribution to a broad set of users. The strategy of creating international public goods in Center breeding programs has clearly succeeded in providing to NARS an increasing amount of improved genetic material that they find useful to release to farmers. The demand for this type of output from CIAT appears to remain high.

Nonetheless, the growth in the use of CIAT developed parental materials foreshadows a further evolution in the Center-NARS partnership for genetic improvement. Increasingly CIAT is moving into a role of using advanced genetic techniques of biotechnology to identify and recombine useful genetic diversity. Once these materials have been developed, an growing number of NARS will be able to use them in their own breeding programs to produce their own advanced lines. Thus, over time it is expected that there will be a continuing trend towards greater use of CIAT parents as NARS take over a greater role in the production of advanced lines. Eventually it is expected that the production of advanced lines at CIAT will decline, and the use of CIAT derived parents will be the most important contribution of CIAT to NARS. Table 4 indicates that although still incipient, this process is now clearly under way in the cases of beans, cassava and rice.

Summary and Implications for Future Analysis

The data presented here demonstrate that with the direct assistance of CIAT, a great amount of new genetic material has been released to farmers by NARS. These releases have occurred throughout the world, but 98% in developing countries. Improved germplasm developed with CIAT assistance has been released for beans, cassava, rice and forages in a wide variety of countries. Overall, the volume of material developed with CIAT assistance is increasing while at the same time the amount of material produced by NARS without direct CIAT assistance is also increasing. The types of materials being released are changing over time. Initially there was a very significant role for direct utilization of collected germplasm, followed by subsequent importance of new lines developed by CIAT based on the germplasm collection. More recently, NARS are beginning to use CIAT materials as parents in their own breeding programs.

These data are indicative of the potential impact of new germplasm. However, to measure impact it is also necessary to know the extent of use of the new genetic materials by farmers and the effects that these material have had on productivity. In collaboration with NARS, CIAT has conducted over 80 studies of these issues. Abstracts of these studies have been published by CIAT, and are available on the world wide web at www.CIAT.CGIAR.ORG under Impact. These studies provide substantial documentation that the germplasm releases that have occurred,have led to adoption by farmers, changes in productivity, and improvements in welfare.

Currently CIAT is participating in a study sponsored by the CGIAR Impact Assessment and Evaluation Group that will marshall all available evidence to make a comprehensive estimate of the use and impact of improved genetic material developed with assistance from CGIAR centers. Results from this study will be forthcoming by the end of 1999. This study will not only better document the economic impact of CGIAR research to improve germplasm, but will also from the basis for addressing other important issues.

The economic value of varieties, and of their specific traits, needs to be elucidated. This information can help inform decisions about the economics of genetic resources conservation. At the same time, new legal regimes with respect to ownership rights to genetic resources have emerged out of the UNCED Rio convention on biodiversity as well as other policy decisions at the national level in many countries. Frameworks are needed to negotiate the use of these rights among different parties, including compensation mechanisms. Better genealogical data will make it possible to assess the economic contribution of the landraces and other varieties that make up today's improved varieties. This information will be critical to such negotiations.

Growing population, environmental degradation, and the risks of climate change all increase the pressure on agricultural research to respond rapidly with new, more productive genetic material for specific agroecosystems. The work of the CGIAR system in conservation, improvement and materials transfer is critical to meeting these challenge. Quantifying the value of these services will help insure that they will be available for future generations.

Table 1. Releases of Improved Germplasm with CIAT Assistance by Region, 1967-98.

	Beans	**Cassava**	**Rice**	**Tropical Forages**	**Total**
Latin American and Caribbean	225	22	240	43	530
Africa	93	0	0	0	93
Asia	1	25	0	1	27
Australia	2	0	0	1	3
Europe	7	0	1	0	8
North America	3	0	0	0	3
Total	**331**	**47**	**241**	**45**	**664**

Table 2. Varieties Released with CIAT Assistance by Crop, Country and Region, 1967-1998

REGION	COUNTRY	RICE	BEANS	FORAGES	CASSAVA	TOTAL
LATIN AMERICA AND THE CARIBBEAN	ARGENTINA	1	30			31
	BELIZE	1				1
	BOLIVIA	7	15			22
	BRAZIL	71	36	7	6	120
	CHILE	2	6			8
	COLOMBIA	21	11	7	7	46
	COSTA RICA	9	18	5		32
	CUBA	7	23	3	1	34
	DOMINICAN REP.	8	3		2	13
	ECUADOR	7	8	1	1	17
	EL SALVADOR	5	5			10
	FRENCH GUIANA	1				1
	GUATEMALA	10	11	1		22
	GUYANA	3				3
	HAITI		1		2	3
	HONDURAS	5	12	4		21
	MEXICO	27	4	4	2	37
	NICARAGUA	7	14	1		22
	PANAMA	9	8	3	1	21
	PARAGUAY	5				5
	PERU	19	12	2		33
	SURINAME	7				7
	URUGUAY	1				1
	VENEZUELA	7	8	5		20
AFRICA	BURUNDI		11			11
	CONGO		12			12
	ETHIOPIA		13			13
	KENYA		3			3
	MADAGASCAR		1			1
	MALAWI		7			7
	MOZAMBIQUE		4			4
	RWANDA		11			11
	SOUTH AFRICA		5			5
	SWAZILAND		3			3
	TANZANIA		7			7
	UGANDA		10			10
	ZAMBIA		3			3
	ZIMBABWE		3			3
ASIA	CHINA			1	4	5
	INDONESIA				3	3
	MALAYSIA				2	2
	PHILIPPINES		1		6	7
	THAILAND				7	7
	VIET NAM				3	3
AUSTRALIA	AUSTRALIA		2	1		3
NORTH AMERICA	CANADA		1			1
	USA		2			2
EUROPE	CYPRUS		1			1
	FRANCE	1				1
	SPAIN		3			3
	TURKEY		3			3
ALL COUNTRIES		241	331	45	47	664

Table 3. Number of Germplasm Releases by Decade, 1970-1998*

Crop	1970s		1980s		1990s**	
	CIAT	NARS	CIAT	NARS	CIAT	NARS
Rice	48	4	103	17	83	22
Beans	10	26	98	76	186	53
Forages	0	0	28	2	17	4
Cassava	0	0	22	na	25	na
Total	58	30	251	95	311	79

* Does not include data for releases prior to 1970 nor for releases for which a date could not be identified. NARS data is only for countries in which CIAT-assisted germplasm releases have occurred.
** Includes data through early 1998.

Table 4. Types of CIAT-assisted Genetic Releases by Crop and Decade (% of total releases)*

	Rice			Beans			Cassava	
	1970's	1980's	1990's	1970's	1980's	1990's	1980's	1990's
CIAT Germplasm Collection	0.0	0.0	0.0	30.0	18.4	11.3	54.5	8.0
CIAT Cross**	22.9	50.5	65.1	50.0	63.2	75.8	31.8	48.0
CIAT Parents	0.0	4.8	9.6	0.0	0.0	6.5	4.5	20.0
CIAT Network Exchange	77.1	44.7	25.3	20.0	18.4	6.5	0.0	0.0
CIAT Technical Assistance	0.0	0.0	0.0	0.0	0.0	0.0	9.1	24.0

* Includes data on varieties for which dates and categories are available.
** Includes both CIAT advanced lines and CIAT crosses selected locally.

3.2 Empirical Studies

3.2.A. Integrated Pest Management Beans - *N. Ruiz-Londoño*

Objetivos del estudio

- Cuantificar el nivel de adopción del MIP para Habichuela en la región del Sumapaz, Colombia.
- Identificar y entender limitantes a la adopción.
- Valorar el impacto de políticas de intervención en el uso de plaguicidas.

Etapas del estudio

1. Diagnóstico

En el año 88 diagnosticó que el uso de plaguicidas para el control de insectos se había constituido en una solución única y peligrosa en los cultivos de habichuela y frijol seco en las zonas de ladera de América Latina.

2. Plan de acción

En 1988 El ICA (Instituto Colombiano Agropecuario) y el CIAT consideraron inaplazable diseñar y desarrollar una campaña tendiente a racionalizar el uso de plaguicidas en *Phaseolus v.* con énfasis en habichuela.

Entre 1988 -90 se diseñó un sistema de manejo integrado de plagas para el cultivo de habichuela en la región. En 1990 se realizaron pruebas del MIP en la estación experimental local

En 1991 se amplió y enfatizó el trabajo participativo con agricultores y se procedió a poner en marcha la entrega de la tecnología por parte del ICA,

3. Evaluación de ex-post de la tecnología MIP

En 1992 se hizo un seguimiento de adopción temprana, se entrevistaron 140 agricultores, en tres municipios de la Provincia del Sumapaz productores de habichuela, encontrándose que los agricultores habían incorporado en forma significativa algunos componentes del MIP al manejo de su cultivo.

En 1995-96 el CIAT hace una evaluación de adopción e impacto de la tecnología MIP en la Provincia del Sumapaz.

Resumen y Conclusiones

1. Con respecto al año base, 1986, se encuentran logros en la adopción de algunos componentes del MIP como la aplicación del insecticida granular al momento de la siembra, la destrucción de residuos vegetales y el monitoreo de Mosca Blanca

2. La adopción encontrada en 1992 fue alta para varios componentes del MIP pero fue sensiblemente diezmada entre 1992 y 1996.

3. Los componentes del MIP son muy conocidos por los agricultores de la región y el nivel de comprensión del mensaje tecnológico y de sus objetivos es alto.

4. Las pérdidas en adopción por componentes se deben a la escasa efectividad de la tecnología MIP cuando se aplica desagregadamente

5. Los logros en adopción no se reflejaron en reducción del número de aplicaciones de plaguicidas por cosecha ni en un uso racional de los plaguicidas que eran los objetivos principales del MIP diseñado para habichuela en la región del Sumapaz.

6. La ausencia de una solución genética impidió reducciones en el uso de fungicidas con efectos indirectos sobre el uso de insecticidas, debido a la práctica generalizada de aplicar conjuntamente los fungicidas e insecticidas

7. No hubo adopción del paquete MIP, la integridad fue desatendida por los agricultores

8. La integridad implica para el agricultor una complejidad mayor en la lucha contra las plagas que la tecnología tradicional – los plaguicidas

9. Los beneficios adicionales del paquete MIP son básicamente sociales al proteger el medio ambiente. Los beneficios para el productor de habichuela, en el corto plazo, no son mejores a los obtenidos con el uso de plaguicidas.

10. Los resultados del estudio plantean la pregunta de que tan factible es que el agricultor use una tecnología más compleja que los plaguicidas, sin resultados sobre la productividad o calidad de habichuela.

11. El punto central parece ser la discrepancia entre quien genera los beneficio ecológicos y quien los recibe. Aparentemente el agricultor no puede internalizar los beneficios que genera al adoptar la tecnología propuesta

12. Se plantea el hecho de que la tecnología es un elemento importante pero no suficiente en la lucha conservacionista

13. Aparentemente los procesos MIP del tipo propuesto para la región del Sumapaz requieren para su adopción de políticas complementarias que estimulen los productores a la adopción de tecnologías diseñadas con objetivos de conservación del ambiente.

14. Los estimativos realizados en este estudio calculan la necesidad de incrementar el precio de la habichuela descontaminada para mercado en un 69 por ciento con respecto al precio actual. Esto para conseguir una reducción en el numero de fumigaciones del 42 por ciento.

15. Definir si el excedente en el precio debe ser asumido por los consumidores directamente o por el Estado a través de subsidios, es una discusión necesaria, pero inaplazable.

16. Este o cualquier otro mecanismo de implementacion de procesos MIP debe basarse en la necesidad de que el agricultor internalice los beneficios de aplicar las tecnologías de protección. Si se quiere garantizar que los procesos MIP tengan espacio en la producción agrícola.

17. La gradualidad en la entrega de la tecnología MIP como solución para la aceptación del paquete total, es viable solo en la medida de que se dé prioridad a los componentes más

autónomos o más solventes en el control de las plagas. Aquellos otros complementarios o coayudantes en el logro de otros objetivos, como los que buscan protección del medio ambiente u otro objetivo similar no pueden ser entregados en forma aislada pues exponen al cultivo a perdidas de productividad.

18. La integralidad en el manejo de plagas y enfermedades debe contemplar el sistema de producción. En la región la presencia de otros cultivos intensivos en el uso de plaguicidas anulan los efectos benéficos de un MIP orientado a un solo cultivo.

19. La susceptibilidad de la variedad a patógenos y la alta inestabilidad del precio de la habichuela crean un escenario de alta dificultad para la aceptación de tecnologías que impliquen riegos en productividad, superiores al manejo tradicional: el uso de plaguicidas.

20. La concentración de la inversión en las etapas iniciales del cultivo crea una barrera para la aceptación de tecnologías que impliquen un mínimo de riesgo de desproteccion de la inversión realizada.

21. La técnica usada por el MIP para definir el momento adecuado de control o Umbral de Acción implica momentos de **no** aplicación, los cuales se definen en términos de la gravedad del ataque y de la situación de precios del mercado. Esta técnica no incluye el valor de la inversión ejecutada, ni la inestabilidad de los precios como elementos de riesgo, factores ambos de especial magnitud en el caso de la habichuela:

3.2.B. Forrajes en los márgenes de bosque: Adopción temprana de la leguminosa *A. pintoi* en la región del Caquetá (Colombia) - *L. Rivas y F. Holmann*

- En la región del Caquetá predominan los pequeños y medianos productores, que desarrollan actividades ganaderas de doble propósito, producción conjunta de carne y de leche. El 87% de ellos utiliza este sistema, en explotaciones con un área total promedio de 159 has.

- Los patrones de uso del suelo, la utilización de pastos y la composición de sus áreas plantadas, presentan gran dinamismo en la región. Comparando los resultados de un muestreo efectuado en 1986 con los de éste estudio, se observa que ha existido una notable diversificación del germoplasma forrajero y un claro proceso de sustitución de pasturas nativas por pastos mejorados. Entre 1986 y 1997 área en pastos mejorados como proporción del área total de la finca subió de 26 a 58%.

- Durante el período de observación, *B. decumbens* la especie de gramínea más difundida en la región y en el trópico latinoamericano, ha perdido importancia relativa frente a otras especies de brachiaria como *humidicola* y *brizantha.*

- Una alta proporción de los productores (83%), informó que tiene problemas en relación con la presencia de plagas y enfermedades de los pastos, lo cual sugiere que existe una alta demanda potencial por nuevos materiales forrajeros más persistentes y productivos. La diversificación del germoplasma parece obedecer a una estrategia de los productores para

hacer frente al 'mión" o "salivazo" de los pastos, la plaga de mayor importancia económica en el Caquetá.

- La leguminosa forrajera *Arachis pintoi* (maní forrajero perenne) recientemente introducida y promocionada en la zona por un proyecto conjunto de CIAT y Nestlé, se encuentra en una fase temprana de la adopción. Los productores que están ensayando con el nuevo material, en su gran mayoría (82%), se encuentran satisfecho con los resultados logrados hasta el momento.

- Actualmente las áreas plantadas son pequeñas, 9.6 has de A. pintoi asociado con gramíneas y 1.3 has como semillero, en promedio por finca. Una elevada fracción de adoptadores tempranos (85%) está dispuesto a ampliar las áreas plantadas con *A. pintoi.*

- Debido a la pequeña magnitud de las áreas plantadas aún no se detectan problemas de viabilidad financiera asociados con los costos de establecimiento y las inversiones adicionales en ganado. Se aprecia un acentuado déficit de información para los productores en temas relacionados con el establecimiento, uso y manejo de las pasturas mixtas basadas en *A. pintoi.*

Resumen

En 1997 se inició y durante 1998 se culminó un estudio sobre la adopción temprana de la leguminosa forrajera *A. pintoi* en la región del Caquetá, representativa de la amazonia colombiana y de los márgenes de bosque del trópico húmedo.

El Proyecto Nestlé, que es un esfuerzo conjunto del CIAT (Proyecto IP5) y la firma Nestlé de Colombia, ha impulsado el uso de ésta leguminosa en la región a través de trabajo de validación y ajuste del nuevo material en las fincas, divulgación de información y apoyo y asesoría a los productores.

La leguminosa forrajera *A. pintoi* (maní forrajero perenne) se constituye en una alternativa promisoria y novedosa para las condiciones del agroecosistema mencionado, por sus características de ser perenne y de uso múltiple: Puede ser utilizada como pastura sola o asociada con las gramíneas y/o como cultivo de cobertura del suelo.

Para apoyar las actividades del Proyecto Nestlé, se elaboró un estudio sobre la adopción de ésta leguminosa en una fase temprana, para conocer su evolución, perspectivas y limitantes, pero en especial para aportar elementos de juicio para el diseño de las futuras actividades del proyecto en la zona, encaminadas a acelerar el proceso de adopción. Este estudio de adopción lo ejecutó el Proyecto BP1 con la colaboración del Proyecto IP5 y la firma Nestlé de Colombia.

La información básica del estudio se recolectó mediante un muestreo tomando como universo al conjunto de fincas proveedoras de leche a la planta procesadora de Nestlé en el Caquetá. Se trabajó con dos tipos de muestra, una completamente al azar que incluyó 174 observaciones y otra dirigida a los productores que con certeza se sabía que estaban ensayando el material. Esta última incluyó 52 observaciones. En total el número de observaciones fue de 226. Desde el punto

de vista estadístico se trabajó con un nivel de confianza del 80% y un error admisible del estimador, el promedio de ventas de leche por finca y por año, del 10%.

Las entrevistas se hicieron con los productores, empleando un formulario convencional que incluía 50 preguntas. El equipo de entrevistadores estuvo conformado por personal técnico del Ciat y Nestlé y por estudiantes de zootecnia de la Universidad de la Amazonia.

La evolución histórica de los sistemas ganaderos del Caquetá se analizó mediante la comparación de los resultados de dos muestreos en la zona, distanciados en el tiempo por un lapso de 11 años. El primero se elaboró en 1986 y fue el producto del trabajo en equipo de Ciat y Nestlé para evaluar la adopción de la gramínea forrajera *Brachiaria decumbens* (Ramírez y Seré, 1990). El segundo punto de referencia es la encuesta elaborada en este estudio durante 1997.

Dinámica del uso de la tierra. La comparación de las dos encuestas permite concluir que ha existido gran dinámica en los patrones de uso de la tierra en el Caquetá durante el período de observación, cuyas principales facetas son: 1) Reducción de la importancia relativa de los pastos nativos ('criaderos", en el lenguaje local) en favor de un mayor uso de pastos mejorados, la proporción de estos con respecto al área total de la finca cayó de 47 a 24%. (Cuadro 1). 2) Diversificación del germoplasma forrajero utilizado, que se manifiesta en pérdida de importancia relativa del área plantada en *B. decumbens* y aumento del uso de otras especies del mismo genero como *humidicola*, *brizantha* y en menor medida *dictyoneura*. La especie *B. decumbens* dentro del genero brachiaria es la más difundida en la región y en el trópico latinoamericano en general, pero es la más susceptible a los ataques del "mión" o "salivazo" de los pastos, el cual afecta considerablemente su productividad. Por lo anterior, una de las estrategias de los productores es diversificar el germoplasma, para tratar de minimizar las pérdidas económicas por ataques de esta plaga (Cuadro 2).

Cuadro 1. Dinámica de uso de la tierra en fincas de doble propósito en Caquetá, Colombia: 1986-1997.

Uso de la tierra	Encuesta 1986		Encuesta 1997	
	Area (ha)	%	Area (ha)	%
Area total de la finca	131	100	158	100
Area total en pastos	95	73	129	82
- Criaderos	62	47	38	24
- Pastos mejorados	33	26	91	58
Area en cultivos	4	3	3	2
Area en descanso	22	17	10	6
Area en bosques	9	7	16	10

Situación actual de las pasturas. De un total de 226 productores entrevistados 187 de ellos, 83%, admitieron tener problemas relacionados con la disponibilidad y calidad de los forrajes, en particular por la alta incidencia en la zona del salivazo. Lo anterior sugiere que existe en la

región alta demanda potencial por nuevos materiales forrajeros con mayor calidad, productividad y resistencia a plagas y enfermedades. Una tabla de frecuencia de los problemas identificados por los productores, que limitan la producción forrajera del Caquetá se presenta en el Cuadro 3.

Utilización, conocimiento y expectativas sobre *Arachis pintoi*

Un elevado grupo de productores entrevistados ha escuchado comentarios sobre la existencia de ésta leguminosa, 179 entre 226 productores (Figura 1). En el momento de las entrevistas 68 productores estaban ensayando el material

El estado actual de las experiencias con maní forrajero es muy variable y va desde siembras muy recientes hasta su utilización en pastoreo. Los lotes sembrados en asociaciones con gramíneas tienen un tamaño promedio 9.6 has y los semilleros 1.3 has. La gran mayoría de productores que ensayan con maní, 57 de un total de 68, lo hacen plantándolo asociado con las gramíneas.

El grado de satisfacción con las experiencias se puede considerar como alto. El 82% manifestó estar satisfecho con los resultados logrados hasta el momento. Los atributos de Arachis reconocidos por los ganaderos están relacionados con: Incrementos en carga animal y en producción de leche, aumentos en las ganancias de peso, alta competencia con las malezas, buena capacidad para asociarse con las gramíneas y alta palatabilidad.

Cuadro 2. Variación de la estructura del área en pastos mejorados Caquetá, Colombia: 1986-1997.

	1986	**1997**	**(%)**
B. decumbens	76.0	64.1	-11.9
B humidicola	0.6	13.8	13.3
Pasto alemán	3.8	11.9	8.1
B brizantha	0.0	4.7	4.7
Arachis asociado	0.0	2.7	2.7
Arachis solo	0.0	0.1	0.1
B dictyoneura	0.0	1.0	1.0
Imperial	5.0	0.7	-4.3
Otras brachiarias	0.0	0.3	0.3
B. ruziziensis	0.0	0.1	0.1
Puntero	7.9	0.3	-7.6
Micay	1.2	0.0	-1.2
Guinea	2.1	0.0	-2.1
Pará	1.2	0.0	-1.2
Elefante	2.3	0.0	-2.3
Otros	0.0	0.3	0.3
Total	**100.0**	**100.0**	**0.0**

Cerca de una tercera parte de quienes han plantado Arachis (31%) informó haber tenido problemas en su establecimiento, relacionados con bajas tasas de germinación de la semilla (8 productores) y lento establecimiento (7 productores).

Cuadro 3. Frecuencia de los problemas que limitan la producción forrajera en fincas del Caquetá, Colombia.

Tipo de problema	**No. de productores**	**%**
Plagas y enfermedades	146	64.6
Baja calidad del forraje disponible	60	26.5
Problemas relacionados con el clima (lluvia, sequía)	24	10.6
Falta de recursos físicos y financieros	8	3.5
Falta de otras opciones forrajeras	3	1.3
Problemas relacionados con la calidad del suelo	5	2.2
Otros	3	1.3

Nota: la suma de productores es mayor que 226, ya que algunos reportaron mas de un problema.

Adopción temprana de *Arachis pintoi.* La adopción de *Arachis pintoi* en el Caquetá se encuentra en una fase muy incipiente, ya que las siembras en su gran mayoría son muy recientes y el número de productores que ensayan el material aún es bajo. La experiencia señala que el proceso de adopción temprana en pasturas o en cultivos de plantación es más prolongado que en cultivos temporales, porque en los primeros la inversión en su establecimiento es de magnitud considerable y el período de recuperación del capital invertido es más largo.

Calculando la tasa de adopción en esta fase temprana del proceso, utilizando únicamente la información de la muestra obtenida totalmente al azar, se encuentra que esta se sitúa en 9.2%. (16 entre 174 productores). La cifra anterior sirvió de base para estimar el área total actualmente sembrada con *Arachis* en la zona de influencia de Nestlé, la cual incluye un total de 2973 fincas. Se estima que el área total sembrada se aproxima a las 3000 has, de las cuales el 88% son siembras de asociaciones con gramíneas

Productividad de los sistemas ganaderos. Los cambios en el uso del suelo han influenciado los niveles de producción y productividad de los sistemas ganaderos de doble propósito en el Caquetá. Los niveles promedios de producción de leche por finca y por vaca en lactancia entre 1989 y 1997 se incrementaron. Esta última subió de 577 a 760 lts/vaca/año. La disponibilidad de forrajes de mejor calidad, resultante de la mayor proporción de pasturas mejoradas probablemente ha inducido avances de algunos parámetros productivos como la natalidad, la cual se incrementó ligeramente de 61 a 63%. La carga animal expresada como cabezas de ganado/ha declinó ligeramente entre los períodos de observación bajando de 1.3 a 1.1. Lo anterior sugiere que en la región existe subinversión en ganado, ya que la carga total no aumentó aunque se incrementaron las inversiones en pasturas mejoradas que soportan mayores cargas.

Viabilidad de la tecnología de pasturas basadas en Arachis. Los análisis de rentabilidad de la tecnología de pasturas basadas en maní forrajero indican que esta es una opción atractiva para los productores en términos de retorno monetario por unidad de capital invertido. No obstante, para lograr altos niveles de adopción, además de un retorno económico alto y estable, se precisa que

la tecnología sea viable técnica y económicamente para los adoptadores. La siembra de una pastura de *Arachis* asociado con una gramínea, implica un aumento en el costo de establecimiento del orden de 80 a 133%, en comparación con el costo de establecimiento de una gramínea en monocultivo. Este incremento de los costos puede tener grandes implicaciones financieras cuando se trate de ampliar las áreas sembradas.

Los productores entrevistados no señalaron al tema financiero como una restricción importante para la adopción. Seguramente se debe que el material aún no se ha establecido a gran escala y por lo tanto no se perciben las implicaciones financieras del elevado monto de capital necesario para efectuar las siembras a mayor escala y para la adquisición de ganado adicional. Se aprecia un marcado déficit en los servicios de asistencia técnica y extensión en las áreas de establecimiento, uso y manejo de pasturas. Este es un aspecto crucial cuando se trata de pasturas mezcladas de gramíneas y leguminosas, que requieren un manejo diferente al tradicional para lograr altos índices de persistencia y productividad.

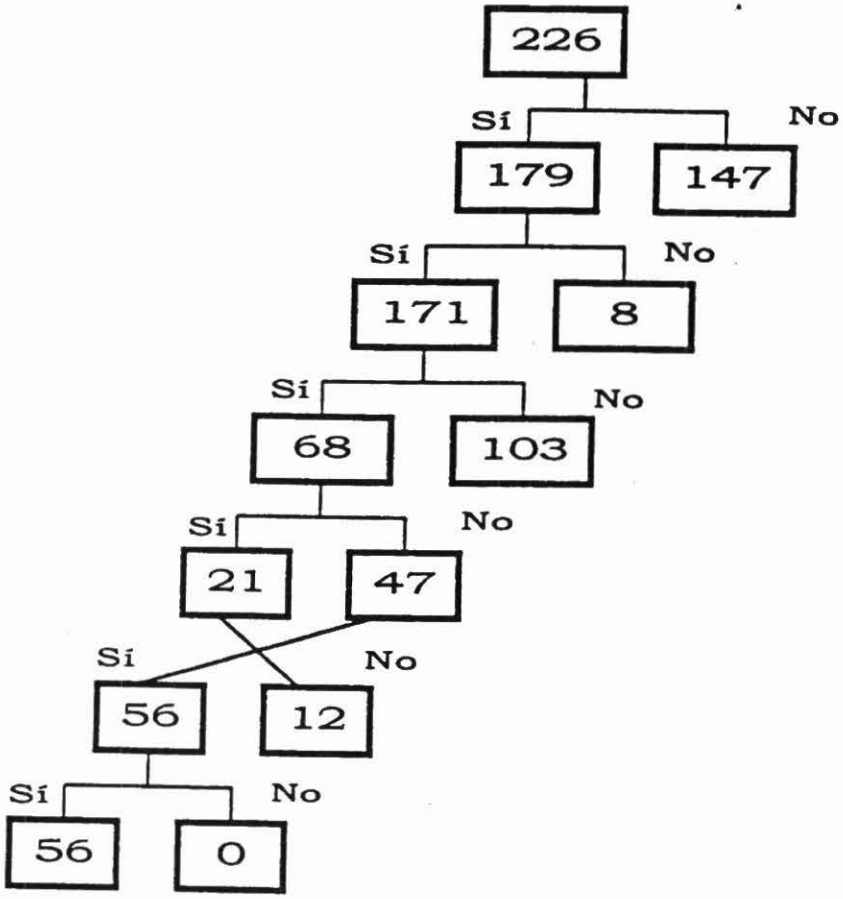
La disponibilidad de insumos críticos, particularmente de semilla de alta calidad, tanto de gramíneas como de leguminosas, aparece como factor muy importante para la viabilidad técnica de las pasturas mixtas. Una gran proporción de fracasos en el establecimiento de pasturas, obedece a las bajas tasas de germinación de la semilla, en especial de las gramíneas.

La alta incidencia del mión en la región, es un elemento de alto riesgo para la estabilidad y productividad de las asociaciones de gramíneas y leguminosas, especialmente cuando uno de los componentes de la mezcla es *B. decumbens*. Nuevas especies de brachiaria tolerantes o resistentes a ésta plaga, tendrán un impacto muy importante sobre la producción y productividad de las ganaderías no solo del Caquetá, sino de otras regiones del trópico húmedo.

Prioridades de inversión en las fincas ganaderas. La casi totalidad (95%) de los entrevistados estaría dispuesto a incrementar la inversión en sus fincas, en la eventualidad de tener acceso a capital adicional. En estos sistemas de pequeños y medianos productores, uno de los factores más restrictivos para expandir la producción es el acceso al capital. En éstas zonas donde la población ganadera es reducida y las posibilidades de introducir ganado de otras regiones es baja, la disponibilidad de ganado depende del crecimiento biológico del hato, el cual es lento en las condiciones de la tecnología tradicional.

En la situación hipotética de tener mayor acceso al capital, los productores invertirían casi la mitad del mismo (48%) en adquisición de ganado, lo cual apoya la hipótesis de que existe una limitación seria en cuanto a disponibilidad de ganado en las fincas de la región. En la formación de pasturas mejoradas se invertiría una cuata parte y el resto se destinaría a inversiones en infraestructura, equipo y compra de tierra. El capital destinado a adquisición de tierra es una fracción muy baja del capital adicional, solo 4%, lo cual indicaría que los sistemas ganaderos de la región tienden a consolidarse en cuanto a tamaño y que las inversiones adicionales estarían orientadas a intensificar el sistema de producción.

Figura 1. Secuencia en las decisiones de los productores sobre adopción temprana de *A. pintoi.* Caquetá, Colombia, 1997



Productores entrevistados

Habían oído hablar de Arachis

Conocían esta leguminosa

Habían ensayado con Arachis

Tuvieron problemas en su establecimiento

Estaban satisfechos con los resultados logrados

Planeaban ampliar el área sembrada

a) Instituciones y Proyectos:

- Nestlé de Colombia
- Proyecto IP5, CIAT
- Proyecto PE5, CIAT

b) *Personas:*

- Carlos Lascano, Proyecto IP5.
- Gustavo Ruiz, Proyecto IP5
- Federico Holmann, Proyecto EP5.
- Néstor Gacharná, Nestlé de Colombia.
- Jorge Rozo, Nestlé de Colombia.
- María Clara Valencia, estudiante de economía, Universidad Autónoma, Cali.

Donantes:
NESTLE de Colombia financió parcialmente el trabajo de recolección y procesamiento de la información de la encuesta. Adicionalmente, aportó personal técnico y apoyo logístico para ubicar y entrevistar a los productores.

3.2.C. CIAT's Integrated Cassava Research and Development (ICRD) Strategy: A Case Study on Adoption and Impact in Northeast Brazil – *M. V. Gottret, B. Ospina, D. Pachico, C. Leite-Cardoso*

1998 Milestones

- Fieldwork, including focus group sessions, semi-structured interviews, and a producers survey, was completed.
- Databases were design on Microsoft Access for the 1989, 1992, and 1998 surveys and data was entered.
- Qualitative data from focus group discussions and semi-structured interviews was transcribed from tapes and notes and analyzed.
- A paper was written and presented at the IAEG Case Studies Synthesis Workshop, Hawaii, USA, 24-26 June, 1998.

Progress Report

Technical change is a key to economic growth and meeting human needs particularly in agriculture in less industrialized countries where agriculture is a major source of employment for the poor as well as being a major factor in food security. Understanding how innovations are diffused among small farmers in low income countries is a crucial issue in insuring that the benefits of innovations are widely disseminated, especially to the poor.

This paper studies the adoption process of new cassava post harvest production technology in the northeast of Brazil in the state of Ceara. This has been chosen for a topic of study because cassava farmers in Ceara are typical of poor farmers in low income countries in terms of their small scale and scarcity of capital and the difficult growing environment. The technology of chipping and sun drying cassava has the advantage of linking small farmers to dynamic growth markets that offer them the opportunity to increase their incomes, and the technology is quite suitable to village conditions in developing countries as evidenced by its widespread use in northern Thailand over the last three decades. Nevertheless, this innovation is relatively complex in that its use requires collective action by farmers as well as the entry into a new market.

This paper will utilize a case study approach to address some key issues in adoption among rural people in low income countries. This case study will aim to provide a thick description of the process from the points of view of various actors utilizing a range of data and information sources (Secherest et al 1997).

1. Background

Cassava is the fourth most important food staple produced in the tropics, with a global production of 118 million tons, of 32 million is produced in South America. (FAO 1997). However, since cassava deteriorates rapidly after being harvested, its importance has declined as populations have urbanized so that per capita cassava consumption has been declining in South

America. This has led to stagnating opportunities for cassava producers, most of whom are small low income farmers. Consequently, studies of alternative uses and markets for cassava are of considerable importance in particular in an effort to identify markets for cassava that have considerable growth potential and thus provide opportunities for small cassava farmers to increase their incomes.

Initially the most promising alternative market for cassava identified in South America was to produce dry cassava chips for incorporation in animal feed concentrates (Pachico et al 1983). The industry of dry cassava chips for animal feeds was originally developed in Asia, where millions of tons of cassava chips have been produced for some decades now. Based on these economic studies, an integrated program of cassava research and development was initiated in order to introduce the opportunity of the market for dry cassava chips for small farmers in South America (Cock 1988; Lynam 1987). The strategy was then defined as an attempt to develop new markets and to link cassava farmers to these new and expanding markets (Best, 1991).

This approach was implemented through an integrated set of institutional, organizational, social and technological interventions designed to link small-scale cassava farmers to new or improved growth markets. In Colombia, project activities rapidly led to penetrating the Colombian animal feed market with dry cassava chips as an alternative carbohydrate source. Estimates calculated that during the period 1984-91 the cassava sector in Northern Colombia benefited by almost US$ 22 million when research to improve cassava crop management was integrated with research on its processing, marketing and consumer preferences (Gottret and Henry, 1992).

In 1989, based principally on the experiences accumulated in Colombia, CIAT and collaborating agricultural research and technical assistance institutions formulated a proposal with the objective of testing the same strategy in the State of Ceará in northeast Brazil.

Northeast Brazil suffers the highest levels of poverty and underdevelopment in Brazil. An estimated 50% of the population earning less than (US$ 130 annually). Low and variable rainfall makes cassava practically the only staple food crop alternative for farmers, and cassava consequently constitutes the main food source. The principal market for cassava in Ceará has been to local small-scale units that process the roots into a flour called ***farinha de mandioca***, a basic staple product.

The introduction of new post production technology into Ceará was facilitated by prior involvement of state agricultural sector agencies in the promotion of cassava-based development activities, especially EMATER (the State Technical Assistance and Extension Service) that had been promoting the development of alternative markets during the period 1981-87.

The strategy followed in Ceará was to look for a large, alternative market into which cassava could enter in good rainfall years when excess cassava production usually means low prices. A pilot project was established which involved the setting up and testing of the production, processing and marketing technology and channels on a small-scale semi-commercial basis.

2. Methodology for this Study

This case study is part of a series of case studies being implemented by CGIAR Centers to assess the acceptance, adoption and impact of technologies and methodologies, developed by the Centers in collaboration with national agricultural research systems. This study will analyze the level of adoption and impact in Ceará, of the Integrated Cassava Research and Development Project Methodology (ICRD), based on the development and adaptation of improved production, processing and commercialization technologies. This study will both provide feedback to improve the performance of integrated post-harvest development programs as well as to document the impacts achieved through this work.

The conceptual framework for this study is that the promotion of small-scale, cassava based agro-industries created an alternative market for cassava roots. It is expected that this alternative market established a floor price for the product, reduced price fluctuations, and increased the farmers bargaining power. These changes in demand and prices reduced the market risk faced by cassava producers, which in turn served as an incentive to increase cassava production.

A variety of data sources are used in this case study including both primary and secondary quantitative and qualitative data.. An important source of quantitative data is the project monitoring and evaluation system that was implemented as part of the original project. This data base included an inventory of the plants constructed in the project including location, size, source of funding etc. In addition, this database contains annual information on the processing costs, production and sale of cassava chips for each cassava chipping plant. The data base also includes cassava farmer groups member information, such as sex, age, land tenure, farm size, cassava area, etc.

For this study qualitative data was obtained from focus groups and interviews with key informants. Focus groups were conducted with cassava producers and processors from successful, partially successful and non-successful groups. The focus group discussion guide included the following themes: (1) Factors which influenced the community decision to establish a dry-cassava agro-industry. (2) Level of community participation on dry-cassava processing activities. (3) Identification and analysis of factors which effect the success or failure of dry-cassava agro-industries. (4) Effect of the new alternative market for cassava (new processing technology) on the adoption of cassava production technology recommended during the project. (5) Identification and analysis of the new processing technology on cassava commercialization channels (cassava uses). (6) Type and quality of institutional support received by cassava producers and processors during the project (technical assistance, credit, community organization, etc.). (7) Effect of the new agro-industry established in the community on its overall development.

Special interviews were also conducted with women who participated in the project. Guides for women interviews included the following themes: (1) Participation of women on the community decision to establish the new dry-cassava agro-industry. (2) Analysis of the participation of women and children in dry-cassava processing agro-industries. (3) Identification of the type and quality of institutional support received by women during the project. (4) Effect of the project

on the sociopolitical position of women in the community. (5) Effect of the establishment of the new cassava agro-industry on overall community development and household quality of life.

Communities were sampled for the focus group interviews based on the information in the project monitoring system. Two parameters were calculated for each drying plant: technical efficiency and financial efficiency. Also, plants were classified according to their source of funding and the support received by the integrated cassava project. The latter was important since some of the plants built, during and after the project, were funded by the Secretaria de Industria y Comercio (SIC), which was a political initiative, but those plants did not receive any support from the project (technical assistance, credit, etc.). Afterwards, drying plants were stratified by their level of technical efficiency and the source of funding. The number of communities sampled were determined based on the mean and standard deviation of the technical and economic efficiency of the drying plants as the key variables of the study, with a confidence level of 90% and a probability of error of 7%.

3. Process of Adoption

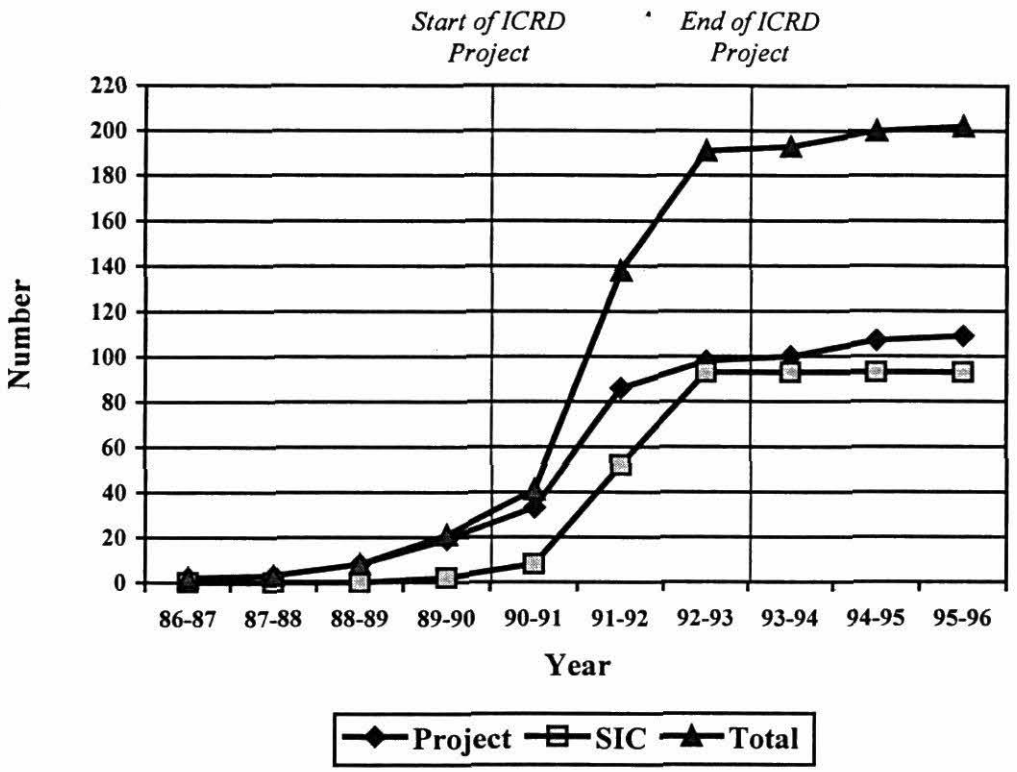
The ICRD project in Ceara, northeast Brazil, was initiated with the aim of establishing the production of dry cassava chips for animal feeding as a viable agroindustrial activity among small-scale farmers. In 1988, the coordination of work among technicians and policy makers led to the formation of the Ceara Cassava Committee (CCC), with the aim of coordinating cassava crop development activities statewide. The incipient CCC played a fundamental role in identifying additional financial resources, which made it possible to install dry cassava agroindustries during the period 1988-89.

As part of the project activities, the 11 groups existing at the onset of the project were reorganized and/or reactivated, and another 147 farmer groups were established for a total of 158 producer groups organized around dry cassava agroindustries by June 30, 1992 when the project was terminated. Most of these groups (75%) were organized during the last year of the project. Some groups were not completely established before the end of the project, because they faced serious problems for lack of availability of funds and consolidation of the groups themselves.

Figure 1 shows the number of plants installed per year during the 1986-1996 period by source of funding. As shown in this Figure, 90 plants where installed during the 1989-92 period, with funds obtained through the ICRD project activities. These groups of farmers received services from the project including technical assistance, credit and training. However, the rapid expansion of the project in terms of number of farmer groups organized was specially significant during the third and fourth year of activities. This fast growth was in part due to the strong intervention of the Ceara State Secretariat of Industry and Commerce (SIC), which launched a program of grant-type financial aid that permitted 93 rural communities to build dry cassava agroindustries. These groups received the grant but not the support system given by the ICRD project.

As a consequence, the rapid expansion of the project in terms of the number of dry agroindustries resulted in the following limitations: (1) poor selection of farmer groups, (2) lack of institutional presence, making it difficult to offer technical assistance support to farmers, and

(3) delay in delivering economic resources to farmers, which caused delay in the installation of dry cassava plants. Moreover, these processes had, all too often, been characterized by its political motivation and the need for rapid action, with minimum time for careful deliberation with farmer groups.

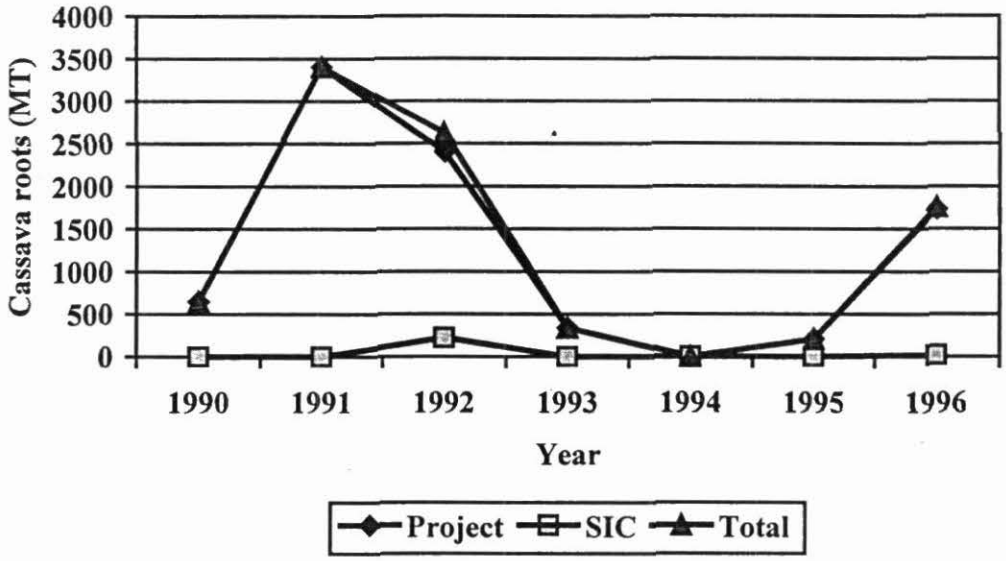


Data source: ICRD project monitoring and evaluation system

Figure 1. Numbers of cassava drying plants installed during the 1986-96 period in the Ceara State of Brazil, by source of funding.

Figure 2 shows the quantity of cassava roots processed by the dry cassava agroindustries during the 1990-96 period. The plants increased production until 1992. Afterwards, production decreased significantly during the 1993-95 period and in 1996 it began to raise again Figure 2 also shows a marked difference on the quantity of cassava roots processed by the cassava drying agroindustries established with the whole support from the project, and the quantity processed by those established by the SIC. Agroindustries established by the SIC only processed 247.4 MT of cassava roots until 1996, while those established by the ICRD Project processed 7002.8 MT of cassava roots in the 1990-96 period.

In 1992, the region had one of the worst droughts they ever had in 1993 and yields decreased dramatically (down to approximately 3.5 ton/ha). This not only affected 1993 cassava yields, but also decreased the area planted to cassava in the next year (1994) since people did not have enough seed to plant. Thus, the startling collapse in dry cassava production in 1993-5 was due principally to the drought. Once the drought was over, the production of dry cassava chips recovered in 1996.



Data source: ICRD project monitoring and evaluation system

Figure 2. Cassava roots processed by the cassava drying agroindustries during the 1990-96 period.

4. Reasons for Adoption and Success

4.1 Community decision to establish a cassava drying agroindustry

Table 1 shows a summary of the results obtained on the farmer group discussions, when farmers were asked about the factors which influenced the community decision to establish a dry-cassava agroindustry. The reasons given by the farmer groups were classified according to community strata, which was defined by the level of technical performance of the processing plant. Adopters include those communities which adopted the processing technology, their agroindustry operated more than one year, and had a technical efficiency higher than 10%. Experimenters includes those communities which adopted the processing technology, their agroindustry operated only one year (at the beginning), and had a technical efficiency lower than 10%. The last group of communities includes those which installed a dry cassava processing plant, but the never operated. This community classification is also applied to the rest of the qualitative data analysys.

The reasons given by all community strata can be classified in three type of responses. The first set of reasons are those related to the advantages related to the development of a new product. The new agroindustry was seen as an alternative market for cassava roots; as a way to reduce the labor and other production costs involved in *farinha* processing, and therefore, as a possibility to generate additional cash income for farmer households.

Table 1. Factors which motivated the community decision to establish a cassava drying agroindustry.

TYPE	Factors	Strata		
		Adopters	Experimenters	Installed but never worked
NEW MARKET OPPORTUNITIES AND USES FOR CASSAVA	Alternative market for cassava roots which gives the community an increased bargaining power when *farinha* prices are low	*** [a]	***	**
	Lower labor and other production costs than those for *farinha* processing made cassava chips production more profitable	***	*	*
	Some cassava producers did not have a *farinha* processing plant, and those who had it, take advantage of the others by charging high rates for using it	*	*	
	Hope to increase the community cash income since *farinha* is mainly produced for own consumption, is less profitable, and the profits from cassava chips production could stay in the community.	**	**	**
	Way to guarantee good feed at a lower price for their animal production		*	*
	To generate employment opportunities in the community	*		
	Hope to improve their quality of life	*	*	
INSTITUTIONAL APPROACH	Influenced by the motivation and support given by EMATERCE, and the trust they had in the institution	***	*	
	Influenced by visits to other cassava drying groups who had experience with the new product	***	*	*
	Availability of grant-type financial resources for the construction of the plant	*		
	The new processing technology was tested with the community	*		
CIRCUMSTANCES	Surplus cassava production when the community took the decision	**	**	*
	Low prices of *farinha* when the community took the decision	***	***	*
	Had some previous experience with the cassava drying technology	*		
	Their land is suitable for cassava production	*		
	There was no interest of the community, the group took the decision without taking into account the community decision			*
	That was what the politicians where offering at that moment			*

[a] The number of asterisks refers to the frequency of response by the communities as follows : *** = high response frequency (70-100% of communities), ** = medium response frequency (30-70% of communities), and * = low response frequency (less than 30% of the communities).

The second set of reasons is related with the motivation given by institutions through the ICRD project. The IDRC project, through its strategic alliance with EMATERCE motivated farmer groups to establish dry-cassava agroindustries, using two approaches. First, EMATERCE gave a direct support to farmer groups, including technical assistance, grant type funds for the installation of the cassava drying plants, credit for operation capital, community organization, and training for the agroindustry management. Second, the ICRD project promoted the exchange of experiences among the different farmer groups, through visits to other neighborhood communities with more experience, and some community leaders traveled to Colombia to learn from farmers groups with more and longer experience with the agroindustry.

The third set of reasons include those that were circumstantial to the moment when the ICRD project was implemented and, as found in this case study, changed later on. In the 1989-91 period there was a surplus of cassava production in the region, and therefore, also a surplus of *farinha*. This production surplus put a downward pressure on *farinha* and cassava root prices, and farmers were loosing money with *farinha* production.

Table 1 also shows reasons given only by some community strata. Among the adopter communities, there are two reasons given by farmers which may have fostered the success of these agroindustries. First, some of these communities have had previous experience with the technology and that gave them some advantage over the other communities. Second, these communities were involved in testing and adapting the technology, therefore, they were empowered by the project through some type of participatory research.

On the other hand, communities which installed the processing plants with grants from the SIC, but never produced cassava chips, gave reasons for establishing the agroindustries which explain in part their failure. First, they establish the agroindustry only because that was what politicians were offering for free and there was no commitment of the community. Second, the whole community was not involved in the decision process, but only a small group of farmers made the decision.

In general, the communities where the cassava plants were established without a full institutional support effort, lacked clarity of vision about the potential benefits of cassava plants. In the more successful adapting communities there was both greater clarity about the reasons for establishing the plants as well as a much closer articulation with official institutions which provided the communities with training and technical assistance that enabled them to be more successful in operating their plans.

4.2 Factors which Enhance the Success of the Dry-cassava Agroindustries

Table 2 presents the farmer groups' views on the factors which enhance the success of the dry-cassava agroindustries. This information was only obtained in the communities where the drying plants operated (adopters and experimenters only), since those communities where plants were installed but never worked could not answer to this question because they failed.

Table 2. Factors which enhanced the success of dry-cassava agroindustries

GROUP	Factors	Strata	
		Adopters	Experimenters
ALTERNATIVE MARKETS AND USES	The increased bargaining power that the new alternative market for cassava roots gave to farmers.	*** [a]	***
	The new agroindustry offered farmers an option to make a more efficient use of cassava production and an alternative market for cassava roots.	***	***
	It was easier to sell cassava chips than *farinha* and they can get cash income immediately.	***	*
	Cassava chips can be easily stored for a long time until prices improve.	**	**
	Cassava producers were motivated to sell their roots to the drying plant since they were paid in cash.	***	
	Cassava chips offered the community a possibility to use their cassava to feed their own animals and increase their number.		
	Lack of a secure market for *farinha*	*	
COMMUNITY ORGANIZATION	There was integration, effort, and involvement of the dry cassava group members since the beginning of the project to build and operate the plant.	***	*
	Since the cassava drying plant is of the community everybody could participate	*	
	Producers began to plant community cassava plots	*	
	Some people were already organized for agricultural production activities		**
TECHNOLOGY	Cassava chips processing cost is lower than *farinha* processing cost, therefore, less working capital is required and the agroindustry is still profitable at lower prices than *farinha*.	***	***
	Cassava chips processing requires less labor, and at the same time liberates labor from *farinha* and *goma* processing.	***	**
	The technology to produce cassava chips is simple and low cost	*	**
	Producers validated cassava production technologies	*	
INST. SUPPORT	Producers received training and technical assistance on cassava production, processing, commercialization of dry cassava, and management of the agroindustry by experienced personnel.	***	**
	The community received credit for cassava production		*
COMMUNITY MOTIVATION	There was interest of households on having a new source of income. Some producers use all their cassava to produce cassava chips and bought *farinha* for own family consumption.	**	**
	The good results were seen fast, therefore, the community began to believe in the success of the project.	*	
	Profits stayed in the community	*	
CIRCUM.	There was cassava surplus production when the agroindustry was established.	*	***
	The community has adequate transportation	*	

[a] The number of asterisks refers to the frequency of response by the communities as follows : *** = high response frequency (70-100% of communities), ** = medium response frequency (30-70% of communities), and * = low response frequency (less than 30% of the communities).

The factors related to marketing of cassava are important. The new agroindustry offered cassava farmers an alternative market with the following advantages according to farmers: (1) Cassava chips can be sold easier than *farinha* and farmers receive cash income almost immediately, in contrast to the lack of a secure market for *farinha*. (2) Cassava chips can be easily stored for a long time, giving farmers the option to wait for good prices instead of having to sell them at the current price. (3) Cassava farmers that were not members of the cassava drying farmer groups, could also sell their cassava roots to the agroindustry and receive cash income.

It is important to note that those communities that were successful, emphasized that there was integration, effort, and involvement of the dry cassava group members from the beginning of the project to build and operate the agroindustry. In some communities, farmers were already organized for agricultural production activities prior to the project, and with the institutional support provided by the ICRD project, they strengthened their organizations. Therefore an important factor which enhanced the success of the agroindustries was the level of community organization and commitment of their members.

The technology for producing dry-cassava chips was also an advantage of the agroindustry according to farmers. The processing technology is simple and low cost. Farmers were able to learn fast how to produce cassava chips and to manage the agroindustry, and the processing costs are lower than those of *farinha* production. These advantages resulted in a lower requirement of working capital and labor and, therefore, a higher probability of economic feasibility of the agroindustry, even at low cassava chip prices. Another important advantage of the technology was that it requires less labor than *farinha* processing, and therefore, liberates labor for other activities and/or increases their leisure time. The technology was also attractive to some communities which have animal production, since it offered the possibility to use their cassava production to feed their own animals and increase their number.

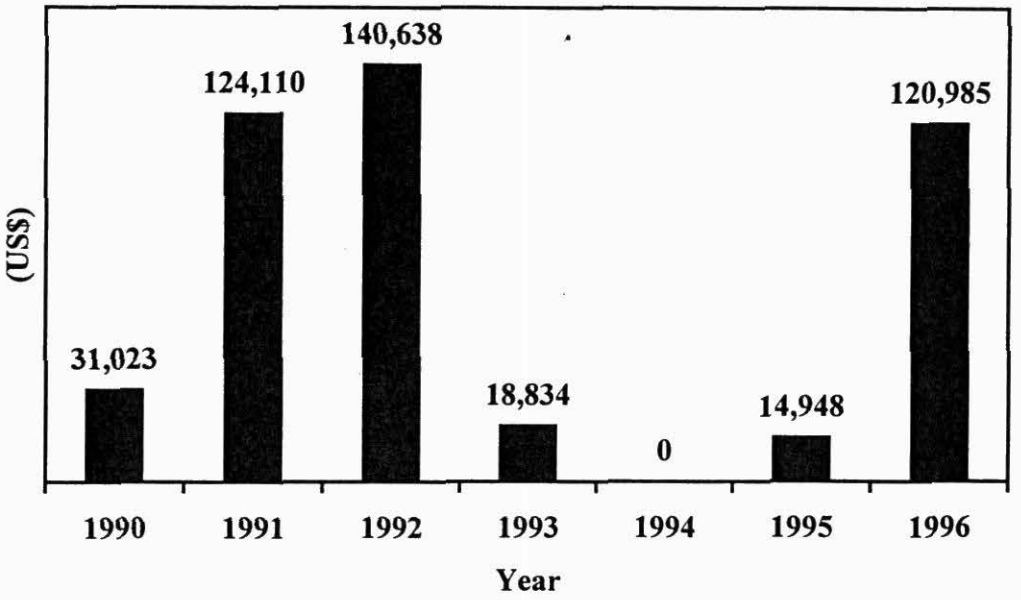
Another important factor, was the support and services provided by the ICRD project, through local institutions, to the farmer groups and their institutions. According to farmers, one of the key factors for their success was the training and technical assistance they received for the production of cassava, its processing into cassava chips, the commercialization of the product, and the management of the agroindustry. However, only a few communities said that the credit they received for cassava production was an enhancing factor.

5. Benefits and Impact of The ICRD Project

5.1 Benefits Produced by the Dry-cassava Agroindustries over Time

Figure 3 shows the flow of total direct benefits from the dry-cassava agroindustries during the 1990-96 period. During this period, a total of US$ 450,537 was generated by the new agroindustry established by the ICRD project in the Ceara State of Northeast Brazil. These benefits resulted from cassava chips sales and include cassava roots sales, processing wages, payments made for other goods and services bought by the agroindustry (fuel, sacks, replacement parts, and oil), and from the distribution of net benefits obtained in the commercialization of the cassava chips. As discussed previously, the drought of 1992 and 1993 constrained the supply of cassava roots in the region, severely affecting the production of

cassava chips during a three year period, which in 1994 was zero. Therefore, it can be argued that the agroindustry was successfully established in the region. However, it is highly dependent on the availability of cassava roots.



Source: Estimations based on the ICRD project monitoring and evaluation system.

Figure 3. Flow of economic benefits generated by the dry-cassava agroindustry, Ceara, Northeast Brazil, 1990-96.

5.2 Aggregated economic benefits of the dry-cassava agroindustry in the region

Table 3 summarizes the estimated direct benefits of the dry-cassava agroindustry in the Ceara State of Northeast Brazil. These results show that the main beneficiaries of the project were cassava producers who sold their roots to the agroindustry and received 69.4% of the total benefits (US$312,707). Dry-cassava farmer groups or processors also received an important share of benefits from the project (20.1%). Furthermore, the majority of these small-scale processors are also cassava producers and they therefore benefited in two ways. The agroindustry also generated some direct employment in the region and dry-cassava plant workers received 5.6% of the benefits. These results show that most of the benefits (95.1%) stayed in the rural communities, and therefore, the ICRD project objective to target benefits to cassava producers and their rural communities has been accomplished.

With respect to the distribution of benefits from selling cassava roots to cassava-based agroindustries, according to farm size, most of these benefits were perceived by farmers with cassava plots smaller than 2 ha. as, 89.5% of cassava producer benefits from root sales to the agroindustry went to the smaller cassava farmers.

Table 3. Aggregated direct economic benefits of the dry-cassava agroindustries in the Ceara State, Northeast Brazil, 1990-96.

Distribution of total income Generated by sales of cassava chips	Aggregated benefits, 1990-96 (nominal US$)	NPV of benefits flow (1990-96) at 5% discount rate (US$)	Distribution of benefits by group of society (% of total benefits)
Cassava producers	312,707	264,225	69.4
Hired labor	25,278	20,853	5.6
Other goods and services [a]	21,829	18,313	4.9
Net benefits to processors	90,723	72,845	20.1
Total income from sales	**450,537**	**376,236**	**100.0**

[a] includes fuel, sacks, spare parts for motors, and oil.

Source: Estimations based on the ICRD project monitoring and evaluation system.

Another important contribution of the ICRD project to improving cassava farmers well- being in Ceará is the fact that the benefits generated were spread among all farmers involved regardless of its land tenure situation. Data from the monitoring and evaluation system of the project shows that those farmers who owned their land captured 58,9 % of the total benefits, renters 32,4 % and share-croppers benefited with 8,7 %.

5.3 Women 's view of impact

Table 4 summarizes women's perceptions and views of the impact of the ICRD project in the region. Intermediary effects of the ICRD project (the new alternative market, training, and employment generation) were only mentioned by a few women and work not given much importance. However, for women of the community the effects of the ICDR project on their workload, income, quality of life, community empowerment, and women's position in the community were given equal or more importance than that gave by the cassava farmer groups.

With respect to women's workload, it is important to analyze this point by understanding that women in this region have a to do a lot of hard work. Most of *farinha* processing activities are done by women with the help of children. When part of the cassava roots produced are processed into cassava chips, women's workload is reduced. Therefore, some labor is released for other activities, and women can either have more leisure time or start some new activities to generate some extra income for the household.

Table 4. Effect of the ICRD project on the community development, according to women.

IMPACT AREA	Effect of the Project	Strata		
		Adopters [a]	Experimenters [b]	Installed but never worked [c]
MARKET	The alternative market for cassava improve cassava roots and products commercialization and the market for *farinha* became more stable.		*	
TRAINING	The community learned the technology to produce cassava chips.		*	
EMPLOYMENT	Employment was generated in the community	*		
WOMEN WORKLOAD AND OTHER ACTIVITIES	The working load of women was reduced, since *farinha* processing requires a lot of labor, which is mainly provided by women.	**		
	Women began to plant small plots of cassava by themselves		*	
	The availability of feed for the animals increased and women began to raise animals with cassava chips.		*	
USE OF EXTRA CASH INCOME	With *farinha* they never had cash money to buy things for the house and the children, however, the production of cassava chips provided some cash to buy food, clothes and shoes, specially for the children, and things for the house; and to send the children to school, and get health services when needed. Some of the people were even able to buy a house or improve it.	**		
	When the agroindustry gave cash income to the husbands, women receive the extra income to spend in things for the house.	*		
QUALITY OF LIFE	The quality of life of families and the community improved, since they got an alternative market for cassava and household income increased.	*	**	
COMMUNITY EMPOWERMENT	Producers became better organized		*	
	Other projects were attracted to the community as a consequence of the ICRD project and the organization of the community.	**	***	
WOMEN POSITION IN THE COMMUNITY	The project helped women to get better organized and participate more in the community activities and decisions.	*	*	
	Now women ask for more things, are asked to do more things, and work more.	*		
	The community began to have a better opinion of women and began to accept that they will participate in the project.	*		

IMPACT AREA	Effect of the Project	Strata		
		Adopters [a]	Experimenters [b]	Installed but never worked [c]
SIDE EFFECTS	The infrastructure of the plant is used also for other purposes		*	
	Some women's husbands had to travel because of the project, and the women had to stay alone with the family.	*		
NO IMPACT	The project had no effect on the community			**

Source: Semi-structured interviews with key women from the communities

[a] The number of asterisks refers to the frequency of response by the communities as follows : *** = high response frequency (70-100% of communities), ** = medium response frequency (30-70% of communities), and * = low response frequency (less than 30% of the communities).

With respect to the extra cash income generated by the new established agroindustry, women stressed that the extra income was used mainly for household expenses, and therefore, the quality of life of community households was improved. With respect to the cassava farmer groups, women gave a high importance to the community empowerment and capacity building effect of the ICRD project. They also mentioned that producers and the community are better organized, and as a consequence other projects and services were attracted to the community.
An additional effect from those cited by the farmer groups, perceived by women is the change in their position in the community. Some women said that the project helped women to get better organized. Therefore, the community began to have a better opinion of women and that increased women participation on activities and on decision making. Also, as expected, women from communities that have dry-cassava plants, but that never worked, have the opinion that the ICRD project had no effect on the community.

6. Conclusions

Some key conclusions that can be drawn form the results of the present paper are:

- **Integration of activities is a sound approach**

The integration of production, processing and commercialization activities around the cassava crop at community level, an stimulate development of the crop. Institutions in charge of technical assistance activities for cassava farmers can not and should not work exclusively in any of these three activities, in isolation from the others.

- **Farmers obtained important economic and social benefits**

Analysis of the benefits generated by the ICRD project in Ceará and the distribution of these benefits among the different actors, clearly indicates that cassava farmers in the region were benefited with new employment opportunities and additional cash income. The establishment of a new market outlet allowed farmers to decide in which market to sell their production according to the prices. This empowerment process of farmers represented a radical rupture on the commercialization schemes that were prevailing in the region for the cassava crop.

Benefits generated by the project were important and significant for groups such as women and landless farmers who are usually left out from the benefits of rural development projects. Additionally, the communities in which the cassava-based agroindustries operated obtained other important benefits such as credit programs, training opportunities and several other projects and activities that were brought to the community as a consequence of the cassava agroindustries.

Staff Involved:

- James Garcia, Impact Assessment Project.

Collaborators:

- Secretary of Rural Development (SDR), Ceará
- Antonio Raimundo dos Santos, Technical Assistance and Rural Extension Service (EMATERCE)
- Marcio Porto, EMBRAPA, CNPMF
- Valerie M. Stewart-Fouts, Timothy R. Stickle, and Lee Sechrest, University of Arizona Consultant Group.

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3.2.D. Farmer Research Committees in Colombia - *J. Ashby, D. Pachico, A. Braun, and M.V. Gottret*

1998 Milestones

- The objectives and methodology proposed for the study were re-evaluated and adjusted to improve the quality of the study.
- Information from the farmer research committees (FRCs) monitoring system was updated and converted to an improved database designed using Microsoft Access.
- A sampling frame for the study was designed, a questionnaire was applied in the field, and descriptive analysis were completed.
- Selected data from a baseline survey conducted in 1988 was entered in a database and analyzed.
- A progress report was prepared.

Progress Report

1. Purpose

Contribute to the analysis of the acceptability, adoption, and impact of CIAT outputs.

2. General Objective

Assess the adoption and impact of farmer research committees (FRCs) in the Cauca Department of Colombia.

3. Products

- Impact of the farmer research committees on diversification of the cropping systems and the level of native research assessed.
- Adoption of technologies recommended by the farmer research committees analyzed.
- Impact of farmer research committees at the household level assessed.
- Level of influence of farmer research committees on institutional agendas, and research and extension methodologies analyzed.

4. Methodology

The study is being conducted in three phases :

1. A survey was conducted with two main objectives: (1) evaluate the impact of farmer research committees on cropping systems diversification and the level of native research, and (2) analyzed the adoption of technologies recommended by farmer research committees.

2. Case studies will be conducted to analyzed the impact of farmer research committees on productivity, food security and nutrition, income, and general wellbeing of farmer households. These case studies will be conducted in a sub-sample of communities with farmer research committees.

3. Semi-structured interviews will be conducted with research, extension, and development institutions personnel with the objective of evaluating the institutional impact of farmer research committees in terms of (1) influence on institutional research agendas, (2) research methodologies, (3) extension systems, and (4) incorporation of the methodology on rural development projects.

The first phase of the study was completed during 1998 and the following progress report refers to this part of the study.

4.1 Sampling Frame

4.1.1 Community Selection

The first step to design the sampling frame was to classified the FRCs in the following categories: (1) active FRCs with technology recommendations, (2) active FRCs without technology recommendations, (3) inactive FRCs with technology recommendatins, and (4) inactive FRCs without technology recommendations. The first and third groups of FRCs, those with technology recommendations, were also sub-classified according to the number of years that have been recommending technologies. The sub-categories are : (1) FRCs which have been recommending technologies for 4-5 years, (2) FRCs which have been recommending technologies for 2-3 years, and (3) FRCs which have been recommending technologies for one year or less. Table 1 shows the number of FRCs under each category and sub-category. In 1998 there are 14 active FRCs with technology recommendations, from which five have been recommending technologies for 4-5 years, three for 2-3 years, and the rest (6) for one year or less. Also, there were five inactive FRCs, but that have already made technology recommendations.

Table 1. Classification of FRCs by their level of activity.

CATEGORY AND SUB-CATEGORY	NUMBER OF FRCS
Active with technology recommendations	**14**
Technology recommendations for 4-5 years	5
Technology recommendations for 2-3 years	3
Technology recommendations for less than 1 year	6
Inactive with technology recommendations	**5**
Technology recommendations for 4-5 years	4
Technology recommendations for 2-3 years	1
Active without technology recommendations	**41**
Inactive without technology recommendations	**20**
TOTAL	**80**

Afterwards, a sampling strategy was designed in order to permit two type of comparisons: (1) comparisons over a time period (1988 versus 1998), and (2) cross-section comparisons (communities with FRCs versus communities without FRCs in 1998). See Figure 1.

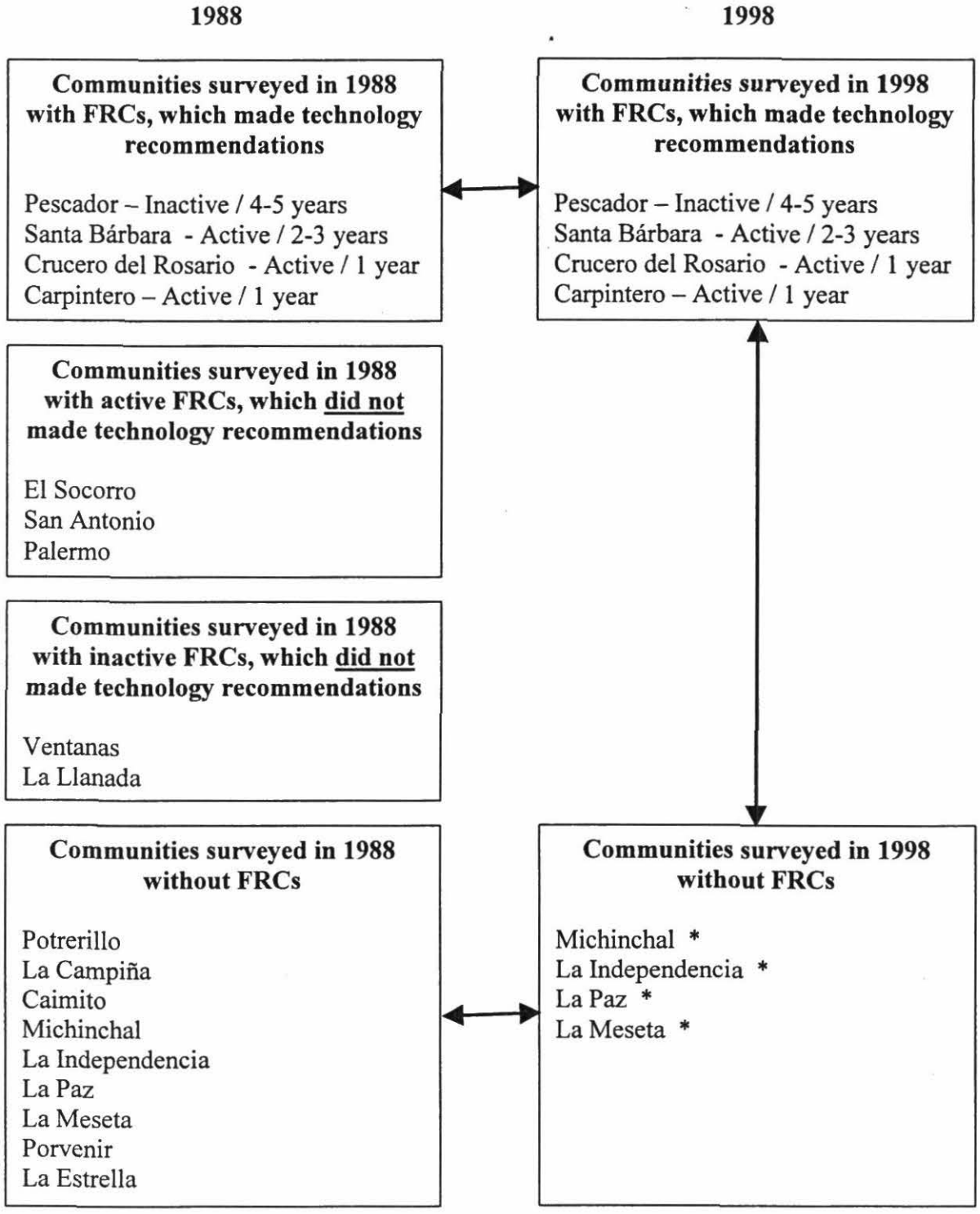

Figure 1. Sampling frame strategy

Comparisons over time : In order to make comparisons over time, information from a baseline survey applied in 1988 was used (Patiño, 1990). This baseline study had the objective to develop a methodological framework for the selection of small farmers to participate in farmer research committees. As shown in Figure 1, four communities surveyed in 1988 have active FRCs in 1998 which made technology recommendations, three communities have active FRCs in 1998 without technology recommendations, two communities have inactive FRCs, and nine communities do not have FRCs. Therefore, the sampling strategy was to select communities that were surveyed during 1988 to make possible this comparison over time.

Cross-section comparisons : This type of comparisons permit the analysis between communities with FRCs and those without them in 1998. However, in order to make this type of comparisons it would be necessary that the communities with and without FRCs have similar characteristics in terms of predominance of small farmers, access to main roads, level of institutional presence, ethnic mixes of the population, population density, and production systems (including altitude, soil fertility, and climate).

Based on this sampling strategy, for the first phase of the study eight communities were selected : the four communities surveyed in 1988 with FRCs which made technology recommendations (Pescador, Santa Bárbara, Crucero del Rosario, and Carpintero), and four communities surveyed in 1988 without FRCs (Michinchal, La Independencia, La Paz, and La Meseta). The four communities without FRCs where selected based on two criteria: (1) similar characteristics in terms of predominance of small farmers, access to main roads, level of institutional presence, ethnic mixes of the population, population density, and production systems (including altitude, soil fertility, and climate), and (2) distance from communities with FRCs in order to have the least possible influence from these communities.

4.1.2 Household Sample Size

Once communities were selected, the second step was to determine the number of households to be interview in each community. The first step was to collect data on the number of households in each community and a list of these households.

Secondly, based on the following assumptions :

- Key variables of the study are discrete (ex: % of farmers who experiment different type of technologies, % of farmers who know, experiment, and adopt the technologies recommended by the FRCs, etc.).
- Key variables of the study have the highest possible variance in order to be conservative (p=0.50, which means that 50% of farmers respond "yes", and 50% respond "no").

it was chosen to interview 49% of the households, giving a 95% level of confidence and a 10% maximum expected error. Households to be surveyed in each community were chosen randomly. Whenever it was not possible to interview a household the next farm to the right was selected, and if not possible to interview this household, the next farm on the left was chosen. Table 2 shows the number of households per community, the sample size, and the number of surveys actually applied in the field.

Table 2. Communities selected, number of households sampled, and number of surveys applied in the field.

2 COMMUNITY	POPULATION SIZE	3 SAMPLE SIZE [A]	4 NUMBER OF SURVEYS APPLIED
Crucero del Rosario	85	42	43
Santa Bárbara	56	28	28
Carpintero	101	50	50
Crucero de Pescador	46	23	23
5 Sub-total with FRCs	**305**	**143**	**144**
Michinchal	76	38	43
Independencia	42	21	21
La Paz	21	11	11
La Meseta	31	16	16
6 Sub-total without FRCs	**170**	**86**	**91**
7 TOTAL	**475**	**229**	**235**

[A] With a 95% level of confidence and 10% maximum error of estimation.

4.2 Questionnaire Design

In order to design the questionnaire to be applied to households, the first step was to define the specific objectives of the first phase of the study. The following objectives were specified

- community awareness of FRCs activities
- participation on FRCs activities and activities with other organizations
- effect of FRCs on diversification of cropping systems and the level of native research
- adoption of technologies recommended by the FRCs
- distribution of benefits received from FRCs among households of different wellbeing categories, and
- preliminary impact of the CIALs on productivity, food security and nutrition, and income, a questionnaire was design to be applied to households.

Secondly, information of the specific technologies recommended by each of the active FRCs was obtained from the FRCs monitoring system database, and afterwards, verified in the field through visits to this FRCs and their communities.

A questionnaire was designed with the following parts:

1. Questionnaire identification and information of the household
2. Awareness of FRCs

3. Participation on FRCs activities and other organizations activities
4. Identification of farm activities
5. Native experimentation
6. Awareness and adoption of technologies recommended by FRCs
7. Level of wellbeing and resources availability
8. Investments on the farm
9. Impact of FRCs technology

The questionnaire was then tested on the field, re-adjusted to improve the language used, improve the clarity of the questions, and the flow of them.

4.3 Fieldwork

Personnel to conduct the survey was pre-selected in the region based on their (1) knowledge of the communities selected for the study, (2) previous experience applying questionnaires in the field, and (3) level of formal education.

After the personnel was pre-selected, they were trained by a CIAT multidisciplinary team with experience on primary data collection. The training last three days and had the following activities: (1) one day training workshop, (2) application of the questionnaire by the pre-selected personnel in the selected communities under the supervision of the CIAT team, (3) a feedback session with the personnel.

Once the training activities were finished, the final selection of personnel was based in their performance on field work. The feedback session also served to make the last adjustments to the questionnaire. Three teams were formed to conduct the survey with one CIAT technician with survey experience which accompany each team during the whole time. Also CIAT professionals on charge of the study were in the field with each team to supervise the work and quality of the surveys applied.

5. Preliminary Results

The analysis of these data has only just been initiated. Nonetheless, for illustration a couple of preliminary findings will be reported here. Organizing and training farmers to run farmer research committees has the immediate objective of improving both the quality and the quantity of research carried on by farmers in rural communities. Nonetheless, farmer research does not begin with the organization of these research committees. Experimenting with new seeds, new crops, and new cultivation practices is a part of traditional culture throughout the world. One purpose of the farmer research committee approach is to provide more systematic methods and approaches which enable farmers to exploit more effectively this traditional inclination towards experimentation. One concern about formalizing farmer research is that it might displace traditional systems of farmer experimentation and knowledge generation.

Figure 1 displays the frequency of autonomous native experimentation by farmers in communities with and without the farmer research committees. The experimentation here refers to trials that farmers are conducting completely on their own initiative, without direct contact with research organizations, NGOs, or the farmer research committees. The figure clearly shows that the frequency of autonomous native experimentation by farmers is consistently higher among farmers in communities with farmer research committees than in communities without farmer research committees. This holds true for all kinds of experimentation: with new soil fertility practices, new disease control practices, new varieties of traditional crops, and new field crops or fruit crops. Thus, it is clear that the presence of farmer research committees, far from depressing the native experimentation typical of traditional knowledge generation systems, actually seems to promote more intense experimentation.

Of course the purpose of farmer research committees is not just to increase frequency or improve the effectiveness of farmer research, but to identify new options that farmers adopt and utilize to improve their livelihoods. Some preliminary results on this issue are available. Figure 2 shows rates of adoption of an improved bean variety, Caucaya, that was originally developed by the Colombian national program in collaboration with CIAT. This variety was first identified as promising for the Cauca region by a farmer research committee in one community that was conducting bean trials.

Adoption of this variety was much faster and has reached a higher level in the community that originally identified the innovation through its farmer research committee. This variety is also spreading to other communities, demonstrating that the results of an individual farmer research community can also yield benefits for other communities. It is noteworthy that among nearby communities, the new variety is spreading faster among communities that have farmer research committees than among communities without farmer research committees.

Analysis of these and other data are continuing, and will be reported in full in 1999.

Staff Involved:

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Collaborators:

- Alfonso Truque, Bolívar Muñoz, Nolberto Zambrano, Corporación para el Fomento de los CIALs (CORFOCIAL)
- Leonel Rosero, Impact Assessment Project, CIAT
- Freddy Escobar, Jorge Luis Cabrera, Participatory Research Project, CIAT
- Carlos Chilito, Rural Agroenterprise Development Project, CIAT

Figure 1: Autonomous Farmer Experimentation in Comunities with and without Farmer Research Commitees (CIALs), Cauca, Colombia 1998 (% of Farmers experimenting)

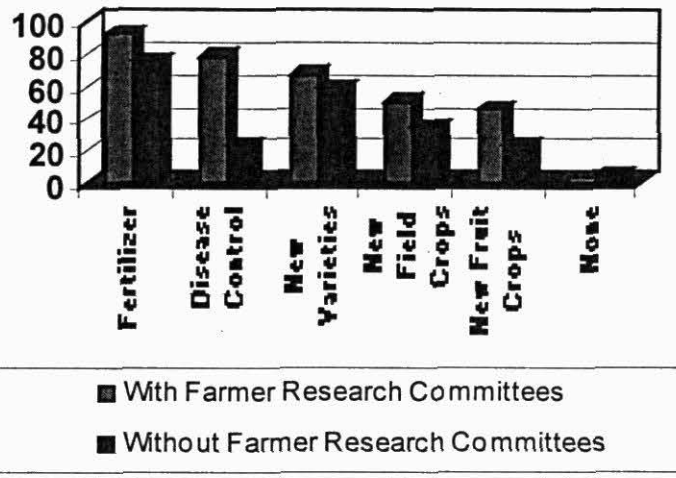
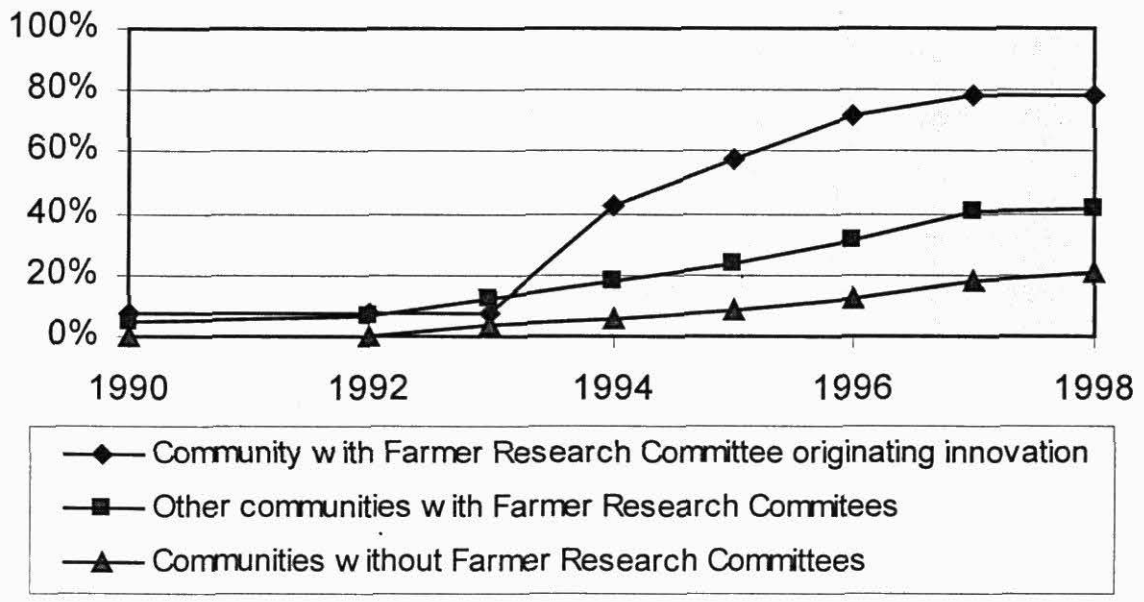


Figure 2: Adoption of Improved Bean Variety (ICA-Caucayá) by Communities in Cauca, Colombia, 1990-1998. (cumulative % of adopting farmers).



3.2.E. Estudio de adopción de Frijol en Bolivia - *N. Ruiz-Londoño*

Fecha de iniciación: Agosto 1998.

Objetivo

Evaluación de la adopción de frijol en Santa Cruz, Bolivia, en términos de:

- Nivel de adopción del cultivo
- Nivel de adopción de las variedades entregadas
- Cambios en el consumo urbano –rural
- Cambios en el manejo de los recursos productivos (Tierra, mano de obra)
- Impacto sobre el ingreso rural
- Impacto sobre el bienestar de la familia campesina

Zona del Estudio

- Zona rural de Santa Cruz de la Sierra
- Area urbana de Santa Cruz de La Sierra

Instituciones Participantes y Aporte

- CIAT
- PROFRIZA
- Universidad Autónoma Gabriel Rene Moreno (Santa Cruz de la Sierra)

3.2.F Adoption and Impact of Three Cassava Varieties in the North Coast of Colombia-

Antonio José López (CORPOICA) and M.V. Gottret

1998 Milestones

- Descriptive analysis of the data was completed and direct benefits to cassava farmers were calculated for 1996.
- A report was prepared for Pronatta and CORPOICA

1. Background

Between 1984 and 1992, the Instituto Colombiano Agropecuario (ICA) released three new cassava varieties in the North Coast of Colombia : Manihoica P-12, ICA-Costeña, and ICA-Negrita. Manihoica P-12 was breed for the Inter Andean valleys of Colombia for fresh human consumption and industry. Since 1981 this variety was evaluated under the traditional evaluation scheme, which consisted of regional trials, by ICA and CIAT. ICA-Costeña and ICA-Negrita were breed by ICA and CIAT with the objective of improving cassava yields to supply raw material for small dry-cassava agroindustries, which in turn produce cassava chips for the feed industry, and for fresh human consumption. The selection process of the two latter varieties was characterized by the active participation of farmers in more than 60 evaluation sites in four Departments of the North Coast (Córdoba, Sucre, Atlántico, y Bolívar), where they were selected as the best varieties.

In 1995 CORPOICA, Regional 2, presented a proposal to Pronatta with the objective of assessing the adoption and impact of these cassava varieties, and asked the advice of CIAT's former Cassava Section for the study design, fieldwork, and data analysis.

2. Project Purpose

Assess and analyze the level of adoption and farm level impact of three released cassava varieties in the Departments of Córdoba, Sucre, Bolívar, and Atlántico of the North Coast of Colombia to contribute to a more efficient use of resources available for research, extension, and to improve the design on new technology development projects.

3. Specific Objectives of the Study

- Assess the level of adoption of the new released varieties and understand the endogenous and exogenous factors which enhanced and/or limited the adoption process to feedback decision makers, with the objective of improving the design of cassava breeding programs.
- Understand the interactions between the structure of the cassava production systems and the level of adoption of the new released cassava varieties.

- Determine the relationships between the research objectives of cassava breeding programs and expert opinion about the desired characteristics of the varieties, with the clients opinion (producers, market agents, industry and fresh cassava consumer)
- Assess the impact of the technology at the farm level in terms of yield and income improvement.
- On-hands training of regional researchers of CORPOICA and CRECED (Centro Regional de Capacitación, Extensión y Difusión de Tecnología) extensionists on the execution of technology adoption studies.

4. Methodology

4.1 Exploratory appraisal

The first step for data collection was a rapid appraisal in order to have a first approximation of the levels of adoption and its variability among the different regions. This appraisal also gave an idea of the reasons that farmers had to (no) adopt or discontinue the use of the new released varieties, as well as a first estimate of the yield differentials among the traditional varieties and the new released ones in farmer fields.

For this purpose a listing of farmers who participated in the new varieties evaluation and/or received seed of the new varieties from CORPOICA or the CRECEDs was obtained. Based on this listing 13 farmers were visited and interviewed.

4.2 Target population

The target population was defined as cassava production units, which are located in cassava production municipalities of the Departments of Córdoba, Sucre. Bolívar and Atlántico. Cassava production municipalities were determined based on the relative importance of cassava production volumes. Of a total of 105 municipalities, 95 were considered as cassava production ones.

4.3 Stratification of the population

Municipalities were pre-stratified by its level of technology influence as follows:

- **Level 1 :** Includes those municipalities where seed of the new released varieties was distributed to farmers, on-farm trials with the varieties were conducted with farmers as well as multiplication plots, a strong institutional presence can be found, and where cassava drying plants or cassava starch plants are installed.
- **Level 2 :** Includes those municipalities which are near from municipalities where seed of the new released varieties was distributed to farmers, an intermediate level of institutional presence can be found, and some may have cassava drying plants installed after 1988.

- **Level 3 :** Includes those municipalities where no seed was distributed to farmers, with a low or null institutional presence, and without cassava drying plants installed.

4.4 Sampling

The information unit was defined as cassava production households, independent of the final use of the product, which have at least 0.25 ha. planted with cassava.
The size of the sample to be surveyed was calculated using the preliminary results of the exploratory appraisal. In this appraisal it was found that 40% of the farmers were using at least one of the released varieties in municipalities included in level 1, 20% in municipalities of level 2, and 10% in those of level 1. Using these estimations, the sample size was calculated with the following formula :

$$n_s = \left(t * \sqrt{p_s q_s} \div LM\right)^2$$

where : n_s is the sample size by strata, p_s is the percentage of farmers in each strata that adopted at least one of the improved cassava varieties, $q_s = (1 - p_s)$, t is the desired confidence level, and LM is the permissible error. For a 90% confidence level and a permissible error of 0.06, a total sample size of 368 surveys were calculated, distributed as follows in each technology influence level : 180 surveys in level 1, 120 in level 2, and 68 in level 1.

Once the total sample was determined by level of technology, the number of surveys to be conducted in each CRECED and strata was calculated proportional to the area planted to cassava in each CRECED and strata as follows :

$$n_c = \frac{A_c}{A} * n$$

where : n_c is the number of surveys to be conducted in each CRECED, A_c is the number of hectares planted with cassava in each CRECED by strata, and A is the total number of hectares planted with cassava. In each CRECED, the number of surveys per strata were also allocated proportional to the hectares planted with cassava per CRECED and strata. The distribution of cassava area among CRECEDs and strata, as well as the sample size is reported in Table 1.

The number of municipalities to be surveyed per CRECED and strata were determined with the criteria that in each municipality a maximum of 10 surveys could be applied. Using this criteria a total of 41 municipalities were surveyed, and its selection was done randomly.

In each municipality, two communities were selected randomly and the total number of surveys per municipality was divided by two in order to determine the total number of households to be surveyed per community. Households were also selected randomly in each community.

Table 1. Area planted to cassava and sampling size by CRECED and Strata

CRECED	Strata 1		Strata 2		Strata 3		Total Survey Number
	ha	Sample Size	Ha	Sample Size	Ha	Sample Size	
Sabanas de Sucre	11887	53	8058	35	602	3	**91**
Sabanas de Bolívar	2129	9	2520	11	0	0	**20**
Valle de los Zenúes	6145	27	2352	10	1839	8	**45**
Alto Sinú	2116	9	1822	8	0	0	**17**
Bajo Sinú	8208	36	5245	23	2052	9	**68**
Norte de Bolívar	2134	9	192	1	573	2	**12**
Depresión Momposina	2530	11	1510	7	2143	9	**27**
Del Caribe	8247	38	5570	25	5530	25	**88**
TOTAL	**43396**	**190**	**27251**	**121**	**12739**	**57**	**368**

4.5 Questionnaire design and application

The questionnaire was design by CIAT and CORPOICA personnel based on the objectives of the study. For this purpose, a list of the information required was prepared and grouped by themes. Afterwards, a questionnaire was prepared to collect the required information with the following sections :

- General information of the household and the farmer
- Farm characteristics
- Cassava cropping characteristics
- New released varieties adoption
- Seed availability and selection
- Characteristics of the traditional and new released cassava varieties
- Cassava commercialization
- Technical assistance and technology transfer methods
- Access to credit
- Effects of the new released varieties at the farm level
- General comments of the producer

Afterwards, the questionnaire was tested in the field and adjusted. The survey was applied by professional personnel of each CRECED during August, September, and October of 1995. These personnel was previously trained by a CIAT and CORPOICA multidisciplinary team, through a training workshop, supervised application of the surveys, and feedback. Further adjustments to the survey were made during the CRECED personnel training sessions.

5. Results

5.1 Analysis of the adoption process

Table 2 to 5 presents the estimated adoption levels for each of the three new released cassava varieties, or for at least one of the three varieties. The assessment of the adoption has been done under four different criteria : (1) farmers who heard about the varieties, (2) farmers who know the varieties, (3) farmers who experimented with the varieties, and (4) farmers who actually plant the new varieties (adopters). Based on these results, the following conclusions can be made about the levels of adoption of the new released varieties:

- The percentage of farmers who heard about, know experimented, and adopted the new varieties is higher in the municipalities with higher technology influence as expected. In this municipalities seed has been given to farmers, some farmers participated in the evaluation of the varieties, the institutional presence is higher, but also the access to fresh market as well as alternative markets (cassava drying plants and cassava starch plants) is higher.

Table 2. Level of adoption of Manihoica P-12 by level of technology influence

	Technology level influence			**Total**
	High	**Medium**	**Low**	**n= 368**
	n=193	**n=121**	**n=57**	
Heard about the variety	42.0	33.0	26.0	**36.6**
Knows the variety	34.7	19.3	15.8	**26.7**
Experimented with the variety	22.3	15.6	12.3	**18.5**
Adopted the variety	14.0	9.2	5.3	**11.1**

Table 3. Level of adoption of ICA-Costeña by level of technology influence

	Technology level influence			**Total**
	High	**Medium**	**Low**	**n= 368**
	n=193	**n=121**	**n=57**	
Heard about the variety	58.5	32.8	28.1	**45.3**
Knows the variety	15.5	10.1	8.8	**12.7**
Experimented with the variety	7.8	5.9	1.7	**6.2**
Adopted the variety	6.2	5.9	1.7	**5.4**

Table 4. Level of adoption of ICA-Negrita by level of technology influence

	Technology level influence			Total
	High n=193	Medium n=121	Low N=57	n= 368
Heard about the variety	30.0	33.6	26.3	**30.6**
Knows the variety	16.1	14.3	5.3	**13.8**
Experimented with the variety	7.8	10.9	1.7	**7.9**
Adopted the variety	5.2	8.4	1.7	**5.7**

Table 5. Level of adoption of at least one of the new released cassava varieties by level of technology influence

	Technology level influence			Total
	High n=193	Medium n=121	Low N=57	n= 368
Heard about the variety	59.1	57.1	43.9	**56.1**
Knows the variety	41.5	30.2	24.6	**35.2**
Experimented with the variety	26.4	25.2	15.8	**24.4**
Adopted the variety	12.9	15.1	7.0	**12.7**

- The level of adoption was relatively low (12.7% of at least one of the three varieties in the whole sample), however with the exception of Manihoica P-12, which was officially released in 1984, the other two varieties have only been officially released in 1991 and 1993 (only 4 and 2 years, respectively, before the year when the adoption survey was applied).

- The percentage of farmers who adopted the technology as a percentage of those who experimented with it is higher for ICA-Costeña (87%) and ICA-Negrita (72%), which were evaluated with the participation of farmers, than that of Manihoica P-12 (60%), which was evaluated with traditional trials conducted by the institutions. The main reason that farmers gave to disadopt the latter cassava variety was that it is rejected by the cassava drying and starch plants because of its high content of water. On the other hand, farmers who disadopt or reduce the area planted with the former two varieties explain that the main reason was that there was not enough planting material. For the case of ICA-Negrita farmers also argue that it does not produce well when planted intercropped with other crops, which is the most common production system in the region.

Figure 1 shows the adoption curves for the three cassava varieties. These curves show the normal adoption pattern, where adoption rates are relatively low in the first phase when farmers are starting to experiment and know the new varieties. In these phase important differences can be observed between Manihoica P-12 and the other two varieties. While the first phase of the adoption process for Manihoica had a duration of nine years, those for ICA-Costeña and ICA-

Negrita lasted only three and four years, respectively. This difference may be explained by the methodology used for the evaluation and selection of the varieties. Farmers participated actively in the evaluation and selection of the two latter varieties.

According to farmers, the new varieties have better yields, have been evaluated and selected with farmers, have higher levels of dry matter (starch), shorter production cycles, and good culinary characteristics. However the adoption was severely affected by the lack of enough planting material, and by the fresh cassava market intermediaries, who do not like to buy cassava roots of these new varieties and punish farmers with lower prices.

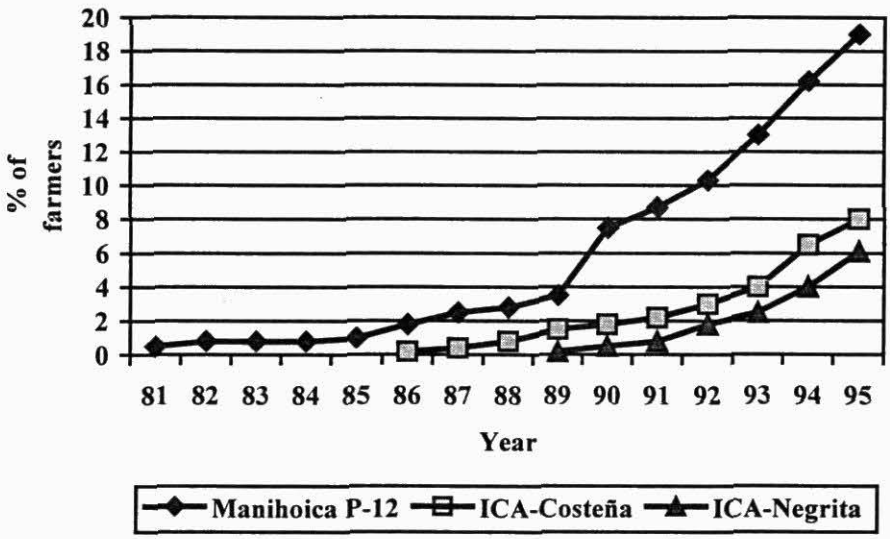


Figure 1. Accumulated % of farmers who experimented with the three new released cassava varieties.

5.2 Assessment of direct benefits received by cassava farmers in the region

Table 6 presents the estimated direct economic benefits received by farmers in 1996 as a result of the higher yields of the new released varieties. Although this is a partial estimation of benefits, and only for one year, this information shows that the new varieties have a good potential to increase yields without additional inputs. This increase in yields results in a significant economic benefit for cassava producers in the region. The farmers who benefited the most from the new technology where those who had access to planting material, technical assistance, and are near to more dynamic markets for cassava (cassava drying plants and cassava starch plants). Also, the adoption analysis showed that farmers with low fertility soils adopted more the technology, since the varieties behave well under marginal conditions. Therefore, farmers on more marginal soils benefited more with the new varieties.

Table 6. Estimated direct economic benefits received by farmers in 1996.

	Variety			Total
	Manihoica P-12	**ICA-Costeña**	**ICA-Negrita**	
Estimated area planted with the variety in 1996 (ha)	2,100	2,800	2,000	6,900
% of total area planted to cassava with the variety [a]	3.5	4.7	3.6	11.6
Yield differential relative to the traditional variety "Venezolana" (ton/ha)	3.3	3.9	5.0	
Production surplus (ton)[b]	6,930	10,920	10,000	27,850
Value of the production surplus (US$)[c]	589,050	928,200	850,000	2,367,250

[a] These percentages have been calculated with the total average cassava area (1994-96) for the four Departments (Córdoba, Sucre, Bolívar, and Atlántico) reported by the Colombian Ministry of Agriculture.

[b] The production surplus has been calculated by multiplying cassava area planted with the variety times the yield differential.

[c] The value of the production surplus was calculated with a weighted price of US$ 85/ton in 1996.

6. Conclusions

- Municipalities of high level of technology influence present higher level of adoption of the new released varieties as expected, since farmers in these municipalities received planting material from the institutions, some of the farmers participated in the evaluation and selection of two of the three varieties, and farmers in these municipalities have better access to alternative cassava root markets.
- The variety Manihoica P-12, which was evaluated and selected with traditional regional trials conducted by the institutions on farmer fields, has a relatively low adoption level after 11 years of its official release (11.1%), and the first phase of the adoption process lasted nine years. Also, almost half of the farmers who experimented with the variety stop using it or reduce the area planted to the variety. The main reason was related to market constraints since dry-cassava and cassava starch plants rejected the variety because of its higher water content, and fresh cassava market intermediaries did not buy the variety or punish it with a lower price.
- The other two released varieties (ICA-Costeña and ICA-Negrita), which where evaluated and selected with farmer participation, reached levels of adoption of around 5.5% after four and two years of its official release, respectively. Also, the first phase of the adoption process was lower and farmers started to experiment with the varieties since the start of the evaluation process.
- Although, the two latter varieties released where evaluated and selected with the participation of farmers, other client opinions, such as those of the intermediaries and processors were not

taken into account. Therefore, the market constraints faced by producers limited the adoption and success of the varieties.

- Besides, the market problem, the main constraint for the adoption of the new varieties was the lack of enough planting material. The reason was that the official release of the varieties was not complemented with effective planting material production projects. Cassava breeding programs require an accelerated planting material multiplication since the evaluation phases and during the first phase of the adoption process after being released. This problem is specially important in cassava, where planting material multiplication in slow.
- Although the adoption rates are not high, it is important to realize that farmers are experimenting with the new varieties as an alternative to their traditional varieties. This results are consistent with the new CORPOICA plant breeding objectives that do not pretend to totally substitute the traditional varieties, but to offer new alternatives to farmers in order to improve their productivity, increase the genetic diversity, and therefore contribute to more sustainable production systems.
- Cassava breeding has the potential to improve yields in farmer fields and under marginal climatic and soil conditions significantly (from 3-5 ton more per hectare), and although the estimation of benefits is still partial and only for one year, it is important to note the income generation potential of new varieties.

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4.1. CIAT Capacity Enhancement

4.1.A. Method - Natural Resource Management - *D. Pachico*

Natural resource management research emerged in the mid 1980's as a major concern for the global agricultural research system, both national programs and international centers. Assessing the impact of this research inevitably became a critical issue, both for prioritizing research and also for monitoring progress.

Impact assessment has become an especially thorny issue because natural resource management research has represented an expansion of the research agenda for many institutions a time when resources have become increasingly scarce. A variety of different methods and tools for assessing impact have been utilized, including indicators; spatial models and geographical information systems (GIS); economic surplus models; farmer participatory techniques; and empirical field surveys.

This paper explores some conceptual and methodological issues related to the assessment of impact of natural resource management (NRM) research and presents a brief overview of some research approaches. The experience of CIAT (Centro Internacional de Agricultura Tropical), with emphasis on Latin America, is used as a vehicle of this paper because it illustrates a number of the issues that are confronting a wide range of institutions and scientists today.

While CIAT can not offer a fully developed model that provides a comprehensive solution to all the issues faced in impact assessment of NRM research today, examination of its experience may serve as a useful platform to stimulate an exchange of experiences and viewpoints in this workshop.

The first section of the paper attempts to appraise the broader context of impact assessment for NRM research. It briefly reviews some dimensions, approaches, and aspects of the reach of impact assessment of NRM research.

The second section of the paper sketches out the broad outlines of some methodological approaches to NRM impact assessment. Ex ante approaches are considered, and some aspects of poverty measurement, extrapolation, and cross scale analysis are noted.

The third and final section of the paper will present brief summaries of the findings of some studies focussing on the impact of NRM research.

Impact Assessment: Desperately Seeking Donors

The high level of current attention that impact assessment of NRM research is attracting, arises to a very substantial degree out of a concern by stakeholders to be able to demonstrate to their constituents that investment in NRM research is yields results in terms of the socio-economic development goals that motivate much research investment.

Generally donors investing in NRM research are not interested in means such as increased knowledge, better research methods or improved models. Rather, their investment is usually driven to attain ultimate development impacts.

These impacts are diverse. They can include increased productivity and efficiency; increased income or welfare for the poor; improved nutritional or health status; the welfare of women or particular social groups; empowerment of the less privileged; environmental quality; welfare of present or future generations.

Different investors in NRM research give different weights to these various ultimate impact outcomes, so almost inevitably impact assessment means different things to different people. These differences in what impact to assess, or how to measure it, are rooted ultimately in differences in values or differences in utility functions as economists might prefer to have it.

"At IDRC we do not strive for objectivity in the usual sense of being remote from the project being evaluated. Evaluation reflects the values and perspectives of those who design and implement the evaluation" (Love 1996). Thus, impact assessment, as a form of project evaluation, like evaluation ultimately rests on a base of subjective values.

Even where there is consensus about what type of impact is being sought of NRM research, the measurement of impacts can typically be approximated through a range of different variables. For example, if increased income is the desired impact, this could be measured as income in a current period, or future income over a number of periods, and could involve asset accumulation or the measurement of income variability.

Likewise, if improved environmental quality is the desired impact, this can be measured through a variety of indicators, for example, biodiversity might be assessed at the level of the plant genome, species, or plant community or ecosystem. Similarly, soil quality might relate to organic matter, profile depth, or soil texture. Gender welfare might be appraised, for example, through access to income, control of assets, or participation in decisions.

While impact assessment has to be based on some initial definition of impact regarding what and how impact is to be measured, equally important is the specification of how the output of NRM research will attain the desired ultimate impacts.

Development impacts like poverty alleviation, environmental quality, nutrition and health, gender welfare, and empowerment, depend on a wide range of other factors besides the outputs of NRM research. The overall performance of the general economy, episodes of violence or warfare, national policy, and social and cultural structures and changes can all have a major effect on the development impacts that NRM research is intended to influence.

Frequently the effects of these other factors will mask or even dwarf those of NRM research. Thus, even when NRM research may be making a contribution to the development outcomes of interest to investors in research, assessment of this impact can be made exceedingly difficult in the presence of other powerful intervening factors.

An Approach to Impact Assessment

Impact assessment does not optimally initiate as a retrospective exercise after a research program has produced an innovation that has entered into use. Impact assessment needs to be a crucial part of research planning and prioritization. Instead, optimal impact assessment should be an integral part of an ongoing monitoring of research progress and product development during the life of a research project. After the conclusion of a research project, impact assessment provides valuable feedback on the effectiveness of a research effort (Pachico 1994).

Logically impact assessment begins with a definition of the desired impact; where it is expected; and for whom it is anticipated. "Outputs can not be assessed fairly unless they are identified from the start," (Goldsmith 1993). Clarifying from the beginning the nature of the expected impact not only provides a basis on which the impact of NRM research will be assessed during the course of the research and at its conclusion, but also it can assist in the specification of research directions most suitable for attaining the desired impact.

Thus, whether ex ante impact assessment is done through structured formal methods or is based simply on the judgements and preferences of research managers and scientists, it largely conditions what impacts can and will ultimately be achieved. Consequently, a precise specification of the outputs expected of a research project outputs and a clear tracing of the logical link between these outputs and particular desired impacts, is the optimal base both for future impact assessment as well as for research planning and prioritization.

Once the expected impacts of NRM research have been determined, then the challenge for applied impact assessment then becomes the definition of how this impact will be measured. Some impacts are relatively straightforward to measure, for example, the direct consequences of adoption of an innovation such as changes in the frequency of spraying or types of agrochemicals used due to an IPM program or changes in yield due to a new variety.

However, the impacts of innovations on ultimate development outcomes like nutrition, poverty, or gender welfare, are far more difficult and often quite costly to measure with any precision. Since these are inherently complex phenomena, resort to indicators has become a key tool for policy and decision-makers interested in impact assessment (Gallopin 1995).

The advantage of indicators is that they simplify information about complex phenomena and the are "easily detectable, relatively simple, and cost effective, and should resort, if possible to existing information"(Harrington et al 1995). An indicator can be usefully defined as "an easily observed variable that may be measured at low cost and is highly correlated with the state of a complex system of interest for decision making", in this case, for impact assessment (Pachico 1996).

To be convincing, indicators need to be theoretically and logically linked, preferably in some causal relationship, with the behavior of the complex system of interest. There are a number of methodological issues involved in utilizing indicators for impact assessment, some of which are touched upon below. Nonetheless, early identification of the variables or indicators that will be used to measure impact is a key step in the impact assessment process.

After a research program has been designed, including specification of its expected outputs and their associated impacts on development objectives, prototype or intermediate outputs will emerge from the research in process. The assessment of the performance of these intermediate outputs will yield further information about the likely or potential impact of a line of research.

Ongoing assessment of research in progress can serve both as a crucial feedback loop to adjust or refine a scientific research project, and it can also lead to a reappraisal of the impact of a research project, for example that it performs different from expected in a particular environment or among farmers of a particular resource endowment. A variety of methods including regional trials, on-farm trials, farmer evaluations, participatory research and surveys can be useful in these continuing assessment of research in process.

As finished products emerge from a research program and diffuse among users, ex post studies of the impact that has resulted from this research is a culmination of the impact assessment process. It is important to note that measurement of the adoption or use of an innovation is not the same as measuring its impact on natural resources management or development goals. Measurement of outputs does not constitute measurement of outcomes. For example, farmers may be observed to use soil conservation measures, but this is not the same as measuring the impact of the conservation measures on the quality of the resource base, or the impact of the improved resource base on farmer welfare, be it farm productivity, income, or nutrition.

In sum, impact assessment is best conceived as an integrated dimension of the entire research process, ranging from planning and prioritizing research, to monitoring research progress, to appraisal of the ultimate outcomes or impacts of research. These are related in that information from intermediate evaluations and adoption or impact studies can feed back to modify ex ante assessment of ongoing or future research.

Ex ante assessment helps to appraise the selected indicators that can be used to measure the expected impacts of a research project. Continuing assessment monitors progress towards the production of a research output and can involve a preliminary assessment of whether it is likely to deliver the expected impacts. Ex post impact assessment addresses whether planned research outputs have in fact been generated and used, and the degree to which this use has led to the expected impacts among various potential beneficiaries

Reach and Impact Assessment

The discussion so far has focussed on what impacts are to be measured, how they can be assessed, and when impact assessment is relevant with respect to the stage of a research program. Equally important is the issue of the "reach" of the outputs of a research program. Reach has been defined by Smutylo and Carden of IDRC as "the groups that are touched by the results of a program".

Thus, the benefits of a NRM research project may reach producers and consumers, males and females, upstream and downstream resource users, current and future generations, land owners and laborers, and farms of different sizes, social status, or agro-environments.

Despite the substantial weight that many investors in NRM research may place on knowing the distribution of benefits, the relatively greater tractability of measuring the aggregate total of benefits of research programs, even though this is often far from a trivial matter, has tended to absorb more attention than fully tracing out the distribution of benefits. Although this may be more difficult and costly of research resources, stakeholder interest in these issues may demand that they receive more attention in the future.

Impact is also distributed spatially. Impacts occur at certain geographic locations, each associated with particular environmental conditions and social groups. Utilizing geographical information systems (GIS) can assist impact assessment, for example, by helping to provide a framework for sample selection for impact study. Similarly, GIS can assist in the extrapolation of impacts from specific locations to wider areas. Some methodological aspects of using GIS in impact assessment are discussed below.

Impact occurs over many years, with significant time lags both between the initiation of a research program and the production of the research output, and between the delivery of a research output and its widespread diffusion among users. While NRM research is likely to take significant time, it should be remembered that the genetic improvement research of the CGIAR system that has had such an impact, took a minimum of a decade from the outset of a program to the delivery of its first outputs, and in many cases it took much longer. NRM research may not require a significantly longer horizon to produce results than did the initiation of international crop improvement efforts.

Moreover, frequently there are significant time lags between the availability of a new agricultural technology and its adoption. For a relatively simple technology in a well-organized sector like irrigated rice in Latin America, peak adoption can be attained within six years. For more complex technologies which lead to greater changes in the production system or are more capital intensive, like forage technologies in Australia, peak adoption may be reached only after 20 years. Because of their generally more complex nature and the more gradual onset of observable impacts, the diffusion of NRM innovations may more closely approximate the path of forages than rice.

Nevertheless, the impact of NRM innovations are often less immediate and therefore less easily observed or measured. For example, decreased soil erosion or lessened loss of biodiversity typically will not have an immediately observable impact on agricultural productivity simply because the effects of resource degradation or its reversal occur over extended periods of time.

Impact Assessment of NRM: CIAT's Methodological Experience

In the context of the issues discussed above, this paper will now turn to a review of CIAT's experience with impact assessment of NRM research. This is done to share, review and critique approaches and methods, without any intention to present a definitive or normative model.

This section will be comprised of three parts. First, approaches to ex ante impact assessment of NRM research will be briefly reviewed. Second, a method of measuring poverty and

extrapolating up from local perceptions of poverty to regional poverty profiles will be briefly described. Third, methods for using the pressure-state-impact-response framework across different scales of analysis will be considered.

Methods for Ex Ante Impact Assessment

The cornerstone of CIAT's Strategic Plan for the 1990's and Beyond was the integration of a major research effort on resource management with its traditional efforts on germplasm development. This was premised on the proposition that traditional research paradigms based productivity considerations needed to give way to new technology design conceptualizations that met ecological performance criteria in an agroecosystems context(CIAT 1991).

To operationalize this vision, a major study was undertaken to identify research problems and opportunities in natural resource management research (Jones et al 1991). Broad environmental classes and within them, land use patterns (agroecosystems) were defined using GIS. These agroecosystems were then prioritized for research based on a number of criteria:

- Economic growth and resource potential
- Poverty alleviation
- Resource Problems
- Research ability of resource and agricultural problems

The first three criteria are essentially measures of the magnitude of the potential impact of NRM research, while the last criteria is a measure of the probability of achieving the potential impact. Taken together, the criteria would assess the expected impact of natural resource management research. Scoring systems based on the above criteria with different weighting schemes were used to assess the impact of conducting NRM research for alternative agroecosystems (Jones et al 1991).

While there was broad acceptance within CIAT of this approach to set the initial priorities for NRM research, it has been suggested that, "scoring should be used sparingly. The results are unreliable and potentially very misleading," (Alston et al 1995 p. 487). In this view there is no adequate substitute for the use of economic surplus models for impact assessment.

Such an approach was used to estimate the expected impact from alternative crop pasture systems for the savannas of South America (Pachico et al 1993). Rates of return to investment in crop systems were derived from shifts in the supply functions of the commodities produced in the systems.

Nonetheless, it was judged that decision-makers were interested as much in poverty alleviation and sustainability as in the crop productivity consequences of management systems. Consequently, scoring was used to assess the effect of project outputs on biodiversity, soil quality, water resources, pollution and pest ecology.

Extrapolating Local Perceptions of Poverty

Because poverty alleviation ranks high among the objectives of many investors in NRM research, a better understanding of how improved NRM impacts on poverty is a crucial issue. This in turn rests critically on the definition and measurement of poverty. Poverty measurement confronts a number of difficulties in terms of the measurement of income, of the importance of different measures of income relative to wealth or assets, and the intra-household and especial inter-gender distribution of control over income and assets.

While external definitions of poverty such as income or expenditure are frequently used as a basis for measuring poverty, and thus the impact of NRM research on poverty, alternative approaches to poverty assessment are being explored (Ravnborg and Guerrero 1997).

Local perceptions are tapped through farmer interviews to develop indicators of well being which can be used as indicators of poverty according to local perceptions rather than externally derived understandings of poverty. In a case study in Honduras interviews in a sample of 90 communities identified a number of indicators of well-being of widespread relevance. These include indicators such as agricultural laboring, non-farm income, land tenancy, livestock ownership, food availability, housing quality and crop choice. These various indicators were combined into a well-being index (Ravnborg et al 1997).

Pair wise corrections were found between the ranking of indicators in 87 out of the 90 communities, thereby confirming that local definitions of well being are highly consistent across communities. Furthermore, GIS analysis was used to extrapolate the poverty measures nationally.

The sample communities were characterized on the basis of altitude, accessibility, public services, ethnicity, gender, and population density. The same combinations of sampling factors are found in a large number of communities outside the sampling area. Thus, the GIS demonstrates where the poverty measures developed at the local community level are likely to be valid given similarities in community characteristics.

The methodology described above attempts to provide insight into local perceptions of poverty and to ascertain the extent to which such local perceptions can be extrapolated nationally. Such an approach offers the prospect of a better capacity to link natural resource utilization issues to the distribution of poverty through geo-referenced databases. This in turn provides a powerful tool for assessing the impact on welfare of innovations in natural resource management.

Measurement of Impact Across Scales

The measurement of impact across scales is a central issue in the assessment of the impact of NRM research. For example, the impact of erosion on the natural resource base varies from the plot to the slope face to the watershed to the river basin. It is essentially a question of measuring impact across different levels of a systems hierarchy. While this is most easily envisioned as aggregation across scales in a spatial hierarchy, it is also an important phenomenon in other

hierarchical systems. For example, biodiversity occurs at a genetic level within a species, among species in a plant community, and across plant communities within an ecosystem.

Figure 1 displays some cross scale vertical and horizontal linkages in the case of land use. Vertically the scales extend from the regional to the global, while horizontally impacts are shown from the environmental to the economic to the social. In the case of land use shown here, a land use change such as deforestation at a local level has a series of consequences for the local level (erosion), to the national level (loss of forests), to the regional level (increased frequency of droughts and floods, to the global level (climate change). Thus, both the nature and the magnitude of the impact of resource management decisions varies by the scale of the analysis. To enable decision makers to grapple effectively with this complexity, not just for technology design but also for policy formulation and policy making, there is a need to integrate these various scales and dimensions in a way that links the issues operating at different scales while at the same time managing the complexity of the system and communicating it in a comphrensible form. The challenge then becomes to develop information systems that allow users the freedom to show many indicators at the same time, to choose the scale and to make their own assessments, conclusions and decisions regarding impacts.

A particularly appropriate conceptual framework for undertaking this challenge is the pressure-state-impact-response model. This use of this approach is illustrated with examples at two scales, one regional (the Amazon basin), the other national (Peruvian forest margins). As the user increases the scale (i.e. moves from region to nation) the nature of the indicators displayed changes to reflect the new scale.

For example, at the regional level in this land use example the pressure is increased accessibility driven by improvements of the road transport network (Figure 2). This accelerates colonization in the forests which changes the state, that is the surface area of the forests. The impact of this is fragmentation of forests, and a possible policy response is the development of legally protected areas. In each case indicators can be developed for the pressure-state-impact-response.

Within the same Amazon basin at the national level of the Peruvian forest margins, a different set of indicators for the pressure-state-impact-response model is displayed (Figure 3).

Using Participatory Research for Impact Assessment

The importance for impact assessment of defining the "reach" of an intervention in order to design the impact assessment strategy involves understanding who the stakeholders are. Participatory approaches to impact assessment take this stakeholder analysis one step further, in providing methods for impact assessment which actively involve the stakeholder.

Involving stakeholders in assessing the impact of NRM interventions can be done from the perspective of two main approaches which have different objectives. In the first approach which can de referred to as functional participation, stakeholder involvement in impact assessment is a means to an end --and is usually initiated by agents in need of a quick and relatively easy way to obtain an impact assessment, which can be qualitatively appealing. The second approach which is referred to as empowering, decision-making or capacity building participation, is an integral

component of a process of building participatory and innovative management of natural resources, which requires stakeholders to have a capacity to monitor and assess changes in the status of those resources.

Involving local organizations in the design of technical innovations for soil water or forest conservation and in planning where to locate them in a landscape, is now widely recognized as a key element of successful innovation. When local organizations involve farmers in experimenting with principles of conservation and adapting these to meet their own needs and constraints, then innovative improvements in NRM are rapidly developed and adopted. Examples are the EPAGRI microwatershed catchment committees in Santa Catarina, Brazil, the Catchment Committees of the Kenyan Ministry of Agriculture, the Agha Khan Rual support Program in Pakistan, the CIPASLA watershed consortium in Colombia, Landcare in Australia (Ashby and Ravnborg, 1998).

An important feature of local organizations in NRM is that they provide a conduit for receiving and exchanging information about the impact of innovations which brings down the cost for the individual stakeholder of experimenting and of enforcing collective conservation. Participatory impact assessment, when it involves all the relevant stakeholders making an impact on each other, provides information about transboundary effects of NRM interventions enabling stakeholders to arrive at a joint plan of action.

Participatory impact assessment therefore, becomes a vital ingredient in a feedback or learning process that increases the effectiveness of the overall participatory NRM process.

Combining conventional and participatory monitoring and assessment of the transboundary or off-site impact of NRM interventions into an ongoing NRM program can be especially important when mobile as opposed to stationary resource flows are involved, or when multiple competing uses exist for a given resource. For example in common property resources with mobile flows that fluctuate unpredictably -- such as stream flow in a watershed-- it is very difficult for users to assess the effects of use by one stakeholder on the amount or quality of the resource (e.g. water) available to another stakeholder, or the benefits to either user from a conservation intervention (Schlager et al, 1992). When cause and effect cannot be determined readily, conflict over usufruct rights is more likely, and it is easier to free ride.

Thus the implementation of a locally managed participatory process of impact assessment is an important element in sustained success of collective action to improve NRM. Landcare in Australia is an example, in which conservation extension groups involving a broad cross section of rural people with a stake in catchment planning are using techniques such as GIS and aerial surveys in an extensive voluntary participatory environmental monitoring and impact assessment.

CIAT's experience includes both functional and capacity building approaches to participation in impact assessment. Participatory methods have been developed at CIAT to provide ex ante assessment of the acceptability to farmers of conservation practices, and these methods have been shown to be good at predicting future adoption behavior.

A capacity building participatory approach is central to CIAT's experience with the development of community-based management of watershed resources for the Tropical American hillsides. In this approach, stakeholder planning involves the definition of indicators for monitoring the implementation and impact of NRM interventions. At the watershed level, beneficiary assessment of improvement in their quality of life as a result of the changes introduced in NRM is a basic feature of the approach. For specific projects which are co-sponsored and cofinanced by the local watershed inhabitants and by external agencies, a "commission" or task force of stakeholders is appointed by the watershed user association to make regular site visits, using indicators for monitoring and assessment which use local knowledge and also may draw on the GIS system developed by the participating research agencies, such as the poverty (or wellbeing) mapping referred to earlier in this paper. For example, CIAT is testing a "soil quality health kit" designed for use by farmers (level 1) and by extensionists (level 2 of the kit) providing simple diagnostic tools which enable users to build a rapid appraisal of the state of the soils in a microcatchment when there are no accurate soils maps available.

Differentiating among groups of stakeholders in relation to poverty or gender and understanding how impact is distributed among them is important for assessing the effect of NRM interventions on equity, and it is integral to participatory impact assessment. When stakeholder analysis is incomplete, and the relevant stakeholders are not represented in a participatory impact assessment, then not only is the picture of impact obtained likely to be incomplete, but the action based on the assessment is likely to be ineffectual because some important actors have been left out.

CIAT's experience with stakeholder analysis illustrates this. Community-based management of buffer zones around hillsides watercourses in Colombia failed to identify semi-landless migrant farmers as Stakeholders. As a result, forest fires spread into the buffer zones as a result of the traditional slash and burn land clearance by these farmers. Subsequent stakeholder analysis enabled the participants to identify several legitimate but conflicting interests. Burning on the neighboring agricultural land was understood to be a rational practice for the farmers, but which had harmful externalities for the community. A set of norms were developed specifying when and how burning could be conducted and in some communities, groups formed to ensure compliance in making firebreaks to protect the bufferzones (Ravnborg and Ashby, 1996).

CIAT's experience shows that stakeholder analysis needs to be conducted with two objectives, each of which may be important and each of which needs to be evaluated independently for its importance to impact assessment. One is whether the relevant stakeholders in relation to a specified NRM problem are fully identified and represented. The other is whether stakeholders bring relevant expertise to the problem. Representation is important for the accuracy of any stakeholder-led participatory impact assessment, and for future ownership by all stakeholders of any action based on that assessment. However, the representative group may not be the most appropriate or most effective group for tapping specialized knowledge, and it may be essential to select stakeholders with special knowledge for certain assessments.

Some Case Studies in Ex Post Impact Assessment

While NRM research is a relatively new area of research, agricultural research has been having an impact—both positive and negative—on the environment since its beginning. The following examples of the impact of CIAT research on the natural resource base demonstrate that the CG centers' do in fact have a history of NRM impact from which to draw upon. They also show that NRM research cannot easily be separated from traditional commodity research, nor is such a distinction really necessary. Since many of the most important NRM decisions are and will continue to be made in the context of agricultural production, a more holistic approach to impact assessment may be most appropriate.

1. Traditional commodity research with unanticipated environmental impacts

Traditional crop research has significant direct and indirect impacts on the natural resource base. Some of these benefits are positive. For example, improvements in disease resistance of irrigated rice has led to reduction in the use of pesticides and fungicides in Colombia, Venezuela and Brazil (CIAT Rice Program Annual Reports). To the extent that use of these chemicals had negative environmental impacts, the improved varieties had a positive impact on management of natural resources.

In addition to the direct effects on chemical use, rice research has also had an indirect effect on land use. Between 1966 and 1996 rice production in Latin America grew by 2.5 percent a year, while price s fell by 30 percent. Eighthly percent of the production increases came from yield increases rather than from expansion of area planted. Irrigated rice yields almost doubled from 3 to 5.5 tons per hectare, while upland rice yields remained unchanged. The result was that upland rice production became increasingly unprofitable, leading to a reduction in rice production in the Brazilian Cerrados and forest margins. Area planted to rice in these fragile areas declined from a peak of 6 million hectares in 1966 to 2.75 million hectares today (EMBRAPA data).

CIAT's research on improved forages for the South American savannas has included substantial work on deep-rooted grasses of African origin. These grasses--Andropogon gayanus and *Brachiaria humidicola*--were found to sequester significant amounts of organic carbon deep in the soil. The researchers concluded that the process could account for the sequestration of 100-507 Mt carbon per year in such improved pastures throughout South America (Fisher et al). As such, it is quite likely that the research initiated largely with the goal of increasing agricultural production is finding benefits in terms of offsetting CO2 emissions from forest burning in the Amazon. Such an impact is of global relevance, as well as ironic to the extent that these pastures may offset some of the negative environmental results of conversion of tropical forests into pastures for cattle production.

In other cases, the impact of commodity research may not be so unequivocally positive. For example, irrigated rice and other improved crops are often heavy users of chemical fertilizers, which can have direct, negative effects on environmental quality.

An impact assessment of an integrated production/processing project for cassava on the north coast of Colombia found indirect, negative impacts on land use in the short run. Adoption of the processing technology designed to help small farmers capture some of the added value in processed cassava increased the demand for cassava, which led to an expansion in cassava production at the expense of pasture and fallow. In the absence of fertilizer or sound crop management practices, this intensification of production would contribute to a decline in soil fertility.

The story doesn't end here, however. Over time it was also found that farmers invested their cassava earnings in livestock, resulting in the eventual reconversion of cassava land back to pasture. It appears that farmers engaged in short term "mining" of a resource in order to get money for a long term investment that could lead to more sustainable production in the future as well as higher levels of income. What this examples shows is that both short and long term impacts need to be considered, along with the role played by factors such as income in decisions regarding short run and long run natural resource use (Henry, Izquierdo and Gottret; Gottret and Henry).

As these examples show, traditional crop research has important environmental implications. While such impacts are often included in ex post project evaluations, what remains to be addressed is the extent to which these types of concerns should be considered ex ante and should form part of the traditional commodity research agenda. Especially in the case of indirect effects, the causality that is relatively clear in hindsight might be difficult to establish ex ante because the outcomes depend heavily on the economic, political, and social parameters of the broader system in which agricultural production takes place.

2. Joint NRM and commodity research

One way to incorporate the NRM concerns into traditional crop research is through joint research projects. The important overlaps between the two research agendas offer many opportunities for collaboration.

Cooperation among forage, rice and soils programs has yielded interesting results about maintaining and enhancing soil quality in the tropical lowlands. Joint work by CIAT, CIRAD and EMPRAPA's Rice research program (CNPAF) showed that monocropping of upland rice has been shown to have a devastating effect on the populations of earthworms, which play an important role in maintaining soil structure. Rotations, on the other hand, can improve macro and micro fauna in the soil. Improved pastures are also associated with increases in the quantity and quality of worms (CIAT pastures and soils programs). What is clear is that adoption of new practices and varieties has a positive impact on the natural resource base. What remains is to measure the value of this improved soil quality through its contribution to crop productivity.

Similar cooperative research is being conducted in Asia. Cassava farmers in Indonesia, Vietnam, China, and Thailand are involved in different combinations of agronomic trials, testing new cassava germplasm and ways to conserve soils through the use of vegetative contour strips. Using simple plastic lined trenches instead of expensive and often complex concrete trenches, collectors, and volume counters to measure soil losses, farmers can see, measure, compare, and

discuss results in the field. Participating farmers have adopted different combinations of new cassava varieties, agronomic practices, and soil conservation measures (PE-5 Annual Report, 1997.)

Farmers in Laos, Indonesia, the Philippines, Vietnam, Malaysia, Thailand, and China are also participating in a "Forages for Smallholders Project." Farmers are able to test forage germplasm for different uses ranging from improved dual-purpose livestock feeding systems to improved fallows or legume cover crops. Researchers and farmers, working as partners, are beginning to develop and adapt adaptable, problem-solving forage-based technologies (PE-5 Annual Report, 1997).

CIAT is also a participant in the global project "Alternatives to Slash-and-Burn". Much of the initial research has been to document the effects of current land use patterns in terms of deforestation, carbon emissions, and biodiversity losses. These measures will serve to help measure impacts as more sustainable land use systems are developed and adopted. Farmer participatory research is being employed in the Peruvian Amazon to develop such systems. Initial farmer testing of new rice and disease resistant banana and plantain varieties is intended to address problems most mentioned by farmers. As farmer and local national agricultural research system (NARS) confidence increases in the use of participatory methods, the research will shift more to improved fallows, secondary forest management, and the development of alternative crops and products (Fujisaka et al, 1998).

CIAT and national scientists have identified and counted frequencies of plants in different land uses--forest, cropping after forest, fallows of different ages, and cropping after fallows--in Acre, Rondonia, Pucallpa, and Yurimaguas. These studies look at plant species numbers, biodiversity losses in the affected areas, plant community succession as land uses in slash-and-burn systems are forced to change over time, the nature of weed invasions, and the effects of human exploitation of various forest products on plant composition. Such research seeks to understand the impacts of current land use in the forest margins in order to assist in the development of policies and technologies meant to preserve biodiversity (Fujisaka et al, forthcoming).

The cooperative commodity/NRM research has lead to a better understanding of the causal relationships between agricultural production practices and the environment. This information is a critical input into the process of setting research and technology development agendas. It also helps identify appropriate indicators of environmental impact to use in the evaluation of research projects.

As mentioned earlier, a remaining challenge in this area of research is to identify which of these biophysical relationships are also economically important. This is critical for priority setting. CIAT and IFPRI are currently working on a project in which soil erosion data will be incorporated into a traditional consumer-surplus economic impact assessment model to try to capture environmental costs.

The emphasis on participatory methods in these cooperative projects also helps keep the research focused on solving problems that farmers consider to be important. By targeting research to the specific needs of farmers and by incorporating farmer's knowledge and experience into the

technology development process, participatory research can lead to shorter adoption lags and to higher levels of local adoption. However participatory research methods have their own problems with regard to impact assessment, namely difficulties associated with scaling-up the results beyond the initial study area. CIAT is working on using GIS to identify regions which are similar in terms of key economic and ecological characteristics to the study site. The results of such research would help to target more precisely the release of new technologies and to increase the impact, especially in the short run.

3. NRM research

Distinguishing between NRM and commodity research is difficult, however there are some situations in which the short-term goals of traditional agricultural or environmental research appear to diverge from those of NRM. Such situations demonstrate some interesting characteristics of NRM research and highlight challenges to impact measurement.

In 1992, participatory evaluation of contour barriers to control erosion was carried out in a pilot area in the Cabuyal watershed in southern Colombia. Many technological options for controlling soil erosion are available to farmers, however adoption levels are low. One reason is that such techniques are designed and recommended on the basis of agronomic data, not necessarily on the basis of how well they meet farmers priorities. The results of the farmers' evaluations—which differed from those of the scientists--were incorporated into recommendations given out by extension programs. Over the next two years, adoption of contour barriers in this zone increased from 2 farmers to 261. More importantly, the farmers preferences as solicited in interviews were closely correlated with what farmers actually adopted, suggesting that participatory evaluation would be a valuable tool in estimating future adoption of technology and designing technologies to maximize impact (Ashby et al, 1996).

The impact of local involvement at the policy level can also be seen in the Colombia research site. In this watershed, an association was created which involves residents and outside organizations working in the watershed. It provides a forum in which stakeholders with diverse interests in the resources of the watershed can identify problems, set priorities, and negotiate solutions. Through concerted action of this group, residents achieved a change in the national policy regarding the maintenance of forested buffer zones around watercourses. Colombian national environmental policy stipulated the creation of buffer zones measuring 50 meters for springs and 30 for watercourses. Local residents considered this to be too big, and since official enforcement capacity was weak, compliance rare.

When this problem was taken up within the association, an agreement was reached with the regional watershed authorities and the local water management board that sizes of buffer zones would be determined on an individual basis, taking into consideration the specific characteristics and features of the area. Technical advice would be provided to help make these determinations. As a result, over the next 18 months, over 135 hectares were enclosed and 150,000 trees planted. The community supplied 3,714 person days of labor to the effort. The local-level consensus and support for the policy also allowed the community to implement a highly effective enforcement mechanism. Anyone who did not participate would have their water turned off by the local water authority. (Ashby et al, 1997 and Ravnborg and Ashby 1996)

Both these examples represent cases where the recommendations based on narrow production or environmental protection considerations were rejected by farmers. On the surface, this does not look like positive impact. However the in terms of the amount of soil actually conserved or the number of hectares actually reforested, impact is higher with the "second-best" practices because they were adopted. Natural resource management problems are often characterized by the fact that the private and social costs and benefits of economic decisions diverge. Since decisions are made by individuals, special attention must be paid to the particular incentives facing each individual. An environmental technology or policy that is incentive compatible—and therefore feasible—may look quite different from one that derives from some concept of the "social good" without regard for whether it can be feasibly implemented. In reality, tradeoffs may have to be made between priorities of the different stakeholders in order to assure implementation.

In terms of quantifying impact, NRM research faces many of the same valuation problems mentioned in earlier sections. Since many resources do not have markets, it is difficult to put a monetary value on them. Research carried out within the context of a particular production system can be valued in terms of the contribution of the resource to productivity. However much NRM research is not that site or system specific. Work is underway by CIAT economists in Pullcalpa to use techniques such as contingent valuation to try put a value on resources, and thereby provide a basis for assessing the impact of projects that lead to changes in the resource base.

Finally, resource management associations such as the watershed user's association can have value to a community far beyond the achievement of their short-term NRM goals. Improving the capacity of a community to organize and work cooperatively to achieve its goals will help it to address other issues that collective action. Incentive problems described above are not unique to NRM, and collective action is one way to help mitigate their effects on economic efficiency. There is increasing evidence that high levels of cooperation and organization can contribute to development (Johnson). Given the dynamic nature of NRM and of the broader economic system, the real impact of strengthening the ability of communities to better manage their own resources may be felt not through short term conservation projects but through its contribution to the better long run use of all community's resources—natural, mechanical, and human. CIAT and the Rockefeller Foundation are currently involved in research aimed at understanding and quantifying the short and long run impact of this "social capital" on NRM and community economic development.

Conclusions

Impact assessment of NRM research serves important functions of insuring the effectiveness of NRM research while also demonstrating its returns to stakeholder-investors. As such, impact assessment is best implemented as an integral part of the entire research process rather than as a retrospective exercise that comes at the end of a research project.

Investors in NRM research are motivated by a complex set of development goals, and their interests are less on the outputs of the research process (scientific knowledge, methods, even

adoption of technology), than on the outcomes which occur as a result of research. These impacts may be economic, social, environmental or institutional.

Careful linkage of the expected outputs of research with the intended development outcomes is crucial to insure that research is planned so that it is directed at having an impact on the outcomes of interest to investors, and also to insure that investors have realistic expectations about how research can contribute to desired outcomes.

Particularly in cases of multi-stakeholder management of natural resources, impact assessment can be of direct relevance to communities, not just to scientists and research managers. Thus, participatory methods of impact assessment can strengthen local capacity for improved resource management as well as function as feedback to scientists and research managers.

Different indicators are appropriate for measuring various types of impact. Ideally these indicators are specified at the outset of the research process; are relatively inexpensive to measure; and correlate closely with the state of the underlying complex development processes. Frequently impact assessment will need to use an array of indicators to assess a variety of outcomes. These will differ in scale both geographically and over time. Moreover, the distribution of impacts among social groups, including by gender, is often of key interest.

A number of empirical studies can be cited where the impact of NRM research has been assessed. These assessments have utilized a variety of indicators, including biophysical (e.g. soil carbon), agronomic (e.g. yields, pesticide applications), economic (e.g. profitability), and social (e.g. well being). Clearly impact assessment is not the exclusive province of a particular set of specialized practitioners. It requires a multi-disciplinary approach, and can well make use of a variety of methods including GIS, participatory research, and bio-economic modeling.

Figure 1. Vertical and horizontal linkages: the case of land use

(Source: Winograd 1997.)

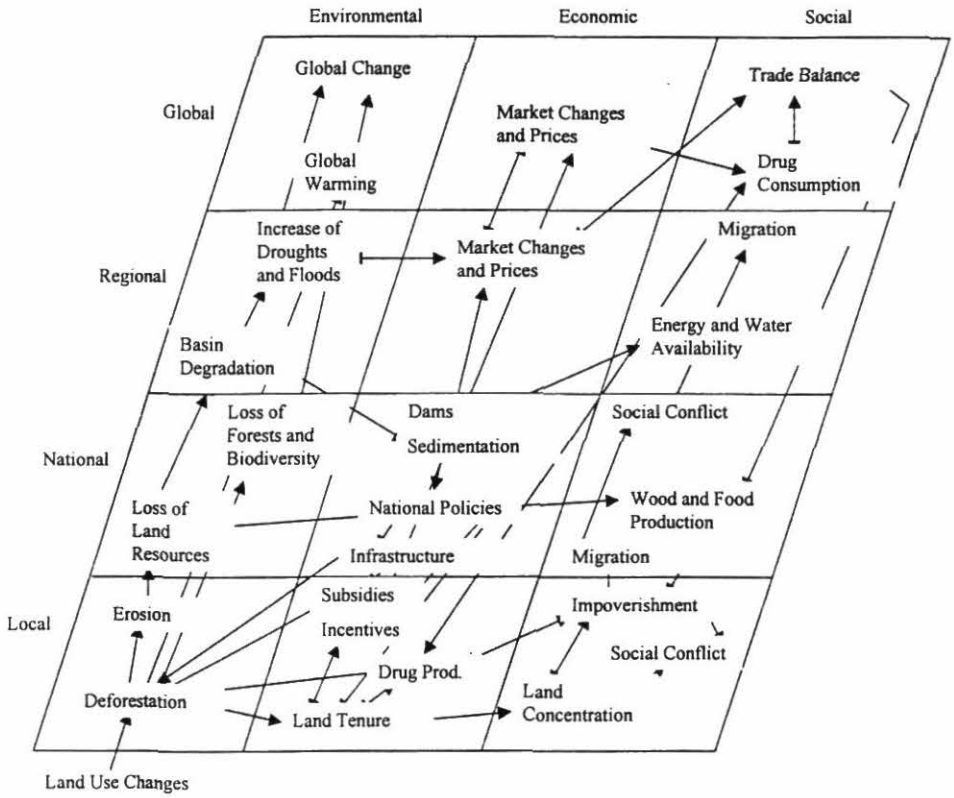


Figure 2: Amazonian Forests - Pressure, State, Impact and Response Indicators

2a. Pressure: Accessibility
State: Surface of Forests

2b. Impact: Fragmentation of Forests

2c. Response: Protected Areas

(Source: Winograd et al 1998)

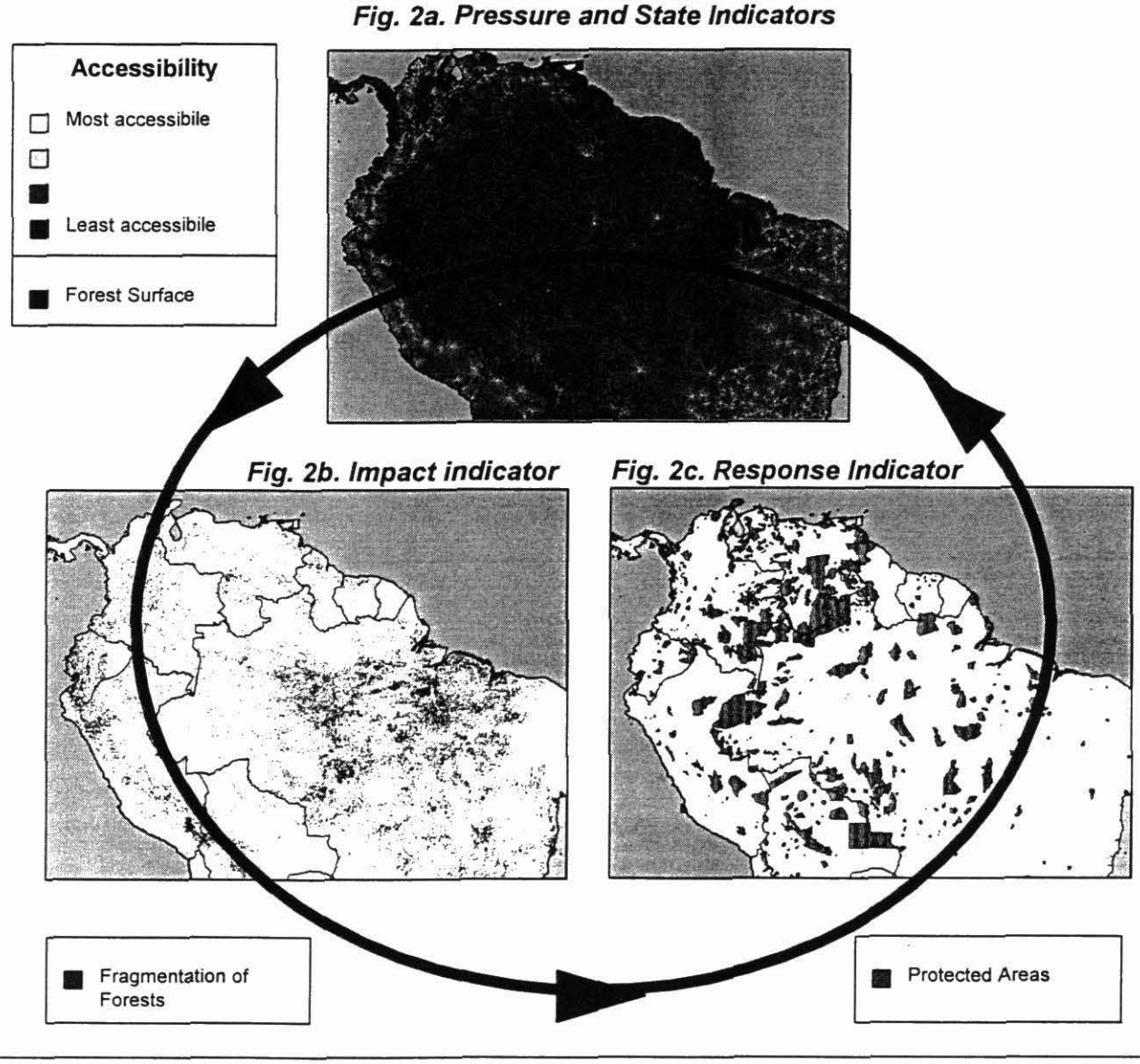
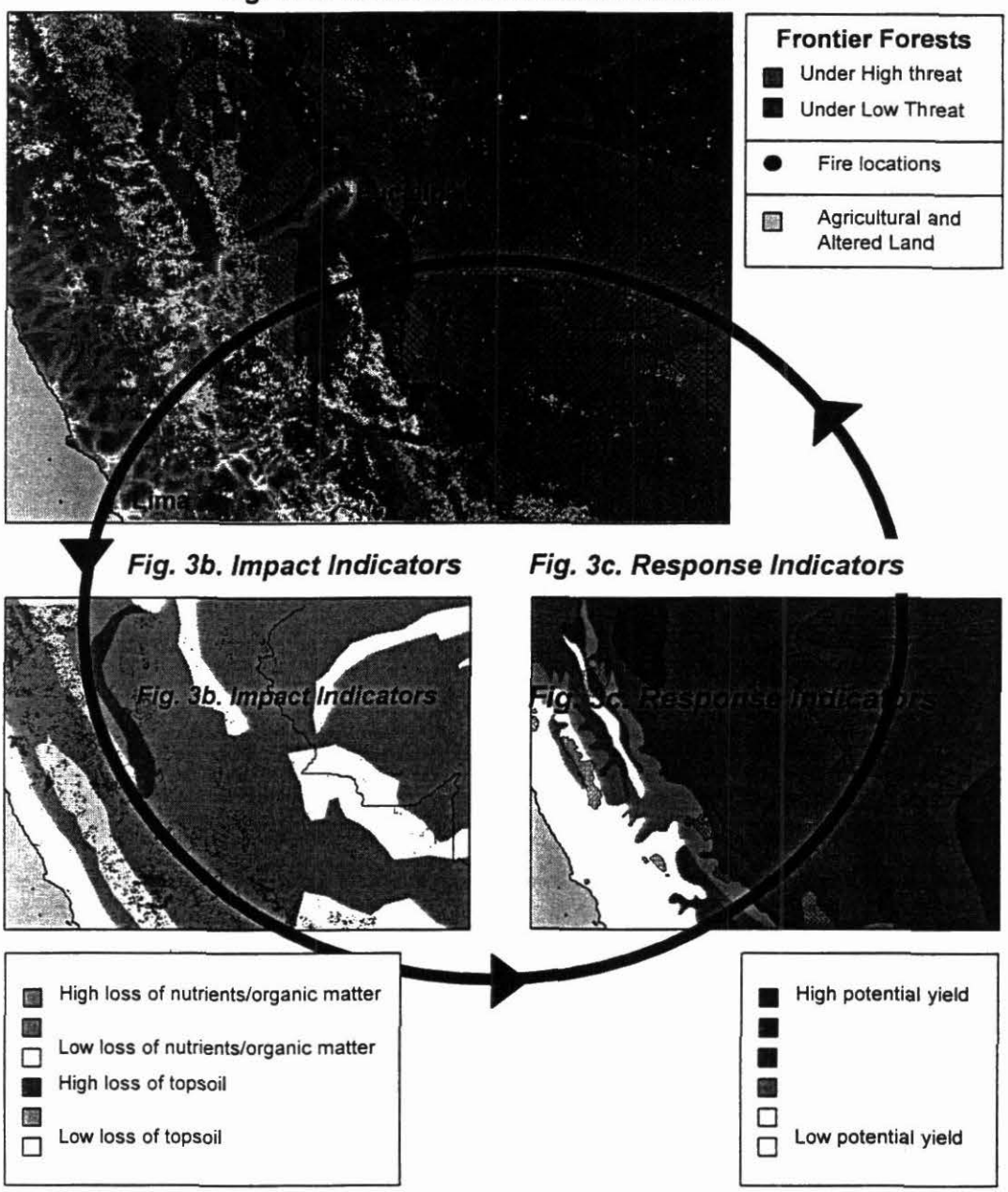


Figure 3: Peruvian Forest Margin - Pressure, State, Impact and Response Indicators

(Source: Winograd et al 1998)

3a.	Pressure:	Frontier Forests under threat Accessibility Distribution of Fires (January 1993)
	State:	Surface of Agricultural or 'Altered' land
3b.	Impact:	Soil degradation - loss of topsoil/nutrients/organic matter Fragmentation of Forests
3c.	Response:	Protected Areas Potential Yield

Fig. 3a. Pressures and State Indicators



4.1.B Agroenterprise Projects and Sustainable Rural Livelihoods : Design of a Methodology to Assess Impact - *M. V. Gottret, and N. Johnson*

1998 Milestone

- A project proposal has been submitted to the Competitive Fund for Small Projects of the Research Program on Methodologies for the Monitoring and Evaluation of Projects for the Management of Natural Resources in Latin America and the Caribbean.

1. Background

Previous research on hillsides and forest margins regions has centered on the development of sustainable production systems and on the conservation of natural resources, however, their adoption in tropical countries has been disappointing (Laing and Ashby, 1992, Kaimovitz, 1992). Constraints of adoption suggest that poor small-scale farmers will have to be offered incentives to induce timely adoption of natural resource conservation practices.

Changing market trends and consumption habits are creating market niches for exotic fruits, nuts, medicinal plants, and organic raw materials, such as essential oils, natural colors, spices and tannin. New opportunities have also arisen for traditional commodities, including cassava, sugar cane, and livestock products, and for local seed production. However, smallholders and small-scale entrepreneurs face many barriers that prevent them from taking full advantage of these market opportunities. They generally have little business experience and lack information about technologies, markets and prices. Moreover, rural areas offer few support services for commercial activities, such as credit, transportation and communications.

In response to these needs, in April 1996, CIAT formally established a Rural Agroenterprise Development Project, convinced that the development of a dynamic and organized smallholder sector linked to growth markets is an effective strategy for contributing both to the alleviation of poverty, and the creation of incentives for sound natural resource management. This builds-up on the Center's experience in cassava processing and marketing, and falls under the framework of the Center's strategy for resource management research.

The overall development goal towards which the Rural Agroenterprise Development project seeks to contribute is :

Improve the wellbeing of the rural population through the promotion and strengthening of rural agroenterprises that link smallholders to growth markets and motivate farmers to invest in the conservation of the resource base.

The specific purpose of the project is :

To develop in collaboration with our partners methods, tools and institutional models for the design and execution of successful rural agroenterprise development projects that integrate market opportunities and postharvest technologies with environmentally sound production and processing practices.

The project integrates its work closely with the activities of CIAT Projects on Community Watershed Management, Sustainable Systems for Smallholders, and Participatory Research and Gender Analysis, that provide input to the project on participatory techniques, production economics, agronomic evaluation of market opportunities, and natural resource management. In turn, the Rural Agroenterprise Development Project provides information on commodity alternatives for the design of sustainable production systems. This collaboration manifests itself through the research undertaken in pilot sites in hillsides and forest margin agroecosystems in Colombia, Honduras, and Peru.

The Rural Agroenterprise Development project's immediate clients and users are the technical personnel of organizations in rural agroindustrial R&D and rural policy makers. Therefore, the project's main aim is to strengthen local, regional, and national institutions. Ultimate beneficiaries are the inhabitants of rural areas, especially small farmers, and rural entrepreneurs, who benefit from training and information on postharvest processing technologies, market analysis, and support services. The project also relates to other institutions outside CIAT pilot sites in Latin America, through (1) direct training, (2) the Program for Rural Agroindustrial Development for Latin America (PRODAR), (3) collaboration with projects in Africa and Asia, and (4) institutions who will access the project Homepage in Internet and use the products of the project.

Since CIAT's Rural Agroenterprise Development Project is a research project whose aim is to deliver tools, methods, and models for the design of sustainable and successful rural enterprise development projects, it is of primary importance to evaluate the impact of the different intervention models in the pilot sites in order to evaluate success and identify needed adjustments. Afterwards, these models can be used to design similar interventions in other regions or expand a project over a wider area. This analysis also serves to compare and contrast different intervention models and their suitability for different situations. Therefore, impact assessment is an important tool to improve the quality and efficiency of the project.

The reduction of funds for research and development projects has brought a high competition for these scarce resources. As a consequence, the need to show the impact of the resources invested in research and development has become more important over the last decade. Donors are routinely asking for estimates of the return on their investment in research and development projects.

In response to these internal and external pressures, impact assessment has become an integral part of CIAT's project management system, and the Center is in the process of incorporating indicators of progress in developing outputs and measures of impact into project design and performance monitoring.

Measuring impact has become more challenging because research and development projects have also become more complex in their effort to respond to the multiple objectives of so called "sustainable rural development", where poverty reduction, conservation of the natural resource base, and community empowerment are the main issues. Furthermore, this kind of project is becoming more prevalent but little is known about how to measure their effectiveness.

Therefore, social scientists have been pressured to develop new methodologies for impact assessment and/or adjust the existing ones to respond to the new challenges and needs.

Impact assessment is no longer limited to the assessment of technology adoption and the economic impact of technological intervention. Rural Agroenterprise Development projects include interventions on marketing, production and post-production systems, support services for agroenterprise development, and on community organization and empowerment. Therefore, impact assessment methodologies need to be able to evaluate these interventions and determine their socioeconomic, environmental, and institutional impacts. Furthermore, "poverty" is too broad a term, which needs to be specified in short term indicators that are easily observable, and that can be related to specific interventions and outputs.

2. Literature Review

The focus on measurable impact within the donor community and the Consultative Group (CG) system poses special challenges for social science research, particularly institutional development programs (Johnson, 1998). Despite its significance, however, often little effort was made to evaluate the impact of institution-building programs, in large part because methodological and empirical problems associated with "quantifying the unquantifiable" (Goldsmith, 1993; Anderson, 1997). The importance of research on social and institutional issues within the CG system is likely to increase as the CG's mandate expands to explicitly include poverty, the environment, health and community empowerment as well as agricultural productivity. Addressing these issues may well require looking beyond specific technologies and individual farmers to the broader socioeconomic system in which they operate (Johnson, 1998).

The importance of collective action in areas such as natural resource management, the provision of public goods and services, and the strengthening of markets and market access demonstrates the critical need for more research on how and why social factors contribute to sustainable development (Seralgeldin and Steer, 1994; Ostrom, 1996). Increased interest in social factors, combined with growing donor demand for measurable impact, results in a major challenge facing applied research programs in social science, not only within the CG system, but in other research and development organizations as well (Johnson, 1998).

Proper impact analysis cannot be tacked on at the end of a project, it must be built into the design and implementation from the beginning. This implies a connection between project planning and impact assessment phases. "Indicators of achievement, success and results are established during the *ex-ante* or planning phase but they are used, validated and enriched in the *ex-post* phase" (Quintero Uribe, 1997 p. 297). Further, an impact cannot be claimed by a project unless it can be logically explained and justified. According to Goldsmith, "outcomes cannot be assessed fairly unless they are identified from the start" (p. 201).

Adoption and impact assessment analysis include (1) technology acceptance studies (2) technology adoption studies, (3) farm system analysis, (4) ex-post benefits estimation, and (5) ex-ante impact assessment. During the last 20 years a huge amount of studies have concentrated in the first three type of studies. *Ex-post and ex-ante* impact studies conducted and the

methodologies used, were targeted to assess simple interventions, such as new varieties or improved production practices on a single commodity, which is produced for a single market. Reviews of these type of studies can be found in Byerlee and Moya, 1992; Collinson and Tollens, 1994; Dalrymple, 1986a, 1986b; Echeverría et al., 1989; Evenson, 1992; Pachico, 1991; Seré, 1986; Stifel, 1992; and Timothy et al., 1988.

There are also some studies on the impact of new post-harvest and processing technologies (Mullen, 1985; Mullen et al., 1991; Scobie et al., 1991; Gottret and Henry, 1994; Best et al., 1994; Gottret et al., 1997; and Ospina, et al., 1998). Most of these studies used consumer surplus models extended to consider the size and distribution of benefits in the context of multiple factors and multiple product markets. Alston et al. (1995) synthesized and extended the existing methodologies for estimating economic impact of agricultural research and returns to investment. However, impact assessment becomes more complex with the need to introduce a portfolio of products in multiple markets. As stated by Pachico (1992) more sophisticated methods have also more demanding data requirements. Furthermore, impact assessment models or methodologies for rural agroenterprise development projects need to deal not only with technological innovations, but with interventions on the marketing systems, support services, and community organizations.

According to Pachico (1992) impact assessment research occupies a key role in International Agricultural Research Centers. At CIAT it has contributed to research prioritization and resource allocation both between and within research programs. However, much remains to be done to enable impact assessment to more fully address equity issues, such as distribution of benefits by gender, community empowerment, or the final effect of research projects on household and community quality of life. Pachico (1992) also states that a major challenge for impact assessment at CIAT will be in assessing the impact of natural resource management research. This involves methodological problems of measurement, benefits distribution and time. It is urgent to expand attention on *ex-ante* analysis as new investment in this area is initiated. The returns to policy and institutional research will also requires special attention.

According to Goldsmith (1993), institutions are essential for agricultural development, yet confusion is widespread about what institutions are and how to evaluate them. He concludes that "evaluation methods for institutions focus on resource acquisition, internal processes, output and outcomes and the linkages among these activities. All the methods are handicapped by difficult definitional, attribution and temporal problems. To evaluate institutional development requires starting with clear definitions, which admit that institutional development is hard to measure and prove".

Goldsmith (1993) also stresses the unspoken hypothesis that a causal connection runs through them, from inputs to institutions to outputs and outcomes at the final user or client level. For example, recommendations made to an institution cause improvements on it that lead, in turn, to better methods for farmers to use and more food for people to eat. While the connections are plausible, evaluators often are forced to treat them as a "black box" that cannot be analyzed or explained in detail. He states that "no-one has yet found an easy way, for example, to find out the effect of policy advice to a country : the final impact may be great, but the causality is usually too subtle to measure exactly. The subtlety is particularly acute with agricultural

research and technology diffusion, in which a long chain of events separates innovations made in the scientist's laboratory from their employment in the farmer's field."

In what is probably the most comprehensive framework to date for the analysis of social capital projects, Ritchey-Vance (1996) describes an evaluation framework that looks at impact across scales – at the individual, the organizational, and the community levels – and along a continuum of tangible to intangible impacts. Developed by the Inter-American Foundation (IAF), the framework is based not on any theory but rather on the field experience of development practitioners. The approach is popular with NGO's and other development organizations. The IAF has been consulted by USAID, Peace Corps, and the WWF among others. The level of disaggregation achieved might make it a useful tool for research projects seeking to understand as well as measure change. The challenge is to select appropriate questions and indicators (Johnson, 1998).

Hyman and Dearden (1998), review comprehensive impact tracking systems of four NGOs that support or implement business development programs beyond credit alone for microenterprises in developing countries. This analysis followed a survey of 41 NGOs based in the United States and Canada belonging to the Small Enterprise Education and Promotion Network (SEEP) and consultations with the "Assessing the Impact of Microenterprise Services " (AIMS) Project staff and USAID.

All four systems relied on both quantitative and qualitative data, although the mix of methods varied. The most common sources of data were program records and client surveys, but others included focus groups, loan applications and renewals, and key informant interviews. Differences in impact indicators across organizations reflected the diversity of their microenterprise programs and institutional mandates, from financial and/or economic impact, the development of community-based enterprises, and nutrition and health impact, to environment and natural resource impact.

Hyman and Dearden (1998) conclude that impact monitoring systems often suffer from insufficient baseline data to allow before-and-after comparisons of program clients The rigor of impact assessment could be improved through more systematic collection of baseline and longitudinal data on clients and use of statistical tests. Also, program clients have rarely been included in selection of impact indicators or design of assessment procedures. Boosting participation of low income and relatively uneducated clients poses challenges and managers and donors have generally have specific information needs. Presenting impact findings to clients in group meetings could help meet their information needs and serve as a check on the veracity of data and viability of recommendations.

The two approaches for assessing institutional development and microenterprise development programs reviewed by Ritchey-Vance (1996) and Hyman and Dearden (1998), provide insights and methodologies, as well as a number of indicators for assessing the impact of rural agroenterprise development projects. However, there is a need for a theoretical framework which will provides the connection between the project, its outputs, and its proposed impact. In order to assess the impact of CIAT's Rural Agroenterprise Development Project, it is necessary to develop a methodology which permits the establishment of a link between the outputs of the

project and the final user, through an institutional strengthening strategy. Also, the existing methodology to estimate the economic impact at the ultimate user level, using economic surplus models, should be extended to include a portfolio of products for multiple markets

3. General and Specific Objective

3.1 Project Goal

Improve the quality and efficiency of rural agroenterprise development projects, which aim to contribute to poverty alleviation while creating incentives for the conservation of the natural resource base, and indicate the return on stakeholder investment.

3.2 Project Purpose

Design an impact assessment methodology to assess the impact of CIAT's Rural Agroenterprise Development Project, on both immediate and ultimate clients and beneficiaries, which can be generally applied.

3.3 Project Outputs

Output 1. Methodology designed to select impact assessment indicators for rural agroenterprise development projects, which are easily observable, and based on a theoretical framework which permits a linkage between project outputs and project goals at the levels of both immediate and ultimate clients and beneficiaries.

Output 2. Impact assessment indicators defined and selected for CIAT's Rural Agroenterprise Development Project.

Output 3. Baseline data on immediate and ultimate beneficiaries collected at one of the CIAT's hillside pilot sites, for future *ex-post* impact assessment.

Output 4. Ex-ante impact of CIAT's Agroenterprise Development Project assessed.

4. Research Plan

4.1 Output 1: Methodology Design

With funding from the Rockefeller Foundation, CIAT hired a Post-doctoral Fellow with the objective of conducting research to model and evaluate the impact of the Center's projects that have as a component of their research agendas the formation or strengthening of social institutions. As a result, a theoretical framework has been developed for analyzing institutional changes. The purpose of this theoretical model is to identify causal links between individuals' goals, the specific characteristics of their physical and social environments, and the economic decisions they make. Since impact is the result of changes in individual decisions, there is a need to begin with a clear idea about how these decisions are made. From there, it is possible to

analyze what types of interventions would most effectively bring about the desired changes in observed outcomes (CIAT, 1997).

The above theoretical framework is based on the "economics of information." Many of the types of institutions and services that Agroenterprise Development Projects focus on local markets; organizations for the production, processing and/or marketing of commodities; organizations which provide local support systems for rural agroentreprises; technology and market information systems; systems for governing the management and use of natural resources – are essentially mechanisms for the collection and management of information. To the extent that these institutions can be improved so that information is gathered and transmitted more accurately and efficiently, they can help individuals make better decisions that result in higher levels of individual and social welfare.

The fundamental contribution of this area of research is the explicit recognition that individuals make decisions on the bases of the information that is available to them. Therefore, the amount of information than an individual or an organization has will affect the decisions that he or she makes. Standard neoclassical economic theory contains the implicit assumption that individual decision makers have costless access to information. In a perfect world, all relevant information about a good or service is captured in its relative price. Market determined prices exactly reflect the marginal value of a particular good or service. Perfect information implies not only that prices contain all the information that individual decision makers need to know, but also that the final allocation of goods and services resulting from their decentralized decision making will be socially optimal.

While the assumption of perfect information is a useful approximation in many cases, there are some situations in which prices clearly do not convey all relevant information. In fact, in some cases - specially relating to natural resources and community empowerment – meaningful prices may not exist at all. Under these circumstances, the resource allocation and corresponding level of social welfare that results from individual decision makers making independent decisions is unlikely to be optimal.

The value of institutions is that they can overcome information problems to improve the accuracy of individual decision making and the social efficiency of resource use. Therefore, it is from the perspective of information economics – essentially who knows what, when, and at what cost – that the effect of institutions and efforts to improve them can best be evaluated. CIAT's Rural Agroenterprise Project improves information in several ways. The project provides information directly, and helps to form or strengthen organizations that can reduce transactions costs associated with information acquisition and transmission. In addition, to the extent that the project performs coordination and monitoring functions, it can help to overcome strategic behavior problems. The project also provides technological and market information that can help recognize new economic opportunities, resulting in a more efficient use of resources and higher levels of wellbeing.

Based on this theoretical framework, a model will be developed for analyzing rural agroenterprise development projects at the operational level. As a result, a generic methodology that explicitly links project outputs with outcomes on immediate and ultimate clients will be

designed. This model will connect ultimate users with institutions and organizations that provide information. The knowledge and understanding of this linkages, will permit the design of a methodology that helps to define easily observable impact assessment indicators.

For this purpose the following activities will be executed :

1. Review of different rural agroenterprise development projects, looking at who their clients and beneficiaries are, the type of information and services they provide, and what type of outcomes they expect – specific problems they expect to solve with their intervention.

2. Based on the above review of projects, a generic rural agroenterprise development project format will be formulated, which captures the important linkages between different types of actors.

3. Using the existing theoretical framework, based on the "economics of information", an operational model will be developed for the generic agroenterprise development project, which will allow to link project outputs to project goals at the levels of both immediate and ultimate clients and beneficiaries.

4. This operational model will then permit the design of a methodology to help in defining impact assessment indicators for rural agroenterprise development projects.

4.2 Output 2 : Definition of Specific Impact Assessment Indicators for CIAT's Rural Agroenterprise Development Project

The methodology designed in the above output will then be used for one specific case study of CIAT's Rural Agroenterprise Development Project. The following activities will be executed in order to achieve Output 2.

1. An operational model will be develop to evaluate a Rural Agroenterprise Development Project, based on the generic model developed in Output 1.

2. A set of observable quantitative and qualitative indicators for Project will be defined by the project team, with support from the CIAT's Impact Assessment Project.

3. The set of indicators defined will be validated with the Project's immediate and ultimate users and beneficiaries with the participation of CIAT's partner institutions on the hillsides pilot sites.

4.3 Output 3 : Baseline Data Collection in one of CIAT's Hillside Pilot Sites

Once specific impact assessment indicators are defined and validated with clients and beneficiaries, baseline data will be collected in one of the two CIAT hillside pilot sites (Cauca, Colombia or Yoro-yorito, Honduras). This data collection activity will be done in collaboration with CIAT partners in the hillside pilot sites. For the collection of baseline data the following activities will carried out :

1. The pilot site for baseline data collection will be selected based on a consultation with CIAT partner institutions and their interest in participating in the study, and the availability of a resource person on the site to support the field work.

2. Instruments for quantitative and qualitative data collection will be selected and designed.

3. Field work will be conducted for baseline data collection.

4. A database will be designed on Microsoft Access and information will be analyzed.

4.4 Output 4 : Ex-ante Impact Assessment

The operational model developed for the CIAT's Rural Agroenterprise Development Project, will then be used to evaluate *ex-ante* impact. These project impact estimates could then be used to predict the magnitude and distribution of potential impact of the Project's outputs.

Collaborators:

- R. Best, C. Wheatly, C. Ostertag - Rural Agroenterprise Development Project, CIAT.

4.2 NARS' Capacity Enhancement - *D. Pachico*

1. Taught ex-ante and ex-post evaluation methods in International Course on Rural Agro-industry and Sustainable Development.

2. Supervised thesis or practicals of students from the University Javeriana, Bogota; the University Autonoma, Cali; the University Autonoma Gabriel Rene Moreno, Santa Cruz de la Sierra, Bolivia.

V. LIST OF DONORS

- Food and Agriculture Organization, Brasilia, Brazil[1]
- Impact Assessment and Evaluation Group[1]
- Inter-American Development Bank[1]
- Nestlé de Colombia, S.A.[2]
- Pronatta (Programa Nacional de Transferencia de Tecnología, Ministerio de Agricultura, Colombia.[2]
- Rockefeller Foundation[1]
- Swiss Development Cooperation[2]

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[1] Direct Contribution to Project BP1.

[2] Contribution to other CIAT Project which supported work executed in collaboration between BP1 and other CIAT project.

VI. PARTNER INSTITUIONS, 1998

CORPOICA, Bogotá, Colombia.

Corporación para el Fomento de los CIAL's, CORFOCIAL, Cauca, Colombia.

Empresa de Asistencia Técnica y Extensión Rural Ceara, EMATERCE, Fortaleza, Ceara, Brazil.

Empresa Brasilera de Pesquisa Agricola: Centro Nacional de Pesquisa de Mandioca y Frutas, EMBRAPA-CNPAF, Cruz das Almas, Bahia, Brazil.

Food and Agriculture Organization, (FAO), Brasilia, Brazil.

Impact Assessment and Evaluation Group, (IAEG), CGIAR.

Instituto Interamericano de Ciencia Agrícola, (IICA), San José, Costa Rica.

International Food Policy Research Institute. (IFPRI), Washington, D.C., U.S.A.

International Service to National Agricultural Research (ISNAR), The Hague, Netherlands.

International Livestock Research Institute, (ILRI), Nairobi, Kenya.

Nestlé, S.A., Colombia.

Secretaria de Desarrollo Rural, SDR, Fortaleza, Ceara, Brazil.

Universidad Autonoma, Cali, Colombia.

Universidad Autonoma Gabriel Rene Moreno, Santa Cruz de la Sierra, Boliva.

University of Arizona, Tucson, Arizona, U.S.A.

Universidad Javeriana, Bogotá, Colombia.

Yale, University, New Haven, Conneticut, U.S.A.

VII. STAFF LIST 1998

• James A. **García**, Ms	Statistician/Data Base Specialist
• Nancy **Johnson**, PhD	Economist, Rockefeller Foundation
• Reed **Hertford**, PhD	Economist, Consultant
• María Verónica **Gottret**, Ms	Economist
• Gabriel **López**	Student
• Bernardo **Ospina**, Ms	Agronomist, Consultant
• Douglas **Pachico**, PhD	Economist
• Gloria **Posada**	Bilingual Secretary
• Libardo **Rivas**, Ms	Economist
• Leonel **Rosero**	Technician
• Norha **Ruíz-Londoño**, Ms	Economist, Consultant
• Stanley R. **Wood**, Ms	IFPRI, Associate member of staff

VII. PUBLICATIONS AND PRESENTATION LIST

PUBLICATIONS AWARD: Outstanding Paper, 1998, Plant Genetic Resources Division, Crop Science Society of America for Epperson, J., D. Pachico and C.L. Guevarra "A Cost Analysis of Maintaining Cassava Plant Genetic Resources." Crop Science 37:5.

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