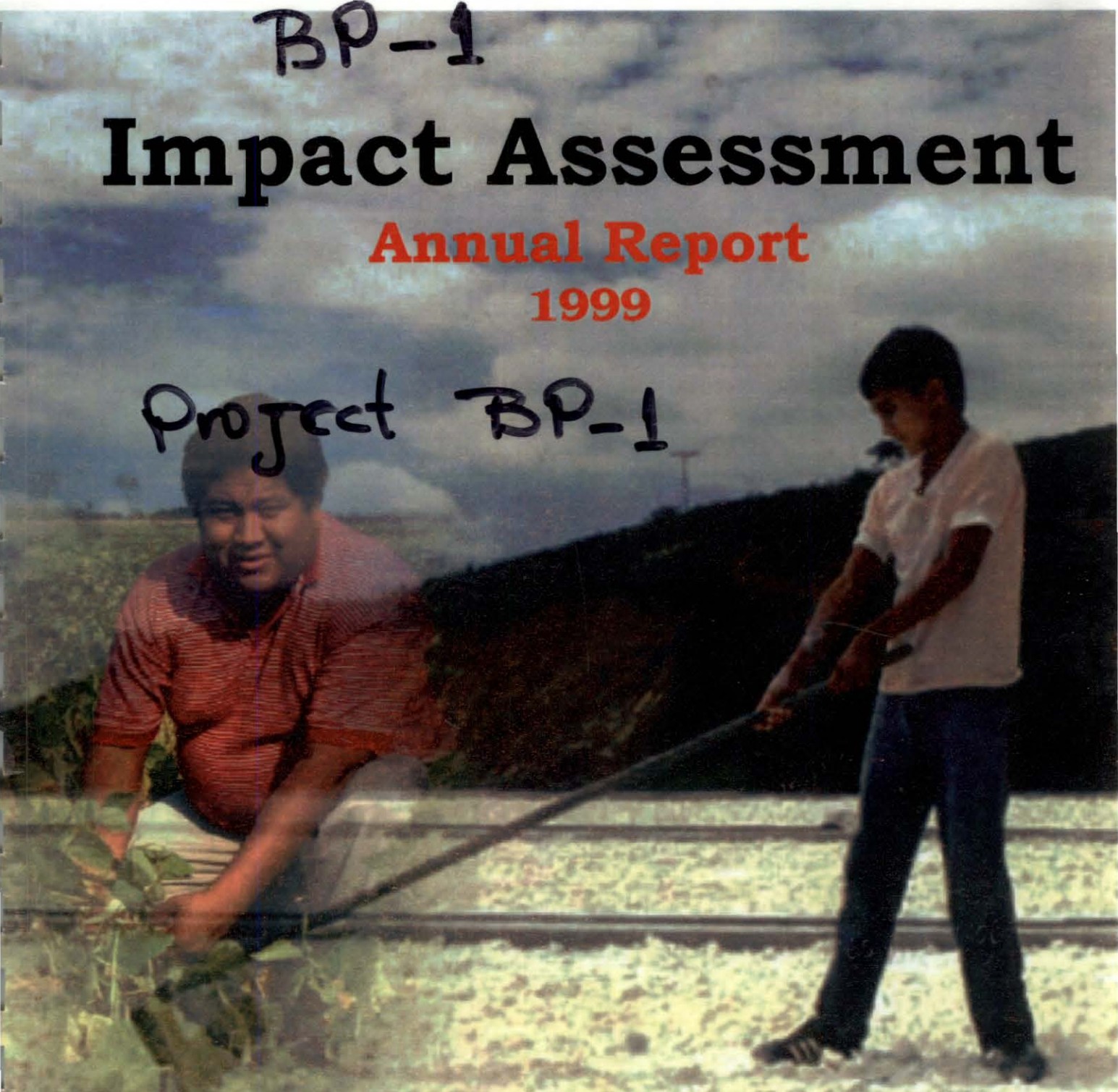
BP-1

Impact Assessment

Annual Report
1999

Project BP-1



Reporting Period
October 1998 - September 1999

Editor, Douglas Pachico

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

IMPACT ASSESSMENT

ANNUAL REPORT

1999

Reporting Period October 1998-September 1999

Editor, Douglas Pachico

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

Table of Contents

Impact Assessment
Annual Report
1999

1999 HIGHLIGHTS

Output 1: EXPECTED IMPACT OF FUTURE RESEARCH ESTIMATED.

Output 1.1. Trends affecting impacts of research analyzed.

Result 1.1.A. Relation between agricultural research and poverty analyzed.

- Employment creation major priority for poverty reduction through agricultural research. Prospects greatest in high value crops, weak in field crops.
- In open economies major impact through productivity increase and attenuated effect of reduced food prices.
- Poverty reduction not central element to improved resource management.

Result 1.1.B. Trends in livestock products in Asia and Africa analyzed.

- Consumption of meat and milk in Asia and Africa significantly greater than production.
- Strong prospects of demand for new technology for intensified livestock production systems in Asia.
- Some potential for low cost livestock producers to export to Asia.

Output 1.2. Impact of future research outputs estimated.

Result 1.2.A. Water Resources in Nicaragua.

- Women would be particularly benefited from improved drinking water resources.

Result 1.2.B. Future Impact of Soils Research.

- Databases and model under development for this research, but no results yet.

Result 1.2.C. Future Impact of Research for Savannas of Colombia.

- Highest returns to research estimated for beef, plantain, milk, rice and fruits, lowest for beans, sorghum, soybeans and maize.

Result 1.2.D. Future Impact of Research Producing Informational Outputs.

- Models being developed, but no results to report yet.

OUTPUT 2: IMPACT OF PAST CIAT RESEARCH MONITORED.

Output 2.1. Information on use of CIAT technology synthesized.

Result 2.1.A. Use of CIAT germplasm documented.

- Over 80% of rice are planted to varieties with CIAT content in Brazil, Colombia, Costa Rica and Ecuador.
- Over 50% of rice area planted to varieties with CIAT content in Argentina, Bolivia, Panama, and Venezuela.
- Over 80% of bean area planted to varieties with CIAT content in Bolivia and Costa Rica.
- Over 35% of bean area planted to varieties with CIAT content in Argentina, Guatemala, Honduras, and Panama.
- In Africa, over 10% of bean area planted to varieties with CIAT content in Congo, Rwanda and Uganda.
- Over 50% of cassava area planted to varieties with CIAT content in Dominican Republic, Haiti, Mexico and Thailand.

Result 2.1.B. Benefits from improved rice germplasm in Latin America estimated.

- Larger share of benefits from improved rice germplasm in Latin America has gone to consumers.
- Increased productivity of irrigated rice has relieved pressure on need to utilize fragile non-irrigated lands for rice production.

Output 2.2. Empirical studies monitor impact of CIAT research.

Result 2.2.A. Cassava processing in Colombia.

- Establishment of cassava processing plants most successful in communities with higher production surplus potential and higher social capital.
- Adoption of improved cassava varieties higher in areas closer to cassava processing plants.
- Poverty reduced in areas where improved cassava production technology adopted.

Result 2.2.B. Cassava Processing in Brazil.

- 95% of increase in cassava production in Ceara state, Brazil, due to new cassava processing plants.
- 70% of benefits from cassava processing plants obtained by cassava growers.
- Women more likely than men to report benefit from cassava processing plants.

Result 2.2.C. New Bean Varieties in Bolivia.

- Introduction of beans as winter crop in San Julian and Colonia Berlin now accounts for over 40% of farmer income.

- New bean varieties earn $9 million in foreign exchange and have created the equivalent of more than 2000 full time jobs.

Result 2.2.D. Adoption of Forages in Brazil.

- Study is being planned with EMBRAPA.

Result 2.2.E. Adoption of Bean Varieties in Tanzania.

- Nearly 40% of farmers who have received improved bean seed continue to grow it.
- Further analysis of reasons for growing or not growing improved beans is planned.

Result 2.2.F. Adoption of bean varieties in Honduras.

- Inclusion of crop losses avoided increased estimated impact by over 80%.
- Areas targeted by BMGV resistant varieties coincide with some of poorest regions in Honduras.

OUTPUT 3: TOOLS TO ASSESS IMPACT OF RESEARCH.

Output 3.1. Data Bases Developed.

- Latin American and Caribbean socio-economic data bases updated.
- Colombia agricultural data base expanded.

Output 3.2. Web Page Developed.

- Data bases put on line with graphical interface.
- Impact assessment web page data base hit by over 1000 users in 1999.

Output 3.3. Methods for Economic Surplus Analysis Improved and Distributed.

- Economic surplus model (MODEX) made available on line and downloaded by 70 users.
- Model enhanced to allow for variable changes in demand.
- English language version of MODEX manual published.

Output 3.4. Methods for Assessing the Impact of Natural Resource Management Research Developed.

- Crop simulation models being linked to market models in order to be able to estimate economic consequences of changes in soil quality under different management systems.
  (Collaboration with IFPRI)

OUTPUT 4. INSTITUTIONAL CAPACITY FOR IMPACT ASSESSMENT ENHANCED.

- Assisted process of developing impact assessment indicators and data collection system for CIAT Ecoregional reference sites.
- Conducted workshop for COLCIENCIAS (Colombian National Science Research Council) on methods of assessing research impact.
- Managed process of introducing log frame planning system into CIAT projects in order to have better performance monitoring indictors.
- Supervised thesis of three students in Bolivia and research of student from University of California, Berkeley.

PROJECT DESCRIPTION

Project BP-1: Impact Assessment

Objective: Generate and disseminate information and tools to improve the capacity of CIAT and partner organizations to allocate research resources efficiently.

Outputs:

1. Expected impact of future research estimated.
2. Impact of past research monitored.
3. Tools developed to assess the impact of research, *ex ante* and *ex post*.
4. Institutional capacity for estimating, monitoring and evaluating research impacts improved.

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

Milestones:

2000 Impact monitoring system developed and implemented in one agroecological site.
Adoption and acceptability of bean technology in Bolivia measured.
Performance of participatory methods in Cauca, Colombia appraised.
Aggregate productivity impact of CIAT germplasm estimated.
Expected benefits of eight potential CIAT projects estimated.

2001 Impact monitoring system developed and implemented for all agroecological sites and CIAT projects.
Expected benefits of eight CIAT projects estimated.
Two field studies on technology adoption and acceptability initiated.
Method for measuring impact of social capital developed and field-tested.

2002 Two studies on technology adoption completed.
Impact of investments in social capital on natural resource management estimated.
Two field studies on technology adoption initiated.
Impact of CIAT research on poverty reduction estimated.

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.

1999 Collaborators: *Future Impact of Research*. Ministry of Agriculture, Colombia; Health Ministry, Nicaragua; CIAT projects-Forages, Rice, Cassava, Beans, Hillsides, Soils; *Impact of Past Research Monitored*: Impact Assessment and Evaluation Group of CGIAR; Yale University; CORPOICA, Colombia; University of California, Berkeley; CNPMF, EMBRAPA, Brazil; Secretary of Rural Development, Ceara, Brazil; ARI, Tanzania; CIAT Projects-Beans, Beans in Africa, Cassava, Rice, Forages, IPM, Hillsides, Land Use, Agroenterprises; *Tools to Assess Impact*: IFPRI; *Institutional Capacity*: COLCIENCIAS, Colombia; All CIAT projects.

CGIAR system linkages: Improving Policies (100%).

CIAT project linkages: Works with all CIAT projects.

LOGFRAME PROJECT BP1

CIAT

Area: **Strategic Planning**
Project: **BP-1 – Impact Assessment**
Manager: **Douglas Pachico**

Narrative Summary	Measurable Indicators	Means of Verifications	Assumptions
Goal Knowledge and expertise for enhancing performance of decision making in the agricultural and development sectors is made accessible to appropriate users.	• Performance of investment in tropical agricultural research improved.	• Research project portfolios in tropical agricultural research	
Purpose Generate and disseminate information and tools to improve the capacity of *CIAT and partner* organizations to allocate research resources efficiently.	• Research resources allocated more efficiently (expected rate of return to CIAT research portfolios increased) • Results of impact analysis used in decision making and priority setting. • Economic and environmental impact of selected past research identified and quantified	• Scientific publications from BP-1 and other projects. • *Published planning documents* of CIAT and partner organizations. • Published minutes of planning meetings in CIAT (BOT, MT, Project Managers) and partner organizations. • External reviews of CIAT • Data on use of CIAT-developed tools	• Adequate funding to agricultural research and extension • Decision-maker willingness to use economic *analysis in research priority* setting.
Outputs 1. Expected impact of future research estimated.	• Trends effecting impacts of research analyzed. • Expected economic, distributional, and environmental impacts identified and quantified.	• CIAT technical publications • CIAT published planning documents	• Willingness of decision makers to use the information • No external shocks that invalidate the results
2. Impact of past CIAT research monitored.	• *Economic, social, and* environmental impact of CIAT research outputs identified and quantified.	• CIAT technical publications	

Narrative Summary	Measurable Indicators	Means of Verification	Assumption
3. Tools developed to assess the impact of Research, *ex ante* and *ex post*.	• Methodologies generated • Data bases compiled and maintained	• Scientific publications and other technical publications such as manuals and guidelines • Data bases available on BP-1 sites on the Internet, on CIAT's internal network, and in BP-1's data library. • Site flow data from websites • Data on registered users of BP-1 software • Citations of project publications and tools in technical publications	• Analyst willingness to use the tools in their impact analysis • Data available to use the tools
4. Institutional capacity for estimating, monitoring and evaluating research impacts improved.	• Appropriate and well designed impact assessment components included in the work plans and budgets of CIAT projects and projects of partner organizations.	• CIAT project log frames and budgets • Work plans of CIAT researchers • Research proposals submitted by projects • Similar documentation from partner organizations	• Institutional and financial support for impact assessment.

OUTPUT I: FUTURE IMPACT OF RESEARCH ESTIMATED

1.1 Trends Analysis

1.1.A. Poverty in Latin America - by: *L. Rivas*

Metas para 1999

- Efectuar una revisión bibliográfica sobre el tema, como marco de referencia para elaborar estudios posteriores.
- Construir una base de referencias bibliográficas como subproducto de la actividad anterior.
- Producir un documento que sintetice las conclusiones más relevantes de la literatura disponible.

Principales Conclusiones

1) Una enorme proporción de la población latinoamericana permanece en condiciones de pobreza e indigencia. El 35% de la población total, más de 160 millones de personas son catalogadas como pobres. Poco se ha avanzado en la lucha contra la pobreza y la desigualdad, los resultados han sido tan pobres, que sus índices se encuentran hoy en los mismos niveles que presentaban hace casi dos décadas

2) La proporción de población en situación de pobreza es mayor en el sector rural que en las ciudades, 61% frente a 39%. El 35% de la población rural y el 15% de la urbana, sobrevive en situación de pobreza extrema. La magnitud de la pobreza rural varía sustancialmente entre países. Durante los 80 incluía a casi toda la población de *Haití* y de Bolivia. En esa misma época en Brasil, Colombia, Honduras y Paraguay dos tercios de los hogares rurales eran pobres y en Chile, Ecuador, Jamaica y Panamá el 50% de hogares se ubicaban bajo la línea de pobreza.

3) Gran parte de estudios se concentran en la pobreza urbana, por lo cual hay serios vacíos de conocimiento sobre la magnitud, características, ubicación de la pobreza rural y de las posibles estrategias para combatirla. Diversas teorías han tratado de explicar la pobreza rural. Los estructuralistas la atribuyen en gran parte a la concentración de la tierra. No obstante, aunque se han hecho reformas agrarias y los niveles de concentración en algunos países han declinado, la pobreza se mantiene. Los esquemas de política económica también han cambiado en diferente sentido, sin embargo la pobreza y la desigualdad se perpetúan

4) Comparando la situación de pobreza de América Latina con la de otras regiones en desarrollo del mundo, se concluye que ésta se encuentra muy por encima del nivel que debería tener, dado su actual grado de desarrollo. América Latina presenta condiciones extremas en la concentración del ingreso. La brecha entre

ricos y pobres es mayor que en cualquier otra región del mundo en desarrollo. El índice Gini para la región en conjunto se estima en 0.52, variando entre 0.43 en Uruguay y 0.59 en Brasil.

5) La concentración del ingreso no difiere significativamente entre sectores urbano y rural, pero existe una amplia brecha de ingreso per cápita entre sectores, en Brasil por ejemplo, el ingreso urbano triplica al rural.

6) Según de Janvry y Sadoulet (1996) tanto la expansión económica, como la recesión han sido regresivas en América Latina. El periodo de crecimiento 1988-1994 fue particularmente regresivo. El crecimiento económico por si solo, no garantiza el alivio y/o erradicación de la pobreza y la desigualdad. Aún en situaciones de alto crecimiento del ingreso, si persisten las condiciones de desigualdad actuales, será muy difícil reducir la pobreza. Aún así, el ciclo económico está asociado con los niveles absolutos de pobreza, durante la expansión tienden a reducirse y durante la recesión a crecer.

7) En América Latina se requiere una profunda y seria revisión de los modelos de desarrollo y de las estrategias anti – pobreza. La mayoría de ellas se orientan hacia el asistencialismo, dejando de lado los ajustes de fondo a los modelos de crecimiento.

8) El impacto del ajuste estructural y de los programas de estabilización sobre la pobreza y la desigualdad en la región ha sido tema central en los debates económicos de los últimos años. No existe pleno acuerdo al respecto, pero la opinión mayoritaria es que un alto costo social recayó sobre los grupos más pobres de la población tanto urbana como rural, que se manifestó en mayor desempleo y subempleo, reducción del salario real y mayor pobreza y concentración del ingreso. Los nuevos esquemas económicos han exacerbado la situación de pobreza en el sector rural, particularmente entre minifundistas y asalariados rurales.

9) Se considera que la acción del estado debe combatir los factores estructurales que generan pobreza y desigualdad, mediante programas de educación, salud, servicios públicos etc. Pero esto debe hacerlo conservando una rígida disciplina fiscal y monetaria, dado que la inestabilidad macroeconómica deteriora sustancialmente las condiciones económicas de los más pobres.

10) En América Latina el desarrollo de nuevas variedades, insumos y métodos de producción ha contribuido a una expansión importante de la producción, la productividad y los ingresos de la agricultura, que ha resultado en cambios sustanciales en la estructura de la producción agropecuaria regional. Pero a menudo, los frutos del crecimiento no han mejorado la situación de los pobres en el campo.

11) Coexisten ancestralmente dos formas de producción agropecuaria, la capitalista y la campesina, conformando un dualismo tecnológico. Un sector agrícola empresarial moderno que cuenta con recursos económicos y tecnológicos apropiados, que tiene fácil acceso a los mercados de capitales de bienes y de servicios. En el lado opuesto, un sector campesino que aún en presencia de alternativas tecnológicas, se encuentra atrapado en una situación de escasos recursos y mercados agrícolas poco desarrollados. Las últimas reformas económicas han podido acentuar ese dualismo. Algunos tipos de desarrollo tecnológico dentro de la agricultura latinoamericana han sido exitosos para incrementar la producción y la productividad, pero no han sido muy eficaces en la lucha contra la pobreza. Se han documentado casos en los cuales la modernización agrícola ha deteriorado las condiciones de vida de los pobres.

12) No se puede concluir que el desarrollo tecnológico en agricultura sea poco importante en la lucha contra la pobreza. La tecnología es clave para la conservación de los recursos naturales, para el crecimiento y la generación de riqueza, los que a su vez tienen conexiones de diversa índole con los niveles de pobreza y desigualdad.

13) Los factores limitantes de la economía campesina y determinantes de la pobreza rural, son de muy diversa índole. En consecuencia, no existe un factor único cuyo suministro sea condición necesaria y suficiente para erradicar o aliviar la pobreza rural. Varios trabajos enfatizan demasiado en solo factor como elemento clave para combatir la pobreza. Algunos concentran la acción en la formación de capital humano, otros en el acceso a tierra y a los recursos productivos y otros en el desarrollo tecnológico. Cuando se analizan estos factores aisladamente, sin incluirlos dentro de una estrategia global de desarrollo, los retornos sociales a la inversión en ellos, considerados individualmente, puede resultar mas baja de lo esperado.

14) Si la educación rural esta acompañada de nuevas alternativas productivas, acceso a recursos como tierra y crédito, desarrollo de mercados rurales, creación de infraestructura física, acceso a servicios de salud etc., es muy probable que en éstas condiciones, el retorno social a la formación de capital humano para el sector agrícola sea muy alto y represente una herramienta eficaz en la lucha contra la pobreza rural.

15) En la región un patrón de crecimiento con sesgo hacia la agricultura es efectivo para reducir la pobreza rural, pero debe estar enmarcado dentro de una estrategia de desarrollo a rural, que incluya políticas redistributivas. La pobreza urbana y rural están más relacionadas en América Latina, que en otras regiones del mundo. Igualmente la población rural es menos dependiente del desempeño de la agricultura. Lo anterior sugiere que sería factible una reducción importante de la pobreza rural, aunque el sector agrícola tuviese un lento ritmo de crecimiento.

1.1.B. Livestock Products in Africa and Asia. by: *L. Rivas - J.A. García*

Metas para 1999

- Analizar las tendencias globales de la ganadería vacuna en Asia y Africa

- Producir un documento que incluya, el análisis de tales tendencias y las principales estadísticas básicas referentes a la evolución del sector ganadero vacuno en Asia y Africa

Principales Conclusiones

1) La dotación relativa de los principales factores de producción ganadera, tierra y mano de obra y ganado difiere considerablemente de un continente a otro: En Africa por cada hectárea destinada a cultivos, existen cerca de 5 hectáreas en pasturas permanentes. En Asia solo hay 2 hectáreas. La dotación de tierra agrícola por habitante de Africa es 8 veces mayor que la de Asia, 2.4 hectáreas frente a 0.3.

2) Los cereales constituyen la base de la dieta en los dos continentes, ellos aportan mas del 50% de las calorías y la proteínas consumidas.

3) Carne vacuna y leche en Asia y Africa no son alimentos tan básicos, como lo son en América Latina. Dentro del consumo total de carnes, en Africa el vacuno predomina ocupando una franja que representa dos quintas partes del consumo total. En Asia el consumo dominante es el cerdo, que contabiliza más de la mitad del consumo de productos cárnicos.

4) La productividad de la ganadería vacuna es significativamente menor en Africa. Por cada animal en el rebaño vacuno, en Asia en promedio se produce 30% mas de carne y 138% mas de leche.

Indicadores agregados de la productividad de la ganadería en Africa, Asia y América Latina. 1997

Producto	Africa	Asia	América Latina
Carne *(kg./cabeza)*1/	17	22	33
Leche *(lt./vaca)*2/	481	1148	1200

1/ Producción de carne en canal por cabeza en el inventario ganadero total. 2/ Producción de leche fresca/vaca ordeñada

5) Tanto en Asia como en Africa la producción doméstica no alcanza a cubrir la demanda interna de carne vacuna y de leche, por lo cual se recurre a las importaciones. Africa importa el 8.4% de su consumo de carne y el 11.4%. del de leche. A pesar del bajo consumo de carne vacuna por habitante observado en Asia (2.7kg. /año), el continente importó anualmente en el período 1990-1997, el equivalente al y15% de su consumo total (1.2 millones de Tm. , que representan

el 11% de la producción de América Latina & El Caribe durante el mismo período).

6) La dinámica de la evolución de la ganadería en Asia y en Africa, presenta facetas contrastantes. En Asia la producción ganadera está creciendo a tasas mayores que las del crecimiento demográfico, en Africa sucede lo contrario.

7) Los indicadores agregados muestran una clara tendencia a la intensificación de los sistemas ganaderos asiáticos. El aumento de la productividad ha sido la principal fuerza que ha impulsado el crecimiento de la producción en Asia. Por el contrario en Africa, con una productividad declinante o estancada, la producción ha crecido debido solamente a la expansión de los hatos ganaderos.

8) La magnitud de la población y su crecimiento, su condición deficitaria en cuanto a carne vacuna y leche, las perspectivas del crecimiento del ingreso, sus bajos consumos actuales, sugieren que en las próximas décadas gran parte del incremento de la demanda de los países en desarrollo, que ha sido documentada en diversos estudios, se concentrará en estas dos regiones del planeta.

Resumen

El CIAT durante muchos años ha efectuado un seguimiento sistemático de las tendencias globales de los mercados y de la producción de carne vacuna y leche en América Latina, dado que el mayor énfasis de sus actividades de investigación en pasturas se coloca en los sistemas ganaderos del trópico latinoamericano. Sin embargo, en algunos proyectos relacionados con forrajes, tales como IP5 y PE5, se incluyen dentro de su mandato algunas áreas de Africa y de Asia. Adicionalmente, en muchos sistemas agrícolas mixtos, muy frecuentes en las regiones tropicales de los dos continentes citados, el componente ganadero es fundamental dentro de los planes y estrategias de desarrollo productivo, en particular en los grupos de pequeños y medianos productores.

Por éstas razones y por considerar, que en un mundo globalizado, para el diseño de estrategias y de políticas, es importante conocer la evolución y perspectivas de las actividades productivas en las diferentes regiones del planeta, durante el presente año se elaboró un análisis de las grandes tendencias de la producción, la productividad, las áreas en pasturas, los inventarios ganaderos y el comercio en los sectores de carne vacuna y leche de Asia y Africa.

La información primaria de este estudio es tomada de la base de datos del Proyecto de Evaluación de Impacto, la cual incluye información de fuentes como FAO, Banco Mundial y otras. A la base de datos, se le adicionó un sistema de generación automática de reportes sobre áreas en pasturas, inventarios ganaderos, producción, consumo y productividad para diferentes productos agropecuarios de Asia y Africa. La información incluida en los reportes se presenta desagregada por regiones y países. El usuario de la base de datos define el producto y el período para el cual precisa la información.

Los dos continentes analizados, en las dos últimas décadas, presentan agudos contrastes en cuanto a dotación relativa de factores productivos y en lo referente al desempeño y las tendencias del sector ganadero.

Mientras en Africa por cada hectárea cultivada existen casi de 5 hectáreas en pastos, en Asia solo hay 2 hectáreas. Igual disparidad se observa en la dotación de tierra agrícola por persona. En Africa por cada habitante hay 2.4 hectáreas de tierra agrícola, en Asia hay menos de media hectárea (0.3). La población asiática en 1997 era casi 5 veces mayor que la de Africa, 3386 millones de personas frente a 680 millones.

Las tasas de crecimiento poblacional en Africa aún permanecen muy altas, por encima del crecimiento demográfico observado en otras regiones en desarrollo. En el período 1990-1997, la tasa de crecimiento promedio anual de la población en el mundo en desarrollo era de 1.4% por año, en tanto que en Africa se situaba en de 2.5%, en Asia en 1.6% y en América Latina en 1.7%. No obstante, la población de las áreas en desarrollo está altamente concentrada en Asia. Por cada 100 habitantes de las regiones subdesarrolladas del mundo, 73 habitan en Asia, 15 en Africa y 11 en América Latina.

Las diferencias en la dotación relativa de factores y en la magnitud y crecimiento poblacional, se reflejan en el tipo de desarrollo productivo que se observa en las distintas regiones del mundo.

En el caso de la ganadería vacuna se puede observar con mayor claridad una mayor tendencia a la intensificación en Asia que en Africa o que en América Latina, como se muestra más adelante.

En cuanto a la estructura del consumo de alimentos, en ambos continentes los cereales constituyen la base alimenticia, aportando una alta proporción del consumo diario de calorías y proteínas. Ellos aportan más del 50% del consumo diario de calorías y de proteínas tanto en Asia como en Africa.

Las carnes y los productos lácteos ocupan una posición secundaria dentro de la dieta africana. En el grupo de las carnes, al igual que en América Latina, el vacuno predomina ocupando una franja equivalente a dos quintas partes del consumo total de carnes, el cual se estima en 14.4 Kg por persona al año.

En Asia el consumo de carnes es la segunda fuente de proteína después de los cereales. En este continente el cerdo predomina en la dieta, representando más del 50% del consumo total de carnes, el cual, en el período 1990-1997, se estimó en 20.8 kg./habitante/año. El consumo de vacuno es poco significativo en Asia, siendo tres veces inferior al de cerdo (2.7 kg. frente a 11 kg./persona/año).

En los dos continentes se observan tendencias contrastantes en cuanto a la evolución de la producción, los inventarios ganaderos y la productividad. La dinámica de la producción de carne vacuna y leche es sustancialmente mayor en Asia que en Africa.

Cabe resaltar en este punto dos elementos importantes: 1) La producción ganadera en Asia en el período 1981-1997 creció a una tasa superior a la del crecimiento de la población. En Africa ocurrió lo contrario. 2) En el crecimiento de la producción ganadera asiática ha jugado un rol muy importante el *incremento* de la productividad (producción/cabeza en el inventario). En Africa la expansión de la producción se origina principalmente en el aumento del rebaño ganadero. (Cuadro2)

Cuadro 2. Tasas anuales de crecimiento de la producción, los inventarios ganaderos, la productividad y la población humana en Asia y Africa.

Promedios 1981-1988 y 1989-1997

Continente	Carne Vacuna					
	Tasas anuales de crecimiento de : (%)					
	Producción		Inventario		Productividad 1/	
	1981-1988	1989-1997	1981-1988	1989-1997	1981-1988	1989-1997
Asia	5.4	9.3	1.5	1.9	3.9	7.4
Africa	0.5	0.6	5.7	1.0	-5.2	-0.4
	Leche					
Asia	4.5	5.6	2.3	3.6	2.2	2.0
Africa	2.8	1.9	2.7	1.1	0.1	0.8

	Tasas anuales de crecimiento de la población (%)	
	1981-1988	1989-1997
Asia	1.9	1.8
Africa	2.8	2.7

1/ Productividad expresada como producción por cabeza en el inventario ganadero

1.2 Impact of Future Research Estimated

1.2.A. Community Management of Resources In Nicaragua - *by: N. Johnson*

An *ex ante* estimate of the benefits of technological and institutional options for improving water quality and quantity was conducted. The study was done as part of broader efforts to assess the impact of strengthening community management of their resources.

The main findings and conclusions were:

Policy Conclusions

- On average, residents of the watershed consider their drinking water to be either good or sufficient. However, they feel that the water sources are declining in both quality and quantity of water.

- Together, residents of the San Dionisio watershed were willing to pay US$9,456 per year to improve existing water sources in the watershed. This is an average of US$4.59/household per year. This is less than the households are willing to pay to participate in a potable water project. A purely technological option such as a deep

well may solve the water problem, however it would be very costly. A combination of technological and institutional options for improving quality and management of existing natural water sources and water projects may also be appropriate.

- Women place a higher value on improving water sources than men. This is consistent with the fact that women do most of the water carrying work.

- Residents to not appear to place an economic value on the health benefits associated with improving water quality. While data suggest that there may be a relationship between water quality and certain health problems, the incidence of water-borne diseases in a household was not positively associated with the household's willingness to pay for improved water quality. This suggests that public awareness campaigns may be required to ensure that residents understand the connection between water and health.

  In follow up work in the study area, interviews with local doctors revealed that reported incidence of health problems associated with contaminated water increased 50 percent between 1988, the year the study was done, and 1999. Therefore it may be the case that people are now more aware of the problem due it its increased gravity.

Methodological conclusions

- The contingent valuation methodology, as implemented by local surveyors rather than outside experts, appears to be appropriate for valuing changes in natural resources in rural Nicaragua. An econometric analysis of the determinants of the households' willingness to pay data found the results to be consistent with economic theory in that expected income and price relationships were observed.

Progress report

El propósito de este estudio era estimar el valor de mejorar el agua potable en la sub-cuenca del Río Calicó, municipio de San Dionisio, Matagalpa, Nicaragua. La disponibilidad de agua, especialmente agua potable, se ha identificado como uno de los problemas más graves en el manejo de los recursos naturales que se enfrenta la gente de la zona (Vernooy et al; Vernooy and Espinoza). CIAT está tratando de mejorar el manejo del agua a través de la generación de nuevas tecnologías, tanto institucionales como biológicas. Este estudio servirá como un ejemplo de evaluación *ex ante* del impacto de este trabajo.

Para hacer el análisis, se utilizarán métodos de valoración económica no basados en el mercado. A diferencia de las herramientas económicas tradicionales que se usan para medir el impacto de la investigación agrícola, estos métodos—el costo del tiempo y la valoración contingente— no dependen de datos observados sobre precios y cantidades, los cuales muchas veces no existen para recursos naturales. Los métodos de valoración no basados en el mercado, se han usado mucho para valorar recursos naturales y ambientales en los países desarrollados, pero su utilidad en países en desarrollo todavía

no ha sido bien comprobada (Shultz). Si los resultados de este análisis resultan ser confiables, apoyarían el uso del método para la evaluación de políticas y proyectos que tienen como fines el mejoramiento de recursos naturales en países en desarrollo. Actualmente, decisiones se están tomando muchas veces en la ausencia de información sobre el impacto economico potencial de cambios en el estado de los recursos naturales.

El informe se organiza así: La sección 2 revisa brevamente la literatura del uso de métodos no basados en el mercado para valorar el agua. La sección 3 describe el estudio y el proceso de la recolección de los datos. En la sección 4 se presenta un análisis descriptivo de los datos. También, se presentan los resultados de un análisis del "costo de tiempo." Los resultados de valoración contingente se presentan en la sección 5, junto con un análisis econométrico de su confiabilidad. Finalmente, en la sección 6 se ofrecen unas conclusiones y recomendaciones metodológicas y políticas.

2. Cómo medir el valor del mejoramiento del agua?

El método apropiado para valorar el agua depende mucho de como se va a usar (Young). El agua se puede usar como insumo intermedio en otro proceso de producción—por ejemplo agua de riego en agricultura—o como bien de consumo final, por ejemplo agua potable. También el agua puede ser un bien publico, como el caso de lagos, ríos o mares que tienen valor ambiental. Ya que este estudio se enfoca en el mejoramiento de agua potable para individuos y familias, el método apropiado de valorarla es como bien de consumo privado.

a. Costos de tiempo

El costo total que se paga por consumir algo no es solamente su costo en dinero, sino también incluye los costos de los bienes y servicios que se asocian con su consumo; uno de los más importantes en las zonas rurales de países en desarrollo es el tiempo. En el caso del agua, el agua misma puede ser gratis, pero si uno tiene que ir hasta un río y traerla a la casa, esto significa un gasto en tiempo. Un cambio en la disponibilidad de agua, por ejemplo, la construcción de un proyecto de agua potable o la recuperación de una fuente cercana, puede tener impacto económico a pesar de que el agua siga siendo gratis porque se permite el ahorro de tiempo.

El tiempo en traer agua a la casa es quizás el gasto más grande que se asocia con el agua, pero no es el único. Agua sucia y contaminada puede traer enfermedades que también pueden implicar una pérdida de tiempo productivo o por lo menos una reducción de productividad. Si el mejoramiento del agua reduce la incidencia de enfermedades asociadas con el agua sucia, puede tener un impacto sobre la salud que se puede medir y valorar

Conceptualmente, el uso del cambio en tiempo asociado con el consumo del agua para medir el valor del cambio es sencillo. Más difícil es decidir qué valor ponerle. El valor apropiado es el costo de oportunidad del tiempo, o sea el valor del tiempo en la actividad que haría la persona si no estuviera trayendo agua o sufriendo de una enfermedad. En

los estudios empíricos, para el costo de oportunidad se usa generalmente el valor del jornal, el salario diario para mano de obra no especializada. Aunque es muy conveniente usar el jornal, también es controvertido. Por un lado, en el mercado laboral generalmente no funciona perfectamente, esto quiere decir que una persona no siempre tiene la opción de salir a trabajar en cualquier momento libre. Donde hay mucho desempleo, el jornal tal vez no es el valor apropiado. Si los que están trayendo agua son mujeres y niños, es aún más complicado justificar el uso del jornal. El Banco Interamericano de Desarrollo usaba la mitad del jornal para valorar el trabajo de cargar agua (Whittington, Mu y Roche, 1990).

Por otro lado, el verdadero costo de oportunidad puede ser interpretado de una manera más amplia. Por ejemplo, si un niño puede estudiar en vez de trabajar, le puede rendir mucho más en el largo plazo que el valor de un jornal. Igual con otros trabajos de las mujeres que pueden tener mucho impacto sobre la salud y bienestar de sus familias. Un estudio reciente acerca del valor de traer agua en Tanzania, encontró que la gente le da al trabajo un valor implícito igual o más que el jornal (Whittington, Mu and Roche, 1990b)

b. Valoración contingente

Otro método para valorar el mejoramiento de un recurso natural es simplemente preguntar a los usuarios "cuánto les vale?" Esto se hace generalmente en la forma de una pregunta como "Cuánto pagaría usted por tener agua no contaminada? Este método—que se conoce como el método de valoración contingente (MVC)—también es sencillo en términos conceptuales y complicado en términos de implementación (Véase a Cummings et al, 1986, and Mitchell and Carson, 1989; Randall et al, 1983 para una discusión teórica y empírica.).

Dado que las preguntas y los escenarios en valoración contingente son hipotéticos, son muy vulnerables a diferentes problemas y sesgos. Uno de los problemas fundamentales con este método es que muchas veces la gente no está acostumbrada a valorar los recursos naturales en términos económicos, y por eso les queda muy difícil contestar las preguntas. Cuando la pregunta tiene que ver con valores ambientales—por ejemplo en el caso de un parque nacional—hay que tener mucho cuidado en la formulación de la pregunta para que el encuestado tenga un marco de referencia para contestar confiablemente. En el caso de los recursos naturales que proporcionan servicios cuantificables—por ejemplo agua ó madera—no es tan difícil para la gente pensar en el impacto económico de un cambio sobre el estado del recurso.

Quizás el sesgo más importante asociado con el MVC es el llamado sesgo "estratégico," en lo cual la gente sobre- ó subestima sus valores de acuerdo con su interés personal. Por ejemplo, si se cree que el fin del estudio es sobre conservación de un recurso, alguien que quiere que se conserve puede decir un valor muy alto, mucho más de lo que realmente pagaría. Por otro lado, si se cree que el estudio es para definir niveles de precios o impuestos, la gente puede decir valores más bajos de sus valores verdaderos.
Pese a estos problemas potenciales, algunos investigadores han dicho que datos basados en mercados hipotéticos no son confiables (Diamond and Hausman, 1993). En el

pasado, la posición del Banco Mundial en cuanto al uso del MVC fue que " la metodología de estimar la disponibilidad de pagar a través de encuestas se ha mostrado ser casi completamente inutíl" (Saunders and Warford, author's translation). Sin embargo, estudios recientes han demostrado, que al tener mucho cuidado con la identificación y resolución de problemas pueden resultar datos consistentes tanto con la teoría, como con la realidad (Whittington et al, 1990a). El Water Demand Research Team del Banco Mundial usó valoración contingente en su estudio multinacional sobre el valor del agua potable y obtuvo buenos resultados. El informe técnico del Banco Mundial " Measuring Economic Benefits for Water Investments and Policies" (Young, 1996) incluye valoración contingente como uno de los métodos recomendados para valorar los servicios del agua.

3. Descripción del estudio

La sub-cuenca del Río Calicó, una de los sitios de referencia del CIAT, está ubicada dentro de la cuenca del Río Grande de Matagalpa en el Norte de Nicaragua. La subcuenca tiene una superficie de aproximadamente 170 km2 (17,000 ha) y abarca todo el municipio de San Dionisio (144 km2) y partes de varios otros. El pueblo de San Dionisio está ubicado a 165 Km de Managua (3.5 horas) y 40 Km de la ciudad de Matagalpa. El relieve está formado en su mayoría por terrenos ondulados o quebrados, de suelos superficiales. El clima va de seco a semiárido. La población total es 23,671 habitantes, de los cuales 11,000 están en la zona urbana. Es una zona sumamente agrícola, donde pequeños productores de maíz y frijol predominan.

Los datos fueron obtenidos a través de una encuesta a nivel de la vivienda que se hizo en 5 comunidades de la subcuenca en el mes de julio 1998. Las comunidades—El Cobano, El Jicaro, Wibuse, Zapote y Susulí—fueron escogidos porque son representativas en términos de los tipos de problemas y conflictos sobre agua que se encuentran en la zona. Se escogió al azar una muestra de aproximadamente 15 por ciento de las familias, que resultó en una muestra de tamaño 153.

La encuesta incluyó preguntas demográficas y socioeconómicas, y también preguntas especificas sobre el uso de agua. Para cada fuente de agua, se preguntaron a los encuestados sobre disponibilidad de agua; destino del agua; y cantidad, calidad y costos asociados con su uso. En el caso de las familias que no contaron exclusivamente con agua potable de llave, se pidió información detallada sobre el tiempo de traer agua de fuentes alternativas. La encuesta también incluyó una sección sobre salud que fue escrita con la ayuda del Centro de Salud de San Dionisio. Se preguntó no solamente quién se enfermó sino también con qué síntomas y por cuánto tiempo.

Finalmente, la encuesta incluyó preguntas hipotéticas sobre disposición de pagar por mejor servicio de agua. Las preguntas se hicieron en la forma de un "bidding game." El encuestador comienza con un precio alto y pregunta al informante si pagaría ese precio para mejorar el agua. Si el informante dice que si, allí termina la pregunta y el encuestador pasa a la siguiente. Si el informante contesta que no pagaría ese precio, el encuestador anota la respuesta y vuelve a hacer la pregunta con un precio más bajo. El

proceso sigue hasta que el informante conteste que si pagaría el precio, ó hasta que se acabe la lista de precios posibles que tiene el encuestador. Para que no se vuelvan cansonas, las preguntas de este tipo generalmente no tienen más que unas 4 o 5 respuestas posibles. Esta forma de hacer la pregunta se considera la mejor para obtener resultados confiables. La desventaja es que las respuestas son restringidas a los valores ofrecidos, pero esto al mismo tiempo asegura que no haya respuestas totalmente fuera de lo que se creería.

La primera pregunta fue sobre cuánta sería la contribución en mano de obra de una familia en la construcción de un proyecto de agua potable, del cual resultaría una llave privada en la casa. Las respuestas se dieron en número de días a la semana por 6 meses. La pregunta solo se hizo a familias que no tenían agua potable en la casa. Ya que los proyectos de agua potable generalmente requieren contraparte de los beneficiarios en forma de trabajo, escribir la pregunta así fue mas cerca a la realidad y entonces más fácil contestar. Otra ventaja de dar respuestas sobre disposición de pagar en días de trabajo es que pueden ser mas confiables en economías no totalmente monetizadas, donde mucho intercambio es en forma de mano de obra (Hardner, 1996).

La segunda pregunta sobre disposición de pagar, dirigida a todos los encuestados, preguntó sobre cuánto la familia estaría dispuesta a pagar por agua de mejor calidad y cantidad de sus actuales fuentes, sean llaves privadas, pozos, ríos, etc. Respuestas se dieron en moneda local por mes. Valoración contigente ha sido útil para valorar proyectos de agua potable o escoger entre distintas fuentes, pero no se ha usado para valorar mejoramientos de fuentes existentes naturales (Whittingtopn et al; Shultz).

Esta pregunta fue muy importante para el estudio ya que el propósito del proyecto CIAT no es ver llaves privadas en cada casa sino mejorar la capacidad de la comunidad de manejar sus recursos de acuerdo con sus propias prioridades y capacidades. Mejor manejo podría resultar no en agua potable de proyecto sino en fuentes naturales más sanas y abundantes. Sin embargo, la pregunta fue en cierto sentido riesgosa porque la gente no está acostumbrada a pensar en pagar por agua de fuentes naturales. Ademas, la pregunta fue vaga en que no se cuantificaron los mejoramientos de la cantidad y calidad.

Antes de presentar los datos y resultados, cabe mencionar una característica importante de la implementación del estudio. En vez de usar técnicos o estudiantes universitarios como encuestadores, se escogió usar gente local. Dado los muchos sesgos que se asocian con este tipo de estudio, generalmente se usan encuestadores expertos y bien capacitados en el método de valoración contingente. Uno de los propósitos de este estudio era ver si el MVC puede ser utilizado por gente local que recibe un mínimo de capacitación.

Saber si el método se puede usar a nivel local es importante porque uno de los propósitos del proyecto CIAT es desarrollar metodología y practicas que las comunidades mismas pueden usar para identificar, priorizar y resolver sus problemas de manejo de recursos naturales. Información sobre el valor económico de estos recursos puede ser muy útil para este proceso, pero si la técnica que se usa para solicitarla solo se puede implementar

por expertos costosos, no es probable que llegue a ser usado por muchas comunidades en sus procesos de toma de decisiones. Ademas, es importante reconocer que mientras el uso de encuestadores locales puede presentar problemas, también puede ofrecer ventajas. Gente local conoce la comunidad, que les da mejor acceso a las familias, y que les facilita reconocer respuestas extremas y no realistas motivadas por alguno de los sesgo.

4. Disponibilidad, Calidad y Uso de Agua en la Subcuenca Río Calicó

La Tabla 1 presenta los valores promedios de unas variables seleccionadas de la encuesta.

a. Socio economía

Según los pocos datos demográficos que se pidieron, la muestra parece representativa de la comunidad en términos de tamaño de la familia y de educación. El promedio de personas por vivienda fue 6.47, comparada con 6.37 en la población (Barreto et al). En términos de educación, el promedio de años de la persona más educada de la familia fue 4.18. Esto refleja el nivel educativo muy bajo de la zona.

Se quería saber algo del nivel de bienestar económico de los encuestados, pero muchas veces es difícil preguntar directamente a la gente sobre sus ingresos. Generalmente la gente es muy desconfiada en cuanto a estas preguntas porque no sabe para qué se usará la información. Al responder a preguntas directas sobre cuánto gana, lo más probable es que la gente mienta. Así quiere responder honestamente, no es fácil estimar ingresos que son muy diversos y variados durante el año en forma de dinero y de especie.

Para evitar problemas, preguntamos sobre fuentes de ingreso y no sobre cantidades. Según los informantes claves que conocen bien la comunidad, hay una relación entre fuente y cantidad de ingreso (Ravnborg et al). Por ejemplo, una familia cuya fuente más importante de ingreso es con el ganado, generalmente es más rica que una familia cuya fuente principal es agricultura. Entre las familias que se dedican a la agricultura, las que tienen café son mejores económicamente que las que tienen solo granos básicos. En general, agricultura/ganado es más rentable que el comercio en la cuenca, y trabajar como jornalero es aún menos rentable.

Dado la predominancia de agricultura en la cuenca—79 por ciento de las familias tienen agricultura/granos básicos como fuente principal—preguntamos sobre las 2 fuentes más importantes para poder distinguir mejor. Basado en las respuestas, creamos un índice que tiene un rango de 1 a 20 donde los valores más altos significan mayores ingresos. El valor más alto que salió en la encuesta fue 19, que corresponde a ganado y agricultura de café. El valor más bajo que salió fue 1, que corresponde al jornal como única fuente de ingreso. El valor promedio de la encuesta fue 13.39, que corresponde a una familia que vive de la agricultura con una combinación de granos básicos y café. La comunidad más rica, según el índice, es Zapote y la más pobre es Wibuse.

b. Agua potable en la casa

San Dionosio cuenta con una red de proyectos de agua potable hechos por varias organizaciones de ayuda y desarrollo, por ejemplo CARE. Sin embargo la cobertura no es completa. Setenta y seis por ciento de la muestra se beneficia de un proyecto de agua potable, que se refiere aquí como agua potable de tubería o de llave. Este alto porcentaje se debe en gran parte al hecho de que Susulí, la comunidad más grande de la muestra, tiene 98 por ciento de sus familias con agua potable. Wibuse es la única comunidad donde no ha habido ningún proyecto.

Beneficiarse de un proyecto de agua potable no quiere decir que la familia no tiene que usar otras fuentes de agua. El racionamiento es común en San Dionisio, sobre todo en la época seca (marzo-mayo). El 28 por ciento de las familias con agua potable sufrió racionamiento en el año pasado. El racionamiento duró un promedio de 1.3 meses. Otra vez se siente la influencia de Susulí en el promedio. En Susulí hubo muy poco racionamiento, menos que un mes, mientras en Zapote se racionó el agua por más de la mitad del año.

c. Fuentes alternativas del agua

Fuentes alternativas se llaman aqui fuentes que no sean la llave. Asi que usar 0 fuentes alternativas significan usar solamente agua de la llave. En la encuesta, las familias usaron un promedio de .76 fuentes de agua y un promedio de .56 fuentes alternativas de agua potable (fuera de agua potable de llave) con un rango de .09 en Susulí hasta 2.31 en Wibuse. El número de fuentes de agua potable es menos que de agua en general porque no todas las fuentes son aptas para agua potable. El número máximo de fuentes usadas por una familia fue 4. Familias escogieron diferentes fuentes de acuerdo con la calidad y cantidad de agua disponible. Muchas veces las fuentes se secan en diferentes épocas del año, a esto hace que las familias vayan a otra fuente. También, las fuentes pueden variar según el uso del agua, por ejemplo para lavar ropa, bañarse o aguar animales. Cabe mencionar que debido a la falta de agua en la zona, el riego es prohibido.

Tabla 1. Valores promedios de variables de la encuesta de agua potable en San Dionisio

Variable	Total	Cobano	Zapote	Susulí	Jicaro	Wibuse
Tamaño de muestra	153	9	17	85	26	16
Personas por vivienda	6.47 (2.91)+	8.56 (4.10)	6.88 (2.39)	6.01 (2.81)	6.23 (2.3)	7.69 (3.44)
Años de educación de la persona más educada	4.18 (2.84)	4.67 (2.78)	4.18 (2.43)	3.82 (2.45)	5.85 (3.92)	3.06 (2.24)
% con tierra propia	80 (40)	67 (50)	76 (44)	79 (41)	85 (37)	87 (34)
Indice de fuentes de ingreso*	13.59 (2.58)	14.44 (1.67)	15.41 (2.58)	13.04 (2.31)	15.12 (2.52)	11.56 (1.97)
% con agua potable de proyecto	76 (.43)	44 (53)	82 (39)	98 (15)	62 (50)	0
Número de meses al año con racionamiento de agua potable	1.3 (2.54)	3.75 (2.5)	6.14 (3.51)	.17 (.7)	2.31 (1.96)	na
Número de fuentes alternativas de agua usadas	.79 (1.0)	1.11 (.60)	1.53 (.62)	.09 (.29)	1.54 (.95)	2.31 (.87)
Número de fuentes alternativas de agua potable usadas	.56 (.77)	.89 (.78)	1.06 (.43)	.07 (.26)	1.12 (.86)	1.56 (.73)
Indice de calidad de agua potable de fuentes alternativas**	1.32 (.51)	1.25 (.420	1.29 (.47)	2.17 (.41)	1.14 (.33)	1.27 (.49)
Indice de calidad de agua de fuentes alternativas**	1.48 (.54)	1.21 (.39)	1.37 (.48)	1.88 (.64)	1.36 (.48)	1.65 (.57)
Indice de cambio de calidad de agua**	2.09 (.43)	1.94 (.42)	2.11 (.33)	2.33 (.52)	2.03 (.41)	2.14 (.49)
Indice de cambio de cantidad de agua**	2.16 (.48)	1.94 (.68)	2.08 (.28)	2.38 (.52)	2.12 (.38)	2.30 (.56)
Uso de agua anual en la casa por persona (m^3)	6.4 (7.9)	6.8 (4.68)	7.9 (3.71)	4.4 (4.7)	7.7 (14.0)	11.8 (10.0)

+ Los números en paréntesis son las "standard deviations."

* Indice de fuentes de ingreso va desde 1 hasta 20. Entre más alto el índice, más rica la familia

** Indice va desde 1 hasta 3, entre más bajo mejor. Nota: Este índice se refiere a fuentes fuera de agua potable de llave.

Tabla 2 muestra los distintos tipos de fuentes que se usan en San Dionisio. Las fuentes más importantes de la subcuenca son río/quebrada, pozo, y nacimiento/manantial El pozo es la fuente más común; 37.2 por ciento de las fuentes usadas fueron pozos. En términos de agua potable, los pozos son aún más importantes; 45 por ciento de las fuentes de agua para tomar son pozos.

Tabla 2. Fuentes de agua por tipo por comunidad (%)

Fuente	El Cobano	Zapote	Susulí	El Jicaro	Wibuse	Total
Río	70	27	37.5	40	16.2	32.2
Pozo	30	4	62.5	45	48.6	37.2
Nacimiento	0	61	0	12.5	20	23.1
Otro	0	8	0	2.5	16.2	7.4

d. Calidad y cantidad de agua de distintas fuentes

La gente calificó la calidad de su agua en una escala de 1 (buena), 2 (regular) ó 3 (mala). Como se muestra en la Tabla 1, en general, la calidad de agua en la cuenca se califica por la gente como buena.[1] El valor promedio del índice de calidad es 1.48. La calidad de agua potable es un poquito mejor, con un valor promedio de 1.32. El valor promedio para el agua del río/quebrada es 1.72 mientras para el agua del pozo es 1.40 y de nacimiento es 1.48. Eso quiere decir que la calidad del agua de pozo es mejor que la del río. Eso es consistente con lo que se dijo anteriormente sobre la importancia de los pozos como fuentes de agua potable. La excepción es la comunidad el Cobano, donde el río es la fuente más importante, inclusive para el agua potable.

Más preocupantes son los índices de cambio de calidad y cantidad de agua de las fuentes usadas. La encuesta pidió que la gente calificara los cambios en calidad y cantidad que ha percibido en sus fuentes. En los dos casos, el valor promedio del índice es más que 2, que significa que la calidad y cantidad de agua están bajando. A nivel de las comunidades, calidad y cantidad se perciben estar bajando en 4 de las 5 comunidades.

e. Consumo de Agua

La Tabla 1 reporta cantidades promedias de consumo de agua por persona por año en las comunidades. La cantidad promedia fue 6.4 m^3, con un rango entre 4.4 en Susuli hasta 11.8 en Wibuse. Para dar una perspectiva sobre su uso, en los EU, el uso per capita para uso doméstico es 259 m^3 anuales mientras en Tanzania es 7.56 m^3 (Drangert). El uso en San Dionisio parece muy bajo, pero hay que tener en cuenta que solo se usó en casa el agua traída de diferentes fuentes. El agua que se usa en la fuente, como para lavar ropa o bañarse no se incluye en los 6.4 m^3.

[1] La única comunidad donde el promedio de calidad de agua no es al menos "regular" es Susulí. Esto a lo mejor se debe a que ya que casi todos tienen agua potable, sólo tres personas contestaron la pregunta. Esta es una muestra muy pequeña y no representativa.

Al comparar los resultados entre comunidades (Tabla 3), se anota que en Susulí se usa mucho menos agua por persona. Esto es curioso porque casi todo Susulí cuenta con agua potable. Se esperaría que fuera al revés. En general, se encontró que en la muestra total, el uso de agua de familias con agua potable fue menos que el uso de familias que no la tienen. Según los datos, familias que tienen agua potable usan un promedio de 5.05 m^3 mientras las que no tienen, usan un promedio de 10.39 m^3. Una explicación es que los que tienen agua potable mal-estiman su uso. Esto se ha observado en otros estudios y se debe a que es más difícil estimar la cantidad de agua que sale de la llave que la cantidad de agua que uno mismo trae en botella del río (World Bank Water Research Team). Sin embargo, el hecho de que todos parecen estar subestimando—sería igual de facil sobre-estimar)—hace no muy probable que sea solo eso. También se podría deber a un interés personal de esconder su uso. Hay conflicto en la zona sobre distribución de agua, entonces es entendible que los que tienen mucha agua no lo quiere mostrar.

Tabla 3. Per Capita Uso de Agua en la Casa (m^3)

Comunidad	**Agua Potable de Tubería**	**Agua de Otra Fuentes**
Muestra total	3.01 (3.97)	3.18 (7.73)
El Cobano	1.26 (160)	5.62 ()
Zapote	3.93 (3.35)	3.93 (2.51)
Susulí	4.20 (4.64)	.23 (.93)
El Jicaro	1.30 (1.41)	6.16 (14.08)
Wibuse	Na	11.80 (10.02)

f. Tiempo en traer agua a la casa

Como ya se mencionó, traer agua de la fuente a la casa es uno de los gastos más grandes asociados con el uso de agua de fuentes alternativas. Tener agua potable libera muchas horas del día de esas personas para diversión o para otras actividades productivas como trabajar en casa o estudiar. La tabla 4 muestra el tiempo promedio gastado por familia en traer agua en un año. De las 65 familias que trajeron agua a la casa, el promedio fue 36.68 minutos al día, con un rango de 4.5 hasta 200 minutos. Esto corresponde a 223 horas al año, o más que 5 semanas de trabajo a 40 horas a la semana.

Es interestante notar que la comunidad que tiene el promedio más alto de tiempo en traer agua, Susulí, es la comunidad con más proyectos de agua. La comunidad con el promedio más bajo, Wibuse, es la comunidad que no tiene proyectos. Esto surgiere que la decisión

de donde construir proyectos fue eficiente según el criterio de minimizar tiempo en traer agua.

Como ya se mencionó, ponerle valor a ese tiempo, es difícil especialmente porque en San Dionisio son generalmente, aunque no exclusivamente, las mujeres y los niños quienes traen el agua. Siguiendo el BID, podemos poner un valor de la mitad del jornal, que era 30 córdobas al día o aproximadamente US$3 al día cuando se hizo el estudio (US$1=10.3 córdobas). Esto implicaría un valor de $42 al año por familia. Dado que hay 2056 familias rurales en la subcuenca y que según la muestra, 42 por ciento traen agua a la casa de fuentes alternativas, el valor total de tener agua potable en todas las casas sería $36,278 al año. Si ponemos el costo de oportunidad a un jornal en vez de medio jornal para capturar los costos más indirectos como estudios perdidos, llegamos a un valor de $72,536 al año para la subcuenca.

Tabla 4. Tiempo promedio en traer agua a la casa*

Comunidad	**Minutos por día**	**Horas por Año**
Muestra total	36.68 (33.05)	223
El Cobano	34.79 (27.09)	212
Zapote	44.62 (48.53)	271
Susulí	49.17 (9.17)	299
El Jicaro	36.43 (32.78)	222
Wibuse	22.39 (14.16)	136

* Se calcula solo para las casas en las cuales se trajo agua, o sea no se incluyeron casa que solo usaron agua de la llave.

g. Salud

Calidad y cantidad de agua tienen mucho que ver con la salud. En San Dionisio, según autoridades médicas, los problemas que más se relacionan con el agua son las enfermedades gastrointestinales como dolor de estomago y diarrea, problemas de la piel como ronchas o picazón. La tabla 5 muestra la incidencia de estos problemas en las comunidades. Diarrea y problemas de la piel fueron relativamente común en Wibuse, donde no tienen agua potable de la llave. En Susulí, donde más se tiene agua de la llave, parece tener menos problemas con enfermedades del agua. En el Cobano, donde más se usa agua del río, problemas de diarrea no son graves, pero hay mucha incidencia de problemas de la piel. La gente dice que eso se asocia con agroquímicos que llegan al río de las parcelas.

Tabla 5. Incidencia de enfermedades asociados con el agua

	Total	Cobano	Zapote	Susulí	Jicaro	Wibuse
Alguién de la familia tuvo diarrea en los últimos 6 meses (%)	35 (48)	25 (46)	35 (49)	24 (43)	46 (51)	81 (40)
Tomar agua les da dolor de estomago (%)	8 (27)	11 (33)	13 (34)	6 (24)	12 (33)	6 (25)
Tomar agua cura enfermedades*	.66 (.7)	1.11 (.33)	1.12 (33)	.38 (.54)	.96 (.81)	.75 (1.00)
Bañarse les da picazón (%)	18 (38)	38 (52)	29 (47)	12 (33)	23 (43)	19 (40)
Bañarse les da ronchas (%)	8 (27)	13 (27)	12 (33)	4 (19)	8 (27)	25 (45)

* índice que va entre 0 (la persona se mejora) y 2 (la persona se pone peorar)

Tabla 6. Distribución de enfermedades graves* reportadas por la comunidad

	Total	Cobano	Zapote	Susulí	Jicaro	Wibuse
Gastrointestinal (%)	25.9	33.3	17.6	40.8	17.4	13
Número de días Enfermos anuales Con problemas Gastrointestinales	4.08 (14.16)	6.66 (20)	8.24 (22.58)	3.64 (13.13)	1.46 (3.82)	4.75 (15.00)
Dolor de cabeza (%)	3.7	0	8.8	0	8.7	0
Gripa (calentura, tos) (%)	48.1	33.3	47.1	44.9	39.1	69.6
Otra enfermedad (eg dengue) (%)	20.7	16.7	26.5	12.2	34.8	17.4
Lesión (%)	1.5	16.7	0	2.0	0	0

*Grave quiere decir que la persona no pudo hacer sus actividades diarias como trabajar o ir a la escuela.

La tabla 6 presenta la incidencia de enfermedades que fueron tan graves que la gente no pudo hacer sus actividades diarias como trabajar o ir a la escuela. Una cuarta parte de estas enfermedades fueron gastrointestinales, y resultaron en un total de 4.08 días perdidos por familia por año, 3.04 de ellos de adultos.[2] Usando los mismos valores del tiempo de arriba, esto implicaría una perdida económica debido a enfermedades gastrointestinales de US$12,583 o US$25,165 al año.

A diferencia del tiempo de traer agua, no se sabe que parte de los días perdidos por enfermedad se deben al agua. Una manera de estimarla es con una regresión por días/enfermos como variable dependiente. Las variables independientes serían

[2] Adulto significa una persona que tiene 11 años o más. Según informantes locales, a esta edad, los niños de la comunidad empiezan a trabajar.

características de la familia y de sus fuentes de agua. Este análisis se hizo, pero los resultados no fueron muy significativos. La única variable que salió relacionada significativamente con días enfermos fue la educación de la mujer, y esta solo en algunas especificaciones del modelo. Ninguna de las variables que tienen que ver con agua potable ni calidad de agua salió significativa.

Cuando la variable dependiente fue incidencia de la diarrea en ve de días perdidos, salió una relación negativa y significativa entre tener agua potable de tubería y incidencia de diarrea. La diarrea implica un costo menos grave en términos de la salud porque no necesariamente implica perder días de trabajo. Parece que los problemas de salud que se ocasionan por el agua son más bien crónicos, así que la gente no percibe costos económicos grandes asociados con ellos. No se relacionan pérdidas económicas con calidad de agua. Estos resultados está de acuerdo con la opinion de los encuestados expresada en una pregunta abierta sobre problemas con agua en la sub-cuenca. Más que 65 por ciento de los informantes dijeron que falta de agua fue el problema más grande, mientras solo 5.5 por ciento dijeron que el problemas más grave fue calidad.

Sin embargo, esto puede estar cambiando. En un seguimiento de este trabajo, se entrevistaron unos médicos de la zona que dijeron que según sus estadísticos, la incidencia de enfermedades relacionadas con el agua ha aumentado en 50 por ciento entre 1998 y 1999 (Baltodano). Puede ser que al poner más grave la situacion, la gente empiece a darse cuenta de la relación. De todas formas, este tema merece más investigacion.

5. Resultados de Análisis de Valoración Contingente

a. Disposición de pagar

Datos sobre la disposición de pagar fueron solicitados con dos preguntas, una basada en días del trabajo y otra en dinero en efectivo. Los resultados promedios se presentan en la Tabla 7.

La primera pregunta fue dirigida a las familias que no tenían agua potable en la casa y que querían tenerla. La pregunta fue:

> *Imagínese que se fuera a hacer un nuevo proyecto de agua en su comunidad. Piense usted en cuánto le valdría tener agua potable de este proyecto.*

Se les dieron 4 opciones para contestar: 4, 3,2 o 1 día a la semana por 6 meses. Estas opciones se escogieron en base de la información dada por informantes claves en la comunidad y de los resultados de las pruebas que se hicieron con la encuesta. Treinta y cuatro personas contestaron la pregunta con un promedio de 2.5 días a la semana. El máximo de que alguien fue dispuesto a contribuir fue 4 días a la semana. El mínimo fue 1 día, o sea nadie contestó con 0. Los promedios varían entre 1.94 días en Wibuse a 3.10 días en Jicaro. En Susulí de las 3 familias que no tienen agua potable, nadie contestó la pregunta entonces no hay valores para esa comunidad.

En términos de valor económico, dos y media días a la semana implica 60 días de trabajo por familia. Hay alrededor de 2056 familias rurales en San Dionisio, y según los datos, 24 por ciento no tienen agua potable. Esto implicaría 494 familias y un total de 29,640 días de trabajo. Si un día de trabajo vale US$3, esto implicaría un valor total de US$88,920 en la subcuenca para la provisión de agua potable a las familias que actualmente no la tienen.

La otra pregunta sobre valoración contingente se aplicó a todas los informantes. La pregunta no tiene que ver con un proyecto de agua potable en si, sino con el mejoramiento del agua de la fuente que ya se usan. La pregunta es en cierto sentido complemento a la pregunta anterior porque se trata de cargo mensual y no de gastos fijos de construcción de un proyecto. La pregunta fue así:

> *Imagínese que fuera posible mejorar la fuente que más utilizan ustedes actualmente, sea agua potable, pozo, quebrada, río, ó nacimiento. Mejorar la fuente significa que habría más agua de mejor calidad de la misma fuente. Piense usted en cuanto le valdría tener agua potable de esta fuente.*

Se les ofrecieron 5 opciones para contestar: 15, 12, 9, 6, ó 3 córdobas al mes (1 cordoba=US$.1) A los que dijeron no a todas las opciones se les colocó 0 como disposición de pagar. Ciento treinta y dos personas contestaron la pregunta con un promedio de 3.95 córdobas al mes. El máximo fue en Cobano, donde el promedio fue 11 córdobas al mes. El mínimo fue en Zapote, donde fue menos que un córdoba. Con 2056 familias rurales, un promedio de 3.95 córdobas al mes implica un promedio de US$788 mensuales a nivel de la subcuenca ó US$9456 al año.

Se cree que en el caso de Zapote, el encuestador o no hizo bien la pregunta o influyó sobre las respuestas. El encuestador es un líder de la comunidad que pertenece al comité local de agua potable (CAP). Una posibilidad es que él interpretó la pregunta como algo que pudiera influir sobre los cargos mensuales que paga la gente con agua potable, y que les comunicó su opinión a los encuestados. Sin las observaciones de Zapote, el valor promedio de disposición de pagar fue 4.40 córdobas al mes. Otro problema que se tuvó con el encuestador fue en la comunidad de Wibuse, donde nadie contestó la pregunta. No se sabe si fue porque no quisieron contestar o porque no se les hizo. Pese a que esta pregunta fue la más difícil conceptualmente y la más vulnerable a confusión y sospechó sobre el uso de los resultados, fue de esperarse que los problemas aparecieran aquí.

Tabla 7. Disposición de pagar por mejor agua

Comunidad	Disposición de pagar en córdobas/mes			Disposición de pagar en días de trabajo a la semana por 6 meses		
	Promedio	Min	Max	Promedio	Min	Max
Total	3.95 (3.84)	0	15	2.5 (.93)	1	4
El Cobano	11 (3.1)	9	15	3 (1)	2	4
Zapote	.21 (.8)	0	3	2.67 (.58)	2	3
Susulí	3.14 (2.6)	0	15	--		
Jicaro	7.04 (4.56)	3	15	3.10 (1.10)	1	4
Wibuse	3 (0)	--	--	1.94 (.44)	1	3

b. Qué tan confiables son los resultados de CVM?

Dado el carácter hipotético de las preguntas sobre disposición de pagar y los problemas que se encontraron en la implementación, sería muy fácil rechazar los datos por no ser confiables. Sin embargo, hay maneras de comprobar la confiabilidad de los resultados usando la teoría económica. Según la teoría del consumidor, podemos imaginar que la disposición de pagar (DAP), es función de las características del agua, como calidad, y de la persona, por ejemplo gustos personales o ingreso.

Podemos escribir la función para disposición de pagar así:

$D_h = a + X_h\beta + e_h$ (Ec. 1)

donde D_h es la disposición de pagar de la vivienda h, a y ß son parámetros y X_h es un vector de características que afectan la disposición de pagar. El error es e_h. Bajo los supuestos tradicionales sobre compartimento económico, podemos predecir como deberían ser ciertas de las relaciones entre las disposiciones de pagar y sus determinantes. Por ejemplo, la relación entre el precio de substitutos para mejor agua— que en este caso sería el agua que actualmente tiene la persona—debería ser positiva así que entre más costoso sea no tener mejor agua, más pagaría la persona por tenerla. También, se supone que la relación entre ingreso y DAP es positiva así que si el ingreso sube, la capacidad de pagar también sube, *ceteris paribus*. Estas relaciones se pueden comprobar estadísticamente. Si las relaciones entre disposición de pagar y sus determinantes son como las esperamos, podemos tener más confianza que los datos de valoración contingente no fueron inventados al azar sino que representen los verdaderos valores individuales.

La ecuación 1 no se puede estimar directamente ya que los valores de D_h que tenemos no son continuos sino restringidos a los valores ofrecidos en la pregunta. Aunque no sabemos los valores exactos de los D_h sabemos los rangos dentro de los cuales se caen. Entones, si W_1, W_2, ...W_n son las opciones de días o córdobas que se les ofrecieron, podemos decir que y_h es una variable "categorical" que tiene los siguientes valores:

$$y_h = \begin{array}{ll} 1 & \text{si } D_h < W_1 \\ 2 & \text{si } D_h < W_2 \\ N & \text{si } D_h < W_n \end{array}$$

Si e_h tiene una distribución "standard normal" tenemos una ecuación para la probabilidad de que D_h esté dentro de un rango. Dejando que i = 1,2...N, $P(y_h = Wi) = P(W_{i-1} < D_h < W_i)$. La probabilidad que $y_h = Wi$ es $F(W_i - a_h - X_h\beta) - F(W_{i-1} - a_h - X_h\beta)$ donde F es la CDF de la distribución standard normal. Esta relación es el modelo ordered probit, que se puede usar para analizar los determinantes de las DAP (Greene, p. 672-676; Limdep manual).

Los resultados del análisis se presentan en la tabla 8. Solo se presenta el signo del coeficiente y el valor-p de la significancia de la variable. La interpretación de los coeficientes de los modelos "ordered probit" es complicada y no se pueden interpretar como efectos marginales de la variable. Para nuestros propósitos, el signo y la significancia son suficientes para examinar hipóteses sobre la magnitud y dirección de los efectos.

Ya que el propósito del análisis es comprobar la confiabilidad de los datos sobre DAP y no examinar los determinantes de DAP, solo se incluyeron los variables consideradas como más importantes en términos económicos. Otras especificaciones más complejas del modelo se hicieron, pero los resultados no fueron muy significativos. Esto fue de esperarse dadas las exigencias del modelo y el pequeño tamaño de la muestra. Ya que los resultados básicos en términos de las variables económicas no cambiaron entre los diferentes modelos, los resultados de los otros no se presentan.

Cuando la variable dependiente fue DAP en días por beneficiarse de un proyecto de agua potable, los determinantes considerados más importantes fueron el índice de ingreso, el tiempo que actualmente se gasta en traer agua para la casa, el sexo del informante, y el número de adultos en la casa. En general, los resultados son consistentes con lo que se esperaba.

Se esperaba que la relación entre ingreso y disposición de pagar fuera positiva ya que una familia con más recursos económicos puede pagar más, *ceteris paribus*. Según los datos, la relación parece ser positiva y significativa a nivel de confianza de 90 por ciento. También se suponía que la relación entre tiempo gastado en traer agua y disposición de pagar fuera positiva ya que el tiempo es el mayor costo asociado con el uso de fuentes alternativas. Como se esperaba, la relación es positiva y significativa a nivel de confianza 95 por ciento.

Tabla 8. Determinantes de Disposición de Pagar

	DAP en días*		DAP en efectivo**	
Variables independientes:	Signo del coef.	Valor de P	Signo de coef.	p-value
Indice de ingreso	+	.08236	+	.14466
Tiempo en traer agua	+	.02296	+	.0015
Actualmente tener agua potable			-	.38436
Dummy de sexo del informante (=0 sí mujer)	-	.10027	-	.33696
Número de adultos (> 11 años)	+	.85145		
Dummy de Zapote (=1 sí comunidad es Zapote)			-	.00000
Número de observaciones	34		128	
Chi square (grados de libertad)	15.95177 (4)		60.7641 (8)	
Significancia del modelo	.00308		.00000	

* número de días/semana/6 meses que se contribuirían a un proyecto de agua
** Córdobas/mes que se pagarían por mejor agua

Otros estudios de valor de agua potable encontraron que las mujeres muchas veces ponen más valor a tener agua potable ya que son ellas quienes más traen agua para la familia. En el modelo, se incluyó una variable dummy que fue 0 si el informante fue mujer y 1 si fue hombre. La relación salió como se esperaba, negativa y significativa a nivel de confianza de 90 por ciento. Las mujeres están dispuestas de pagar más por mejor agua. Esto se debe tomar en cuenta en la formulación de políticas y proyectos para mejorar el servicio del agua potable porque si ellas son las que más se beneficiarían de mejor agua potable, son las que más participarían o contribuirían.

La variable sobre el número de adultos en la familia fue incluida porque el número de personas influye sobre la capacidad de la familia de contribuir con la mano de obra. Dado los altos tasas de desempleo en la zona, podría ser que la disponibilidad de la mano de obra influyera en la disposición de pagar directamente y no a través del ingreso. Sin embargo, la relación no es sencilla, porque al tener mucha mano de obra en un ambiente de desempleo también implicaría más capacidad de traer agua y entonces menos demanda de agua potable. Por eso, la relación podría ser o positiva o negativa. En este caso, si la variable significativa sale, no que quiere decir que haya efectos mixtos.

La tabla 8 también presenta los resultados del "ordered probit" análisis de las respuestas de la pregunta sobre disposición de pagar en moneda local por mes por mejorar las actuales fuentes de agua. Se incluyeron las mismas variables de arriba más 2 dummy variables, una si la familia tenía agua potable y otra si la familia vivía en Zapote. La dummy para Zapote controla por el hecho de que parece que hubo influencia del encuestador sobre las respuestas a esta pregunta. La alta significancia de la variable en el análisis apoya la sospecha.

En este caso, también el ingreso salió importante, y con la dirección (positiva) esperada. No llegó al nivel de confianza de 90 por ciento, pero tener un nivel 85 para un variable tan impreciso como el índice de ingreso es adecuado. De hecho, los buenos resultados logrados con el índice de fuentes de ingreso apoyan su uso como alternativa para medir recursos económicos de una familia.

Según los resultados, tiempo de traer agua es también un determinante importante de la disposición de pagar por mejor agua. Aquí, la relación lógica entre tiempo y disposición de pagar no es tan obvia ya que mejorar la fuente no significa que la fuente sea más cerca. Una explicación podría ser que una de las razones más importantes para gastar tanto tiempo en traer agua es que no se puede ir siempre a la fuente más cercana porque ó el agua está de mala calidad o porque la fuente no tiene agua todo el año. Esto se apoya por una correlación positiva y significativa entre tiempo en traer agua y el número de fuentes alternativas que se usa por familia.

El sexo no parece ser un determinante muy importante en este caso como en el caso de DAP en días por agua potable. Este puede ser debido a que mejores fuentes todavía implican tiempo en traer, pero también hay otra explicación posible. Otros estudios también han encontrado una diferencia en el efecto del sexo sobre disposición de pagar en días y en efectivo (World Bank Water Research Team). Las mujeres frecuentemente son más dispuestas a comprometer mano de obra que dinero en efectivo.

Al tener agua potable no parece significar que una persona esté menos dispuesta a pagar por mejor calidad. La relación es negativa pero no muy significativa. Esto es de esperarse ya que tener agua potable actualmente en San Dionisio no significa tener una fuente consistente de buena agua.

En general los resultados de los modelos ordered probit son como se esperarían si las respuestas sobre disposición de pagar fueran verdaderos valores para mejor agua. Las variables importantes salieron significativas y con la dirección esperada. Esto nos puede dar confianza que las respuestas de los encuestados sobre su disposición de pagar son confiables y que se pueden usar como base para la evaluación de un proyecto que tienen como fin el mejoramiento de agua en la zona.

6. Conclusiones y Recomendaciones

a. Observaciones metodológicas

Los resultados de este estudio confirman la utilidad del método de valoración contingente para valorar los servicios de recursos naturales que no tienen mercados. Los resultados del análisis son consistentes con la lógica económica, o sea no parecen ser cifras inventadas sino verdaderas disposiciones de pagar por mejor servicio de agua potable.

La confiabilidad de los resultados no quiere decir que no hubo problemas con la metodología o su implementación. En cuanto a la implementación , en general los resultados apoyan el uso de encuestadores locales, pero hay que poner mucha atención,

tanto en la selección como en la capacitación, de ellos. En el caso de Zapote, se cree que el encuestador entendio el próposito de la pregunta sobre disposición de pagar, pero que por desconfianza sobre el ultimo uso de la información influyó sobre los resultados. Esto muestra que no es suficiente tener encuestadores que entienden las preguntas sino que también son objectivos en cuanto a las respuestas.

En cuanto a la metodología de valoración contingente, un propósito del estudio fue ver si la gente es capaz de contestar preguntas sobre el valor del mejoramiento de fuentes naturales. Según los resultados, parece que sí. A pesar de la falta de experiencia con mercados de agua y de detalles especificos sobre los cambios propuestos, las respuestas de la gente sobre DAP por el mejoramiento de fuentes naturales conforman con la lógica económica.

Esto es importante porque muchas veces los proyectos participativos como los del CIAT no pueden ser más específicos sobre sus propósitos antes de empezar a trabajar. Las actividades especificas del proyecto dependen de las prioridades de la comunidad. Lo que este estudio muestra es que a estas prioridades se les puede asignar un valor económico. Estos valores pueden ser muy utiles para CIAT o otras institutciones en sus procesos de planeacion y priorizacion.

b. Conclusiones y recomendaciones politicas

En terminos de implicaciones politicas, el estudio confirma que disponibilidad de agua es un problema económicamente significante en la subcuenca del Río Calico. Según el análisis de los datos, parece que el problema de agua potable en la subcuenca tiene que ver más con la disponibilidad de agua que con la calidad. No tener agua disponible en una fuente cercana se refleja en tiempo gastado en buscar y traer agua para la casa.

Puede ser que haya problemas crónicos de salud asociados con el uso de agua contaminada, pero la gente no parece fijarse mucho en ellos cuando toma decisiones económicas sobre el agua. Habría que estudiar esas relaciones mas al fondo y luego, si se justifica, iniciar programas de educación para que la gente se de cuenta de las consecuencias de agua de mala calidad. Parece que el tema es urgente porque según los médicos, la incidencia de enfermedades relacionadas con el agua está creciendo rápidamente.

En términos de valor económico de mejorar el agua, tenemos varias opciones que salieron del análisis. Se presentan en la tabla 10. A nivel de la subcuenca, el costo actual de traer agua a la casa se estima a US$ 36,278 si el tiempo vale medio jornal y a US$ 72,536 si vale un jornal entero. Según los datos de valoración contingente, la gente de la subcuenca que no tiene agua potable está dispuesta a contribuir mano de obra con un valor total de US$88,920 para poder beneficiarse de un proyecto. Para tener mejor agua potable de sus fuentes actuales, la gente de la subcuenca está dispuesta a pagar US$9,456 al año.

Tabla 10. Valores Económicos de Tener Mejor Agua Potable

Método	Valor en US$
1. Costo de tiempo	
@ ½ jornal	36,278/año
@ 1 jornal	72,536/año
2. DAP por agua potable	88,920
3. DAP por mejores fuentes actuales	9,456/año

Aunque es difícil comparar los distintos resultados, hay algunas observaciones que se pueden hacer. Si un proyecto de agua potable se espera durar 10 años y la tasa de descuento es 15 por ciento, el valor anual de la contribución sería US$17,718. Esto implicaría que el valor que la gente le está dando al tiempo de traer agua está por debajo de medio jornal. Esto parece razonable dentro de las condiciones de San Dionisio, donde hay altas tasas de desempleo y bajos niveles de asistencia a la escuela. Sin embargo, hay que tener en cuenta que los proyectos actuales de agua potable de San Dionisio no eliminan la necesidad de traer agua. Una familia con agua potable todavía gasta un promedio de 63 horas al año en traer agua. Esto es la tercera parte de lo que gasta una familia sin agua potable, pero todavía es un gasto significativo.

Se esperaba que la gente pagara menos por mejorar fuentes existentes, sobre todo porque usar estas fuentes todavía implica gastar tiempo, aunque quizás sea menos que antes por poder usar fuentes más cercanas. Otra razón por la cual las respuestas a está pregunta fueron menos que a la otra es que las respuestas fueron en dinero en efectivo y no en días de trabajo. En una economía no completamente monetizada y donde hay mucho desempleo, la gente prefiere pagar con mano de obra y no en efectivo.

El próximo paso es usar la información económica que salió de este estudio como parte de un análisis de los costos y beneficios de las distintas opciones para mejorar la situación.

Una opción para lograr un mejoramiento del agua sería abastecer la subcuenca entera con proyectos de agua potable. Esto es la meta del departamento gubernamental que se encarga de agua y acueducto. El primer problema es, como se ha mencionado varias veces, los proyectos que ya existen no siempre funcionan bien. En parte es por falta de agua, pero tambien se debe a mal manejo y mantenimiento. En el caso de falta de agua, una posibilidad es construir pozo profundos, pero esto es muy costoso y hasta ahora no se ha considerado seriamente. Datos sobre el valor económico de mejor servicio de agua potable serían importantes para la evaluación de esta opción.

Otra solucion para el problema de falta de agua en la comunidad que se ha usado antes es hacer acuerdos entre comunidades donde una se abastece del agua de la otra. Estos tratos siguen funcionando, pero es cada vez más difícil hacer nuevos, sin afectar la cantidad de agua disponible en las comunidades donde se encuentran las fuentes.

Actualmente el agua potable se maneja a nivel de la comunidad a través de un comité de agua potable (CAP). Ultimamente se inició un proceso de formar una asociación de los CAP, que podría ayudar resolver problemas de redistribución entre comunidades.

Sin embargo, redistribuir en un ambiente de escaez siempre es controvertido. El hecho de que los encuestados de Susulí, una comunidad que abastece agua a otras comunidades, parecen haber sistemáticamente subestimado su uso de agua para ocultar la cantidad que tienen muestra lo difícil que sería implementar una redistribución. Hasta ahora las comunidades recipientes no han pagado por el agua que reciben. Establecer mercados de agua podría facilitar la distribución eficiente de agua, pero son pocos de los encuestados que apoyan la idea de pagar por uso (por cantidad de agua). El 79 por ciento está en contra de la idea de instalar medidores de agua para medir y cobrar el uso actual. Habría que cambiar la actitud de la gente para poder implementar un plan basado en el mercado.

En cuanto al mal mantenimiento de los proyectos, esto es algo que se observa mucho en proyectos de agua potable. Podría reflejar que la gente no es o capaz o interesada en mantenerlos bien (World Bank Water Research Team). Lo más probable es el segundo, y que otras opciones para provisionar agua potable sería más eficientes (World Bank Research Team; Whittington et al; Drangert). Es interesante notar que cuando se les preguntó a los encuestados que soluciones recomendarían para sus problemas de agua, solo 20 por ciento de los encuestados dijeron la construcción de más proyectos.

La opción alternativa que se ha contemplado en este estudio es mejorar la cantidad de agua en fuentes naturales a través del mejor manejo de recursos naturales a nivel de la subcuenca. En la encuesta, 59 por ciento de los encuestados sugirieron esta opción para resolver el problema. Una de las ventajas más grande de esta opción es que su propóspito no es redistribuir sino aumentar la cantidad de agua disponible. Asi es menos controvertida, por lo menos a primera vista.

Se cree que mejor manejo de los recursos naturales aumentarían la cantidad y calidad de agua dentro de la subcuenca. El problema es que cambiar el patrón de uso de la tierra en la subcuenca también tiene que implicar redistribución de los beneficios de los recursos naturales. Puede ser que ya que otros recursos—como suelos o bosques—son privados, es más fácil para la gente pensar en negociar su uso, o a través del mercados o otras instituciones. Sin embargo, es probable que esta solución también vaya a necesitar un cambio social y/o institucional que permita negociar el uso de recursos naturales a nivel de la comunidad.

c. Investigación futura

Para hacer los resultados de este estudio más útiles a nivel de planeación, habría que extrapolarlos a niveles regionales y nacionales. Se planea hacer este análisis basados en los datos de SIG, con los cuales podemos identificar otras cuencas parecidas dentro de Nicaragua y en todo Centroamérica. Para asegurar que los datos sean lo más confiable posible, también sería aconsejable llevar acabo el mismo estudio de valoración contingente en otras subcuencas.

Para hacer que los resultados sean útiles a nivel de politicas y proyectos, se necesita más investigación en dos campos distintos. El primero es en el area de manejo de recursos maturales. Como se han dicho varias veces, todavía no se entiende muy bien la relación entre uso de la tierra y disponibilidad de agua. Cuantificar esta relación es clave para desarollar un plan de manejo con el propósito de aumentar la disponibilidad de agua. En la encuesta, a gente habló de los efectos de las quemas y de la deforestación sobre agua y estos podrían ser temas prioritarías para la investigación biophysica en esta area.

También se necesita más investigación socioeconomica. Organización social fue un componente importante en todas las soluciones propuestas para resolver el problema de disponibilidad de agua. Tenemos que saber más sobre cómo mejorar la capacidad organizacional de una comunidad y cómo desarollar mercados o otras instituciones alternativas que facilitan la redistribución o negociación del uso de recursos naturales.

Collaboration:

- Maria Eugenia Baltodano, CIAT-Laderas, Managua, Nicaragua and the staff of the San Dionisio Centro de Salud, who contributed questions on health for the survey.

  Maria Eugenia used the data to write a paper for a course on resource valuation that she took at a local university.

1.2.B. Soils Research - *by: A. Gierend*

Two studies are in progress: (1) an ex-ante study of the impact of soil management technologies and agropastoral systems for the Savannas in Latin America (first analysis results are expected at the beginning of October 1999, and the final written document some weeks later), and (2) an adoption and impact study of multi-purpose erosion barriers for the hillsides in Latin America (to be completed by the end of year 1999).

1999 Milestones

- Experimental field results from agropastoral systems and soil management technologies are screened and reviewed for the impact study,
- GIS soil maps are developed for the Savannas in Latin America including agricultural production statistics, area, and population for the different soil type zones.

Ex-ante study of the impact of soil management technologies and agropastoral systems for the Savannas in Latin America

This study is aimed at providing a comprehensive economic analysis of key technologies developed by CIATs NRM program in the area of soil conservation and sustainable production systems for the Savannas. As such the study is a continuation of previous ex-ante impact studies of NRM technologies such as agropastoral systems for the Latin American Savannas done by L. Rivas, and L. Sainint (documented in the Trends of CIAT

commodities 1990, 1991) but incorporates some analytical extensions and spatial coverage, for example:

- It examines a broader set of technologies including various soil management technologies and production systems developed by CIAT and collaborate national research institutions for the Savannas,
- provides a complete coverage of the Savannas in Latin America with almost 320 mil ha mainly located in Brazil, Colombia, Venezuela, and Bolivia, and
- applies GIS maps for the delineation of homogenous impact zones in the Savannas in which adoption rates, the potential yield effects, and other technical parameters are expected to be of similar magnitude.

The various technologies under examination are:

- Application of lime and corrective fertilization for improving the chemical properties (level of macro and micro nutrients, pH level) of the acid and nutrient deficient Savanna soils).
- Corrective land preparation techniques for breaking up compaction layers (use of deep chisels), no-tillage and minimum tillage systems for monocropping and agropastoral systems.
- Various agropastoral systems with maize, rice, and soybean as annual crops that are rotated or associated with grass and grass/legumes pastures. Furthermore, different lengths of rotational cycles are considered as well.

GIS maps are constructed to delineate zones of homogenous impact within the Savanna contributing to the fact that the time and rate of adoption as well as the effect these technologies have on soil fertility, crop yields and livestock production differ markedly due to climatic soil, topographic and country-specific characteristics. It has been assumed that "soil type" is the most important indicator for demarcating zones with homogenous technology impact. Based on this, FAO/UNESCO soil maps for Latin America, digitized maps of agricultural production on municipal and department level for Colombia, Brazil, Venezuela, and Bolivia, and the Savanna map developed by P.G. Jones et al. (CIAT, Strategic Plan in the 1990s and Beyond.) have been used to derive a GIS sub-zonation for the analysis. Intersection of these three map layers results in a zonal system of different soil types and groups of soil types in the Savanna.

The economic impact of these technologies are measured by their aggregate contribution to increased crop and livestock production due to higher yields in monocropping, additional production of a annual crop in agropastoral systems, and higher productivity of pastures for dairying and ranching. All these technologies are referenced against the current predominant land use systems in the Savannas, namely native or improved pasture with low input use, monocropping with low fertilization, and traditional land preparation. In accordance to the former studies in NRM such as those mentioned earlier, simple cost-benefit analysis is applied for calculating the value added from increased production assuming that commodity prices stay constant. Even though prices might be affected from these technologies, especially in countries where the Savannas occupy

large parts of the agricultural land and production share, the estimated economic benefits from these technologies are not much affected compared to economic surplus analysis.

Collaborators:

- Kate Lance, Glenn Hyman, GIS unit
- Edgar Amézquita. PE-2

1.2.C. Savannas and Forest Margins in Colombia - by: *L. Rivas*

Metas para 1999

- Proveer un marco de referencia para la evaluación *ex-ante* y *ex-post* de los actividades de los proyectos de investigación del CIAT, dentro del Convenio de Cooperación técnica y científica suscrito entre el Ministerio de Agricultura y Desarrollo Rural de Colombia (MADR) y el CIAT, que tiene como área objetivo la Amazonia y Orinoquia (A&O) colombianas.

- Efectuar un ejercicio de evaluación ex-ante, estimando los beneficios potenciales a consumidores y productores, mediante la aplicación de modelos de excedentes económicos, en actividades agropecuarias con alto potencial para A&O.

Principales conclusiones:

1) La producción agregada de la región presentó gran dinamismo durante el período de análisis, creciendo el PIB regional en el período 1980-1995 al 6.6% por año, frente al 3.8% para el país como un todo. Parte de esa dinámica es explicada por el auge petrolero que caracterizó dicho período.

2) La agricultura regional también mostró un dinamismo importante. Las áreas cultivadas casi se duplicaron, creciendo en promedio por año al 4.7%, en contraste con el crecimiento del área cultivada del país de solo 0.7% anual.

3) La densidad poblacional es muy baja, pero se observaron elevados índices anuales de crecimiento de la población en regiones específicas como Arauca (10.1%), Vichada (7.5%), Putumayo (6.2%) y Casanare (4.4%).

4) No obstante lo anterior, la población que habita la región sigue siendo una pequeña fracción del total del país, por lo cual su mercado interno es reducida y A&O se convierte en exportador neto de alimentos y materias primas para el resto de Colombia.

5) Se destacan como cultivos importantes regional y nacionalmente, por la magnitud de las áreas utilizadas y el volumen de producción, arroz, maíz, plátano, palma de aceite y yuca. En 1994 de un total de 445 mil hectáreas cultivadas, el 90% de ellas era

ocupado por los cultivos citados. La ganadería, por los recursos de tierra que utiliza y por su aporte a la disponibilidad de carne y de leche del centro del país, es de vital importancia económica en A&O.

6) El patrón de crecimiento de la producción agropecuaria en la región ha sido de carácter extensivo. El avance de la producción de los cultivos más importantes como arroz, yuca, plátano y palma de aceite, es explicado en una alta proporción por el incremento de las áreas plantadas, en tanto que el crecimiento de los rendimientos ha sido muy limitado. (Véase Cuadro 1)

7) El inventario ganadero total de A&O se estima en aproximadamente 6.6 millones de cabezas, equivalentes a casi una cuarta parte del hato nacional. De ese total, cerca del 80 % se ubica en la Orinoquia, también conocida como los Llanos Orientales. Asumiendo diferentes capacidades de carga, según los distintos grados de avance de la ganadería en las diferentes regiones que la conforman, se estima que el área total en pasturas de A&O se aproxima a 10 millones de hectáreas.

8) Los resultados de la aplicación del modelo de excedentes económicos MODEXC a 16 actividades productivas en A&O, algunas de ellas tradicionales de la región y otras nuevas o de reciente aparición, para determinar el impacto potencial del desarrollo y uso de nuevas tecnologías en A&O, permite concluir que la rentabilidad social de las inversiones en el desarrollo tecnológico es muy alta, dada la elevada magnitud de los beneficios sociales esperados, comparada con los actuales niveles de inversión para el desarrollo de las mismas.

9) El valor presente de los beneficios sociales, calculado para un horizonte de tiempo de 15 años y una tasa de descuento del 10%, fluctúa en rango us$174 millones para carne vacuna y U$ 3 millones para fríjol. En orden descendente según el valor presente de su beneficios esperados los diferentes cultivos aparecen así: Carne vacuna, plátano, leche, arroz, frutas, yuca, palma de aceite, maíz, soya , sorgo y fríjol. En el grupo de las frutas se incluyen naranja, piña, aguacate, mango, papaya y sandía.

10) La distribución de los beneficios tecnológicos entre productores y consumidores, cuando se asume un modelo de economía cerrada, se concentran en los consumidores en los alimentos con baja elasticidad precio de la demanda como arroz, fríjol, leche, carne. En bienes que son utilizados como materias primas para procesamientos agroindustriales, con elasticidades precio de demanda más altas, los beneficios tienden a concentrase en los productores de esos cultivos, es el caso de soya, palma, sorgo.

11) La apertura comercial, en el caso de bienes transables en los mercados externos, tales como carne, arroz y leche, permite mejorar la equidad en la distribución de los beneficios entre productores y consumidores.

12) En el estudio se discute el potencial de los frutales en A&O y los factores que pueden limitar el impacto del desarrollo de nuevas tecnologías. Es importante el

mejoramiento varietal, pero adicionalmente se precisa el desarrollo de métodos de manejo agronómico y de control de plagas y enfermedades. El desarrollo frutícola en la región debe enfocarse desde una perspectiva global, donde la tecnología de producción es un elemento clave, pero los aspectos de procesamiento, transporte almacenamiento y distribución son críticos, para lograr altos niveles de la adopción e impacto en A&O.

Resumen

Dentro del convenio de Cooperación Técnica y Científica, suscrito entre el Ministerio de Agricultura y Desarrollo Rural de Colombia (MADR) y el Centro Internacional de Agricultura Tropical (CIAT), que busca implementar sistemas de producción y componentes tecnológicos apropiados y adaptados a las condiciones económicas y ambientales de la Amazonia y Orinoquia (A&O) de Colombia, durante el presente año se elaboró un marco económico de referencia, basado en un esfuerzo importante de recolección y análisis de la información actualmente disponible para el área objetivo.

El citado marco de referencia es indispensable para el trabajo de evaluación *ex –ante* y *ex-post* de los beneficios sociales atribuibles al cambio técnico en producción en el área bajo estudio.

Para éste propósito gran parte del esfuerzo se concentró en la recolección procesamiento y análisis de información. Se consultaron bases de datos nacionales e internacionales tales como Agris, Agrícola, Cab, Catal, Fao, Base de datos Agrícolas de América Latina, Ministerio de Agricultura y Departamento Nacional de Planeación de Colombia.

Adicionalmente se revisaron numerosos estudios relevantes al tema. Como subproducto de ésta actividad se elaboró, con el programa EndNote, una base de referencias pertinentes para la región interés, la cual en la actualidad cuenta con 66 entradas y se espera ampliarla en el futuro.

El análisis de tendencias está referido a las dos últimas décadas e incluye dotación de recursos físicos y humanos, producción global, producción agropecuaria, uso de la tierra y evolución de la productividad. El principal limitante para este trabajo ha sido la disponibilidad de información, no solamente en cuanto a cantidad sino a calidad y consistencia de las series de tiempo.

Los mayores falencias en cuanto a disponibilidad de información se observan en el subsector pecuario, en el que se presentan serias dificultades para conocer la magnitud y distribución de las áreas en pasturas, la productividad, el nivel de los inventarios ganaderos y la producción de carne y de leche.

El análisis considera las dos grandes ecoregiones: Amazonia y Orinoquia. La primera incluye los departamentos de Amazonas, Caquetá, Putumayo, Guainía, Guaviare y Vaupés y tiene un espacio territorial que se aproxima a 40.3 millones de hectáreas. La

segunda incluye las divisiones territoriales de Meta, Arauca, Casanare y Vichada, que contabilizan en conjunto cerca de 25 millones de hectáreas.

La Amazonia y Orinoquia constituye un inmenso territorio, que representa cerca del 60% de la superficie colombiana, véase Figura 1., con una importante dotación de recursos de tierras, energéticos y mineros, que si se utilizan adecuadamente, mediante de la aplicación de nuevas tecnologías eficientes y sostenibles, harán una significativa contribución al avance socioeconómico del país en las próximas décadas.

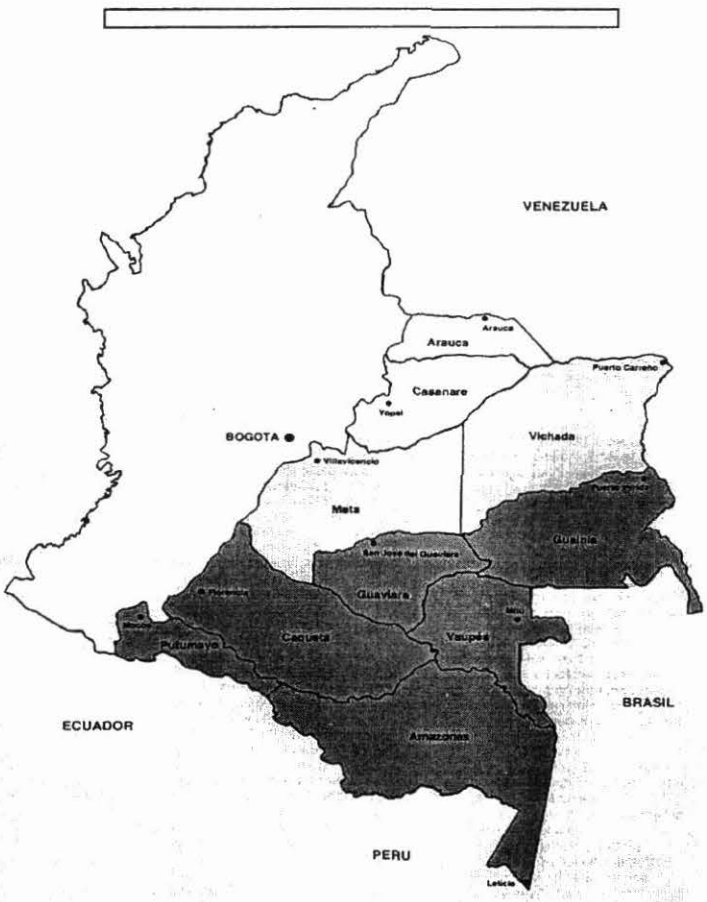
Se emplea el modelo MODEXC de evaluación de excedentes económicos, para determinar el beneficio potencial de diferentes alternativa tecnológicas y aportar elementos de juicio para la priorización de actividades de investigación dentro del Convenio MADR – CIAT. Para la estimación del impacto potencial en A&O , se considera que dos fuerzas impulsan el avance de la producción. La primera se refiere a la intensificación de la misma en las áreas actualmente cultivadas a través del incremento de los rendimientos. La segunda es la extensificación o expansión de las áreas de cultivo. Los valores presentes (VP) de los beneficios esperados se presentan en el Cuadro 2.

Los supuestos asumidos para la evaluación del impacto son muy conservadores en cuanto a la expansión de las áreas de cultivo y al avance de los rendimientos. Se asume que al cabo de 15 años de difusión de las nuevas tecnologías las áreas adicionales incorporadas a la producción llegarían a un cuarto de millón de hectáreas (Cuadro 3) y que el aumento de los rendimientos en los cultivos sería del 20% con respecto a los rendimientos actuales.

Los beneficios del desarrollo y adopción de nuevas tecnologías que eleven la productividad de las actividades agropecuarias en A&O, resultan altos comparados con los actuales niveles de inversión para el avance tecnológico en la región objetivo. Estos beneficios se expresan como el valor presente del flujo anual durante un período de 15 años, resultante del uso de las tecnologías mejoradas en A&O.

Actividades tradicionales como la ganadería presentan un alto potencial para su mejoramiento productivo, pero nuevas actividades como por ejemplo los frutales podrían jugar un rol muy importante en el proceso de diversificación de la producción en la región bajo estudio en los próximos años.

Figura 1. **Amazonia y Orinoquia de Colombia**
Extensión territorial y Ubicación geográfica



Cuadro 1. **Tasas anuales de crecimiento de la Producción, el Area y los Rendimientos de los principales cultivos en la Amazonia y Orinoquia de Colombia** 1981-1997

Cultivo	Tasa anual de crecimiento (%)		
	Producción	**Area**	**Rendimiento**
Arroz	1.4	2.0	-0.6
Arroz riego	-2.2	-1.9	-0.3
Arroz secano manual a/	-14.9	-13.3	-1.6
Arroz secano mecanizado b/	0.9	1.8	-0.9
Maíz c/	1.2	0.0	1.2
Maíz tradicional c/	3.3	2.0	1.3
Maíz tecnificado c/	-1.5	-6.2	4.7
Soya d/	5.7	2.4	3.3
Sorgo	-8.9	-11.7	2.8
Palma africana e/	20.0	18.2	1.8
Plátano e/	10.7	6.7	4.0
Cacao e/.	3.6	3.4	0.2
Fríjol	4.8	-1.6	6.4
Yuca e/	5.0	4.6	0.4
Algodón	4.8	1.3	3.5
Ajonjolí f/	54.0	48.3	5.7
Caña miel g/	2.3	5.5	-3.2
Caña panela h/	-8.1	-5.9	-2.2

a/ 1986-1997 b/1984-1997 c/1982-1997 d/ 1987-1997 e/ 1981-1996 f/ 1986-1994 g/ 1993-1996 h/ 1992-1986. Fuente: Cálculos basados en cifras del Ministerio de Agricultura

Cuadro 2 Beneficios Potenciales del Desarrollo y Adopción de Nuevas Tecnologías en la Amazonia & Orinoquia de Colombia 1/

Productos	Excedentes Económicos (millones de $ col)			Excedentes Económicos (us$ millones) 2/	
	Consumidor	Productor	Total	Total	Anualidad
Carne	236225	43140	279365	174.6	22.9
Plátano	127093	40159	167252	104.5	13.7
Leche	135489	20500	155989	97.5	12.8
Arroz	148160	5162	153322	95.8	12.6
Frutas	71888	46479	118367	74.0	9.7
Naranja	23524	14675	18199	23.9	3.1
Piña	22587	10771	33358	20.8	2.7
Aguacate	12724	7761	20485	12.8	1.7
Mango	5730	4701	10431	6.5	0.9
Papaya	4043	4727	8770	5.5	0.7
Sandía	3280	3844	7124	4.5	0.6
Yuca	58941	57609	116550	72.8	9.6
Palma de aceite	22134	59338	81472	50.9	6.7
Maíz	26538	11121	37659	23.5	3.1
Soya	3339	10910	14249	8.9	1.2
Sorgo	2187	4534	6721	4.2	0.5
Fríjol	4306	523	4829	3.0	0.4

1/ Los beneficios potenciales corresponden al valor presente (VP) del flujo anual de excedentes a productores y consumidores durante un período de 15 años, empleando una tasa de descuento del 10%.
2/ Se utiliza una tasa de cambio de $ col 1600 por dólar.

Cuadro 3. Area bajo nueva tecnología al finalizar el proceso de Adopción en Amazonia y Orinoquia colombianas.

Cultivo	Area Actual (000 ha.)	Area Nueva Incorporada a la producción (000 ha.)	Area Total bajo nueva tecnología al finalizar el proceso de adopción (000ha)
Arroz	140.0	70.0	210
Fríjol	1.6	3.2	4.8
Yuca	27.1	13.6	40.7
Maíz	114.6	57.3	171.9
Sorgo	9.2	4.6	13.8
Soya	21.2	10.6	31.8
Plátano	65.8	32.9	98.7
Palma de aceite	48.0	21.5	64.5
Frutas	0	42.7	42.7
Ganadería 1/	2264.0	0	2264.0
Amazonia	740.8	0	740.8
Llanos Orientales	1523.2	0	1523.2
Total	2691.5	256.4	2947.9

1/ Se refiere a la fracción del área ganadera actual que al finalizar el proceso de adopción estaría bajo nueva tecnología

1.2.D. Information Outputs - *by: N. Johnson*

Highlights

None to date

Progress Report

The goal of this study, which is just getting underway, is to get a better idea of the potential economic, social, environmental impacts of CIAT's information outputs. From GIS data bases to methodologies for farmer organization to guidelines for identifying opportunities for rural agro-enterprise, information is an increasingly important output of CIAT research.

Developing useful agricultural and natural resource management technologies requires an understanding not only of the constraints that farmers and communities face in terms of resource availability, but also of their goals for resource management and the individual and collective processes that influence how land use decisions are actually made. Taking all these factors into consideration ensures that technologies meet an identified need, and increases the chance that they will be adopted, and that there adoption will improve the welfare of the community.

Since many of these processes are complex and highly location specific, researchers cannot hope to understand them all. Rather than try to do so, another option for researchers is to incorporate individuals and communities into the research process. Working together with scientists, they can help identify and design technologies in line with their own needs, constraints and priorities.

One of the roles for researchers in this case is to facilitate this participation by providing people with the information that they need in order to arrive an accurate conclusions and decisions concerning different technological and management options. This could include information about the short and long term impacts of certain land use practices, about existing or potential market opportunities, or about how to manage negotiation and conflict in a collective decision making process. By providing individuals and communities with the information, tools, and skills they need to make decisions about what is best for them, we can contribute to equitable and sustainable management of local resources.

CIAT has done a great deal of work in this area, particularly in the NRM projects. Over the past two years, impact assessment unit has also focused attention on how to understand and measure the impact of these new types of outputs (Johnson, 1999). Many of the old conceptual and empirical techniques for measuring impact of agricultural technologies are not appropriate. New ones are being developed, and some examples of empirical impact analysis have been done in CIAT (Riveria y Estrada; Johnson and Baltodano).

The goal of this project is to extrapolate the results of CIAT studies and other studies by other researchers that are consistent with the conceptual framework for valuing the benefits of improved information, to get an idea of what the potential economic benefit of these information outputs is. This will involve a review of the literature to identify appropriate studies. It will also involve GIS analysis to identify where and how, which is already underway. Efforts in both of these areas are underway, and a preliminary report of results will be prepared for the CIAT annual review in November, 1999.

OUTPUT II: IMPACT OF PAST RESEARCH MONITOREO

2.1 Reviews of Past Research Impact

2.1.A. CIAT Germplasm - *by: N. Johnson*

Highlights:

- Time series data sets on the release, diffusion and impact of improved crop varieties to which CIAT has made a contribution have been constructed.
- Data has also been collected on the human resources devoted to crop improvement in CIAT, the national programs, and in some cases, the private sector.
- Preliminary analysis of the data suggests that the rate of both release and adoption of new varieties over time has increased, suggesting that the impact of the so-called Green Revolution has not slowed over time as some have suggested. In many cases the observed yield gains associated with new varieties has declined, however many of these varieties offer non-yield characteristics such as disease and stress-resistance or processing quality which make farmers prefer them to older varieties.
- Varieties developed at CIAT are increasingly being used as parents, and even grandparents, in crosses made by national programs. This suggests that the relationship between CIAT and national programs has been complementary rather than competetive.

Progress report:

CIAT, along with several other CGIAT Centers, is participating in a global study on the impact of improved germplasm from international agricultural research centers (IARCs) on varietal production and on agricultural productivity. In 1998, a database was created which contains information on varietal releases of CIAT commodities (rice, beans, cassava, and forages). The data categorized releases according to name, date of release, country of release, and nature of CIAT's contribution to the variety. Analysis of that data showed that (Pachico and Johnson, 1998).

In 1999, data collection focussed on documenting the impact that varieties with CIAT content have had in the countries in which they have been released. Estimates exist for _ countries (Table 1). Data has also been collected on human resources devoted to breeding in CIAT and in the national programs.

Table 1. Percent of total crop area planted to varieties with CIAT content for selected countries, 1997

Country	Rice	Beans	Cassava	Forages
Latin America and the Caribbean				
Argentina	72	42		
Bolivia	50	95		
Brazil	94	50	2	.03
Colombia	82	9	9	1
Costa Rica	89	85		
Cuba	33		26	
Dominican Republic	22		52	
Guatemala		38		
Haiti			59	
Honduras		43		
Ecuador	86	19	8	
El Salvador		25		
Mexico	9		88	
Nicaragua		30		
Panama	63	40	2	
Uruguay	6			
Venezuela	71			
Asia				
China			1	
Indonesia			.5	
Philippines			3	
Thailand			52	
Vietam			9	
Africa				
DR Congo		18		
Ethiopia		5		
Malawi		.2		
Rwanda		16		
Tanzania		2		
Uganda		10		

The data will be used to analyze the impact of CGIAR breeding activities on the production of new varieties both within the CGIAR and among the national programs. The goal of the analysis is to understand not only what impact the CGIAR has had directly, but also how the CGIAR centers have influenced activities of national partners, and increasingly, of the private sector. Preliminary evidence suggests that the relationship between IARCs and NARS has been complementary rather than competitive, however more analysis must be done to confirm this.

A progress report on the IAEG study will be presented at International Centers' Week this year. Presentations of the data and analysis are also planned for the year 2000 meetings of the American Association for the Advancement of Science and International Association of Agricultural Economists. The project is scheduled to end next year, however several opportunities exist for continued analysis and publication of the data collected through the project.

Collaborating Persons and Institutions:

- Prof. Robert Evenson, Center for Economic Growth, Yale University
- CIAT projects IP1, IP2, IP3, IP4, IP5 and PE1 as well as FLAR and CLAYUCA.

2.1.B. Rice and Forages in Latin America - *by: L.R. Sanint - L. Rivas*

Metas para 1999

- Empleando alternativamente los enfoques de evaluación *ex- post* (para el arroz) y *ex-ante* (para los forrajes) estiman el impacto económico de tecnologías basadas en germoplasma, en términos excedentes que reciben consumidores y productores y analizan su distribución entre los diferentes estratos sociales, dentro del contexto del cambio tecnológico como herramienta útil para ayudar al alivio de la pobreza.

- Producir un documento para presentar en el Taller Internacional sobre la Evaluación del Impacto de la Investigación Agrícola en el alivio de la pobreza.

Principales Conclusiones

América Latina es una de las regiones más urbanizadas del mundo, en donde la pobreza aparece generalizada, particularmente en las ciudades.

La evaluación *ex –post*, muestra que en el caso del arroz, la generación de tecnologías basadas en el desarrollo de germoplasma y de su manejo eficiente, ha generado riqueza en el transcurso de las tres últimas décadas, favoreciendo especialmente a los consumidores y a los productores que emplean el sistema irrigado, logrando duplicar la producción, sin incrementar el área y con una reducción significativa en el uso de pesticidas.

El análisis *ex - ante* del impacto de las tecnologías forrajeras sobre los mercados de leche y carne, indica que en condiciones de economía cerrada, dados los relativamente bajos coeficientes de elasticidad precio de sus demandas, los principales beneficiarios del cambio técnico son los consumidores, debido a la reducción de los precios reales y al incremento del consumo.

De lo anterior se desprende que cualquier alternativa que permita bajar el precio de los alimentos conlleva enormes beneficios para los consumidores, lo cual es muy relevante

para América Latina, dado su alto índice de urbanización y la magnitud de la población pobre urbana.

El análisis *ex post* de la generación de tecnologías arroceras. enseña que el impacto depende de condiciones económicas muy cambiantes y que es peligroso y quizás injusto, juzgar la bondad de las mismas en situaciones coyunturales o de corto plazo.

En el caso de bienes transables en los mercados internacionales, como lo son carne vacuna y leche, la apertura de los mercados puede contribuir significativamente a mejorar la equidad en la distribución de los beneficios tecnológicos entre productores y consumidores y aún más, mejorar la participación en los beneficios totales de los grupos mas vulnerables (consumidores más pobres, productores más pequeños.)

La implementación de estrategias que busquen avances tecnológicos y que permitan aprovechar de manera sostenibles las ventajas de dotación de recursos naturales de la región, no solo generan beneficios directos para los productores, sino indirectos para el sector rural y para el resto de la economía a través de los encadenamientos (linkages).

Resumen

Las tecnologías de la Revolución Verde, basadas en el desarrollo de germoplasma, han proporcionado extraordinarios beneficios tanto a los consumidores como a los productores. Sin embargo, hay muchos indicadores que muestran que aún persisten problemas agudos de pobreza y desnutrición los cuales, a nivel de América Latina, se han venido concentrado en las ciudades, por ser ésta una de las regiones más urbanizadas del mundo.

El análisis de los procesos de adopción e impacto de nuevas tecnologías para establecer causalidades con la pobreza tiene que ir más allá de los mismos, ya que las tecnologías son herramientas muy puntuales que no llegan a explicar los cambios más complejos relacionados con este problema o con otros como la nutrición o el uso de los recursos naturales. La pobreza tiene aspectos estructurales y culturales muy arraigados puesto que, al constituir un subproducto social "indeseable", no puede desligarse de los juicios de valor.

Se trata de un problema que requiere visión global con actuaciones locales. Las tecnologías diseñadas específicamente para incrementar la eficiencia y la productividad, sin deteriorar los recursos naturales, pueden contribuir considerablemente al alivio de la pobreza actual y futura; pero es importante que haya condiciones propicias para que, quienes adoptan, puedan percibir los beneficios.

Este trabajo analiza los beneficios a la investigación dedicada a obtener mejores variedades de forrajes --para carne vacuna y leche-- y de arroz. Estos tres alimentos representan la tercera parte de las proteínas y la quinta parte de las calorías consumidas por los latinoamericanos.

El análisis ex-post de la adopción de nuevas tecnologías arroceras en América Latina durante los pasados treinta años permite identificar, a grandes rasgos, que se ha obtenido mayor productividad y que, a su vez, ha habido implicaciones favorables sobre la generación de riqueza, beneficiándose tanto los consumidores como los productores de riego (donde, de manera independiente a la dotación de recursos, todos adoptaron las nuevas variedades).

También hubo perdedores, especialmente entre los productores de secano. En cuanto a los efectos sobre el medio ambiente, se duplicó la producción de arroz sin incrementos de área y con aplicaciones más racionales de plaguicidas. Se observa que el alza en los rendimientos de arroz de riego ha actuado como válvula de escape, que alivió la presión de cultivar arroz en zonas de suelos frágiles e inestables, como son los de los márgenes de bosques y los de sabanas, en donde disminuyó considerablemente el área cultivada, a la vez que se incrementaron los cultivos bajo riego.

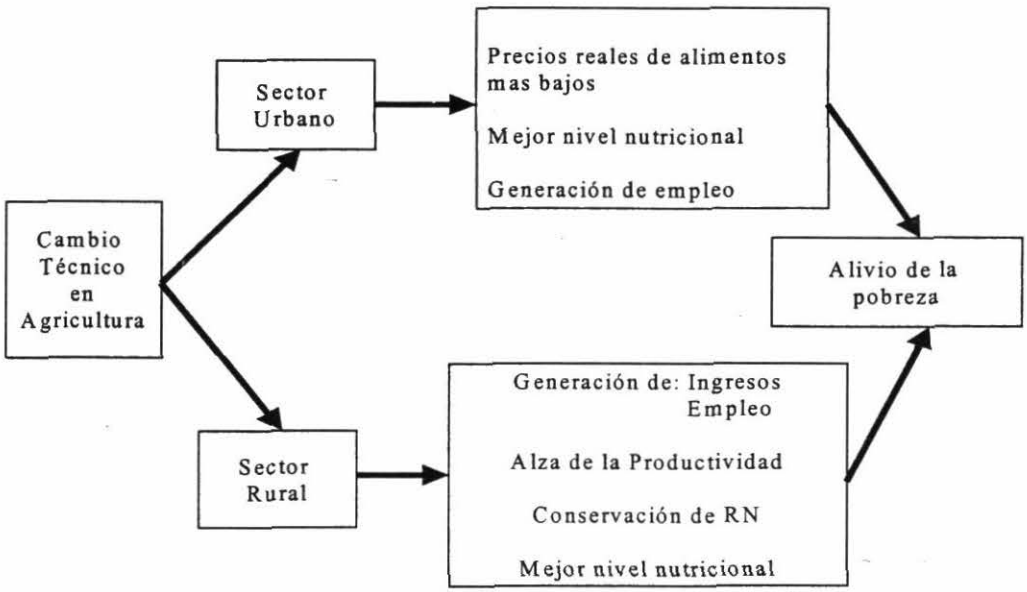
Pese a una adopción masiva de nuevas variedades, el comportamiento de la producción a nivel nacional difiere considerablemente de un país a otro, lo que confirma que las tecnologías, por sí solas, no se traducen automáticamente en ganancias para el sector o para sus usuarios. Estos procesos deben analizarse a través de largos períodos de tiempo, ya que las distorsiones temporales así como los afanes precoces por demostrar adopción e impacto a donantes escépticos seguramente conducirá a debilitar los esfuerzos de la investigación, ante la ausencia de un apoyo decidido para procesos cuyo impacto tiene múltiples dimensiones en el largo plazo.

Las actividades de investigación para mejorar forrajes muestran importantes beneficios *ex-ante*, tanto para los consumidores como para los productores, especialmente en situaciones de apertura comercial. La ganadería vacuna se adapta muy bien a la favorable dotación de recursos de la región en materia de agua y tierras y, en muchos casos, es una primera etapa obligada en los procesos de intensificación en el uso sostenible de dichos recursos.

La ganadería vacuna latinoamericana por su importancia económica en la región presentan múltiples encadenamientos hacia adelante y hacia atrás dentro del aparato económico ("backward and forward linkages"). La adopción de nuevas tecnologías ganaderas en la región, debido a estos encadenamientos, puede inducir la generación de múltiples efectos secundarios, que pueden superar los efectos primarios. Las variadas implicaciones del cambio técnico sobre el alivio de la pobreza se presentan en la Figura 2.

El fortalecimiento gremial y su atención a la generación de nuevas tecnologías son indicios de que los agricultores son conscientes de los beneficios recibidos; su lógico compromiso con el sector y la dependencia que tienen de la productividad para continuar siendo rentables, eficientes y competitivos, los ha convertido en donantes de la investigación, con lo cual se está recuperando la estabilidad y eficacia de la misma dentro de planes colaborativos de largo plazo.

Figura 2. Relaciones entre Cambio Técnico y Alivio de la Pobreza



2.2 Empirical Studies to Monitor Impact of Past CIAT Research

2.2.A. Integrated Cassava Research and Development (ICRD): CIAT's Experience in the North Coast of Colombia – *by: M. V. Gottret, M. Raymond*

1999 MILESTONES

- Secondary data on cassava production, processing and marketing, and census data for the North Coast of Colombia was collected and organized in a database.
- Data from a cassava producer's survey conducted in 1991 was organized in a database and re-codified.
- The monitoring and evaluation system of the ICRD project was updated.
- The impact of the ICRD Project in the North Coast was re-analyzed with a conceptual framework and an econometric model designed to link product outputs, with intermediary effects, with final development impact.
- Quantitative results were validated through informal interviews with cassava drying cooperative members and their testimonies were video taped.
- A paper was written and presented at the International Workshop on "Assessing the Impact of Agricultural Research on Poverty Alleviation", San Jose, Costa Rica, 14-16 September 1999.

ABSTRACT

In 1981, the Integrated Cassava Research and Development (ICRD) Project was implemented as an integrated set of institutional, organizational, and technological interventions designed to link small-scale cassava farmers to expanding markets. The Project's objective was to develop both technology and market opportunities for cassava producers in the northern Colombia, targeting especially small farm owners and landless farmers. The paper assesses the Project's impact on participating communities in terms of poverty alleviation, and identifies the avenues by which the Project was able to bring these positive changes. The ICRD Project showed that agricultural research can contribute tangibly to poverty alleviation, but with the following conditions that (1) market and post harvest research and development are integrated with production technology research agenda; (2) inter institutional partnerships are developed, whereby different institutions with their own expertise, comparative advantages, and mandates collaborate to respond to the demands of local community organizations and individuals; and (3) existing social and human capital is used to create intimate networking among institutions, local social organizations, and individuals.

INTRODUCTION

Cassava is an important crop throughout the tropical world for small farmers with access to marginal lands. Its high tolerance, compared with other crops, of seasonal low rainfall, high temperatures and intermediately fertile soils makes it an essential source of food security and cash income in areas where few alternatives exist, such as in the semiarid North Coast of Colombia. In the early 1980s, the region grew 35% of the country's total cassava production.

According to Janssen (1986), in the 1980s, the small farmers of the North Coast obtained 40% of their cropping income by marketing cassava. The crop was also important for on-farm consumption, and as an employment generator, creating about7.3 million wage-days per year.

Despite its socioeconomic significance to the Colombian North Coast during the 1980s, marketing the crop was very difficult. Most of the cassava was used for on-farm consumption or sold on the fresh markets; only small quantities were used for starch production or the preparation of traditional snack foods. Regional urban consumers were supplied through a marketing channel that quickly transferred the cassava roots through several intermediaries. The short shelf life of harvested fresh roots made marketing cassava a risky business: losses were high and fluctuations of daily price large. Cassava margins were often more than double the farmgate price. Urban demand was declining because of high prices and uncertain quality, limiting the sale of cassava to regional markets.

Market alternatives were needed. The Centro Internacional de Agricultura Tropical (CIAT) identified dried cassava chips for the animal feed industry as a potential alternative. The Integrated Cassava Research and Development (ICRD) Project was set up in 1981 to widen market opportunities for small farmers in the North Coast, secure a price floor for cassava, and thus provide a sustainable source of income for the farmers. The Project targeted small landholders and tenant farmers working farms of less than 20 ha. About 80% of farms in this region fell into this category but in aggregate, represent less than 10% of total farmland (DANE 1974). In the early 1980s, the Colombian North Coast was characterized by poverty levels that were higher than the national ones: 76% of the population had unsatisfied basic needs and 55% were living in misery, compared with 64% and 36% at the national level respectively (Colombian Census 1985). The small farmers targeted by, the ICRD Project was therefore among the poorest populations of the region, already poor by national standards. The ICRD Project lasted from 1981 to 1989.

This paper evaluates the main hypothesis driving the ICDR Project and its overall impact on poverty. To determine whether the ICRD Project reached its goal and whether the observed impact matched the expected ones, this paper focuses on assessing the impact the Project had on participating communities in terms of poverty alleviation within these communities. The paper also aims to identify the avenues by which the Project brought about these changes. The paper thus analyzes (1) the emergence of cassava drying organizations, especially within the targeted population, and the expansion of cassava drying capacity in the region; (2) the short-run intermediate effect of the new alternative market developed for cassava roots, (3) the new market influence on the adoption of modern varieties; (4) the contribution of the ICRD Project to poverty alleviation; and (5) the sustainability of the impact after the Project ended and after the national economy opened up to international competition. Lessons learned from the ICRD Project's experience are also discussed.

THE CHALLENGE

In 1981, cassava farmers in the North Coast faced depressed prices as a consequence of the initial approach taken by the Integrated Rural Development, (DRI) whose credit program, established in 1977 by the Colombian government, had the effect of encouraging farmers to

greatly intensify cassava production (Janssen 1986). By 1981, cassava production was extremely high and unable to find buyers, many farmers plowed their crops without harvesting.

With prices falling below production costs, problems of massive credit default appeared. Limited markets for cassava belied the DRI's basic premise that production increases would improve small farmers' income. After the 1981 debacle, farmers were afraid to increase cassava production. Small-farm development in the North Coast region clearly did not depend on production increases alone, but also on marketing. The DRI therefore began searching for alternative markets for cassava.

In the same period, CIAT was concerned that, constrained by lack of markets, cassava farmers in Latin America were not adopting improved production technologies developed during the 1970s. CIAT therefore studied alternative uses for cassava to identify markets with growth potential, the most promising of which was the use of dried cassava chips as an energy component in animal feed concentrates (Pachico et al., 1983). This industry was originally developed in Asia, where millions of tons of dried cassava chips had been produced for export. After conducting economic studies, CIAT initiated an integrated approach to cassava research and development to introduce this market opportunity to South America (Cock 1985; Lynam 1987).

The program's strategy was to link small farmers with the expanding market for animal feed concentrates (Best et al. 1991). With secure, more profitable, markets established for their cassava crop, farmers would be more likely to adopt improved, cost-reducing production technologies, thus improving their cassava production and, consequently their incomes.

THE INTERVENTION

For the DRI, also facing the challenge of finding alternative markets for cassava, CIAT was a natural partner, because it had already identified such possibilities. The Center had also begun developing appropriate cassava processing technology, and conceptualizing the ICRD strategy. In 1981, then, together with the DRI-program, the ICRD Project was implemented through an integrated set of institutional, organizational, and technological interventions designed to link small-scale cassava farmers to expanding markets, thus to stimulate farmer demand for improved production technology with potential to improve small farmers' income and welfare.

The Project to establish an agroindustry based on drying and chipping cassava roots required the construction and operation of small-scale processing enterprises, owned and managed by small farmer associations. The technology was brought from Asia, but was tested, adjusted and diffused with small farmers' participation. This low-cost and appropriate technology consisted in chipping cassava roots, which were then spread on cement floors and sun dried.

The ICRD Project was coordinated by the DRI, in collaboration with other decentralized public and private institutions. Each institution assumed an agreed set of responsibilities in accordance with their own mandates and capacity as summarized in Table 1. The ICRD Project was executed in four (Best et al. 1991):

Experimental phase: 1981-1982

The Project began with a group of 15 farmers, selected from the municipality of San Juan de Betulia, Department of Sucre. A pilot plant was built, processing technology was evaluated and adapted, and an operational scheme was developed for local conditions. Seven tons of dried cassava chips were produced and distributed among several animal feed industries to obtain feedback on their potential interest in buying the product and the price they would pay. As a result, one industry committed itself to buying the entire production of the next cassava season.

Demonstration phase: 1982-1983

The pilot plant became semi-commercial, with the farmers themselves taking full responsibility for managing the plant. This period provided reliable data on the plant's operation and consolidated the market for the product. A technico-economic feasibility study was conducted, and its positive results prompted the DRI to create a line of promotional credit for establishing additional drying plants. The pilot plant itself expanded capacity and was used as a demonstration and training model for other farmer groups interested in building drying plants in their communities.

Replication phase: 1983-89

Drying plants were replicated at other sites in the North Coast. At the same time, the development and validation of production technologies were intensified, and the methodology of farmer participation was incorporated into technology development. By the period's end, 39 drying plants were being managed by small-farmer cooperatives, and private individuals had installed another five plants. As dried cassava chips production reached 5,600 tons, the product had to be promoted among a larger number of buyers. The National Association of Cassava Producers and Processors (ANPPY), an association of small-farmer cooperatives, was created and took responsibility for marketing the dried cassava chips . In 1989, the ICRD Project, as a formal interinstitutional activity, ended.

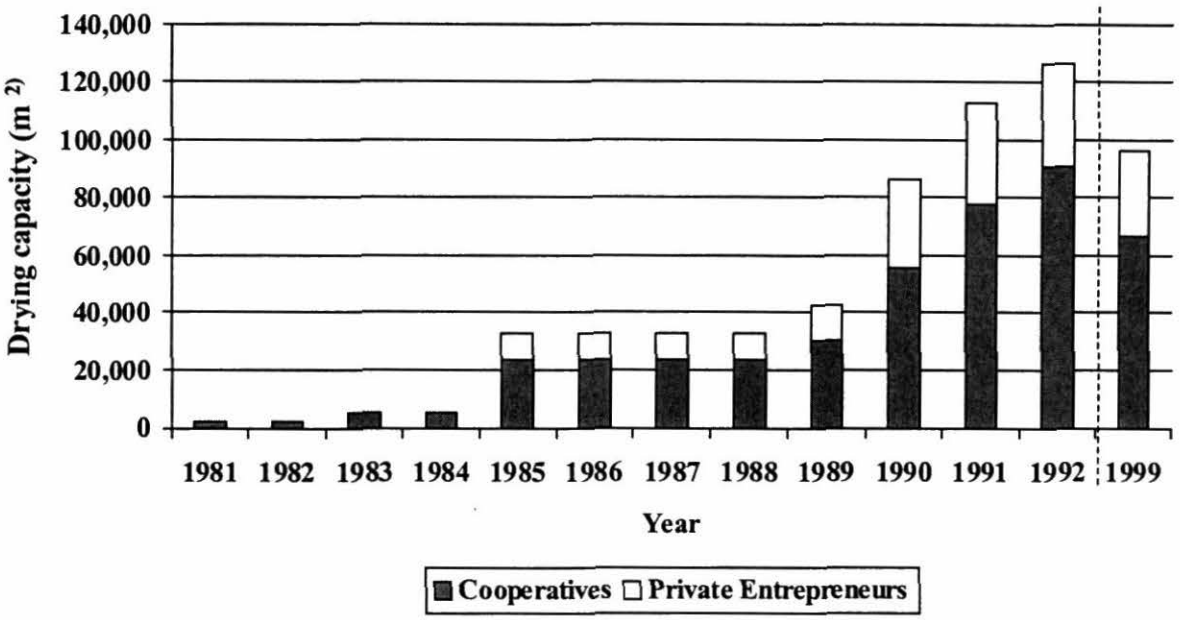
Reduced Institutional Support Phase: 1989-1993

By 1993, 138 processing plants for drying cassava were operating. Small-farmer cooperatives managed 101 plants, while private individuals, who had adopted the processing technology but not the organizational model, built the remaining 37. The total drying capacity of all 138 plants was 179,715 m^2, of which private entrepreneurs installed 28% (Figure 1). This rapid growth in private investment occurred mainly during this phase, when the technology was completely adapted to local conditions, the market already established, and the economic feasibility of the investment proved. The risk therefore assumed by the private entrepreneurs was lower. In 1993, dried cassava production reached 35,000 tons, valued at US$6.2 million, and requiring 90,000 tons of fresh roots. This volume represented 10% of total cassava roots marketed in the region. Probably 36% of small cassava farmers in the region were selling cassava roots to the dried cassava agroindustry, and 15% of all small farmers were members of a cooperative.

Table 1. Private and public institutions and their responsibilities in the Integrated Cassava Research and Development (ICRD) Project, North Coast, Colombia.

Institution	Responsibilities
CIDA[a]	Finance the Project's experiment and demonstration phases, and the first two years of the replication phases.
ANPPY[b]	Marketing of dried cassava chips.
CAJA AGRARIA[c]	Provide credit for cassava production.
CIAT[d]	Develop production and processing technology, provide technical assistance and training to national personnel, conduct socioeconomic and market studies, and monitor and evaluate the Project's progress.
CECORA[e]	Provide technical assistance in processing, marketing, and management.
CORFAS[f]	Provide technical assistance in processing and marketing, investment and working capital credit, and credit advice.
Cooperatives[g]	Provide labor for constructing the drying plants and participate actively in the whole Project.
DANCOOP[h]	Provide legal advice to cooperatives.
DRI[i]	Provide institutional coordination and financing in DRI areas (municipalities where farms are smaller than 20 ha).
ICA[j]	Develop and adjust production technology and provide technical assistance.
INCORA[k]	Provide technical assistance on production and processing, and credit for land reform beneficiaries.
PMA[l]	Provide credit for the construction of drying plants, using funds obtained through sales of food aid, which were channeled through CORFAS.
PNR[m]	Provide institutional coordination and financing in PNR areas (municipalities with social and violence problems).
SENA[n]	Assist in community organization and provide business management training, including permanent consulting services.

[a] Canadian International Development Agency
[b] Asociación Nacional de Productores y Procesadores de Yuca
[c] Caja de Crédito Agrario, Industrial y Minero
[d] Centro Internacional de Agricultura Tropical
[e] Central de Cooperativas de la Reforma Agraria, Ltda.
[f] Corporación Fondo de Apoyo de Empresas Asociativas
[g] Organized communities for cassava-drying activities
[h] Departamento Administrivo Nacional de Cooperativas
[i] Fondo de Desarrollo Rural Integrado
[j] Instituto Colombiano Agropecuario
[k] Instituto Colombiano de la Reforma Agraria
[l] World Food Program
[m] Plan Nacional de Rehabilitación de la Presidencia de la República
[n] Servicio Nacional de Aprendizaje



Source: ICRD Project monitoring and evaluation system.

Figure 1. The Emergence Of The-Cassava-Drying Agroindustry In The North Coast Of Colombia, 1981-1992.

HYPOTHESIS ON THE IMPACT OF THE ICRD PROJECT

The conceptual framework for the expected impact of the ICRD Project in the Colombian North Coast and its links with the adoption of cassava production technology are illustrated in Figure 2. The promotion of small-scale, cassava-based agroindustries was expected to create an alternative market for cassava roots, which, in its turn, was expected to establish a price floor for the product in the fresh market, narrow price fluctuations, and enhance farmers' bargaining power. These changes in demand and prices would thus reduce market risks faced by cassava farmers and create an incentive to increase cassava production.

Over the short term, cassava farmers would increase their production by expanding the area planted to cassava. The reduced market risk, over the longer term, would stimulate the adoption of improved cassava production technology, therefore improving productivity. Thus, cassava production in the region would be reflected by increased cassava area and crop productivity.

Hence, the changes in prices and production, hypothesized to be brought about by the technological changes in the region, would be translated into changes in consumer, processor, and producer surpluses. Thus, income would be raised and employment would be generated, not only as a consequence of increased cassava production in the region, but as a result of the established agroindustry. The increased income and additional employment opportunities for small-scale and landless farmers in the rural communities would be expected to encourage overall community development, foster social organization, and reduce poverty levels in the population.

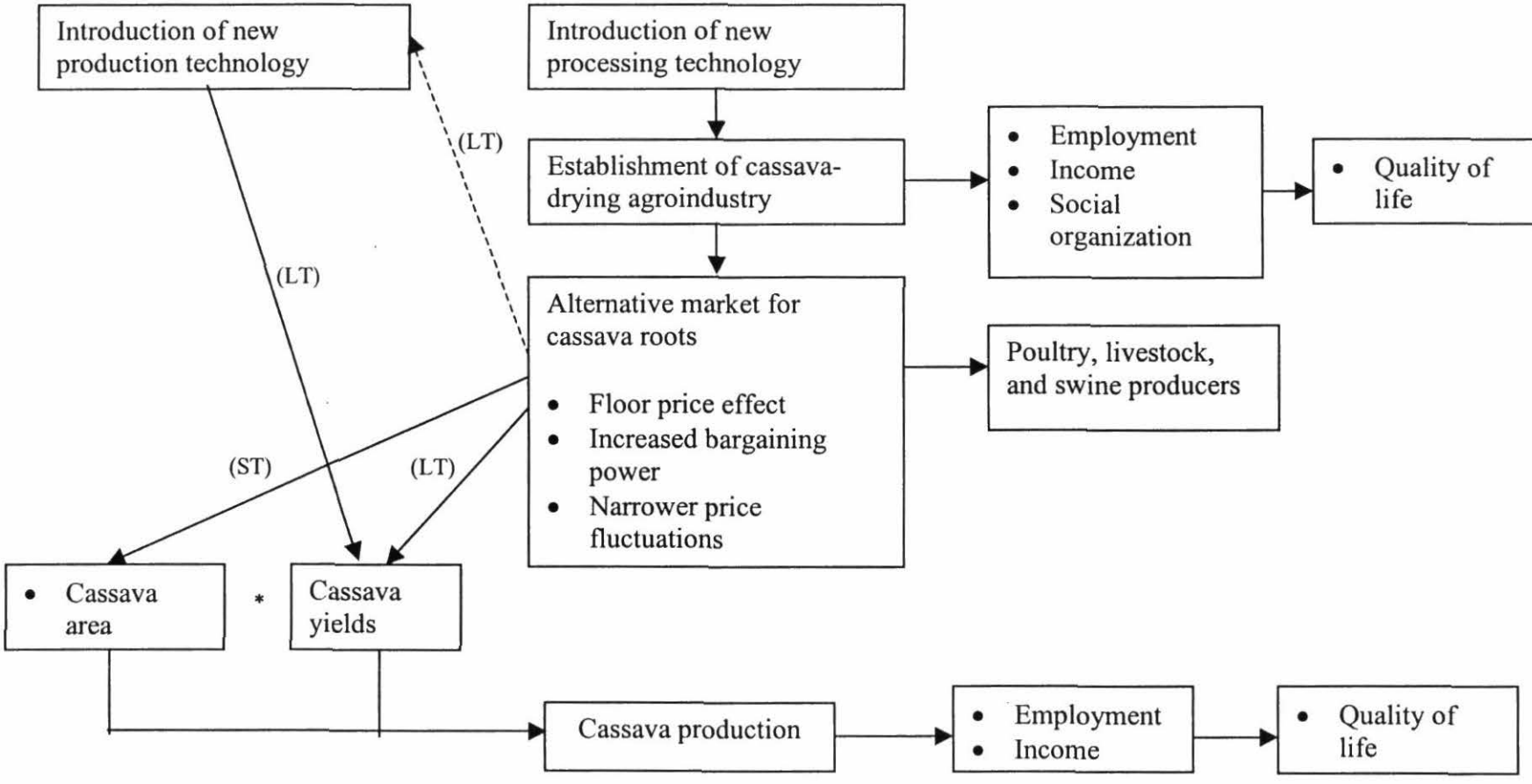


Figure 2. Conceptual framework for the expected impact of the Integrated Cassava Research and Development (ICRD) Project, North Coast, Colombia.

(ST, LT = short-term and long-term effect on cassava production, respectively)

METHODOLOGY

The hypothesis poses a series of questions on the effective impact of the ICRD Project, such as: did cooperatives emerge in poor communities? What were the attributes of the communities where cooperatives were established? To what extent did the ICRD Project have an impact on the community, first through the development of the new agroindustry, then later by encouraging the adoption of new production technology? How did the changes brought by the ICRD Project contribute to poverty alleviation?

To answer these questions, the analysis needs to be broken into three broad questions, which, while being individually analyzed, must be linked with each other. These questions are (1) where and to what extent cooperatives emerged; (2) how did cooperatives influence the adoption of new technology; and (3) what were the effects of both the agroindustry and production technological improvements on poverty.

COOPERATIVES EMERGENCE ANALYSIS

Using the Colombian municipality as our definition of a community, we first model the farmers' decision to enter the market of dried cassava chips, i.e. to build one or more cassava drying-plants in the community. Farmers will decide to build a plant if the profits from its operations outweigh the fixed costs involved in organizing the cooperative and building the plant. They first determine what the profits will be, which directly depend how much they can produce of cassava chips, i.e. the total drying capacity. A desired drying capacity will be determined given the cassava roots production, the transaction costs, and the demand for fresh cassava in the municipality. This desired drying capacity is such as to maximize the profits from the drying activities. Let DC^* for municipality k represent this desired drying capacity, then:

$$DC_k^* = f(S_k, D_k, TC_k^{coop}) \quad [1]$$

The vector S_k represents the factors affecting the potential supply of fresh cassava roots, that is, the land available to grow cassava, the productivity of farmers, and the farm size found in the municipality. The greater the potential supply of cassava to the drying plants, the greater is total drying capacity needed in the municipality. More land available to grow cassava (from increases in cropped land or substitutions of other crops for cassava), the greater is the potential supply of roots to the plant and thus desired drying capacity. Similarly, greater productivity suggests greater potential supply. Three measures of productivity are used: the percentage of farmers treating their seeds, the percentage of farmers using pesticides and the average experience at growing cassava. The last factor affecting potential supply is farm size distribution in the municipality. Traditionally, small farmers grow cassava as a cash crop, large farmers growing it only as feed for their cattle. Thus, smaller average farm size and a more uniform distribution of small farms should indicate greater potential supply to the drying plants.

The variable D_k represents the demand for fresh cassava roots in the municipality. Greater the demand of fresh cassava roots, less is the alternative market of dried cassava

chips is needed as an income generator. The desired capacity should therefore be lower with a higher demand.

The TC_k^{coop} variable captures the transaction costs of selling the cassava to the drying plant. The greater the transaction costs of selling cassava roots to the plant, lower are the profits of the farmer to sell it to the plant. It implies a lower potential cassava supply to the plants and as such, less drying capacity will be needed.

Once the profits are determined, the farmers compare them to the fixed costs of building the plant. The farmers will decide to build the desired drying capacity if the net benefits are positive. This comparison can be represented by a net benefit index function:

$$I_k^* = I(S_k, D_k, TC_k^{coop}, TC_k^{fresh}, F_k) \qquad [2]$$

S_k, D_k and TC_k^{coop} capture the profits just as in desired capacity (expression [1]). The transaction costs of selling to the department fresh market, TC_k^{fresh}, and the organizational costs, F_k, are the fixed costs of building the drying capacity. The bigger, urban, fresh markets are found in the department capitals. The distance to these markets dictates transportation costs, which increase with distance. After a certain distance, the transportation costs become too high for these markets to be feasible alternatives. Hence, the transaction costs involved in selling to the fresh market should influence only the decision of to build a plant and access a new market, and not the desired plant capacity.

The vector F_k consists of variables that affect the organization of the cooperative and building of the plant specifically: previous experience with local community associations, presence of institutions[3] in the municipality, average formal education level of cassava farmers, and commitment of farmers to the community as represented by the percentage of farmers who own land in the municipality. The first three F_k variables capture the human and social capital found in the municipality. Previous experience with associations, measured by the number of community associations, and average formal education indicate the capacity and ability of the community to organize itself and how its members can work together. The presence of institutions, as measured by the number of production technology Projects, encourages and helps provide the social and human capital necessary to organize a cooperative.

The cassava-drying capacity of a municipality will equal the desired capacity if the benefits index is greater than zero. The complete decision process can be summarized as follows:

$$DC_k = \begin{cases} DC_k^* & \text{if } I_k^* > 0 \\ 0 & \text{if } I_k^* \leq 0 \end{cases} \qquad [3]$$

[3] These institutions include the cassava-production technology research programs of CIAT and ICA, and extension activities of ICA, INCORA, and Caja Agraria. (see Table 1 for explanation of the acronyms).

A two-part model allows the econometric implementation of this decision. In the first stage, a probit over the presence of cooperatives in the municipality will estimate whether the benefits I_k^* were positive. Then, using the prediction on the probability of organizing a cooperative, the amount of drying capacity built will be estimated by an ordinary least square regression. The econometric system is therefore:

$$\begin{aligned} &\Pr(C>0) = f(S_k, D_k, TC_k^{coop}, TC_k^{fresh}, F_k) \\ &DC_k = f(S_k, D_k, TC_k^{coop}, \hat{\Pr}(C>0)) \qquad \text{if } I_k^* > 0 \end{aligned} \qquad [4]$$

This system will answer questions such as: Was the ICRD Project, aiming to create a market alternative for poor farmers, successful at establishing cooperatives in the poorer communities? And, Was the target of encouraging the Project in small-farmer communities (where most of farms are 20 ha or smaller) reached?

Production Technology Adoption

To analyze the long-term impact of the ICRD Project on yield increases through the adoption of modern varieties requires a conceptual framework of the adoption decision. The farmer can adopt a new variety and yet decide to continue planting some of his cassava area to a traditional variety. His decision consists therefore in choosing the proportion of cassava area to plant to modern varieties (M_i). To make this decision, the farmer will consider the factors affecting its production directly, opportunity costs, and the availability of information about the new varieties and their seed.

Factors affecting production include the farmer's productive assets such as the size of the land owned and of the land farmed, formal education, experience in growing cassava (Z_i), and the availability of credit and technical assistance (Z_k). The possibility of working off-farm constitutes the major opportunity cost for a farmer (C_k), and will influence all his cropping decisions, including whether to plant modern cassava varieties. The presence of community organizations and public institutions will influence adoption by providing information and planting material of the new varieties (I_k). Drying plants also provided information and planting material to farmers, and to capture this diffusion channel, two variables will be included in the analysis: the distance to the drying plant and the presence of a drying plant, using the predicted probability estimated in the previous step ($\Pr(C \geq 1)$). The distance to the drying plant also captures the transaction costs the farmer must bear to sell his production to the drying plant (included in the C_k vector for purposes of estimation). All these factors and the outcome of the decision can be represented as follows:

$$M_i = f(Z_i, Z_k, C_k, I_k, \hat{\Pr}(C_k > 0)) \qquad [5]$$

Because the decision is measured as a percentage, truncated at 0 and 1, a tobit regression will be estimated. Such a framework will allow us to answer questions like: Did the presence of drying plants influence the adoption of new cassava varieties? And are new varieties planted more widely in municipalities where greater drying capacity is found?

Impact on Poverty

Ultimately, the interest of this analysis lies in whether the Project helped reduce poverty within the participating communities. To measure this contribution, changes in poverty levels from 1985 to 1993 are used. The presence of cooperatives in the communities and the adoption of modern varieties ($Pr(C > 0)$ and M_i respectively) should partially explain these changes in poverty. These two parts of the ICRD Project will be included as the predictions from the previous calculations, as these contain the full information about the different decision levels. Community associations may also have a direct impact on poverty reduction (Ca). Therefore, they should be included as an aggregate to the analysis. Finally, poverty levels can be affected by diverse factors other than the Project. To capture these external effects, we include variables meant to characterize the municipality. These are the rate of urbanization (U), the distance to the department capital to measure economic opportunities (Km) and average family size (Fa) to measure poverty at the family level. Expression [6] summarizes the quantitative analysis performed:

$$\Delta \text{ in poverty}^{k}_{1985\text{-}1993} = f(\hat{\Pr}(C_k > 0), \overline{\hat{M}}_i, Ca_k, U_k, Km_k, \overline{Fa}_k) \quad [6]$$

The analysis will be carried out on two measures of poverty: the percentage of households with unsatisfied basic needs, which measures the percentage of people below the poverty line, and the percentage of households living in misery.

The data used to analyze the different questions came from the following sources: (1) a survey on adoption among cassava-farmer households; this was conducted in 1991 by CIAT (Henry et al. 1994); (2) 1985 and 1993 census data from the Colombian Department of Statistics (DANE); and (3) a national household survey conducted by DANE and DRI in 1981 (Sanint et al. 1985).

REACHING THE POOR: COOPERATIVE EMERGENCE ANALYSIS

Table 2 shows that cooperatives emerged in communities with higher potential production surplus, and higher social and human capital. With respect to cassava supply conditions, cassava drying agroindustries tended to emerge in municipalities with higher potential cropping land, smaller average farm size, and with more innovative farmers who previously adopted low-input use technologies such as seed treatment (see $Pr(C \geq 1)$ column, Table 2). Existing local demand for cassava also had a negative impact on the establishment of cassava-drying plants. Hence, the results for these variables indicate indeed that dry cassava agroindustries tended to emerge in communities with higher cassava production and lower fresh demand.

Social and human capital played an important role in the emergence of cooperatives, as captured by previous experience with community associations, institutional presence, and average education in the community. Human and social capital influenced the capacity that the community had to become organized and ask for institutional support to build a processing enterprise. The treatment of seed also indicates the presence and influence of

Table 2. Cooperative emergence in small-farming communities participating in the Integrated Cassava Research and Development (ICRD) Project, North Coast, Colombia

	Pr(C ≥ 1) (0-1)[a]	Total drying capacity (m^2 of drying floor)
Supply conditions (S_k)		
Potential cropping land (km^2)	0.0028569 (0.041)	0.0187499 (0.997)
Average farm size (ha)	-0.0412731 (0.052)	-144.7366 (0.444)
Farm size ratio of large to small farms	-0.002028 (0.957)	-480.5438 (0.112)
Farmers who treat their seed in 1985 (%)	0.1569036 (0.035)	-103.646 (0.325)
Farmers who used pesticides in 1985 (%)	-0.0193325 (0.225)	515.0793 (0.000)
Average experience (years)	0.0415369 (0.235)	506.5765 (0.017)
Fresh cassava demand (D_k)		
Cassava consumption (tons in the municipality per year)	-0.0003901 (0.037)	0.6787577 (0.298)
Transaction costs to cooperative and fresh market (TC_k)		
Average distance to municipality center (km)	-0.025784 (0.251)	-239.6173 (0.110)
Distance to department capital (km)	0.0021942 (0.160)	
Factors influencing fixed costs (F_k)		
Number of community associations in 1985	0.0712221 (0.040)	
Institutional presence (dummy)	0.5814004 (0.039)	
Average formal education (years)	0.4408504 (0.030)	
Land tenure (percentage of farmers owning land)	0.0044131 (0.393)	
Constant		1055.27 (0.811)
Inverse mills ratio		-2381.347 (0.282)
Observed probability	0.4186047	
Predicted probability calculated at the mean	0.5610753	
Number of observations (municipalities)	43	18
Log likelihood	-13.1363	
Pseudo R^2	0.5506	
Adjusted. R^2		0.7329
Root mean square errors		3345.5

[a] In this table and in Tables 3 and 4, values in parentheses are the *p*-values, which indicate the level of significance of the variables.

technological programs (public institutions) in the municipality. This technique was suggested by public institutions involved in agricultural technology research. The institutions developed the technique through on-farm trials, providing at same time human capital to the farmers.

The results show the importance of community associations, institutions and education to the establishment of the dried-cassava agroindustry. Both technology development institutions and community organizations influenced the Project's implementation, suggesting that research institutions should work in partnership with local community organizations to enhance the probability of Project success.

For the communities that created one or more cooperatives (see "Total drying capacity" column, Table 2), two factors influenced their decisions on how much capacity to build. First, the more overall experience that a community has with growing cassava, the greater the drying capacity the community will build. This effect of level of experience can be interpreted in two ways: farmers with more experience are more productive, and therefore, have a greater potential production to supply a drying plant; or, alternatively, experience measured as an average can be proxy for the importance of cassava in the region, both in terms of production and income generation. The second factor influencing community decision is the extent of use of high input-use technologies, as measured by pesticide use. This effect is also directly linked to productivity of the farmers in the municipality. Thus, more experience and higher productivity represent higher potential production and greater importance of cassava to the municipality, thus creating a higher demand for drying capacity.

The Project's target of reaching small farmers was achieved, because cooperatives emerged in communities where the average farm size was lower. However, the drying capacity built was neutral to farm size, and depended strictly on variables related to cassava production. Drying plants also emerged independently of land tenancy indicating that the Project reached equally those communities composed mostly of landowners and those mostly of landless peasants. Furthermore, the existing pre-Project human and social capital dictated in large part if a cooperative would emerge.

SHORT-TERM EFFECT OF THE NEW ALTERNATIVE MARKET FOR CASSAVA

The development of the dried-cassava agroindustry in the Colombian North Coast as was hypothesized by the ICRD methodology created an alternative market for cassava roots. A price floor for cassava was established and over the short-term, farmers reacted by increasing their cassava area. As shown in Figure 3, prices for fresh roots rose between 1983 and 1993 at an annual rate of 2.5%. Also, the price paid for cassava roots by the cassava-drying industry started to provide a price floor, which provided a secure market for cassava farmers. If the price of fresh cassava roots fell under the price floor or the quality of the roots was not acceptable to the fresh market, the farmer had the option of selling his or her product to a cassava-drying plant. As expressed by cassava farmers of Socorro (San Juan de Betulia, 1993): *"I remember when I was child, there were producers that were left with their cassava... there were no markets for the product."* And *"... of course, it was the cooperative that has practically given life to cassava*

cropping in this region. Previously, there were years when nobody would buy the cassava, there was no market, and the roots were completely lost." By linking farmers to expanding markets, the cassava market situation was improved. *"...Now, we have different market alternatives, the fresh market, the drying plant and the new starch plants that are being built. If the fresh market offers a better price, then farmers try to sell their roots to this market, but when things become complicated, farmers will surely sell their crop to the drying plant".*

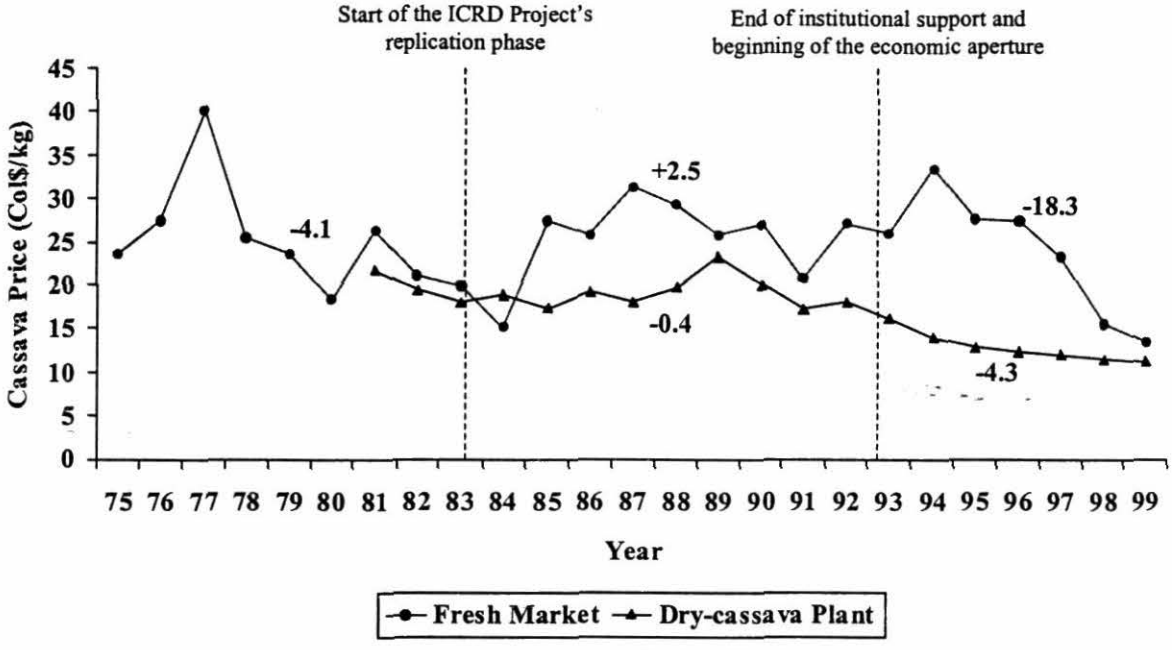


Figure 3. Trends in cassava prices to small farmers in the North Coast of Colombia, 1975-1999, showing the impact of the Integrated Cassava Research and Development (ICRD) Project (1981-1989). Prices are based on the 1990 Colombian peso. Data were obtained from the ICRD Project monitoring and evaluation system. Values in the field indicate price trends in percentages.

Over the short term, this new market alternative created an incentive to increase area planted to cassava. As presented in Figure 4, the area under cassava in the Colombian North Coast has increased at an annual rate of 7% between 1983 and 1993. Results from the 1991 cassava-farmer survey show that 42.7% of cassava farmers increased their area planted to cassava between 1983 and 1991. Of the farmers who responded that their cassava area was increased, 50% said it was because the market for cassava had improved, 22% said that land availability had increased, 12% had substituted yam for cassava, because of the incidence of a serious yam disease, and 5% received credit for cassava cropping.

This short-term effect of the Project is described by Alvaro Meza, cassava farmer and cooperative associate of Sabanas de Beltrán, Los Palmitos, Sucre. *"The construction of the drying plant has been one of the major achievements of this community, and the changes in the standard of living are obvious. The association has improved the market*

for cassava. Before farmers only planted a quarter or half of a hectare with cassava... mainly for home-consumption. Now, farmers plant 2-3 hectares of cassava because they have a secure market. The drying plant pays members and nonmembers in cash, therefore, they increased their cassava cropping area, and this means a higher income."

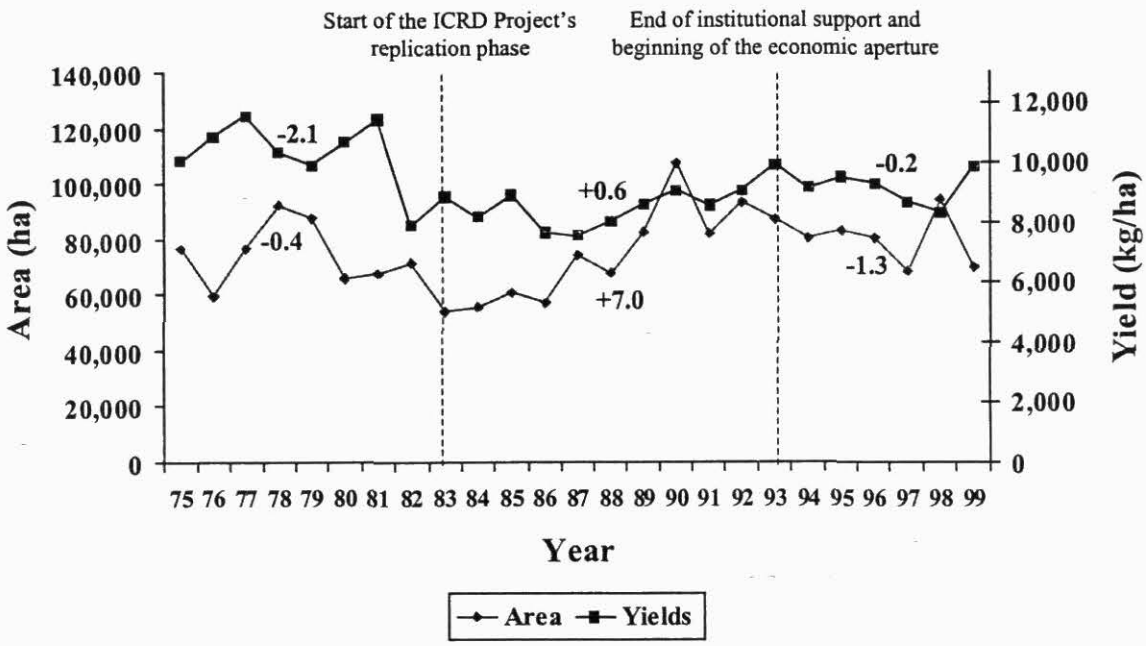


Figure 4. Trends in cassava area and yields in the North Coast of Colombia, 1975-1999, showing the impact of the Integrated Cassava Research and Development (ICRD) Project (1981-1989). Data were obtained from the Colombian Ministry of Agriculture. Values in the field indicate trends in percentages.

COOPERATIVE IMPACT ON ADOPTION

The long-term impact of the new agroindustry was hypothesized to foster the adoption of improved production technology, such as new varieties to increase cassava yields. The results in Table 3 partially validate this hypothesis. About 77% and 5% of cassava farmers in the region adopted varieties Venezolana and P-12, respectively. On the average, cassava farmers also planted 82% of their cassava area to modern varieties. The presence of a drying plant in the municipality did not influence directly the farmers' decision to adopt. However, the proximity from the farmer's field to the nearest drying plant has a positive impact on the adoption of modern varieties. This result captures two possible effects of the drying plant on technology adoption. The first is related to the new market alternative and more stable fresh prices as discussed previously. As such, farmers have more incentive to increase their production by either increasing the area planted or adopting new technology to increase yields. The other effect of drying plants is to enhance technology diffusion in three ways: first, technological programs found cassava-drying cooperatives to be natural partners for technology diffusion, by allowing them to reach a larger number of farmers. Cassava farmer associations also foster farmer-to-farmer networking, which was found in previous adoption studies to be a major

Table 3. Individual decision on the adoption of modern cassava varieties in small-farming communities participating in the Integrated Cassava Research and Development (ICRD) Project, North Coast, Colombia

	Percentage of cassava land under modern varieties (0 – 1)[a]
Percentage of farmers planting modern varieties	
Venezolana	77%
MP-12	5%
Average Cassava area with modern varieties	82%
Productive assets (Z_i)	
Farm size (ha)	-0.023093 (0.057)
Land owned (ha)	0.0248194 (0.040)
Formal education (years)	-0.0301515 (0.164)
Experience (years)	-0.0006649 (0.899)
Help for production (Z_k)	
Percentage of farmers receiving credit (%)	0.0025323 (0.416)
Percentage of farmers receiving technical assistance (%)	0.0017679 (0.445)
Transaction and opportunity costs (C_k)	
Agricultural wage (Col$ /day)	-0.0011691 (0.000)
Distance to drying plant (km)	-0.004106 (0.012)
Institutional and communitary presence (I_k)	
Institutional presence (number of technology programs)	0.7136442 (0.000)
Number of community associations in 1985	0.0006092 (0.881)
Presence of a drying plant, Pr(C≥1)	-0.0019026 (0.334)
Constant term	2.896443 (0.000)
Number of observations	481
Pseudo R^2	0.1763

[a] See footnote a of Table 2.

source of technology diffusion (Henry et al. 1994). Furthermore, a major constraint to adoption – availability of planting material -- was partially overcome by the cooperatives' establishing of seed multiplication plots.

The adoption decision was also influenced by the presence of technology development Projects implemented by cassava research institutions in their municipality. The percentage of cassava area planted to modern varieties was therefore higher where more technology projects were active in the municipality. The positive effect of land tenure on the adoption of modern varieties could be linked to institutional presence. In general, farmers who owned land were more willing and able to test new varieties on their farms, and therefore to participate in institutional on-farm trials. As a result, by participating in on-farm trials, farmers could experiment by themselves with the new varieties and were more prone to adopt them. Hence, as the amount of land owned increased, the cassava area under modern varieties also rose. Nevertheless, although modern varieties tended to be more readilly adopted by farmers who own land, they tended to reach small landholders more than large ones.

Finally, the opportunity costs of working off-farm faced by farmers also had an impact on the adoption. The higher the agricultural wage in the municipality, the lower the importance of cassava cropping as an income generation activity is for the farmer. Consequently, farmers will grow cassava mainly for on-farm consumption, and will have fewer incentives to increase cassava yields by adopting new varieties.

This analysis allows us to conclude that the cassava-drying agroindustry indirectly influenced the adoption of modern varieties through the transportation costs that farmers faced in marketing their cassava. It also provided a more secure market and a platform for diffusing technology and planting material. Adoption was also encouraged by the presence of technology research Projects in the communities. Therefore, the new agroindustries, the presence of institutions and access to drying plant each played an important role amd has an additive effect on the adoption of modern varieties.

MAKING A DIFFERENCE FOR THE POOR

Table 4 shows impact of the ICRD Project on poverty reduction. Changes in "unsatisfied basic needs" and in "misery" show that the ICRD Project contributed to poverty reduction, not directly through the emergence of cassava-drying cooperatives, but through the provision of new production technology and its diffusion as captured by the adoption of production technology. For both poverty indicators, the higher the percentage of cassava area planted to modern varieties in a municipality, the greater the reduction in poverty. An increase of 10% cassava area under modern varieties will reduce the percentage of households living under the poverty line by 0.8%, but the percentage of households living in misery will be reduced 1.2%.

An economic surplus model applied to the ICRD Project by Gottret et al. (1994), that shows the distribution of returns among the different groups of society, supports the above results. The study concluded that the direct benefits generated by the processing source of technology diffusion (Henry et al. 1994). Furthermore, a major constraint to

adoption – availability of planting material -- was partially overcome by the cooperatives' establishing of seed multiplication plots.

Table 4. Impact of the emergence of processing plants and adoption of the modern cassava varieties on poverty reduction, in small-farming communities participating in the Integrated Cassava Research and Development (ICRD) Project, North Coast, Colombia.

	Change in Unsatisfied Basic Needs[a] (0 – 100)[b]	Change in misery[a] (0 – 100)
Emergence of a cooperative (Predicted Pr(C ≥ 1))	0.0075919 (0.813)	-0.03603 (0.271)
Adoption rate of modern varieties (average of predicted M_i)	-0.0786932 (0.089)	-0.12281 (0.011)
Number of community associations in 1985 (Ca)	0.0685485 (0.373)	0.061414 (0.430)
Urbanization level (Percentage of municipality population living in urban areas) (U)	0.0166886 (0.790)	0.280527 (0.000)
Distance to department capital (km)	-0.0003117 (0.980)	0.005693 (0.651)
Family size (Fa)	-1.716249 (0.064)	-2.57316 (0.008)
Constant term	2.997286 (0.697)	-6.57982 (0.400)
Number of observations	43	43
Adjusted R^2	0.0528	0.4652
Root mean square error	6.6294	6.7182

[a] All three changes represent the change in the percentage of households from 1985 to 1993 living under the conditions indicated. The unsatisfied basic needs indicator represent the poverty line.
[b] See footnote a in Table 2.

The adoption decision was also influenced by the presence of technology development Projects implemented by cassava research institutions in their municipality. The percentage of cassava area planted to modern varieties was therefore higher where more technology projects were active in the municipality. The positive effect of land tenure on the adoption of modern varieties could be linked to institutional presence. In general, farmers who owned land were more willing and able to test new varieties on their farms, and therefore to participate in institutional on-farm trials. As a result, by participating in on-farm trials, farmers could experiment by themselves with the new varieties and were more prone to adopt them. Hence, as the amount of land owned increased, the cassava area under modern varieties also rose. Nevertheless, although modern varieties tended to be more readilly adopted by farmers who own land, they tended to reach small landholders more than large ones.

Finally, the opportunity costs of working off-farm faced by farmers also had an impact on the adoption. The higher the agricultural wage in the municipality, the lower the importance of cassava cropping as an income generation activity is for the farmer. Consequently, farmers will grow cassava mainly for on-farm consumption, and will have fewer incentives to increase cassava yields by adopting new varieties.

This analysis allows us to conclude that the cassava-drying agroindustry indirectly influenced the adoption of modern varieties through the transportation costs that farmers faced in marketing their cassava. It also provided a more secure market and a platform for diffusing technology and planting material. Adoption was also encouraged by the presence of technology research Projects in the communities. Therefore, the new
The following testimony by Don Carlos, a cassava farmer and cooperative member of Segovia, Sampués, Sucre, validates the findings of the econometric model on the contribution of the ICRD Project to poverty alleviation. *"Before our situation was critical. We used to live with only one pair of pants; we were all day workers. For example, we didn't eat three meals per day... if we had breakfast; we didn't have lunch. And now... I said that there was a change. If you walk around the village, you can see that almost all the houses are built of brick and cement. The village has a water supply and part of it has a sewage system, and all of this was acquired with the little we obtained. We don't live in adobe houses anymore, where you could see the beds from outside. The hammocks used to be made with jute, and now we have at least a more comfortable bed. Now we have money to send the children to school and to dress them, to buy shoes and socks, and we have enough to eat three meals too... and well... sometimes we even have enough to buy some beers... ha, ha, ha..."*

In conclusion, the ICRD Project directly and indirectly reduced the levels of poverty by creating an alternative income-generation activity through selling roots, creating employment, and reducing production costs through improved production technology. The organization of communities around a tangible activity that generates income and employment also fostered existing levels of social and human capital, and therefore, further empowered the communities.

ICRD PROJECT SUSTAINABILITY

Four years after the Project officially ended, some institutional support for cassava continued in the region, but terminated after 1993. At the same time, the Colombian Government moved toward a neoliberal system by opening up the economy to international competition (economic aperture) and decreased its presence, both in size and intervention. Figure 5 shows that, after 1993, prices of both dried cassava and fresh roots paid by the agroindustry decreased at annual rates of 5.5% and 4.3%, respectively. These steep decreases in prices were a result of Colombia importing grains for animal feed at lower prices, which were at that time particularly low, reducing to almost zero the profit margins received by cassava-drying organizations. During the same period, the collapse of institutional support eliminated the availability of credit at low-interest rates for use as working capital. These two shocks, combined with the lack of accumulation of working capital by most associations, forced 28% of the cassava drying plants to stop processing between 1992 and 1993. Eight cassava associations also closed down

because their members were displaced by violence in their respective communities. Hence, dried cassava production dropped from 35,000 tons in 1993 to only 7,000 tons in 1994.

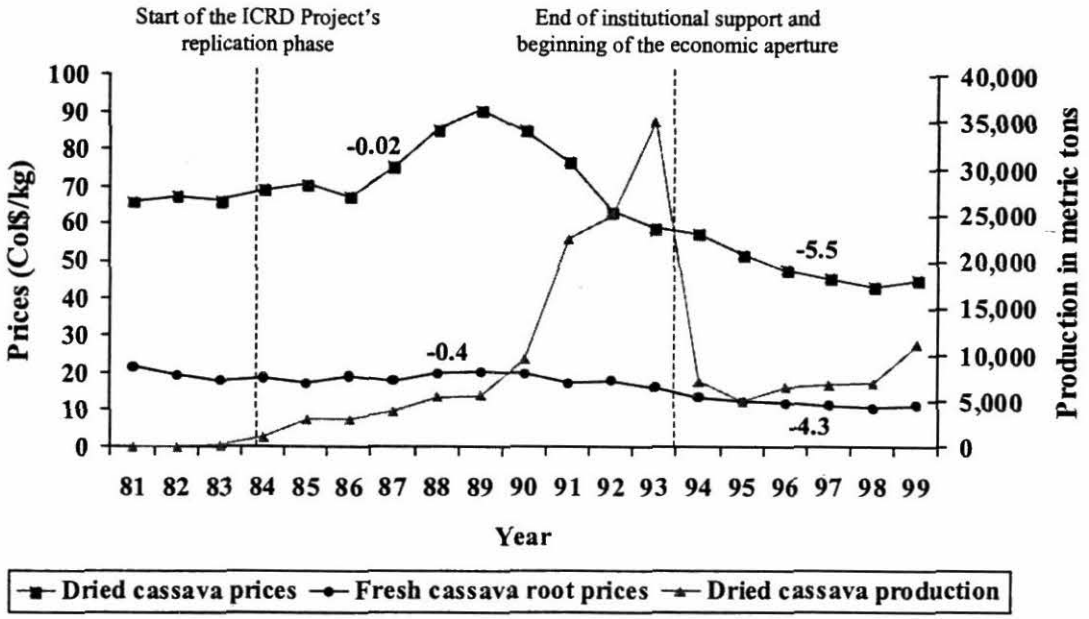


Figure 5. Trends in cassava prices and dried cassava production in the North Coast of Colombia, 1981-1999, showing the impact of opening up the country's economy to international competition (economic aperture). Prices are based on the 1990 Colombian peso.

Even though cassava farmers faced these two major shocks to the dry cassava agroindustry, in 1999, 56 cassava-drying plants are still operating. Of these 56 plants that still operate, 43 belong to small-farmers' cooperatives, although 15 rent their plant to individual entrepreneurs. Figure 5 also shows that dry-cassava production is starting to increase again as grain imports are becoming more expensive due to the recent devaluation of the Colombian peso. These results show that the sustainability of the program is highly dependent on the macroeconomic environment, which directly affects the viability of the developed marketing alternative.

CONCLUSIONS AND LESSONS LEARNED FROM THE PROJECT

As the analysis has shown, the emergence of the cassava-drying agroindustry created an incentive for adopting modern varieties, which, in turn, contributed to poverty alleviation. The central hypothesis of the ICRD Project methodology was therefore validated: if agricultural research institutions want to make a difference for the poor they should not only concentrate their efforts on production technology development, but also on postharvest and market research. At the same time, agricultural research should be articulated to a broader demand-led development process in order to achieve poverty alleviation goals. Such an integrated approach allows (1) better identification and articulation of farmers' needs in terms of production and postharvest technology, and

market research; (2) development of an accordingly more complete set of technology; and thus 3) a more efficient contribution to poverty alleviation.

However, the emergence of cooperatives was influenced by previous existence of local community organizations, which helped communities demand support services from institutions (both governmental and nongovernmental). It also implies that national and international institutions should take advantage of these local community organizations and their expertise to identify and reach the poorer small farmers, and to help implement research and development programs.

Another type of partnership contributed to the success of the ICRD Project: interinstitutional partnership among national and international institutions involved in technology research and rural development. These partnerships allowed the conduct of demand-led research that was articulated to a multipurpose support system. Such cooperation among institutions permitted the inclusion of a broader range of services such as technical assistance on production, processing, marketing, management, and organization, as well as credit. Coordination with other governmental programs such as the land reform was also possible. These partnerships were built around the needs of targeted groups, permitting them to respond adequately and directly to the communities' demands and needs.

The experience of the ICRD Project in the Colombian North Coast shows that agricultural research can contribute tangibly to poverty alleviation. However, it requires three very important components: first, the integration of market and postharvest research and development to the production technology research agenda; second, the use of interinstitutional partnerships, where each institution provides its own expertise, comparative advantage, and mandate to respond to the demands of community organizations and individuals; and third, the fostering of an intimate networking among institutions and local social organizations and individuals, building on existing local social and human capital.

Staff Involved:

- James Garcia, MS Statistician and Database Specialist, Impact Assessment Project
- Carlos Chilito, Technician, Rural Agroenterprise Development Project
- Elizabeth de Paez, English editor, Communications Unit
- Fernando Pino and Julio Martinez, Communications Unit, Design Office

Collaborators:

- Alain de Janvry and Elisabeth Sadoulet, University of California at Berkeley
- Federación Colombiana de Productores, Procesadores y Comercializadores de Yuca, FEDEYUCA
- Eusebio Ortega, cassava farmer from Sucre
- Alberto Fernández, Colombian Ministry of Agriculture
- Departmental Agricultural Secretary Offices of the North Coast of Colombia
- Antonio José López and Alvaro Tolosa, Corpoica Regional Offices for the North Coast of Colombia.
- Antonio Dorado, Professor of Univalle and Video Producer.
- Rosalina Varela, United Nations World Food Program office in Colombia.

2.2.B Integrated Cassava Research and Development (ICRD): A replication of CIAT's Experience in Northeast Brazil – *by: M. V. Gottret, B. Ospina, D. Pachico, and C. Leite-Cardoso*

1999 Milestones:

- Producers survey data for 1989, 1992 and 1998 was re-analyzed and tabulated.
- An economic surplus model was used to estimate regional economic benefits from the project for the 1989-98 period.
- An impact highlight was prepared for the CGIAR Mid-term meeting in Beijing May 24-26, 1999.
- An improved paper that incorporates the new analysis made in 1999 is being prepared for presentation at the meeting of the Brazilian Cassava Society to be held in Manaus, Brazil 13-17 de October, 1999.

Background

The Challenge

The Northeast of Brazil has long constituted the single largest concentration of poverty in Latin America. More than half of all Brazilians living in poverty, and almost two-thirds of the country's rural poor, lives in the Northeast. According to the Ministry of Planning some 12 million rural inhabitants of the Northeast live in extreme poverty, with annual per capita income under US$214—less than one-tenth of the national average (Zyl et. al, 1995).

Among the underlying causes of rural poverty in the Northeast are the relatively poor resource base of large parts of the region, and agro-climatic conditions that make them vulnerable to drought. Additional constraints include the skewed access to land and the virtual absence of a functioning rural financial system for the poor. As a result, low input use and slow rates of technology adoption characterize the Northeast agriculture. Productivity is low, with output per farm worker less than half that of other regions.

One of the nine States of this region is Ceará, which suffers the highest levels of poverty and underdevelopment in Brazil and an estimated 50% of the population earn less than US$130 annually. Low and variable rainfall makes cassava practically the only staple food crop alternative for farmers, and consequently it is the main food source. The principal market for cassava has been the *"casa de farinha", a* communal-type, small-scale processing unit utilized to process the roots into a flour called ***farinha de mandioca***, a basic staple product, especially in the rural sectors of northeast Brazil. In Ceará alone, it has been estimated that there are more than 14,000 *casas de farinha* with an annual output of near 200,000 MT of cassava flour which consumes about 65% of total cassava production in the State.

The dependency of cassava producers in a single market made them vulnerable to declining and highly fluctuating prices, particularly in years with good rainfall, when excess production usually means low prices. Moreover, *farinha* processing is a labor-intensive activity, which results in relatively high processing costs (around US$60 per MT). Also, those farmers who do not own a "*casa de farinha*" have to pay high rates for the use of the processing infrastructure. This situation has led to stagnating opportunities for cassava producers, most of them small low-income farmers. Therefore, an alternative market was needed for cassava.

The Intervention

To test the Integrated Cassava Research and Development approach, in 1981, CIAT initiated activities in Colombia in collaboration with national institutions, aimed at overcoming the inherent market limitations caused by lack of diversification in cassava markets. This project was implemented through an integrated set of institutional, organizational, social and technological interventions designated to link small-scale cassava farmers to new or improved growth markets, thus stimulating farmer demand for improved production technology with potential to improve small farmers welfare (see Gottret and Raymond, 1999).

Based principally on the experience in Colombia, in 1989 CIAT and collaborating agricultural research and technical assistance institutions formulated a proposal to test the same strategy in the State of Ceará in northeast Brazil. Afterwards, a grant was approved by the W. K. Kellogg Foundation for the 1989-92 period to set up and test the production, processing and marketing technologies and channels on a small-scale, semi-commercial basis.

The implementation of the project in Ceará was facilitated by prior involvement of state agricultural sector agencies in the promotion of cassava-based development activities, especially the State Technical Assistance and Extension Service (EMATERCE), which promoted the development of alternative markets from 1981 until 87. A state-level cassava committee (CCC) that had been created in 1988 served as the foundation upon which the organizational and operational infrastructure of the ICRD project in Ceará was built. Three elements were essential ingredients in the ICRD methodology: a) the existence of an economically viable, already proved technology (dry cassava chips), b) an expanding market (animal feed industry), c) available technical backstopping (CIAT and Brazilian institutions).

As in the case of Colombia, the project went through a demonstration phase from 1989-90, followed by a replication phase from 1990-93, and a farmer's management phase afterwards. However, there was a previous phase between 1981 and 1987 that can be called a "government managed experimental phase".

Methodology

The conceptual framework for the study is that promoting small-scale cassava-based agroindustries can create an alternative market for cassava roots which is expected to establish a floor price for cassava, reduce price fluctuations and increased the farmers' bargaining power. This should reduce the risks faced by cassava producers and act as an incentive to increase cassava production, both by increasing the planting area or adopting technology over the longer-run.

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

Additional quantitative data was obtained from the following sources. A baseline survey conducted in 1989 (the first year of the project) and applied to 161 cassava producers and processors of the Ceará State. A second survey was conducted in 1992 (last year of the project) and applied to 781 cassava producers and processors beneficiaries of the ICRD Project, 118 cassava producers and processors non-beneficiaries of the ICDR Project, and 33 community level surveys. A third and additional short survey was conducted in 1998 as part of this study. This last survey was applied to a sub-sample of 233 cassava producers and processors who where beneficiaries of the project and 66 cassava producers and processors who where non-beneficiaries (based on the 1989 and 1992 surveys). The following topics were included the survey: (1) producer characteristics, (2) characteristics of the production unit, (3) characteristics of cassava production, (4) adoption of cassava production technology recommended during the ICRD project, (5) uses of cassava production, (6) agroindustry support services provided by institutions: credit and technical assistance, (7) effect of the new technology on farmers income, (8) women role in the ICRD project and women perception on the impact of the project.

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:

- factors influencing the community decision to establish a dry-cassava agro-industry;
- level of community participation in dry-cassava processing activities;
- identification and analysis of factors which effect the success or failure of dry-cassava agro-industries;
- effect of the new alternative market for cassava on the adoption of cassava production technology recommended during the project;
- identification and analysis of the new processing technology on cassava commercialization channels;

- type and quality of institutional support received by cassava producers and processors during the project;
- effect of the new agro-industry established on the overall development of the community.

Interviews were also conducted with women from communities who participated in the project and included the following themes:

- participation of women in the community decision to establish the new dry-cassava agro-industry;
- analysis of the participation of women and children in dry-cassava processing agro-industries;
- identification of the type and quality of institutional support received by women during the project;
- effect of the project on the socio-political position of women in the community;
- effect of the establishment of the new cassava agro-industry on overall community development and household quality of life.

Sampling strategy for collection of primary data

The sampling strategy was designed in two stages. In the first stage, communities were sampled based on the information available in the project monitoring and evaluation system, and, in the second stage, families were sampled based on the information available in the 1992-survey database.

Community sampling strategy:

Communities were selected for the focus group interviews on the basis of the information in the project monitoring system. For each drying plant two parameters were calculated for each drying plant: technical efficiency and financial efficiency. Plants were also classified according to their source of funding and support received from the ICRD project. The latter was important as some of the plants built during and after the project were funded by the Secretaria de Industria y Comercio (SIC) as a political initiative, but they did not receive support from the project such as technical assistance, credit, etc. 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%.

Household sampling strategy:

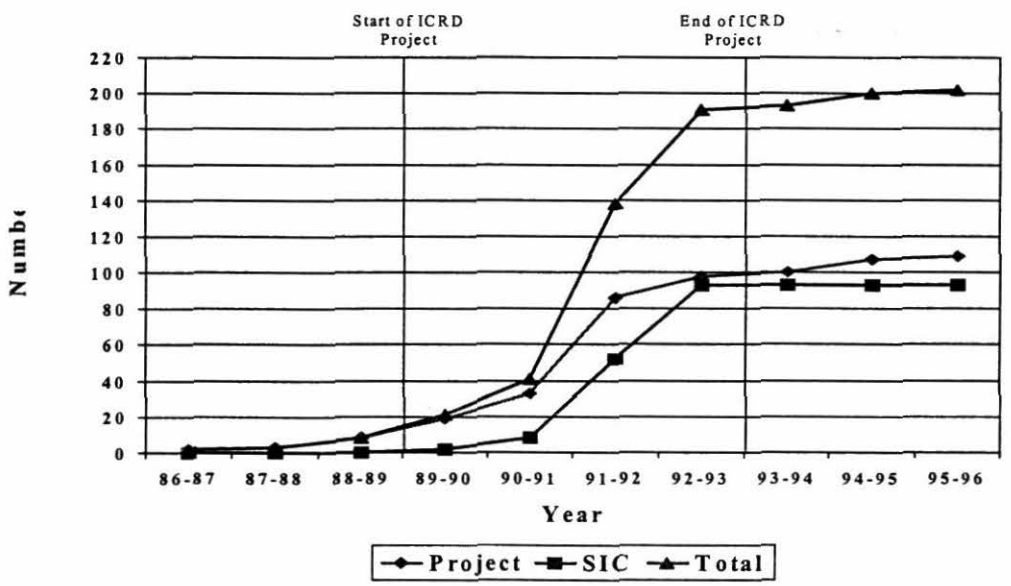
To determine the number of families to be interview, six variables were chosen from the 1992 survey: (1) area planted with cassava in 1991, (2) total farm size in 1991, (3) average cassava area 1988-91, (4) % of farmers which respond that their cassava yields improved, (5) % of farmers which respond that their income improved due to the project, and (6) % of farmers selling and/or using their cassava for cassava chip processing. Based on these variables, a sample size of 299 farmers was chosen with a confidence

level of 80% and a probability of error of 25%. Of the 299 farmers that were interview, 233 are members of cassava drying cooperatives and 66 farmers and non-members.

The Impact

Dry-cassava organizations emergence

Figure 1 shows the number of cassava drying plants installed per year during the 1986-1996 period by source of funding. One hundred and nine cassava producer associations were organized around cassava-drying plants during the 1987-96 period, of which ninety were installed during the 1989-92 period, with funds obtained through the ICRD project activities. These groups of farmers received whole support services from the project in terms of technical assistance, credit, training, and other services related to farmer organization strengthening. An additional 93 dry-cassava agroindustries were established as a result of a Ceara State Secretariat of Industry and Commerce (SIC) grant-type financial aid program. These groups received the grant but not the support system provided by the ICRD project. The established processing groups produced a total of 7,250 MT of dry-cassava during the 1980-96 period, of which 7,000 MT were produced by the groups supported by the ICRD project.



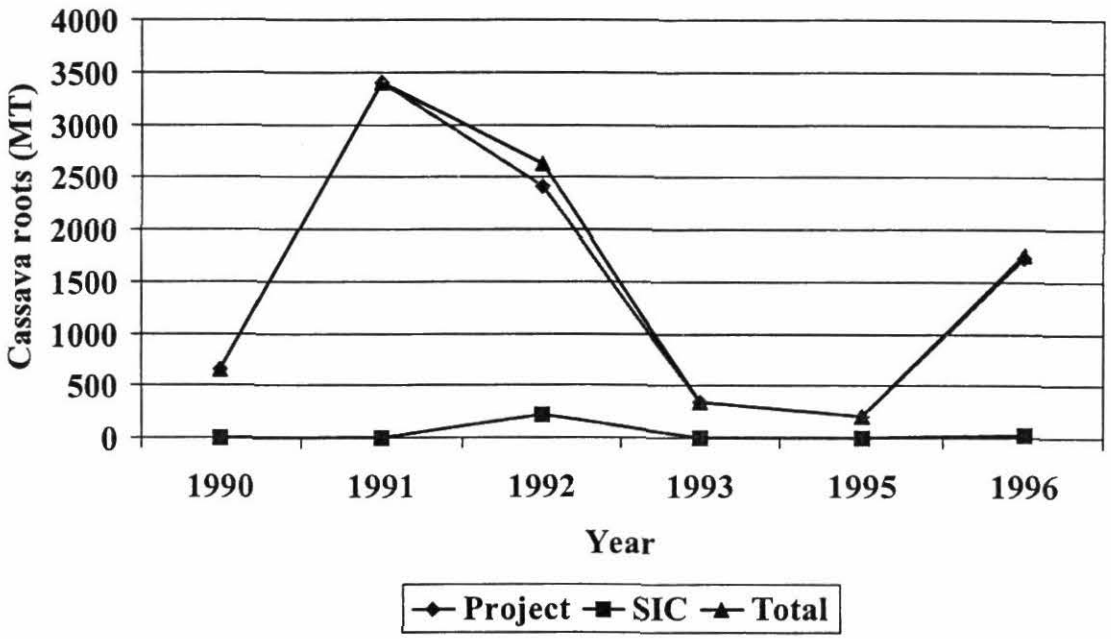
Data source: ICRD project monitoring and evaluation system

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

The community decision to establish dry-cassava processing organizations was influenced by two major factors. The first has to do with the advantages of developing the new market for cassava roots, which was seen as a way of reducing labor and other production costs involved in *farinha* processing, and as a source of additional cash income for farmer households. The second is related to the motivation given by the ICRD project. The project, through its strategic alliance with EMATERCE, motivated

farmer groups to establish dry-cassava agroindustries in two ways. EMATERCE gave direct support to farmer groups, which included technical assistance, grants for the installation of the cassava drying plants, credit, community organization and training in agroindustry management. In addition, the ICRD project promoted the exchange of experiences among farmer groups through visits to other neighborhood communities. Some community leaders traveled to Colombia to learn from farmer groups with more experience of the agroindustry.

The quantity of cassava roots processed by the dry cassava agroindustries during the 1990-96 period can be seen in Figure 2. Production increased up until 1992, after which it decreased significantly until it began to rise again in 1996. Figure 2 also shows the marked difference in 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 ton of cassava roots from 1990 to 1996, while those established by the ICRD Project processed 7002.8 ton. In 1992 the region experienced one of the worst droughts in its history as a result of which yields dropped dramatically (down to approximately 3.5 ton/ha). This not only affected 1993 cassava yields, but also decreased the area planted in 1994 as farmers did not have enough seed to plant. Thus, the startling collapse in dry-cassava production in 1993-1995 was due principally to the drought. Once this was over production began to recover.



Data source: ICRD project monitoring and evaluation system

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

Short-term effect of the new alternative market

More than half of cassava producers and all the adopting communities see the new processing technology as an alternative market for cassava. According to farmers the new agroindustry offered them the following advantages:

- Cassava chips can be sold easier than *farinha* and farmers receive cash income almost immediately whereas the market for *farinha* is very insecure.
- 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.
- Cassava farmers who were not members of the cassava-drying organizations could also sell their cassava roots to the agroindustry and receive cash income.

During 1998, 18.2% of cassava producers were selling part of their cassava production to dry-cassava processing plants, and 7.3% of them were processing dry-cassava themselves. Therefore, cassava commercialization was improved and the *farinha* market became more stable. Since 1989 *farinha* prices have increased at an annual rate of 11%, of which a 5% can be attributed to the new market. In 1998, 47.4% of cassava farmers said that root prices were improved as a result of the ICRD project.

In the short-run, cassava producers responded to the new market incentive increasing their average cassava area from a mean 1.9 ha in 1989 to 2.5 ha in 1992. Also, area planted to cassava in the Ceara increased at an annual rate of 4.7% between 1989 and 1992.

Longer-run effect on the adoption of improved production technology

In the longer-run, cassava farmers started to adopt technology recommendations to improve cassava yields. The recommendation with the highest level of adoption is the practice of weeding the crop more than three times during the cropping cycle, which was adopted by 71.2% of farmers. In 1998, 49.2% of cassava farmers were selecting seed before planting and 33.6% where doing it before and during harvesting as recommended. As a result of seed selection only, yields were increased by 0.5 MT per ha, which yields an additional income of 17US$ per ha of cassava. Additionally, 7.3% of farmers are applying organic fertilizers to the cassava crop, as recommended by the ICRD project, resulting in an additional yield of 3 MT per ha. The net profit from this practice is estimated to generate an additional net income of US$25 per ha, after paying for the fertilizer. Farmer group discussions showed that although farmers are aware that by applying fertilizer cassava yields increase significantly, they simply lack the economic resources to buy them. Furthermore, farmers argue that if they have the resources to buy fertilizers, they prefer to apply them to higher value crops, such as vegetables. Although As a result of the adoption of this improved production practices, average yields increased from 7.2 ton/ha in 1992 to 7.7 ton/ha in 1998.

Direct economic benefits of the dry-cassava agroindustry

The increase in cassava area (23.2% of farmers increased their cassava area in 1992) and productivity (25.7% of farmers said that yields have increased in 1998) has resulted in an overall increase in cassava production in the Ceará State. Total production in the State increased from an average of 987,282 ton in 1987-89 to an average 996,711 ton in 1995-97. Around 95% of this increase in production can be attributed to the ICRD project. However, the potential of the new market and improved production technology to further increase cassava production was hampered by three factors: the skewed land distribution (only 25.2% of cassava farmers own their land and 19.8% are land reform settlers in 1998), the poor resource base and climatic conditions (severe droughts in 1993 and 1994), and the lack of working capital.

Table 1 summarizes the estimated direct benefits of the dry-cassava agroindustry. These results show that the main beneficiaries of the project were cassava producers who sold its roots to the agroindustry and received 69.4% of the total direct benefits (312,707 US$). 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 they 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.

Table 1. Aggregated direct economic benefits of the dry-cassava agroindustries in Ceara state, 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, sacs, spare parts for motors, and oil.
Source: Estimations based on the ICRD project monitoring and evaluation system.

With respect to the distribution of benefits from selling cassava roots to cassava-based agroindustries, most of these benefits accrued to farmers with cassava plots smaller than 2 ha as 89.5% of cassava-producer benefits from the sale of roots to the agroindustry went to the smaller cassava farmers.

Another important contribution of the ICRD project to improving the well- being of cassava farmers 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 58,9 % of the total benefits, renters 32,4 % and sharecroppers benefited with 8,7 %.

These results are validated with the findings of the focus group discussions conducted in 1997 and the 1998 cassava-producers survey. One third of cassava producers consider that their household income was increased as a result of the establishment of the new cassava processing agroindustry, and 50% of women agree with this. All the adopting communities consider that cash income has been increased because cassava roots can be sold to the new agroindustry, and producer organizations receive extra income from dry-cassava processing.

Regional economic benefits from the ICRD project

Besides the direct benefits of the project from cassava processing activities and the demand of the agroindustry for cassava roots and labor, the ICRD project also brought indirect economic benefits to the region. These additional benefits were brought via changes in *farinha* prices, and the overall increase in production due to the increase in area planted to cassava and productivity. The results of an economic surplus model show that between 1989 and 1998, the ICRD project generated benefits valued at US$ 1.5 million. Cassava producers profited from lower production costs, higher demand and an increased price for roots, with benefits amounting to 950 thousand. Total direct benefits for dry-cassava processors adds to 555 thousand US$, of which the main beneficiaries were cassava producers who sold their roots to the agroindustry and cassava producers who participated in dry-cassava associations who also received benefits from the distribution of net profits. Further economic benefits were delivered to *farinha* processors (185 thousand US$), who although had to pay higher prices for cassava roots, also received better prices for their product. *Farinha* consumers were the only group that lost as a consequence of the ICRD project (190 thousand US$) since they had to pay higher prices for the product.

Changes in the quality of life

Quality of life of the adopting communities was also improved as a result of the ICRD project. In 1998, 47% of women said that their quality of life was improved as a result of the project, 20% acquired durable goods, 34% feel that the household workload was decreased, and 13% that new employment opportunities were generated for their families. As expressed by women of these communities "...the production of dry-cassava provides some cash to buy food, clothes and shoes, specially for children..." Other women also said that the new agroindustry "...allowed them to buy things for the house, send children to school, and get health services when needed..." Some women also argued that "..some of the people were even able to buy a house or improve the one they had...".

Besides the additional income generated by the ICRD project and the improvement in the quality of life, the organization of community households around a common interest which resulted in tangible benefits for them, has empowered the adopting communities. As expressed by farmers and women "...other projects and services were brought to the community as a result of its organization...". These other projects and services range from infrastructure (electricity, water dwell, housing, school, cashew juice processing plant, "peto" (bread made from cassava starch) agroindustry, etc.) to services (baby care center, credit, training, etc.), and to other development projects. Community members also said that "...people learned to work as a group, participates more in community organizations, and learned to develop communitary projects..." Therefore, signs of improved levels of social capital can be observed in the adopting communities.

Conclusions

Some key conclusions can be drawn from the results of this case study:

Farmers obtained important economic and social benefits

Analysis of the benefits generated by the ICRD project in Ceara 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, according to price, in which market to sell their production. This strengthened farmers and represented a radical break with the existing commercialization schemes for the cassava in the region.

Benefits generated by the project were important and significant for groups such as women and landless farmers, who often do not benefit from rural development projects. Additionally, communities 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 organization among producers that was fostered by the project.

Integration of activities is a sound approach

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

Partnerships are a must to increase project effectiveness and efficiency

The ICRD project umbrella offered a context in which institutions worked in partnership among them, where each provided its own expertise, comparative advantage, and mandate to respond to the demands of cassava drying organizations. Also, a network among institutions and local organizations was fostered, which permitted to build on existing social and human capital, which develop farmers groups organizational skills

further. These local organizations became efficient partners and collaborators of the institutions.

Policy support is a major factor for the success of rural agroenterprise projects

Farmers, when faced with new and more profitable market outlets, try to increase their production either by increasing their area or by adopting improved technologies to increase yields. However, the political environment can either enhance or constraint the success of integrated agroenterprise projects.

The success of this type of projects is directly affected by policy decisions. The small improvement that was achieved in cassava production and productivity levels in Ceará could be attributed directly to the lack of policy support represented in the absence of credit lines for purchasing land, fertilizers, etc. Cassava farmers with small size plots and without economic resources to invest in improved production technologies could have several markets available, but they may not be able to take advantage of these opportunities.

Staff Involved:

- James Garcia, Ms Statistician and Database Specialist, 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
- Lee Sechrest, Michelle Stewart, and Timothy Stickle, University of Arizona.

2.2.C. Adopción e Impacto del Fréjol en Santa Cruz, Bolivia. 1999. *by: Norha Ruiz de Londoño*

- Antecedentes

En los años 80 se introdujo el fréjol *phaseolus vulgaris* o Fréjol Común a Bolivia, concretamente al Departamento de Santa Cruz.

Esta acción se realizó conjuntamente entre la Universidad Autónoma Gabriel René Moreno (UAGRM) y el Centro Internacional de Agricultura Tropical (CIAT).

A partir de 1988 el CIAT crea el Proyecto de Frijol para la Zona Andina (PROFRIZA), financiado parcialmente por la Agencia Suiza para el Desarrollo (COSUDE).

En este mismo año la Asociación Menonita de Desarrollo Económico MEDA emprendió en Bolivia la tarea de incentivar asociaciones de productores con el propósito de reducir la vulnerabilidad frente a las fuerzas del mercado. Así nace en Santa Cruz la Asociación de productores de Fréjol ASOPROF.

El objetivo de introducir el fréjol en Santa Cruz fue el de involucrar a Bolivia en la producción de un alimento que contribuyera a mejorar los estándares nutricionales de los consumidores y proporcionara al agricultor nuevas opciones de ingreso y de uso del suelo.

Los agricultores a los cuales se enfocó el trabajo de fréjol fueron básicamente los localizados en las áreas de penetración de la Selva Amazónica, quienes habían emigrado desde el altiplano Boliviano hacia la llanura de Santa Cruz buscando oportunidades para su subsistencia

A la fecha se estima un asentamiento de cerca de 8000 familias emigrantes, con 50 mil personas quienes ocupan unas 300 mil hectáreas de selva.

Después de 15 años de iniciada las acciones para introducir el cultivo de Fréjol Común - *phaseolus vulgaris*- en Bolivia, los integrantes del Proyecto (PROFRIZA y la UAGRM) contrataron el presente estudio de evaluación de adopción e impacto.

La evaluación busca definir la situación de la producción y de los productores antes y después de fréjol, así como el impacto en el consumo doméstico, en el mercado de exportación y en algunos indicadores macroeconómicos de la región.

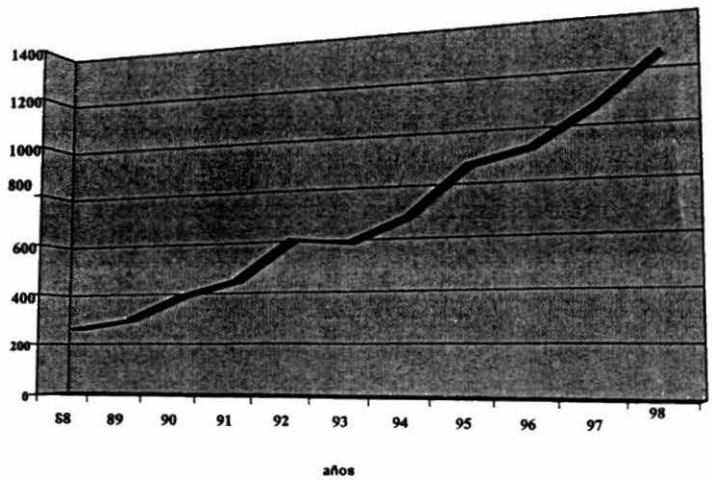
- Marco de referencia

En la actualidad la Llanura de Santa Cruz dispone de 1.2 millones de hectáreas en cultivos de tipo agroindustrial los cuales muestran una alta dinámica de expansión. En la ultima década el área agrícola de Santa Cruz se incremento en 375 por ciento a expensas de la Selva (ver fig. 1)

Los cultivo agroindustriales son explotados básicamente por grandes agricultores o empresas. Según un estudio del Centro de Investigación y Manejo de Recursos Naturales renovables, el 90 por ciento de la tierra en producción es explotada por grandes agricultores que solo representan el 5 por ciento de los cultivadores.

Dentro de este contexto el Fréjol Común ocupa solo un 1.5 por ciento del área pero involucra a gran número de pequeños agricultores situados en las zonas de penetración.

Fig 1. Evolucion del Area en Cultivos, Santa Cruz Bolivia
(miles de has)



- Metodología

Se definen varios niveles de estudio: Producción, consumo urbano y rural y comercialización.

A nivel regional se obtiene información secundaria para analizar la participación del fréjol en la producción agrícola, su evolución y sus mercados.

A nivel de los productores se captura información primaria para analizar los cambios introducidos por el cultivo del fréjol en el uso de la tierra y de la mano de obra y otros recursos de la producción, así como también trata de identificar y evaluar el bienestar de las familias de los agricultores involucrados en el fréjol.

A nivel de consumidores se captura información primaria para analizar la incorporación del fréjol a la dieta alimenticia y su importancia relativa en la ingesta calórica y proteica.

En el cuadro 1 se muestra las Fuentes consultadas o encuestadas y el tamaño de la muestra manejada.

Cuadro 1. Fuentes de información consultadas para el estudio de Adopción e Impacto de fréjol. Santa Cruz 1999

Nivel	Producción	Consumo		Región	Comercio
		Urbano	Rural		
Fuentes	-252 agricultores -2 localidades: San Julián y Colonia Berlín -80 mujeres, esposas de productores	-367 amas de casa de la Ciudad de Santa Cruz. -5 niveles de ingreso	-261 amas de casa -2 localidades: San Julián y Colonia Berlín	**-Cámara Agrop. Del Oriente (CAO)** -Instituto Boliv. de Comercio Exterior (IBCE) -Centro Invest. de Recursos Nat Renov.(CIMAR) -Coorp. Para el desarrollo de SC (CORDECRUZ)	Exportadores: ASOPROF BOLIVIAN SHOJI ASOMEX
Tipo de información	-Características de la producción, rendir costos. -Destino p reducción e ingreso de fréjol -Información base para identificar indicadores de bienestar para la zona	Consumo de fréjol y de otros alimentos	Consumo de fréjol y de otros alimentos	Estadísticas sobre cultivos y actividades de la región	Volúmenes exportados, precios y destinos

- Resultados

Esta sección se presenta agrupada en cinco temas:
Nivel de Adopción de fréjol
Impacto sobre la región
Impacto sobre la producción y los productores
Impacto sobre el consumo
Impacto sobre el Bienestar

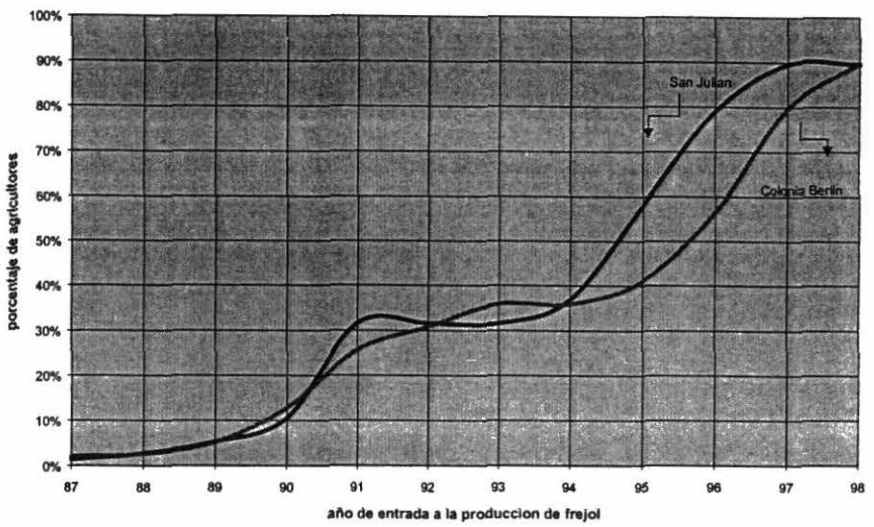
Nivel de Adopción de Frejol Común

El nivel de adopción se cuantifica en términos de agricultores que incorporaron el fréjol como alternativa de cultivo y en términos de consumidores que lo integraron a su dieta alimenticia.

En el lado de la producción se estudian las áreas de San Julián y Colonia Berlín, dos de las zonas más importantes en asentamiento de colonizadores emigrantes del Altiplano Boliviano.

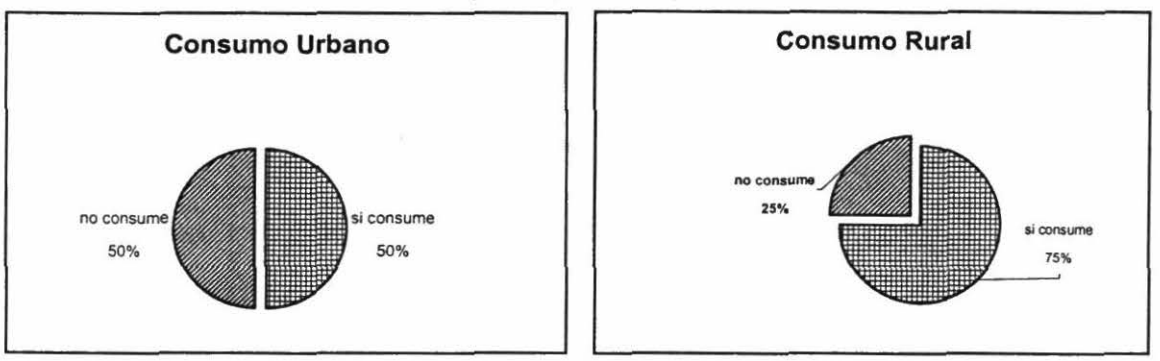
Las curvas de adopción muestran un proceso lento en los primeros años, el cual se intensifica hacia 1990 a 91. De allí permanece estable hasta 1994, año a partir del cual la adopción se acelera y llega a un punto de un 90 por ciento de agricultores adoptando el Fréjol Común como cultivo. (ver fig. 2)

Fig 2. Curvas de adopcion de frejol. Santa Cruz Bolivia.



- Del lado de consumo la adopción del Fréjol Común como producto alimenticio es del 50 por ciento en familias del sector urbano y del 75 por ciento en el sector rural de la zona de colonización.

Fig 3. Consumo de Frejol en el Sector Urbano y Rural de Santa Cruz. Bolivia
(Pocentaje de Familias)



Impacto sobre la región

a) En 1997 las estadísticas para la región muestran cerca de 15 mil hectáreas sembradas con Fréjol Común, incluida el área de producción de semilla. Para 1998 se estima con base a los datos de consumo domestico y exportaciones en mas de 20.000 mil hectáreas.

b) La introducción del Fréjol Común creó una nueva fuente de divisas para el país. En 1997 sus exportaciones alcanzaron un valor de 8.8 millones de dólares.

c) El Fréjol eliminó la necesidad de inmigrar a otras regiones para obtener trabajo en el invierno. Se estima con base en los datos de la encuesta que el fréjol requiere unos 30 jornales por hectárea y que en total la actividad de producir fréjol Común generó entre 450 mil a 500 mil jornales directos por año.

d) El Fréjol redujo los costos de producción de los cultivos de verano al bloquear las malezas que proliferaban durante la estación invernal problema denominado la "crisis del barbecho". Se estima que la reducción en gasto, para la región que tuvo fréjol como rotación en el invierno es de 1.5 millones de dólares/anuales.

Impacto sobre la producción y los productores

e) Con base en los datos de la encuesta se estima que en el área de producción comercial de Fréjol Común (Provincia Ñuflo de Chávez), un 63 por ciento de jefes de hogar están vinculados al Fréjol Común como agricultores o como jornaleros.

f) Los agricultores han encontrado en el Fréjol Común una opción de cultivo para el invierno: Un 86 por ciento del área cultivada en esta estación lo es con fréjol.

g) Antes de la introducción del el Fréjol Común solo un 9 por ciento del área cultivable era explotada en el invierno.

h) El ingreso por Fréjol representa un 43 por ciento del ingreso total de los agricultores entrevistados.

i) El Fréjol Común generó una fuente de trabajo para el agricultor y su familia: Cerca de la mitad de los jornales utilizados en la explotación son aportados por la familia lo cual representa cerca de 222.500 jornales/ano.

j) El Fréjol Común agrio a los pequeños agricultores de la región, las puertas a los mercados intencionales. El 60% del fréjol producido se exporta.

k) La producción local de Fréjol Común con miras a la exportación generó un mercado domestico importante, tanto a nivel rural como a nivel urbano. El 29 por ciento del fréjol producido se consume en la ciudad de Santa Cruz.

Impacto sobre los consumidores

El consumo de fréjol se analiza en base a:

El tipo de consumidores que ingresaron en el consumo.
Las cantidades consumidas.
La importancia relativa en la ingesta nutricional

a) Como se anoto anteriormente el Fréjol Común ha logrado introducirse como opción alimenticia en Santa Cruz. En el cuadro 2 se puede observar que un 75 por ciento de las familias localizadas en las áreas rurales estudiadas consumen Fréjol Común. En el sector urbano un 50 por ciento de las familias lo consumen y en los estratos bajos de la población el porcentaje alcanza al 84 por ciento de las familias.

   Estos datos indican claramente que los grupos de población mas favorecidos por la introducción del Fréjol Común en la región han sido precisamente los sectores pobres de la población.

b) El consumo per capita estimado para la población rural es alto (23.5 Kg per capita año), mayor que el promedio de Brazil (18 Kg). En el sector urbano el consumo es de 6 Kg per capita año, pero en los estratos bajos de la población alcanza los 12 Kg per capita año.

c) Las cantidades promedias para la población consumidora de Fréjol Común son del orden de los 31 y 12 Kg per capita año en el sector rural y urbano respectivamente, cifras altas aun para piases tradicionales en el consumo de fréjol como Brasil y México

d) En el sector Rural el Fréjol Común aporta una tercera parte de los requerimientos diarios de proteína.

e) En el sector urbano los consumidores más pobres de la población suplen con el Fréjol Común un 17 por ciento de los requerimientos proteicos diarios

- **Cuadro 2. Consumo de Fréjol Común (*phaseolus vulgaris*) en Santa Cruz, Bolivia 1999**

	Rural	Urbano
Familias que consumen fréjol (Proporción del total de familias) Del total de las familias De las familias de estratos bajos	 75% -	 50% 84%
Cantidad de fréjol consumido (Kg per capita año) **Promedio de la población total** **Promedio de los consumidores** Promedio de los consumidores de estratos bajos.	 23.5 31.1 -	 6 12.1 14.0
Aporte nutricional proteico (Proporción del fréjol en los requerimientos diarios) De la población total De los consumidores de fréjol De los consumidores de estratos bajos	 26.3 35.0 -	 6.7 13.0 16.5

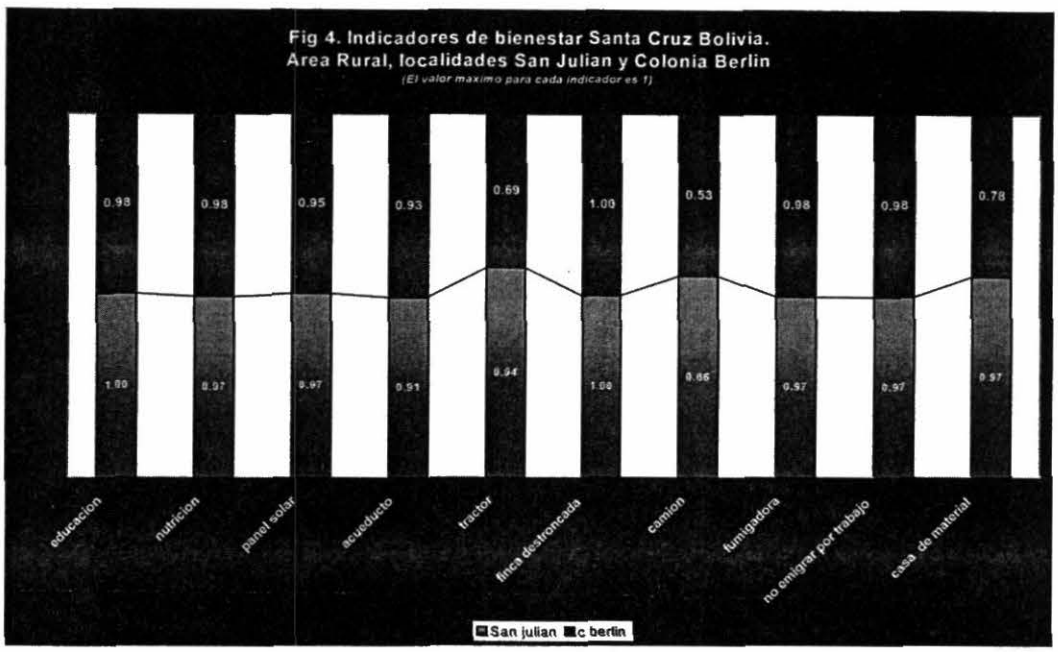
Impacto Sobre el Bienestar de las Familias Rurales

Se entrevistaron 90 amas de casa del sector rural para tratar de identificar los elementos más importantes en el Bienestar de dichos pobladores y el nivel de satisfacción alcanzado en las localidades ubicadas en las zonas de producción de fréjol Común. (ver fig. 4)

Los indicadores de bienestar identificados son:

- Obtener una educación para los hijos superior a los padres
- Obtener una alimentación más nutritiva
- Disponer de un panel solar para obtener energía eléctrica
- Tener agua conducida por acueducto
- Tener una casa de material con techo de teja y no de palmas
- Tener la tierra descepada (libre de troncos de arboles)
- No tener que emigrar por trabajo.
- Disponer de un tractor para preparar la tierra.
- Disponer de un camión para trillar y sacar la cosecha.
- Disponer de una fumigadora para las labores de cultivo.

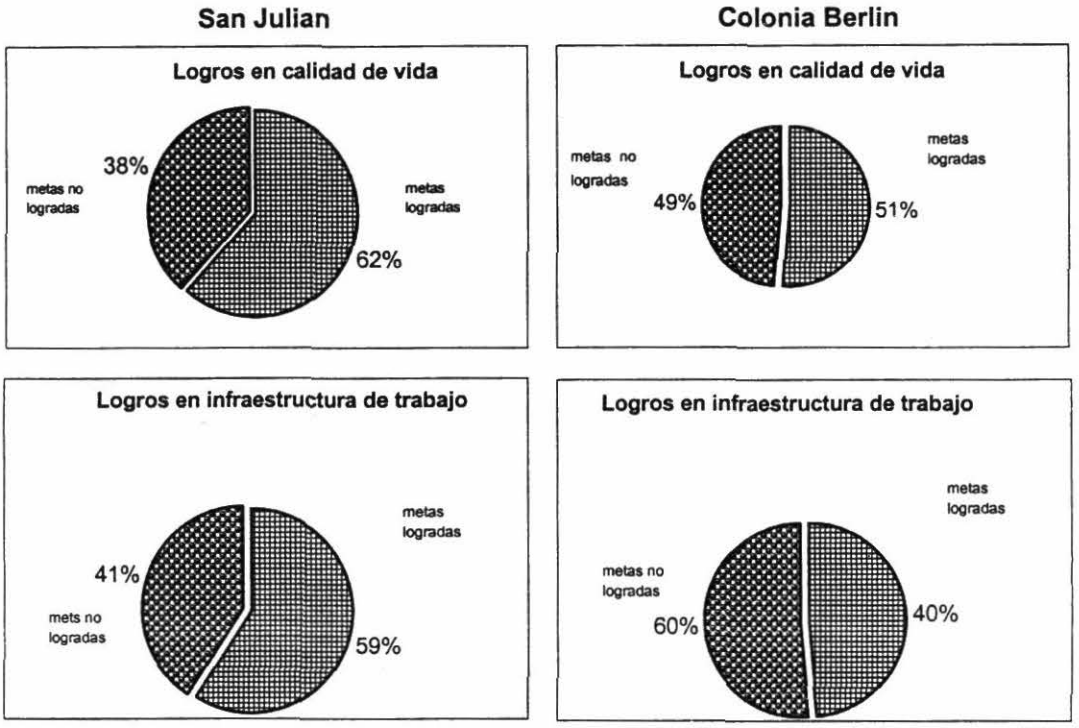
En la fig.4 se muestran los indicadores de Bienestar identificados y su peso relativo en las dos localidades rurales estudiadas.



Se le asigno un peso a cada indicador de acuerdo a la frecuencia reportada por las entrevistadas.

Se enfrentaron las metas de bienestar con los logros expresados por las amas de casa. Las amas de casa manifiestan que han conseguido mejoras en bienestar, (ver fig. 5) y describen el rol que el Fréjol Común jugo en la obtención de algunos logros.

Fig5. Metas de Bienestar. Porcentaje de Cumplimiento. Santa Cruz, Bolivia



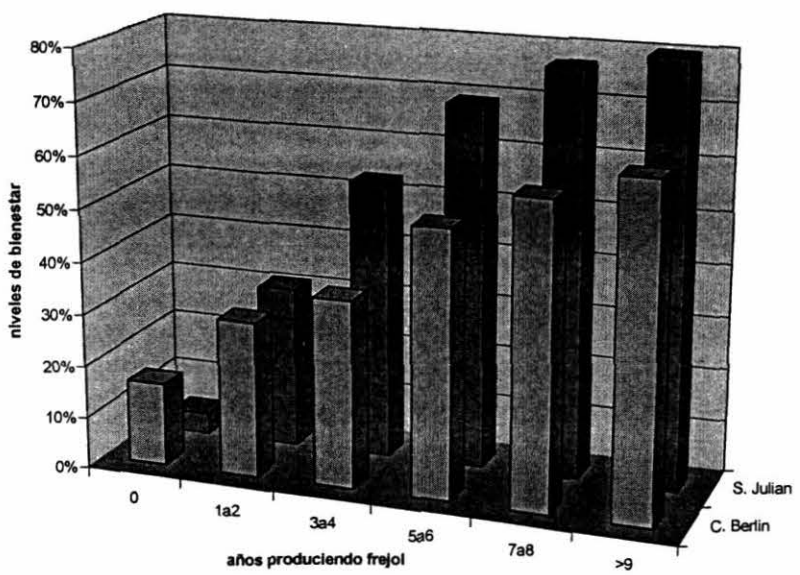
-Las mejoras en nutrición se asocian con el Fréjol Común por la incorporación de este leguminosa en cantidades apreciables a su ingesta alimenticia.
-La notable reducción en la necesidad de emigrar en búsqueda de trabajo en el invierno es una ganancia que obviamente esta relacionada con el cultivo de fréjol que es prácticamente el único cultivo de invierno para estos agricultores.
-Las mejoras en el nivel de educación de los hijos han sido posibles por la disponibilidad de dinero en épocas marginales de cultivo. (En promedio los padres tienen 2 años de educación, y los hijos 7.5 años).
-La posibilidad de acceder a infraestructura de producción (maquinaria, equipos y mejoramiento del terreno, concretamente eliminación de troncos de arboles) fue facilitada por la disponibilidad de mayor ingreso y mejor flujo de dinero para el agricultor. El Fréjol Común aporta cerca de la mitad del ingreso de agricultor y genera un ingreso monetario importante en la estación marginal para la agricultura en la región.

Con la información recogida se realizó un análisis de Regresión Lineal. (Ver cuadro 3).

Cuadro 3. Coeficientes de regresión Santa Cruz				
Variable	**Descripción**	**Coeficientes de regresión**	**Unidad**	**Probabilidad**
X1	Años produciendo Fréjol	.055199	# de años	1.1 E-18
X2	Localidad 1= San Julián 0= Colonia Berlín	.131061	Dummy	7.5 E -06
	Intercepto	.178297		1.7-E -09
Y	Nivel de bienestar alcanzado		% de Bienestar	
R2= .72 N= 80				

El nivel de ajuste de la función y la calidad de los coeficientes permite conceptualizar que la entrada y permanencia del cultivo de Fréjol Común han sido un elemento importante en la consecución del bienestar en estas localidades. (ver fig. 6).

Fig 6. Logros en Bienestar vs. años produciendo frejol



	0	1a2	3a4	5a6	7a8	>9
C. Berlin	16%	30%	36%	51%	58%	63%
S. Julian	4%	31%	53%	69%	77%	80%

Colaboradores del Estudio:

- Ingeniero James García. CIAT.
- Ingeniero Juan Ortube, Profesor Universidad Gabriel René Moreno.
- Estudiantes de Tesis de la Universidad Gabriel René Moreno: María C Franco, Yanet Ortubé, René Flores.

2.2.D. Forage Adoption in Brazil - by: *L. Rivas*

Antecedentes

La gramínea forrajera A. *gayanus*, fue liberada como cultivar apropiado para las condiciones edáficas y climáticas de los Cerrados de Brasil en 1980, con el nombre de cultivar Planaltina. A principios de la presente década se elaboró un estudio inicial para evaluar la adopción y el impacto de éste material en el área de influencia de Brasilia (Saez y Andrade, 1990). El citado estudio estimó un área plantada con *A. Gayanus* de aproximadamente 1.5 millones de ha en 1992. Cálculos muy aproximados, basadas en las ventas de semilla, señalan que la superficie sembrada con esta gramínea en los Cerrados de Brasil, actualmente puede estar alrededor de 4 a 5 millones de hectáreas.

Desde el estudio inicial, desarrollado en una etapa relativamente temprana de la adopción, el proceso no se ha vuelto a monitorear. Adicional a lo anterior, en la región se aprecia un gran vacío de información y de documentación sobre la adopción y el impacto socioeconómico y ambiental de los nuevos cultivares de gramíneas y leguminosas forrajeras liberados en los últimos años para los trópicos latinoamericanos

Por lo anterior, en la reunión del Convenio EMBRAPA- CIAT, efectuada en Octubre de 1998, se incluyo este estudio como una de las actividades a desarrollar dentro del marco del referido Convenio, supeditado a la consecución de financiamiento por parte de un donante externo.

Se elaboró conjuntamente con EMBRAPA/CPAC una propuesta de investigación, la cual fue presentada para financiación a IDRC. Inicialmente el monto propuesto, fue considerado alto por la agencia donante y los alcances de la propuesta limitados, en cuanto a que solo se consideraba el impacto económico.

En conversaciones recientes con IDRC, se pudo constatar que la mencionada agencia estaría dispuesta a financiar una propuesta de menor valor, que incluyera algunos aspectos sobre impactos ambientales y sociales. La suma anterior se complementaría con recursos ya aprobados, provenientes de fondos operativos del Convenio EMBRAPA – CIAT.

En el momento se está trabajando en el diseño de una nueva propuesta para presentarla a IDRC, basada en la recolección de información a muy bajo costo (entrevistas telefónicas a productores, grupos de enfoque, estudiantes de tesis, etc.). Antes de finalizar el año se

presentará la nueva propuesta a IDRC. Se espera iniciar el trabajo de campo el próximo año.

2.2.E. Bean Adoption in Buboka District, Tanzania – *by: M. V. Gottret, L. Mukandala, J. Mafuru and S. David*

1999 Milestones

- An analysis of the factors influencing the adoption of Lyamungu 90 in Buboka District, Tanzania, to complement the existing descriptive analysis was proposed and started.

Background

Bean production characteristics in Buboka District

Beans play a major role in the domestic economy of the banana-coffee-based production system of Buboka District in Tanzania. Although rainfall follows a bimodal pattern, the *vuli* season (September-November) is more favorable for bean production. Only 40% of households grow beans in the *masika* season (March-May), when rainfall is heaviest and temperatures and light intensity is lower. As such, yields are significantly higher in the *vuli* season than in the *masika* season: 998 kg/ha compared to 260 kg/ha. In contrast with most eastern Africa populations, the Haya, the dominant group, have a strong preference for small-seeded bean varieties which are traditionally eaten mashed with plantains, sweet potatoes or cassava. While both small and large seeded beans are sold, the former has low demand and commands a lower price.

In Buboka district beans are grown in two distinct land use patterns. The first is called *kibanja (*spelled *vikanja)*, where beans are grown intercropped with permanent crops such as bananas (cooking, brewing and sweet), coffee (mainly robusta) that are planted near the homestead and in pure stand. The other land use type is called *kikamba (*spelled *vikamba)*, where beans are planted intercropped with other annual crops such as maize, cassava, yams, sorghum and groundnuts). Production in *kikamba* is usually less and is consider risky, especially under low rainfall conditions due to the poor water holding capacity of soils in *kikamba* fields. As such most food crops are grown in kibanja fields where women provide most of the labor in bean production and play a key decision-making role.

Beans became an important cash crop in high potential areas of Buboka District in the 1980s as a result of crop failure in drier areas of the country, which reduced the production of beans, and the increased demand from Rwandan refugees and other areas of the country. Farmers responded by expanding bean areas on both *kibanja* and *kikamba.* This increase on importance of beans for income generation resulted in changes in farmers' varietal profiles and the gender organization of production. With respect to varietal profiles, farmers adopted a dualistic production strategy of growing small seeded varieties for own consumption and large seeded varieties for sale. In terms

of gender organization of production, male involvement in bean production increased either through independent male production or by increasing the participation of males on decision-making.

The introduction of new bean varieties

The most widely grown varieties in the region are called Rosecoco (either K20 from Uganda or a local Calima seed type variety). Two bean varieties, Lyamungu 85 and Lyamungu 90, were developed for mid-altitude zones of Tanzania such as the Buboka District. The characteristics of the two varieties, which are indistinguishable to the untrained eye, are summarized in Table 1.

Table 1. Characteristics of bean varieties Lyamungu 85 and Lyamunge 90

Characteristics	Bean variety	
	Lyamungu 85	Lyamungu 90
Growth habit	Type IA	Type IA
Seed color	Dark red mottled	Red mottled
Seed size	57.39/100 seeds	49.99/100 seeds
Maturity	70-89 days	70-89 days
Expected yield	1500-3594 kg/ha	1000-3452 kg/ha
Cooking time	48 minutes	49 minutes

Between 1989 and 1992, 5-6 farmers in each village of Buboka District hosted researcher-design on-farm trials with both varieties and had access to the new varieties since they were instructed to use the seeds as they liked after completion of the trials. However, the amount of seed received by those farmers was limited to about 100. In September 1992, 120 kg of variety Lyamungu 90 was distributed to 240 farmers in 15 villages in Buboka, Muleba and Karagwe Districts of the Kagera region in the west of Tanzania. In Buboka District, 69 kg of seed was distributed to 138 households in 7 villages located in diverse bean production potential areas (high, medium and low potential).

Objectives of the study

The overall objectives of the study were:

- Document the adoption of variety Lyamungu 90 five years after initial seed distribution.
- Assess the impact of the new variety on household income, production organization, land use patterns, male involvement in bean production and varietal diversity.
- Analyze the factors influencing the adoption process of Lyamungu 90 and predict future adoption patterns.

Methodology

Data collection

A formal survey was conducted in February 1998 in nine villages classified according to their production potential as shown in Table 2. In each production potential area, three villages were selected: one where seed had been distributed directly or through on-farm varietal trials (participating village) and two neighboring villages. A total of 50 households were randomly selected in each "participating village", and 25 in each neighboring non-participating villages, giving a total sample of 300 households.

Table 2. Survey sampling strategy and size

	Production Potential Area					
	High potential		Medium potential		Low potential	
	Village	sample size	village	sample size	village	sample size
Participating village[a]	Kabalenge	50	Ntoija	50	Mugaza	50
Non-participating villages	Mtakuja	25	Kasharu	25	Kigarama	25
	Kahaba	25	Kishogo	25	Buhanga	25
Total sample size	100		100		100	

[a] Participating villages are those where seed had been distributed directly of through on-farm varietal trial.

A questionnaire was designed including the following themes: (1) characteristics of the farming system, (2) socioeconomic characteristics, and (3) awareness and adoption process of variety Lyamungu 90. The adoption of Lyamungu 90 was verified by visual identification from a sample of seed. For this purpose, enumerators were trained to distinguish between the new varieties and Rosecoco. Parallel to the questionnaire application, wealth indicators were identified with the communities using the wealth-ranking methodology. Based on these results, households were classified in four wealth categories as follow: rich (2%), above average (16%), average (66%) and poor (16%).

Analysis of the factors influencing the adoption process

Three models are being estimated to analyze the factors influencing the adoption of Lyamungu 90 (L90) to see which one explains the adoption process better:

1. Binomial Logit Model: This model assumes a logistic distribution, and for its estimation a binary dependent variable, A, is being used; A=1 if the farmer grew L90 in vuli 1997, and A=0 if the farmer did not grow L90 in vuli 1997.

2. Multinomial Logit Model: This model also assumes a logistic distribution, but uses a sequential categorical variable, CA, as the dependent variable. Therefore, the dependent variables takes the following values: CA=0 if the farmer doesn't know

L90, CA=1 if the farmer knows L90, but never grew it, CA=2 if the farmer grew L90 before vuli 1997, but stopped planting it afterwards, CA=3 if the farmer grows L90, but did not grow it in vuli 1997, and CA=4 if the farmer grew L90 in vuli 1997. Categories CA=3 and CA=4 can also be grouped into one category: "the farmer continues to grow L90." Therefore, this model will determine the effect of a set of characteristics of the individual which influence the adoption process at three levels: (1) access to information about the new variety, (2) decision to plant (experiment) with the new variety, (3) decision to continue planting the new variety (adoption).

The multinomial logit model gives more information than the binomial logit model since it let us conduct the analysis at three levels: what characterizes those farmers who had access to information about the new variety? what characterizes those who decided to experiment? Finally, what characterizes those who adopted the new variety?

3. Tobit Model for Censored Data: This model uses a continuos dependent variable, which in this case is defined as the percentage of bean area planted to L90 in vuli 1997. In this model, the dependent variable takes values > 0 if the farmer adopted the new variety, and takes a value of 0, it the farmer did not adopted the new variety. Therefore, the dependent variable is limited in its range, and if an OLS (ordinary least square) model is estimated, the results will be biased, even asymptotically.

The independent or explanatory variables, which are being used to explain the adoption process, are the following:

1. Wealth category: As explained before these categories were defined based on wealth indicators identified by the community. The indicators used were: (1) use of hired labor (households who hire labor are considered better-off than those who does not), (2) house type, (3) frequency of using manure (applied to bananas specifically and not beans) and (4) surplus food production. The variable takes the following values: 1 = rich, 2 = average, and 3 = poor.

2. Household type: 0 = male headed households, and 1 = female headed households.

3. Involvement in varietal trials: 1 = yes, and 0 = no

4. Sex of main and second farmer: 0 = main and second farmer in kibanja are males, 1 = a combination of male and female farmers in kibanja, and 2 = main and second farmers in kibanja are females.

5. Use of beans: 0 = subsistence farmer, 1 = subsistence and market-oriented farmer (double purpose), and 2 = market-oriented farmer.

6. Decision-maker on bean crop: 0= male only, 1= female only, 2= male and female together, and 3= male and female on separated fields.

7. Production system: 0 = household grows beans only on kibanja, and 1 = household grows beans on both kibanja and kikamba.

8. Importance of beans on income generation: position that beans where ranked according to its importance for income generation.

9. Age of household head: Number of years

10. Experience growing beans on kibanja: Number of years of experience

11. Production potential zone: 0 = low potential area, 1 = medium potential area, and 3 = high potential area.

Results

Descriptive results from the survey show that 27% of the households had ever grown L90, but only 11% of them (33 households) still had seed of the variety at the time of the survey and 9% (27 households) planted the variety in *vuli* season 1997.

Some preliminary results were already obtained from the models proposed to analyze the factors influencing the adoption process; however, they require a careful examination because of the small number of adopter observations. One of the necessary conditions for these models to run is that there should be at least the same number of non-adopters (0s) or adopters (1s) as dependent variables. In this case, 17 independent variables are being used and since there are 33 adopters, or 1s, there is no problem in estimating the model. However, because of the small number of adopters compared with the number of non-adopters, the significance of the explanatory variables is low, and therefore the explanatory power of the model. Only one variable was found significant at a confidence level of less than 0.05, and is the involvement in varietal trials. As expected, the probability of adopting the variety is significantly greater in those households who participated in on-farm trials.

A proposed methodology for this type of situations is to take a sub-sample of non-adopters and run the model with a small number of observations. This option, among others, is actually being consider for further runs of the model.

Staff Involved:

- James Garcia, Ms Statistician and Database Specialist, Impact Assessment Project

2.2.F. Bean Adoption-Honduras. *by: Nancy Johnson and Justine Klass*

Highlights

- Past estimates of the economic impact of bean varieties that are resistant to bean golden mosaic virus (BGMV) may significantly under-estimate their true impact by failing to account for the value of yield losses avoided as well as yield gains realized. In the case of the main bean producing region of Honduras, if crop losses associated with the virus are between 50 and 90 percent, the results of this analysis suggest that the underestimation of impact is between 84 and 92 percent.
- Results of a poverty mapping exercise using data from the Honduran Population Census show that many of the areas targeted by the BGMV-resistant varieties were also areas of high poverty, where poverty is defined by the percent of the population with 40 percent or more of its basic needs unmet.
- According to a participatory poverty assessment carried out in Honduras, inability to cope with an unexpected crisis such as a crop loss or a major illness is one of the defining characteristics of poverty. To the extent that resistant bean varieties reduce the risk of crop loss, they can contribute greatly to poverty alleviation even if they do not increase yields dramatically. Poverty seems to be defined as much by wealth variability as by wealth levels, and resistant varieties can reduce variability.

Progress Report

Background

This study draws upon results from many different research projects in CIAT with the goal of better understanding the impact of improved bean varieties on agricultural production and on poverty. The paper was prepared with the collaboration of researchers in IP1 and the Whitefly project for the International Workshop on the Impact of Agricultural on Poverty Alleviation in Sept. 1999. Planned future work includes refining the model for predicting BGMV incidence, and using the simulation to quantify exactly how much adoption and impact occurred in areas of significant poverty. The empirical analysis will be extended beyond a small study region to a national analysis.

Introduction

In the 1970s, bean golden mosaic virus (BGMV) began to spread throughout Middle America, threatening the production of beans, an important food crop in the region. Controlling BGMV became top priority among bean breeders in the region, and by the late 1970s, their efforts had resulted in the release of a first generation of virus-resistant bean varieties to farmers. These varieties were quickly and widely adopted. By 1996 an estimated 40 percent of the bean area in Central America was planted to resistant varieties, often reaching as high as 80 percent in BGMV-affected regions (Viana, 1998; Viana et al, 1997). In 1984, CIAT was awarded the King Badouin Prize for its work on BGMV in Central America.

The cumulative value of the increased production that resulted from the new varieties has been estimated at over $200 million dollars in 1998 (Johnson, 1999).[1] In 1998 alone the impact was estimated at over US$17 million. While these benefits far surpass the costs associated with bean breeding research over the years, they are likely to underestimate the real benefits of disease resistant bean varieties.

One reason is that conventional *ex post* impact assessment is based on observed differences in yields of traditional and improved varieties in farmers fields. Since one of the main benefits of a disease resistant variety may be to maintain existing yields in the face of disease pressure, it is difficult to capture the full benefits of the new varieties by looking at observed yields alone. The appropriate comparison is between the observed yields of improved varieties and the yields that we would have observed with traditional varieties under similar circumstances in the absence of improved varieties. Since collecting survey data on the latter is not possible, this paper attempts to estimate the magnitude of the production losses that were averted as a result of BGMV-resistant varieties by looking at experimental data and at the results of a climate-based GIS statistical technique that created risk maps of BGMV incidence. The analysis is done for the case of Honduras, an important bean producer in Central America.

Another reason why the economic value of the observed increase in bean production that resulted from improved varieties may not capture their full social benefit is that the dollar value alone does not tell us about who received benefits nor how they were used. Since IARC's goals include both increasing agricultural productivity and reducing poverty, if a technology can be shown to have contributed to poverty alleviation, then this is an important impact over and above the economic value of production. To understand the relationship between the new varieties and poverty, we need to go beyond monetary value and look at where the impacts occurred, who benefited from them, and how the beneficiaries' wellbeing was affected. Using the results of recent studies on how to define, measure, and map poverty in Honduras, this paper will identify where and how improved bean varieties have contributed to the alleviation of poverty among bean producers.

The paper is organized as follows. Section 2 looks at bean production in Honduras, with particular reference to the problem of whitefly and BGMV. Section 3 presents the model and results of an estimation of the expected benefits from improved varieties based on the expected value of production with and without improved varieties. The results are then compared with those of conventional impact analysis. Section 4 relates this economic impact to poverty alleviation in Honduras. Section 5 summarizes the results of the analysis and discusses their implications for research and for policy.

2. Bean Production and Producers in Honduras

Beans are one of the two most important crops in Central America in terms of both production and consumption. Beans are a traditional part of the diet in Central America,

[1] Value is in 1990 dollars.

and beans, along with maize, often form the main food source of the poor. In 1997 per capita consumption is reported to be between 9 and 21 kilos per year, however it varies greatly depending on the economic level of the consumer (Viana et al, 1997). Within the category of basic grains, beans are second only to maize in area planted, and are the number one source of farm income (Viana, 1998).

Honduras is the third largest bean producer in Central America following Nicaragua and Guatemala. In 1998, 83,000 hectares were sown to beans, slightly more than in 1970 but less than the high of nearly 120,000 ha planted in 1994 (Chart 1). Production has been similarly variable (Chart 1). During the period 1970-1998, the area planted increased by a total of 16 percent and production increased by 18 percent with the difference due to small increases in yield (Chart 2).

The main bean production area is in the central and central-eastern part of the country, where approximately 60 percent of production occurs (Map 1; Martel and Bernsten, 1995). A 1993 study by the Bean/Cowpea CRSP conducted in this zone found that a third of Honduran farmers planted beans (ibid.). The farms were generally small--average area planted to beans was 1.08 has—and were considered non-commercial in the sense that their production was primarily for home consumption, though surpluses were sold on the market. The degree of market participation of bean farmers has grown over time (Schoonhoven and Pachico). In the past most farmers produced primarily for their own consumption, however, according to the survey, in 1993 only 13 percent of farmers neither bought nor sold beans. Half reported selling and 37 were net buyers (Martel and Bernsten.)

The survey also found that smaller farmers plant relatively more beans than larger farmers, suggesting that it is a more important crop for the smaller farmers. Big farmers are more commercially oriented, but the income earned from beans is relatively more important to the small farmers since it makes up a greater portion of their income. In terms of production practices, there is no difference in chemical use between small and large farmers (Martel and Bernsten).

The main production constraint in the region is BGMV (Martel and Bernsten). The virus arrived late to Honduras, where the first reported incidence was in 1985. In 1989, there were severe outbreaks with crop losses ranging 10 to 100 percent (Rodriguez et al, 1994). Whiteflies cause extensive crop damage both as a pest and a vector. Whiteflies are phloem feeders, hence they directly contribute to reduced plant productivity by consuming the nutrients carried in the phloem. In addition, they produce a honeydew that grows a sooty mould which contaminates fruit and vegetables and reduces plant productivity. Specific whitefly species also act as a vector of plant pathogens and transmit plant diseases, such as *B. tabaci* transmitting BGMV. *B. tabaci* transmits the virus in a semi-persistent persistent manner. This means the virus needs time to be acquired and transmitted (Morales, 1994). The virus is retained when the vector moults but it does not multiply in the vector and it is not transmitted congenitally to the progeny of the vector. It can be transmitted by grafting but not by contact between plants, seed or pollen (Brunt *et al.*, 1996). Map 2 shows virus susceptible areas in Honduras.

The first resistant variety , Dorado, was released in 1990 and several others soon followed (Table 1). The varieties spread quickly, and by 1996 adoption rates were as high as 80 percent in some areas (Viana et al, 1997, Martel and Bernsten; Map 3). No association was found between adoption of Dorado and farm size, which suggests small farmers are just as likely to adopt the variety as large farmers (Martel and Bernsten). This makes sense since resistant varieties, unlike some high yielding varieties, are not dependent on costly chemical inputs or optimal growing conditions to make them perform. They can be adopted without significant changes to the production system. Martel and Bernsten do find an association between farm size and adoption of another improved variety, the high-yielding but non-resistant Catrachita which was released in Honduras in 1987. This may reflect greater risk aversion on the part of small farmers since it appears that yield alone is more attractive to larger than smaller farmers.

In terms of yield, which variety is highest yielding variety depends on many factors, and is therefore highly variable. Honduras has two growing seasons, the *primera*[2] and the *postrera*,[3] with the latter being the main production season. Martel and Bernsten found that Catrachita is highest yielding during the *primera* and Dorado during the *postrera*. These results are consistent with the fact that the virus is only a problem in the *postrera* (Rosas, 1999). Dorado offers no significant advantage over traditional varieties in the *primera* but does in the *postrera*. The fact that the resistant variety appears to offer a yield advantage only in the virus season supports the idea that it is not the variety's yield potential but rather its reduced yield variability that makes it valuable to farmers.

In terms of price, traditional varieties generally sell for higher prices than improved varieties. This reflects the fact that traditional varieties have been selected by farmers over generations to exhibit the desired production, processing and consumption characteristics of the region. Improved varieties must often sacrifice certain desirable characteristics in order to obtain high yield or disease resistance. In the case of beans in Honduras, for example, Dorado does not have the light red color that is most valued in the region, and is also reported to have some undesirable cooking characteristics. This accounts for the improved variety's lower market price relative to the traditional variety.

3. The Economic Impact of Virus-Resistant Varieties: Getting the Counterfactual Right

To evaluate the impact of a new variety we want to compare the situation with the new variety to what would have occurred had the new variety not existed. In many cases, if both traditional and new varieties continue to be planted, the yield of the traditional varieties can be used to represent the counterfactual, which is the situation that would have occurred if there had never been improved varieties. Many impact studies of improved resistant varieties have been done based on observed yield differences. In Honduras, yield advantage of BGMV-resistant varieties has been observed to be between

[2] *Primera* refers to the first growing season, which is from May to September.
[3] *Postrera* refers to the second growing season, from September/October to December/January.

0 and 38 percent, averaging about 18 percent (Viana, 1998; Viana et al, 1977 ; Martel and Bernsten).

In the case of varieties whose main advantage is a high yield, the comparison between traditional and improved varieties may be appropriate because the observed yield increase is the main benefit of the variety. In the case of resistant varieties, however, observed yield differences may not tell the whole story. The value of a resistant variety may not be that it obtains higher yields than were possible with traditional varieties, but rather that it maintains its yield in the presence of pests and diseases. This suggests the need for a way to measure the losses that did not occur as well as the gains that did.

Data on observed yields are collected from farm-level production data. In experimental trials, trial plots are either selected randomly, or they are chosen with great care to ensure that different varieties are grown in comparable conditions in order to be able to compare the results. We would not expect farmers to make planting decisions based on either of these methods. Farmers decide what to plant where based on their own criteria, among them how they can obtain the highest output.

If the location of the field or choice of cropping pattern affects the expected damage from BGMV, then we would expect farmers to take this information into consideration when deciding what to plant where. For example, areas where the likelihood of virus damage is high would be expected to be planted to resistant varieties whereas areas where the probability of virus damage is low may be planted to the higher priced traditional varieties. In a sense what farmers are trying to do is minimize the observed difference between traditional and improved varieties, planting traditional varieties where possible and improved varieties where necessary.

Therefore we can say that if certain conditions exist—namely that farmers have a choice between traditional and improved varieties, that probability of virus is not random but rather correlated with farm characteristics, and farmers maximize profit—then it will not be appropriate to interpret the yields of traditional varieties, as observed in selected fields, as representative of what yield would have been if traditional varieties had been planted over the entire bean area. Observed yields of traditional varieties will be higher than what would have been observed in the absence of the option of a resistant variety.

One way to more accurately estimate the benefit of improved varieties would be to use data from experimental trials which control for the biases described above (Smale et al, 1998; Morris el al, 1994). A sample of data for Honduras show that the resistant variety (Dorado) has a yield advantage of between 0 and 59 percent over the traditional local varieties.[4] Caution must be used in interpreting results of experimental trials since yield observed in trials are general much higher than in farmers fields. However the results of the experimental trials do suggest that in areas where disease pressure is high, the benefits of improved varieties may be greater than what we observe in the field.

[4] 1992 data from Voysest (add citation) and El Zamorano, nd, "*Tio Canela.*"

Another way to estimate the benefits of improved varieties is to simulate what production would have been in the absence of improved varieties. If information is available about the determinants of disease incidence and intensity, it may be possible to estimate what production would have been in the absence of new varieties.

Klass et al (1999) describe several methods for predicting the probability of virus occurrence based on the geographical and climatic characteristics of an area. The dynamics of BGMV are complex and are determined my many factors, however geographical and climatic conditions are considered by virologists to be significant determinants of virus occurrence. Therefore statistical analysis can be used to predict the probability of occurrence based on where the virus has been observed in the past.[5]

Klass et al test several techniques for predicting the occurrence of BGMV in Central America. For the case of Honduras, the most accurate appears to be a Fourier transform with principle components analysis, a process developed to help scientists and other plant collectors identify likely areas for finding specific plant species (Jones et al, 1997; Jones and Gladkov, 1999). Map 4 shows the results of the analysis for Honduras. The map shows the spatial distribution of the probability of virus incidence throughout the country. using this information we can calculate the expected value of production with and without improved varieties, we can get an estimate of the full benefit of improved varieties, including crop losses which did not occur because resistant varieties were available.

2.1 Empirical Estimation

In order to do the calculation, we need data on yields and on damage from the virus. In terms of virus damage, observed crop losses due to the virus range from 10 to 100 percent in Honduras. In the absence of information on the geographical determinants of virus intensity, we do the analysis for different levels of crop damage and compare the results. [6]

The other parameters used in the simulation are presented in Table 2. For simplicity, we will only consider the cases of one traditional variety, *Rojo de Seda*, and one improved variety, Dorado. Since the *primera*, there is no yield difference between traditional and improved varieties, we use yield from that season as base estimates of yield potential of the variety. As discussed earlier, the price of traditional varieties is generally higher than resistant varieties due to their market characteristics. In this case, the traditional variety sells for 19 percent more than the resistant variety.

In the absence of resistant varieties, we can estimate the total expected value of production as:

$$_{p}\,[(1-p)*(Y) + p(Y)(L)]* H_p * P$$

[5] It should be noted that this GIS model will be expanded to include other factors that affect BGMV, perhaps most importantly cropping pattern in the area.

[6] Results are only reported for an average loss of 50 percent however for the conference we will have results for different levels of crop loss.

where p is the probability that the virus occurred, Y is yield of the traditional variety, L is loss due to virus, H_p is the number of hectares with probability p , and P is the price of the traditional variety.

In the case where farmers have the choice to plant either improved or traditional varieties, if we assume that each farmer wants to maximize the expected value of his or her production, than we can determine aggregate production by setting expected value of production with traditional varieties equal to expected value with improved varieties and solving for the probability that makes the expected values the same. All the area with probability of virus occurrence higher than this threshold probability will be planted to the improved variety since the expected value of production is higher. All the area with probability lower than the threshold value will be planted to the traditional variety.

2.2 Results

The analysis was done for bean producing areas of the states of Francisco Morazán and El Paraíso (Map 5). The results are presented in Tables 3 and 4.[7] As shown in Table 3, depending on the level of crop damage associated with the virus, the production gain with improved varieties ranges from 7 to 58 percent, which is above the range of field observations, and in line with what experimental data suggest.

According to the simulation results, the level of adoption of the new variety ranged from 61 % when crop damage was 90 percent to only 30 percent when crop damage was 25 percent. Actual adoption of improved varieties is about 73 %, with 50 percent of that area devoted to Dorado (Viana, 1997). Given that some of the improved varieties are not resistant, the actual adoption level of resistant varieties is slightly lower, in the range of 65 percent. These results suggest that the model, while highly simplified, does an accurate job of predicting adoption. It also implies that the expected crop damage is quite high.

Table 4 reports the average yields of the different varieties with and without resistant variety. By using data from farmers fields, we are comparing yields between traditional varieties ($Yield_{TR}$) and improved varieties ($Yield_R$) under Scenario 2. Under this scenario in which improved varieties are available, the average traditional yields were between 5 and 6 percent higher than the average improved yields. However when we compare the traditional yield under scenario 1 ($Yield_{TT}$) with the average yield under Scenario 2 ($Yield_A$), we see that the latter is up to 11 times greater than the former, depending on the level of crop damage. If the level of crop damage is low, then there is little difference between $Yield_{TT}$ and $Yield_A$ but when it is high, the difference is very large.

These results clearly demonstrate that appropriate specification of the alternative scenarios—with and without the technology—can be potentially very significant in estimating the impact of a new technology. Both the experimental data and the simulation results suggest that estimates based on observed data underestimate the total

[7] See Appendix 1, a technical note on the estimation procedure.

impact of resistant varieties since an important part of their contribution is to maintain yields.

3. Poverty in Honduras

The results of the previous sections show that disease-resistant bean varieties have contributed to a significant increase in bean production, and in bean farmers' incomes. While the size of the economic benefits that resulted from the research is an important indicator of its impact, the dollar value alone does not tell us very much about the impact of the research on poverty. We need to do more analysis in order to understand how these benefits of increased production translate into changes in the lives of the poor.

Fortunately, in the case of Honduras several studies exist about to define, measure and map poverty. The results of the studies provide insights into who the poor are, where they are, and why they are poor. By carefully examining the conclusions of these analyses and comparing them to what we know about the diffusion and economic impact of improved bean varieties, we can identify where and how bean varieties have contributed to the alleviation of poverty.

3.1 How to define poverty

How to define poverty has become an important research question both conceptually and empirically. Traditional measures such as income or expenditure are increasingly being criticized as inadequate indicators of human welfare. While such monetary measures have advantages in terms of comparability across space and time, they often fail to capture non-monetary aspects of standard of living—very important in many developing countries—and can be difficult to estimate reliably due to a reluctance on the part of individuals to reveal how much they earn. Alternatives methods are being developed to more accurately identify and understand poverty.

3.2 Measuring and mapping poverty in Honduras

Honduras has been the focus of several different poverty measurement exercises in recent years. In one study, census data were used to create a national poverty map that ranks each village according to the degree to which residents' basic needs were satisfied (see Oyana et al., 1998). In another study, the focus was on identifying and understanding local people's perceptions of poverty (Ravnborg et al, 1998). While this study does not provide a national map of poverty, it does provide a more nuanced definition of poverty as well as clear and easy to observe indicators of wellbeing. Because the poverty indicators are in terms of local people's activities, assets and livelihoods, they make it possible to relate the impact of technical interventions such as new crop varieties to directly to changes in poverty. Together the results of the two poverty analyses allow us to identify where and how these impacts occurred in the case of improved bean varieties.

3.2.1 Material standard of living: the Unsatisfied Basic Needs (UBN) Approach

In 1996, CIAT undertook a project to measure and map poverty in Honduras basedon census data (Oyana, 1998; PE4 Annual reports, 1997 & 1998). The data come from the 1988 Honduras Population Census and are calculated at the *aldea* (village) level (SECPLAN, 1991). The approach was called the Unsatisfied Basic Needs (UBN) method and involves the selection of basic needs criteria, and the identification of measurable indicators of the level at which these needs are satisfied (Boltvinik). In the case of the CIAT study. The basic needs identified were quality housing, access to basic services, ownership of non-land assets, and education. For each of these basic needs, several measurable indicators were also identified. In the case of housing quality, for example, the measurable indicators were the materials used in construction of the walls, floor and roof. In the case of basic services, measurable indicators were water source, use of latrine, presence of electricity, and fuel source (See Oyana et al, 1998)

After selecting the criteria and indicators, minimum standards and level of unsatisfaction were identified. Communities were rated according to their average level of satisfaction of the minimum standards. Five levels of poverty were identified (Table 5). The poorest households, Level 1 in the analysis, had average unsatisfaction levels of 85 percent or higher. Level 4, the so-called threshold level, includes communities that on average meet the minimum requirements. In level 5 communities, an average of 55 percent of families exceed the minimum requirements. Map 6 shows the distribution of statistically-significant areas of poverty in Honduras according to the UBN criteria.[8]

3.2.2 Participatory poverty assessment

In 1996 a participatory poverty assessment (PPA) was carried out by BID/DANIDA/CIAT in three states in Honduras: El Paraíso, Yoro, and Atlantida (Ravnborg et al, 1998). The poverty index identified by the PPA has eleven components (Table 6). The components of this index have been statistically validated and can be considered representative of the larger population which the sample communities represent. Some indicators, like income, housing quality and asset ownership, are elements of more conventional poverty measures. However according to the PPA local people complement these measures with others such as the ability to contract day-laborers, degree of involvement with agricultural output markets, access to health and health care, participation in financial markets, and food security.

It is also interesting to note what potential indicators did not turn out to be significant in the PPA wellbeing index. In terms of agricultural production, production of basic grains alone was not a distinguishing factor between rich and poor households. This is likely due to the fact that most households were producers of basic grains. However the amount of land people owned and the extent to which they participated in the market

[8] The statistically significant poverty areas were calculated using the geographical analysis machine (GAM) (Openshaw, 1997). GAM was developed to identify localized patterns in spatial data without prior knowledge of where to look. It treats all points equally and assumes all patterns are localised clusters without the need of additional information of scale or frequency of these patterns.
The final results illustrated the statistically significant poverty areas using the three and four basic factors as defined by Couillard et al (1997).

were associated with well being. This is consistent with what Martel and Bernsten find, namely that the larger market-oriented farmers are better off than the small, subsistence-oriented farmers.

In a companion study for three Honduran watersheds (Río Saco in Atlantida, Cuscateca in El Paraíso, and Tascalapa in Yoro) aimed at understanding the relationship between poverty and natural resource management, residents were surveyed about agricultural and NRM practices (Ravnborg et al, 1999). Their answers were later classified according to well-being level, as determined by the participatory index described above. The analysis finds no significant difference between well being levels in terms of land use or production practices, as measured by land preparation, use of chemical inputs, or use of crop varieties. Rich and poor do not use different agricultural technologies, at least not in the production of basic grains such as maize and beans. This suggests that benefits of technologies such as improved varieties are not only being appropriated by the better-off farmers.

3.3 Interpretation of different measures: the case of beans

In this analysis we are interested in the impact of improved bean varieties on poverty. Overlaying the poverty map and the bean production map reveals a significant area of overlap (Map 6). Adding the virus map shows that the target area for disease-resistant varieties also coincides with areas of moderate to extreme poverty. Since the poverty map is from 1988, before the release of the first resistant variety, it can be interpreted as the "before" picture upon which to base the design and targeting poverty alleviation efforts.

Given the way poverty is defined in the UBN indicator, however, it is difficult to draw conclusions about the direct impact of new varieties on poverty. We have shown that new varieties increase the expected value of production for farmers. Given that most bean farmers are small producers who produce for both home consumption and for sale, and given that we have evidence that both rich and poor producers adopt the same varieties, we can say that small farmers have increased their production and incomes as a result of the varieties. According to the results of the simulation in Section 3, 40 percent of the total economic benefits from new varieties occur in areas of statistically significant poverty.

While the geographical coincidence of poverty and economic benefits from a new technology is certainly suggestive of an impact on poverty, it alone does not guarantee that poverty was reduced. To make that conclusion we need to know more about what happened at the individual and household level as a result of the increased production and income. This is the type of information we can obtain through an analysis of the results of the PPA, which provides links between household economic activity to underlying determinants of poverty.

First, one of the components of the PPA well-being index has to do with market integration, particularly with respect to basic grains (maize and beans). Self sufficient

producers and net buyers are considered to be less well off than net sellers. Since there is no evidence of a correlation between variety use and wellbeing level, and since the benefit of the technology is to increase production, the technology clearly had an effect on poverty by increasing net bean sales for adopting producers. Net buyers moved closer to self sufficiency, while self sufficient producers and net sellers increased their incomes. According to the PPA index, this change would represent an improvement in producers' wellbeing.

Second, to the extent that producers increase their cash income as a result of the new variety, the index offers several avenues for linking increased cash income to well being, for example, improving housing quality, purchase of animals, or savings. Similarly, to the extent that increased production reduces the chance of food shortage, it also contribute directly to poverty reduction. In some cases these conclusions appear similar to what the UBN analysis suggested, however the difference is that in this case community residents themselves identified the mechanisms that relate increased income to household well being. This makes the argument that the increases in production contributed to poverty alleviation much more powerful.

A third way that the disease-resistant varieties contribute to poverty reduction is to reduce the risk associated with bean production. There is a vast literature on the relationship between risk aversion, wealth, and agricultural production, in particular on how risk affects small farmers (Moscardi and de Janvry, 1977; Dillon and Scandizzo, 1978; Binswanger, 1980; Rose and Graham-Thomasi, 1986). Both theory and empirical evidence suggest that small, poor farmers are risk averse, which means that they would be willing to trade gains in average yield for reduction in variability of yield. A technology such as a disease-resistant bean variety whose main benefit is to reduce the probability of a large, negative outcome such as crop loss, would be particularly beneficial to small, poor farmers. As the empirical results of Section 3 suggest, this appears to have been the main benefit of the BGMV-resistant varieties in Honduras.

Several of the indicators in the participatory well being index directly link reduction of economic risk to increases in well being. In the indicators about health and food security, the thing that distinguishes the non-poor from the poor is their ability to cope with a crisis like an illness or a food shortage. Those who have the resources to handle these problems on their own without having to seek help from others are considered to be much better off than those who do not.

One of the ways that people handle these crises, according to the index, is by using savings or by selling assets such as land or livestock. Therefore the value of these assets—in themselves indicators of well being—is also related to risk reduction. Selling the assets allows households to smooth their consumption in the face of highly variable production and income.

The importance that poor people place on security and independence—on not having to ask for money, food or employment from family and friends—appears to be a very important aspect of well being that is not captured by conventional poverty measures

(Ravnborg, 1998). Eight of the 11 participatory indicators have some element of risk coping or reduction, [9] reflecting the truly profound role that risk plays in determining the well being of poor households To the extent that disease-resistant bean varieties have contributed to the reduction of uncertainty and dependency by maintaining yields and reducing variability associated with bean production, they have contributed significantly to poverty alleviation.

5. Summary and Conclusions

This paper demonstrates the importance of disease resistant bean varieties in Honduras, both in terms of their economic impact and their impact on poverty reduction. By taking into account not only the production increases observed but also the losses that were avoided, we arrive at a significantly higher estimate of the economic contribution made by the disease resistant varieties.

The analysis of impact also went beyond monetary value to look at where and how the new varieties affected the lives of producers. By comparing maps of bean production and variety adoption with a poverty map based on unsatisfied basic needs, it was shown that a significant amount of the economic benefit from improved varieties was generated in areas where there are moderate to high levels of poverty.

To understand how the resistant varieties contributed to poverty reduction, the benefits of the new varieties are analyzed in light of the results of a participatory poverty assessment that was carried out in Honduras. The poverty indicators that resulted from this analysis link changes in agricultural production and income directly to poverty. Since empirical evidence shows that new varieties have increased production and income in bean growing areas, we can logically conclude that beans varieties have contributed to a reduction of poverty.

Specifically varieties contributed directly to the alleviation of poverty by increasing output, allowing producers to increase net bean sales and income. Perhaps more importantly, the risk reducing nature of the disease resistant varieties helped to increase the household food and economic security, reducing the probability that the household would have to cope with an emergency such as a crop loss. Economic security and the freedom from dependence on others for basic necessities form an important part of household well being, according to local poverty profiles.

These results have several lessons for research and for policy. The first is that accurate impact assessment requires accurate definition of the "with" and "without" situations. Many times the appropriate counterfactual is difficult to identify, and even harder to measure. More attention must be paid to measuring the benefits of varieties that are pest and disease resistant, rapidly maturing, low input, or easy to process. Non-yield characteristics are still often not accorded the importance that increased yields are in impact assessment, simply because there is no easy way to measure their benefits.

[9] Land ownership, selling day labor, income, cattle, animals, money, health, and food security.

Empirical implementation of these studies will also require new data collection and methods of data analysis.

The second conclusion is that it is possible to target research towards poverty alleviation by mapping poverty and areas of impact. In this analysis, the overlaying of bean production, virus incidence and poverty quite accurately identified the critical areas. Adoption studies show that these areas were in fact where impact occurred. Since there are many mechanisms by which agricultural research affects poverty, the geographical coincidence may not be necessary for a project to be well designed and successful. However if the goal of the technology is to benefit producers directly, then this type of spatial analysis can be very valuable. The increasing availability of data and sophistication of analytical tools is making this work much more efficient and effective.

Finally, the way a technology works may be as important as where it works in having an impact on poverty. The more detailed and dynamic definitions of poverty that are resulting from recent research on well-being and poverty can be very useful in identifying which types of technologies will most benefit poor farmers and why. In the case of beans, the fact that varietal selection was not something that was systematically related to wealth suggests that crop improvement may be an appropriate way to target agricultural technology to poverty. Similarly, technologies that reduce risk rather than simply increase average yield may be particularly beneficial to the poorest farmers since they reduce the chance that these farmers will face an agricultural or economic shock with which they are ill prepared to cope.

These concepts of risk aversion and biasing technologies towards small, poor farmers are by no means new (Pachico, 1983). What is new is our better understanding of what poverty is and our better ability, via new empirical methods, to identify specific characteristics of poverty in specific environments with sufficient precision that they can be useful in the process of developing agricultural technologies that contribute to the reduction of poverty.

Table 1 Improved Bean Varieties Released in Honduras

Variety Name	Year Released	Relation to CIAT
ESPERANZA 4	1984	GRU accession from CIAT collection
COPAN	1982	CIAT line
ILAMA	1982	CIAT line
ARAULI 85	1987	CIAT line
CATRACHITA	1987	CIAT line
DORADO	1990	CIAT line
DON SILVIO	1992	CIAT line
ACACIAS 4	1980	CIAT cross locally selected
ORIENTE	1990	CIAT cross locally selected
DICTA 122	1996	CIAT cross locally selected
DICTA 113	1996	CIAT cross locally selected
TIO CANELA 75	1994	NARS cross with CIAT parent
Desarural		Without connection to CIAT
Zamorano		Without connection to CIAT

Source CIAT Impact Assessment Data Base (www.CGIAR.CIAT/IMPACT)

Table 2 Simulation Parameters

Parameter	Unit	Value(s)
Yield of Traditional Variety in *primera* (Y_T)	T/H	.430
Yield of Resistant Variety *primera* (Y_R)	T/H	.430
Price of Traditional Variety (P_T)	US$/kg	.506
Price of Resistant (P_R)	US$/kg	.425
Crop Loss Due to Virus (L)	Pct	90,75,50,25

Source: Martel and Bernsten

Table 3. Estimated Quantity and Value of Increased Production Due to Disease Resistant Varieties with Different Levels of Disease Intensity

	L =90%	L=75%	L=50%	L=25%
Production with improved variety (t)	5736	5714	5744	5595
Production without improved variety (t)	3620	3991	4609	5227
Total production (t)	9356	9705	10353	10882
Pct change in production	58.5	43.2	24.6	7
Adoption rate (%)	61	56	55	30

Table 4. Estimated Yield Changes under Different Scenarios and Virus Intensities

	L=90%	L=75%	L=50%	L=25%
Scenario 1: No Resistant Varieties				
$Yield_{TT}$ (th/h)	.266	.294	.339	.385
Scenario 2: Resistant Varieties				
$Yield_{TR}$ (th/h)	.409	.408	.414	.404
$Yield_{R}$ (th/h)	.430	.430	.430	.430
$Yield_{A}$ (th/h)	.422	.420	.423	.412
Yield Advantages				
$Yield_{R}$ over $Yield_{TR}$	5.0%	5.4%	4.0%	6.5%
$Yield_{A}$ over $Yield_{TT}$	58.5%	43.2%	24.6%	7.0%
Magnitude of difference	11.6	7.9	6.2	1.1

R = resistant
A=average of traditional and resistant
TT = tradition when no resistant available
TR= traditional when resistant was available

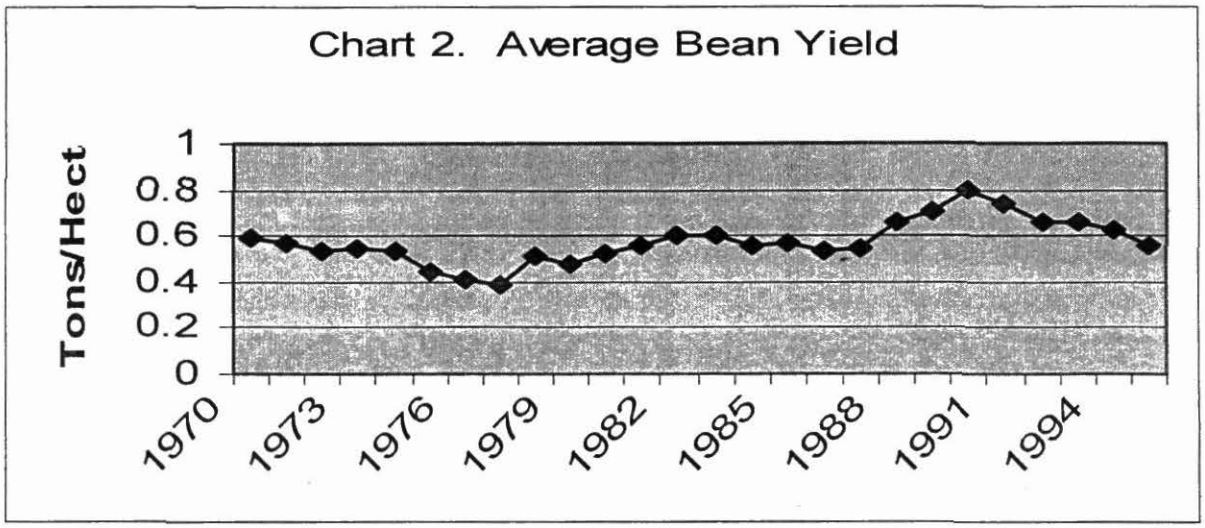
Table 5. Household Poverty Classes in Honduras in 1994 (Unsatisfied Basic Needs method)

Stratum Number	Definition of Poverty	Minimum value of index	Maximum value of index	Average non-satisfaction level of household basic needs (PCT)
1	Extremely Poor	.7	1	85
2	Poor	.4	.7	45
3	Moderately Poor	.1	.4	25
4	Threshold of poverty	-.1	.1	0
5	Non-Poor	-1	-.1	-55

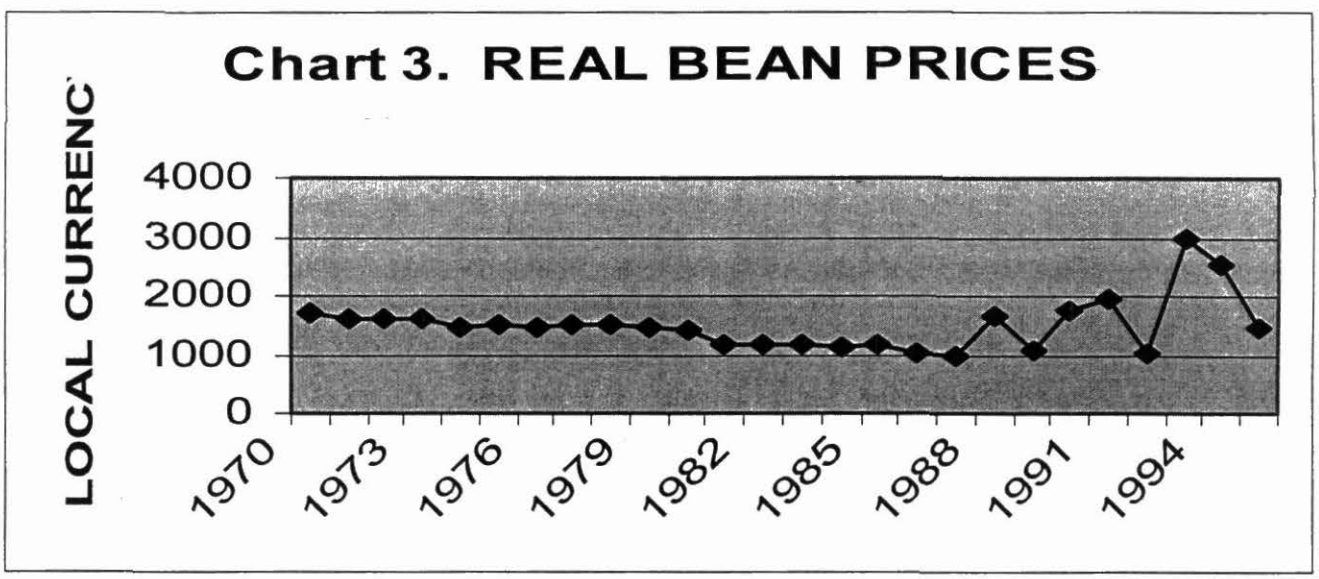
Table 6. Components of the Participatory Well-being Index

Variable	Well being level	Condition
Land Ownership	Highest	The household owns 4 manazanas or more, or has land in pasture or gives land in rent to other farmers
	Middle	Household owns land but fewer than 4 manazanas and doesn't have land in pasture nor land in rent to other farmers
	Lowest	Household doesn't own land or only owns the house and land upon which it stands
Sell Day Labor	Highest	Nobody in the household works as a day laborer and the housewife does not do housework for other families nor prepare food to sell
	Middle	Someone in the household works as a day laborer but either for fewer than 9 months or for more than 9 months but fewer than 3 times a week
	Lowest	Someone in the household works full-time for more than 9 months a year as a day laborer or if the housewife does house work for other families or sells prepared food
Income	Highest	Someone in the household is a professional, a businessman or a merchant or if children or other relatives send remittances
	Middle	Someone in the household is a skilled worker but no one in the household is a professional, businessman or merchant, and the household receives no remittances.
	Lowest	No one in the household is a professional, businessman, merchant or skilled laborer, and the household receives no remittances.
Hire Day Labor	Highest	Household contracts day labor
	Middle	Household does not contract day labor
Cattle	Highest	The household has cattle
	Middle	The household does not have cattle
Animals	Highest	The household owns horses, pigs or oxen
	Middle	Household owns chickens but not horses, pigs nor oxen
	Lowest	Household owns no animals
House	Highest	If the household owns its own house and the house is of good quality
	Middle	Household owns its own house but it is not of good quality
	Lowest	Household owns its own house but it is of very poor quality or does not own its own house
Market Participation	Highest	Household grows coffee or cacao or if household does not buy basic grains and sells half or more of its production of basic grains
	Middle	Household does not grow coffee but buys both buys and sells basic grains or if the household does not but basic grains and sells less than half of its production
	Lowest	Household does not grow coffee or cacao and it buys basic grains in addition to using all of its production for home consumption
Money	Highest	Household has a savings account or makes loans to others
	Middle	Household does not save nor make loans
Health	Middle	No one in the house was sick or if someone were sick he/she paid for adequate health care either with own money or by selling assets
	Lowest	Someone in the household has health problems and they were treated by asking relatives for money, borrowing money, or by going to the herbalist, or they were untreated for lack of money
Food Security	Middle	Household has not experienced a food shortage, or did for less than a week and solved it without having to ask others for food or money, to reduce number of meals, or to send the wife or children out to work
	Lowest	Household experienced a food shortage for more than a week, or of less than a week but had to solve it by asking for food, by borrowing money or by sending wife and children out to work

Source: adapted from Ravnborg et al, 1998

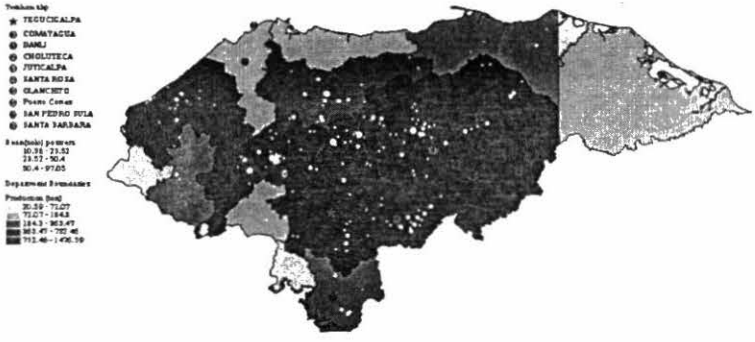


Source: FAO



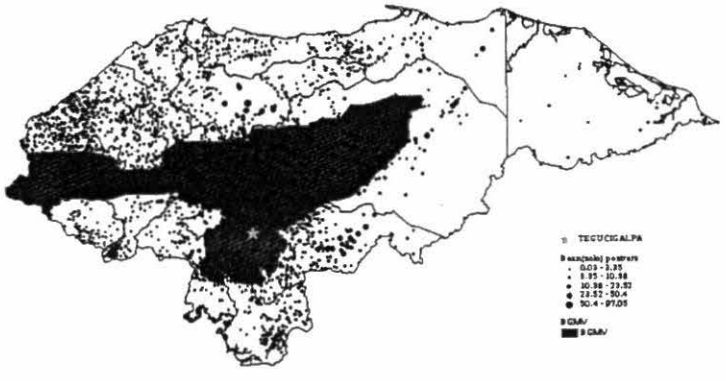
Source: FAO

Map 1: Bean production (1993) areas in Honduras (postrera)



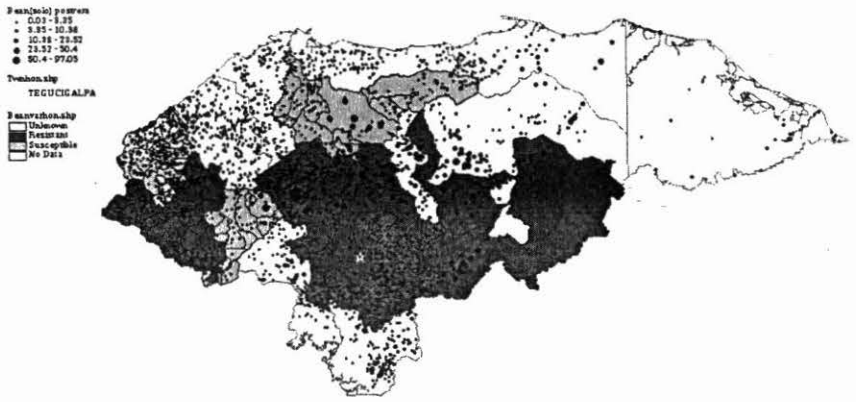
The darker the area the greater the bean production.

Map 2: Virus Area with Beans

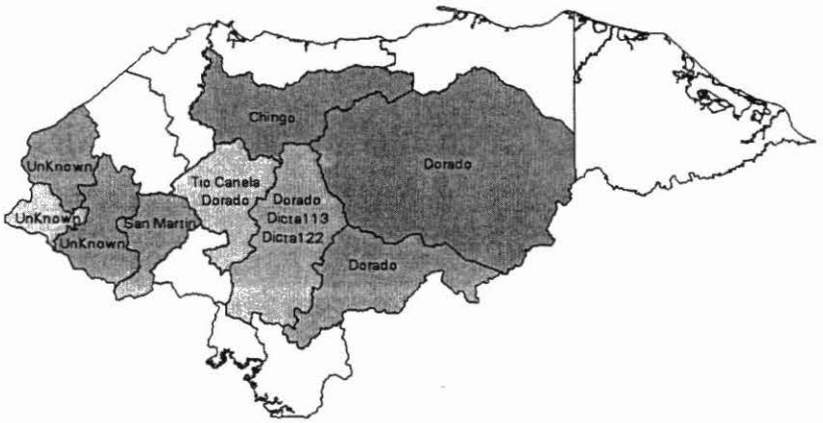


Note blue striped area contains BGMV virus
Source: Morales (1994)

Map 3: Areas of adoption of new varieties mapped as resistance to BGMV



Map 3a: Varieties being used in each department



92521

OUTPUT III: TOOLS DEVELOPED TO ASSESS IMPACT OF RESEARCH

3.1 Data Base Development - by: *J. A. García*

Durante 1999 se realizaron labores de obtención, compilación, actualización y adición de datos clave a la mayoría de las bases de datos que el proyecto BP1 ha venido manteniendo, desde hace varios años, con el propósito de disponer de sistemas de información que puedan servir de apoyo, en un momento dado, al proyecto de Evaluación de Impacto, a los proyectos de investigación del CIAT y a los diferentes proyectos de instituciones e investigadores colaboradores del CIAT.

La Base de datos Socioeconómicos de América Latina y el Caribe, la cual dispone de información proveniente de diversas fuentes como FAO, USDA, FMI y World Bank entre otros, fue actualizada en un año más de información al haber sido incorporados datos correspondientes al año 1997 para las series de datos sobre comercio, uso de fertilizantes, riego y maquinaria, precios al productor, población, y tipo de cambio. Las serie de datos de producción se actualizaron con datos correspondientes al año 1998. Igualmente, durante 1999 se adicionó la serie de datos para Precios Internacionales de diferentes productos agropecuarios cubriendo los años 1967 a 1997.

La base de Datos de Colombia se adicionó con datos correspondientes al año 1997, a nivel de departamento y a nivel nacional, en lo que respecta a las series superficie cosechada, producción y rendimiento de los diferentes productos agrícolas. Nuevas series de datos se adicionaron a esta base de datos, las cuales se relacionan en el cuadro 1.

Cuadro 1. Series de datos adicionadas durante 1999 a la base de datos de Colombia.

Variable	Unidad	Serie
Valor de la producción agropecuaria nacional	Millones $ de 1975	1990-1997
Participación porcentual de los productos en el valor de la producción total	%	1990-1997
Sacrificio de Ganado Bovino (machos, Hembras)	# de cabezas	1981-1997
Exportaciones de Ganado Bovino (Machos, Hembras)	# de cabezas	1981-1997
Peso de Ganado Bovino (Vivo, en canal)	Toneladas	1981-1997
Valor producción Ganado Bovino	Millones $ de 1975	1981-1997
Producción de Leche de Vaca	Millones de litros	1981-1997
Importaciones de Leche de Vaca	Millones de litros	1981-1997
Sacrificio de Pollos	Millones	1981-1997
Rendimiento de Pollos	Kg/Unidad	1981-1997
Valor de la producción de carne de pollo	Millones $ de 1975	1981-1997
Número de Huevos de gallina producidos	Millones	1981-1997
Valor de la producción de huevos de gallina	Millones $ de 1975	1981-1997
Índice mensual de Precios al Consumidor para diferentes productos agropecuarios en las principales ciudades del país	Dic. 1998 = 100	Enero/1965-Enero/1998

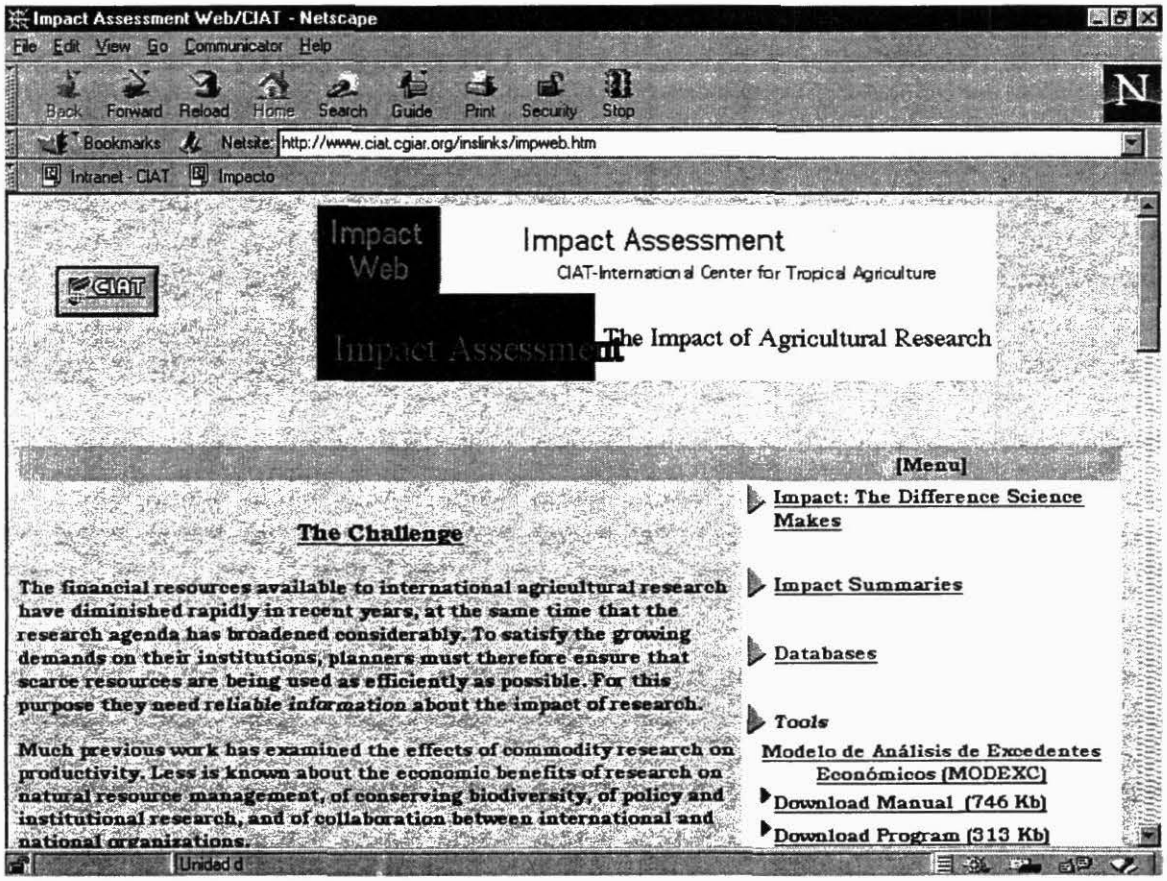
3.2 Web Page Development - *by: J. A. García*

3.2.A. Modificaciones

Durante 1999 se realizaron modificaciones en el diseño de muchas de las páginas del Web de Evaluación de Impacto con el propósito de obtener una mejor apariencia así como de permitirle al usuario una mayor facilidad de navegación.

Algunas de las páginas modificadas son las siguientes:
- Página principal (ver Figura 1).
- Menú de Bases de Datos disponibles vía Internet (ver Figura 2).
- Despliegue de consultas a la base de datos en forma gráfica (ver Figura 3)
- Menú de Trends in CIAT Commodities (ver Figura 4).

Figura 1. Página Principal.



3.2.B. Acceso a Bases de Datos

Toda la información almacenada en las diferentes bases de datos (base de datos de América Latina, base de datos de Colombia, base de datos de Variedades) está disponible vía Internet. Mediante el menú de acceso (Figura 2), cualquier usuario puede ingresar a la base de datos y extraer la información deseada la cual puede ser visualizada en forma

de tabla o en forma de gráfica (ver Figura 3). La gráfica obtenida puede ser modificada por el usuario directamente en su propio computador y ajustada a sus necesidades particulares ya sea en lo que respecta a tipo de gráfica, color, título, o cualquier otra de sus características.

Figura 2. Menú de acceso a las Bases de Datos.

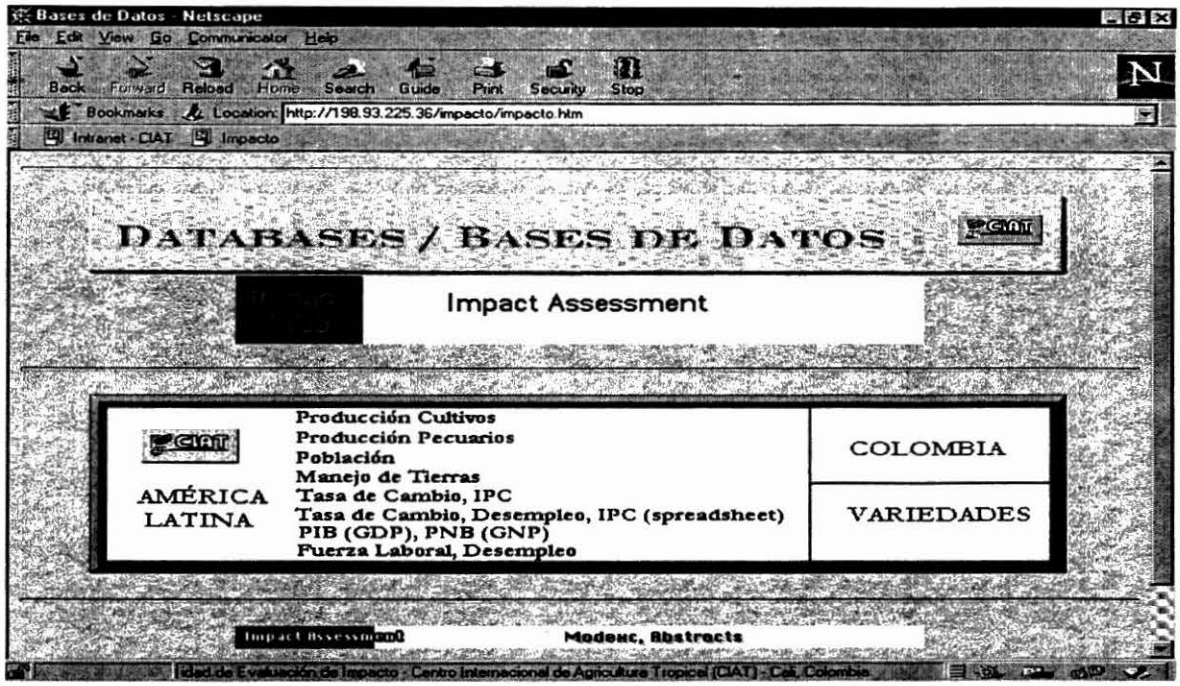
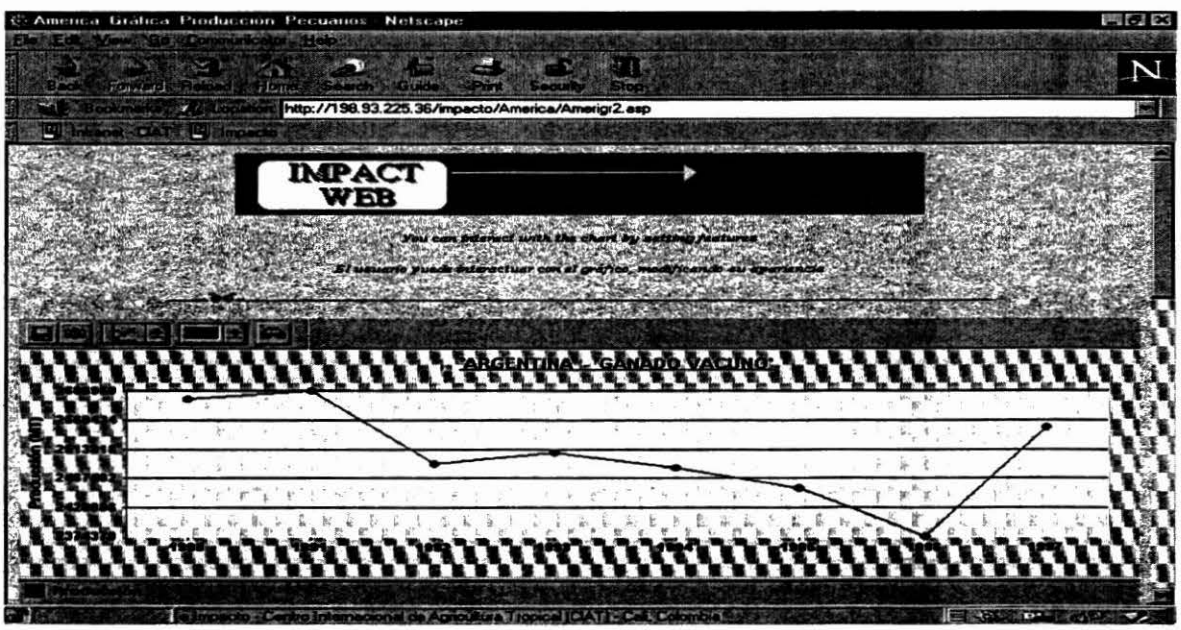


Figura 3. Respuesta, en forma gráfica, a consulta realizada a la base de datos.

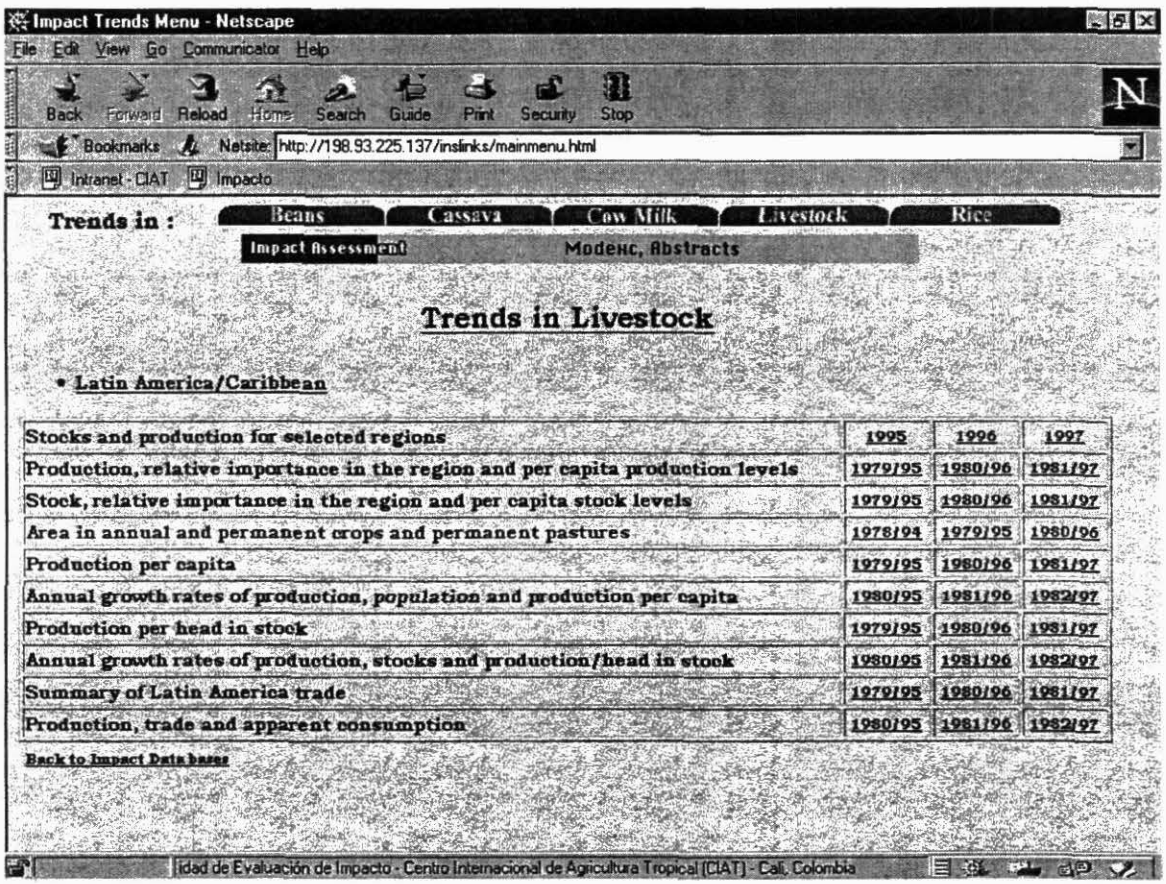


3.2.C. Trends in CIAT Commodities

El sistema de generación automática de reportes, disponible en la Base de Datos Socioeconómicos, fue complementado para permitir la elaboración de tablas de tendencias, no sólo para América Latina sino también para Africa y Asia.

Utilizando dicho sistema se generaron los cuadros correspondientes a los Trends 1997 para los productos Arroz, Frijol, Carne, Leche y Yuca. Los cuadros respectivos pueden ser consultados vía Internet previa selección del producto deseado a partir del menú principal de productos el cual es desplegado en parte superior de la Figura 4.

Figura 4. Menú de acceso a Trends in CIAT Commodities.



3.2.D. Utilización del Web y consultas a las bases de datos vía Internet

El Web dispone de un sistema de información de visitas que permite analizar los diferentes accesos, dado que el sistema registra datos acerca del país de origen, la dirección Internet del sitio de ingreso, la fecha y la hora del ingreso, entre otros. Esta información nos muestra que el Web ha sido consultado por usuarios de Estados Unidos, Canadá, 9 países de Sur América, 5 países de Centro América y el Caribe, 14 países de Europa, 9 países de Asia, 3 países de África además de Australia y Nueva Zelandia. Los

usuarios en general están vinculados a instituciones educativas, comerciales, gubernamentales o a organizaciones como la FAO, el Banco Mundial o el CGIAR.

El cuadro 2 muestra un total de 1009 visitas (distribuidas por región) que fueron realizadas durante el período 20 de Octubre de 1998 al 20 de Septiembre de 1999, lo que significa, que durante los 334 días considerados, la Web tuvo un promedio ligeramente superior a 3 visitas diarias. Se observa en este cuadro, que el grupo principal de usuarios está conformado por organizaciones sin ánimo de lucro donde están incluidos los centros internacionales pertenecientes al CGIAR, la FAO, el Banco Mundial, entre otros. El segundo mayor grupo de usuarios lo conforman los Estados Unidos y Canadá seguidos muy de cerca por los países Europeos. Un cuarto grupo lo conforman el resto de países del continente americano (Sur y Centro América) ubicados muy distantes de los países del Asia y del continente Africano. Se observa igualmente, que a un buen número de usuarios, el sistema de automático de registro fue incapaz de identificarles su procedencia.

Cuadro 2. Visitas por región realizadas al Web de Impacto.

Visitas por región			
1.	.net y .org	424	42.02 %
2.	EEUU y Canadá	120	11.89 %
3.	Europa	115	11.4 %
4.	Sudamérica	92	9.12 %
5.	Centroamérica	38	3.77 %
6.	Asia	28	2.78 %
7.	Australia	21	2.08 %
8.	Africa	6	0.59 %
	Desconocido	165	16.35 %

En cuanto al uso de las bases de datos a través de Internet, las estadísticas muestran un total de 324 consultas realizadas a la base de datos de América Latina, 174 consultas efectuadas a la base de datos de Colombia y 71 a la base de datos de Variedades.

Los datos más solicitados en la base de datos de América Latina corresponden a las series de Producción de Cultivos con 125 consultas y a las series con los indicadores macroeconómicos Tasa de Cambio e IPC con 67 consultas. Las series restantes muestran un número de consultas realizadas que varían entre 23 y 49.

La base de datos de Colombia tuvo 174 solicitudes de información donde se destaca que 68 de ellas correspondieron a consultas sobre datos de producción de cultivos. Las series de datos restantes tuvieron solicitudes que varían entre 18 y 29 consultas.

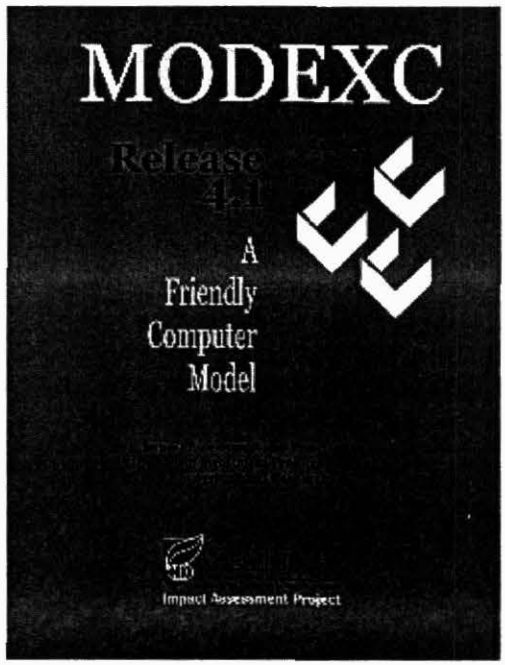
Las estadísticas anteriores son el resumen para el período comprendido entre el 10 de Enero de 1999, fecha en que se implementó el sistema de registro de consultas, y el 20 se Septiembre de 1999. Es destacable que en este período de solo 8 meses, los visitantes al Web han mostrado interés por el sistema de información implementado, el cual seguirá permanentemente en proceso de actualización, crecimiento y desarrollo.

3.3 Methods - Economic Surplus Models - *by: J. A. García, L. Rivas*

Durante 1999 se realizaron una serie de actividades tendientes tanto a mejorar el modelo de análisis de excedentes económicos - MODEXC, como a hacerlo disponible a una mayor población que pudiera estar interesada en hacer uso del modelo.

Por las razones anteriores, el modelo se convirtió a una nueva versión en Excel-97 donde el lenguaje utilizado para comunicación con el usuario es el Inglés. De igual manera, el manual del usuario, inicialmente escrito en idioma Español, fue traducido al idioma Inglés y posteriormente editado y publicado en el documento "MODEXC Release 4.1. A Friendly Computer Model" (ver Figura 5).

Figura 5. Portada del manual de usuario de MODEXC (versión en Inglés)



La versión del modelo MODEXC disponible en Internet ha sido solicitada durante el período Enero 20/99 a Septiembre 20/99 en 70 ocasiones. Las estadísticas registradas muestran, que personas radicadas en los Estados Unidos, Australia, 9 países de Sur América, 9 países de Centro América y el Caribe, 4 países de Europa, 3 países de África y 1 país del Asia han obtenido copia del modelo y del manual. De igual manera, los registros muestran que un total de 40 usuarios están vinculados con instituciones de investigación, 17 con universidades y 13 con instituciones de carácter comercial. Estos resultados nos indican que MODEXC está llegando a una amplia comunidad donde

puede llegar a constituirse en una buena herramienta de apoyo, particularmente en el caso de las instituciones universitarias y de investigación.

Modelo de Excedentes Económicos MODEX

Metas para 1999

- Incrementar la utilización del modelo tanto a nivel nacional como internacional
- Continuar con el mejoramiento de aspectos conceptuales y teóricos relevantes.

Resumen

Para cumplir con el primer objetivo se produjo una versión en inglés tanto del modelo como del manual, los que se pusieron a disposición de los usuarios en la pagina Web del Proyecto de Evaluación de Impacto, para facilitar su conocimiento y difusión.

En la parte conceptual del modelo se hizo una mejora significativa en el tema de impacto del cambio tecnológico sobre la demanda. Esto último se puede ejemplificar en mercados como el de yuca, en donde un cambio tecnológico en el procesamiento y utilización del producto seco, puede derivar en un incremento en la demanda por yuca fresca.

Las versiones anteriores del modelo incluían un parámetro (w), que correspondía al incremento genérico anual de la demanda, derivado de un cambio tecnológico en la producción. Dado que al mercado pueden entrar diferentes tecnologías, en distintos momentos del período de evaluación, con diferentes patrones de difusión y que algunas de ellas pueden inducir incrementos en la demanda y otras no, la versión anterior del modelo era muy limitada, ya que no asociaba el incremento de la demanda con una tecnología específica ni con su patrón de difusión.

La versión actual relaciona el crecimiento de la demanda con cada tecnología evaluada y con su patrón específico de difusión y de obsolescencia. De ésta forma, la magnitud del efecto sobre la demanda en el caso de una tecnología dada, dependerá del momento en que empieza su adopción, de la intensidad de la misma, y de la velocidad del proceso de obsolescencia o desadopción.

Para lograr lo anterior, se asume que el coeficiente (w_i) corresponde a la tasa de crecimiento de la demanda, inducida por la adopción de la tecnología i. Tal coeficiente tiene un patrón de crecimiento logístico, similar al de la adopción de la tecnología bajo evaluación. De ésta forma la presión de demanda generada por la adopción de la tecnología i, es baja cuando ella se encuentra en sus primeras fases de adopción, se incrementa cuando la adopción se consolida y comienza a declinar en la medida en que la tecnología entra en su fase de obsolescencia.

3.4 New Tools For The Economic Evaluation Of Agricultural Technologies Having Natural Resource Impacts: Cropping in the Savanna Ecosystems of Meta Province, Colombia - *by: S. Wood*

BACKGROUND AND JUSTIFICATION

Greater demands for accountability, shrinking research resources, and the growing complexities of research goals are focusing the attention of R&D managers on the need for improved R&D evaluation and decision making methods. Furthermore, the increasingly competitive nature of R&D funding is accelerating the search for areas of comparative advantage or complementarity in research -- essential information for selecting strategically important research themes and appropriate R&D partners.

Methods for evaluating the direct production affects of technology, such as those involving increased genetic potential or improved efficiency in the use of inputs such as seed, labor, machinery, and fertilizer are fairly well established and increasingly applied. However, when the scope of inquiry is expanded to include productivity dynamics arising from the interaction between new technologies, production systems, and natural resource stocks and flows, these methods are at best partial and more often indedquate. There is an urgent need to systematically extend the R&D evaluation framework in order to encompass this natural resource dimension.

A major development issue in the extensive humid tropical savannas of Latin America is the difficulty of managing the highly-weathered soils in a sustainable way. Even modest attempts at increasing livestock and crop productivity must be undertaken with great care if a rapid decline in (already low) soil fertility is to be avoided. Furthermore, new technologies should not only prevent soil productivity losses in a cost-effective manner but, ideally, should also help to increase the inherent productive capacity of soil over the long-run. As has been demonstrated in the Brazilian cerrados, there are potentially large payoffs from bringing savannas into more intensive, long-term agricultural production[10]. In Colombia, however, the savanna (or Llanos) area has been subjected to much land speculation, associated primarily with the laundering of drug money, and land prices have been artificially inflated relative to their agricultural opportunity cost. At the same time, continued guerilla operations and high interest rates have done little to foster positive attitudes to long-term land-enhancing investments. It is important, therefore, that realistic analyses are made of the potential economic attractiveness of new agricultural technologies targeted to such areas. This study, therefore, is concerned with the development of improved methods that can not only evaluate the direct and natural resource impacts of technical change, but that can also represent the broader policy and market context within which technical change takes place.

The International Centre for Tropical Agriculture (CIAT) has been a pioneer in the development and practical application of economic approaches to research evaluation

[10] Recognising that a mix of agricultural and other land uses such as ecosystem conservation (e.g., preservation of gallery forests and other important biological habitats) may well be preferred from a social, rather than private, perspective.

(Pinstrup Andersen et al 1976, Scobie and Posada 1977, Lynam and Jones 1984, Pachico, Lynam and Jones 1987). In recent years the International Food Policy Research Institute (IFPRI) has also been active in further development of R&D evaluation methods as well as analytical tools such as the DREAM software (Alston, Norton and Pardey 1995, and Wood and Baitx 1998). Since the evaluation of natural resource related research poses new and difficult challenges CIAT and IFPRI are collaborating in this joint methodological research venture together with Michigan State University (MSU), the International Fertilizer Development Centre (IFDC), and postgraduate students from Wageningen and Bogotá.

STATEMENT OF THE PROBLEM

Accelerated loss of soil productivity under cultivation

The development problem faced is that while the savannas are extremely extensive their agricultural use is limited, primarily because of poor soil productivity. Not only are the savanna soils of relatively low inherent fertility under natural conditions, but even those low levels degrade relatively rapidly under cultivation (typically the soils are unproductive after 3-5 years of cultivation). Furthermore, the soils are relatively poorly drained, and in the rainy season many areas are difficult to access. These biophysical limitations have, in turn, provided little incentive for systematic, sustained investment in infrastructure in the llanos. Most economic exploitation has been associated with low-productivity extensive livestock operations. Investment in agricultural research targeted to the llanos has been made in the expectation that more intensive, sustainable production systems can be developed. There is even a hope that some of these production systems could bring about significant long-term increases in the intrinsic productive capacity of savanna soils (e.g., by building up organic matter, and improving the soil's physical and biochemical properties).

Estimating the potential biophysical impacts of technical change

From an evaluation perspective the goal is to broaden the traditional scope of analysis. There is increasing concern with measuring the impact of technology not only on crop or livestock productivity, but also on the stock and condition of the underlying natural resource base (in this study the soil resource). To do this requires some means of estimating the implications of each change in soil condition on productivity in the current and all subsequent years – knowing that devising adequate measures of soil condition is, in itself, no easy matter. For example, while there is growing evidence that much of the rapid decline in the productivity of llanos soils under cultivation is related to a breakdown in physical structure, soil scientists and agronomists have traditionally focused more on measuring chemical soil properties such as the availability of nitrogen, phosphorus, and organic matter.

In an attempt to capture the complex interactions of climate, soil, and crops for R&D purposes there has been a major scientific investment in the development of crop growth simulation models, and perhaps the best known of these is the DSSAT© suite of models for, rice, wheat, maize, barley, sorghum, millet, beans, soybean, peanut, potato, cassava,

and pasture. While they offer, in principle at least, the opportunity for integrated assessment of crop yield (main product and residues), soil moisture, nitrogen, phosphorus, and most recently, organic matter, the models largely reflect accumulated research experience in temperate zones, most notably in the USA. Furthermore, there is considerable variability in the reliability and completeness of each of the component modules. Nonetheless, with proper calibration there is growing evidence that such models can provide a systematic and robust means of jointly estimating important crop, water, and soil variables over a broad range of biophysical and management conditions, including those found in tropical developing countries. The models allow analysts to evaluate new genetic materials with improvements in, say, yield potential, light, water or fertilizer use efficiency, and pest and disease resistance, as well as improved management practices such as in the timing and quantity of water and (organic or inorganic) fertilizer applications.

Simulation models can also be extremely helpful in overcoming another significant constraint in performing ex ante R&D assessments – how to assess the *combined* effect of a number of simultaneous technological enhancements. A crop improvement research program may comprise a range of distinct initiatives related to both germplasm and agronomy and it is extremely difficult to know how those technologies may work together. In the absence of explicit experimental data, analysts have simply (and most likely erroneously) assumed the combined effect of different technologies to be additive. Crop simulation models offer the possibility of applying a number of simultaneous technological changes and then relying on the model's internal intelligence of crop growth processes to integrate those changes in a meaningful way, and trace out their combined impact on yields and soil conditions. This makes for much simpler, and probably more reliable, elicitation of R&D expectations from scientists. Each disciplinary group need only describe its expected R&D outputs in terms of the specific plant, soil, or water processes their work will impact, and need not be asked to make extremely speculative estimates of the final consequence of their work on, say, crop yields in farmers' fields.

Finally, the use of process-driven simulation model holds open the possibility of extrapolating calibrated models across space and time to look at the broader effects of technical change. We are particularly concerned here with extrapolating across time since a major goal of research is to develop viable long-term production systems. Unfortunately, long-term experiments are rare and simulation models offer a promising way of making some judgement about long-term prospects even though we may only have, say, (as in the experiments used in this study) 3-5 years of experimental data on which to base our forecasts. The implicit assumption is that we can make more reasonable forecasts if our underlying prediction tool (the crop growth simulation) is built around the capacity to model generic physical processes than if it is, for example, a black-box regression technique.

MSU and IFDC are collborating in the study because of their long association with the original crop growth components of DSSAT but also because of their exoertise in specific new components of direct relevance to the study. MSU has recently developed a

phosphorus response model that is capable of representing the complex dynamics of savanna soils in which phosphorus availability is one of, if not the, major soil fertility constraint. IFDC's expertise includes the integration of DSSAT with GIS as well as participating in the development of the "sequential" module that handles multi-year simulation. IFDC has also worked on improving the DSSAT user interface.

Estimating the potential socio-economic impacts technical change

The established means of evaluating the impacts of technical change in agricultural production were not designed for the complexities of measuring and valuing related impacts on natural resources. Existing methods generally treat a new technology as having a constant yield increase or cost reduction effect in the field of any given adopter. Thus, R&D impacts on the aggregate level of production arise only as a consequence of changes in adoption over time (e.g. as more producers adopt the technology the impact of the technology becomes greater). In the cases of interest here, however, the introduction of crop production systems into natural savanna bring about significant changes in soil conditions that have cumulative impacts on in-situ productivity, and the assumed "ceteris paribus" condition of the economic evaluation no longer holds.

Experimental data are available from the Carimagua site in Metá department over a number of years, and cover a number of different production system treatments (rice monoculture, maize monoculture, maize/soybean rotation) and untreated control plots. These data allow the change in yields and soil variables for each production system treatment in each year to be calculated *relative to the control plot*, and hence, automatically allows for (nets out) the effects of year-to-year climate variation. By calibrating the DSSAT model to these different treatment effects we can estimate the relative changes in yields, soil moisture, nitrogen, phosphorus (an perhaps carbon), *with* and *without* these treatments. Furthermore, DSSAT will be used to extrapolate the effects observed over 3-5 years to a longer time series of effects for say 25 years that will correspond to the time needed to make an economic evaluation (because adoption can occur, and hence economic benefits can be gained, over many years).[11]

The economic evaluation will be made independently for each commodity - rice, maize, soybean, and will explicitly take into account only the (observed and DSSAT simulated) yield effects associated with each production system treatment. However, it is important to note that;

1. Yield levels are changing as a consequence of the underlying changes in soil resource conditions. Hence, we do capture all the (on-site) agricultural productivity impacts of changes in the soil resource, and,

[11] The evaluation of impacts on pasture improvement was purposely excluded because the DSSAT pasture model was not considered sufficiently reliable. Furthermore, and perhaps more importantly, pasture effects are compounded by livestock grazing and herd management issues that confound the evaluation. To keep the evaluation tractable the study focuses on crop systems. Extension to pasture/animal sysyems would be a logical next step in extending this line of research.

2. DSSAT models the maize/soybean rotation in a single simulation, recognizing the relevant biophysical interactions between the two crops. Thus, even though the economic model treats them as separate commodities from a market perspective, the R&D effects input to the economic model do include any production interactions between the crops, e.g., the yield effects we obtain for maize are greater than they would be otherwise be because of the nitrogen fixing capacity of preceeding soybean crops.

On the basis of the market data currently being collected we expect to use the *municipio* as the basic economic unit of analysis, although municipios will be stratified (and perhaps broken down) by zones using the Colombian agro-ecological classification system (IGAC 1985). Only production will be broken out at the municipio level, and we will use two demand regions – one to represent the current and projected *internal demand* in the Metá department, and the other (which we will assume is located in Villavicencio) to represent actual and potential *export* to Bogotá, the recipient of practically all the department's agricultural surplus. A preliminary list of the specific production and consumption regions to be modelled in each commodity simulation is attached. In the cases of maize and rice, production data are available at a disaggregated level; for traditional and technical maize, and for irrigated and rainfed rice. The new technologies being tested in the Carimagua experiments are for technical maize and rainfed rice, but all types will be included in the economic analysis to ensure that potential impacts on the overall maize and rice markets are taken into account.

After calculating total benefits for both producers and consumers we will use farm size and land use data collected from agricultural census to estimate the likely distribution of producer benefits among different producer groups.

OBJECTIVES

General Objective

The principal objective of this study is to develop and test the feasibility of new methods for the economic evaluation of technologies having significant impact on the stock or flows of natural resources that underpin agroecosystem productivity. If the methods can be validated they can serve not only to assess the likely impact of technologies currently under development for the Colombian Llanos (the source of the study's empirical data), but also as a general means of testing a range of strategic research policy and technology design scenarios. Such a capacity could help generate greater research benefits and alter the distribution of benefits in ways deemed more socially acceptable (for example, by increasing the share of benefits accruing to poor rural households).

Specific Objectives

1. To describe the existing production systems in the Metá department with regard to the production of maize, rice and soybean

2. To analyse the trends in prices, production costs and technology adoption (specifically in irrigated and rainfed rice, and technical and traditional maize production systems) in Meta department.
3. To use the DSSAT model to generate long term estimates of biophysical impacts of R&D (by calibrating the model on data from the CIAT/CORPOICA experimental station at Carimagua, Meta. These biophysical simulations will be performed at CIAT).
4. To combine the results of 2 and 3 above and perform a range of economic simulations of the potential benefits of the new rice, maize and soybean technology across the Metá department.
5. Make an assessment of the distribution of economic benefits both spatially (e.g., across different municipios), and by different producer groups

RESEARCH QUESTIONS

In order to satisfy the objectives mentioned above consideration must be given to the following research questions:

1. Assuming no technical change and falling world commodity prices can, Llanos crop producers remain competitive? How much would the sector shrink in the next 25 years if no new technologies were introduced?
2. Could monoculture production of rice and maize be biophysically and economically sustainable? If so, under what level of inputs?
3. Based on the *experimental* data, what would be the long-term gains of adopting a maize/soybean rotation?
4. Given recent trends in *farm level* crop productivity, prices and technology adoption in the Metá department what would be the potential economic benefits from promoting the new maize/soybean rotation? Would those benefits cover the estimated costs of research?
5. Do the the potential benefits vary spatially, reflecting the variation of agroecological, market, and demographic conditions? Which producer and consumer groups will be most affected?

THE APPROACH

The economic framework for evaluating R&D relies on the concepts of welfare economics, in particular on estimating changes in *economic surplus* (in total, as well as separately for producers and consumers). Benefit streams arising from the adoption of new methods of production for rice, maize, and maize/soybean can be calculated on an annual basis over a user-specified simulation period, normally of 20-30 years. And these benefits can then be offset against R&D costs in order to calculate benefit-cost measures of the attractiveness of the R&D investment.

Representing technical change

If we first consider that a new technology is fully adopted, its likely impact will depend on two main considerations;

1. The initial market conditions for the specific agricultural commodity that the technology was designed for
2. The subsequent change in supply and demand conditions for the given commodity over time. Specifically the difference between the market evolution *with* and *without* the new technology.

In reality the decision to adopt (or not adopt) the new technology is taken by different producers at different times so the likely rates and levels of adoption in different regions are important elements in estimating the stream of economic benefits arising from technical change. The full technology investment and use cycle incorporated in the economic model includes;

1. A time lag for the development and testing of new technologies
2. A measure of the uncertainty associated with the R&D process (probability of R&D success)
3. The potential impact of technology, K (arising from, say, yield increasing or input reducing technologies) that is expressed as a *reduction in the unit cost of production.* The size of K in each year, K_t, will be estimated by the DSSAT model.
4. A time lag following the release of a new technology until the ceiling level of adoption is likely to be reached
5. A ceiling level of adoption (in area or quantity terms)
6. A rate of disadoption if, say, the effects of a single "wave" of new technology are being modelled.

The data

The information on which this study will be based comes from primary and secondary sources. Primary data comes from several sets of "long-term" (3-5 year) experimental field data and on-farm trials involving different crop and pasture germplasm, crop rotations, and management practices in the llanos. The experiments monitored changes in pasture production, animal live weight gains, and crop yields over time as well as recording the simultaneous changes in a range of soil properties. These benchmark data help establish the biophysical (and, hence, economic) impacts of new production systems in an experimental setting. The on-farm trials and municipio production data provide additional information on the extent to which producers are actually adopting new technologies given the overall sector trends and the resource and market constraints that producers face. These data have been collected over the last 10-15 years by CIAT in collaboration with the Colombian national research agency CORPOICA (formerly, until 1993, known as ICA), the International Fertilizer Development Centre (IFDC) and others.

Secondary information for the Metá province being collected in Bogotá and Villevicencio includes; production, area, yield, prices, and costs of production, as well as census data on population and farm size. As far as possible this data is being collected at the municipio level (of which there are 24 in Metá). Additional information will include detail on wholesaler prices at Villevicencio and Bogotá the major markets for agricultural surplus from Metá department.

Methods and data analysis

After defining the scenarios for estimating the potential economic impact of new production technologies in the llanos of Metá, the R&D evaluation package, DREAM, will be used to simulate the likely magnitude and distribution of the economic benefits of technical change.

Biophysical data from the Department of Meta will be used to identify a number of relatively homogeneous agroecological zones across the department, beyond the experimental sites. The biophysical model, calibrated data from the experimental sites, will then be run with regionalized climate and soil parameters, and the results of that calibration (performed at CIAT) will be linked directly to municipio data in the economic evaluation. This evaluation will include estimates of the total economic benefits for both producers and consumers.

Workplan 1999-2000

January - June 1999

- Format experimental data for input and use in DSSAT model (sequential analysis component). This work will be undertaken at CIAT (Mariela Rivera)
- Initiate calabration of DSSAT model for rice and maize monoculture treatments, as well as the maize/soybean rotation treatments.(Marial Rivera – CIAT)
- Collect production, market, and adoption data for Meta province. (Astrid Hernandez, Liliana Mosquera, Bogota and Cali)
- Collect biophysical data and survey/census data for Meta province (Astrid Hernandez)
- Establish dialogue with MSU and IFDC and plan the details of their involvement (Stanley Wood).

July - December 1999

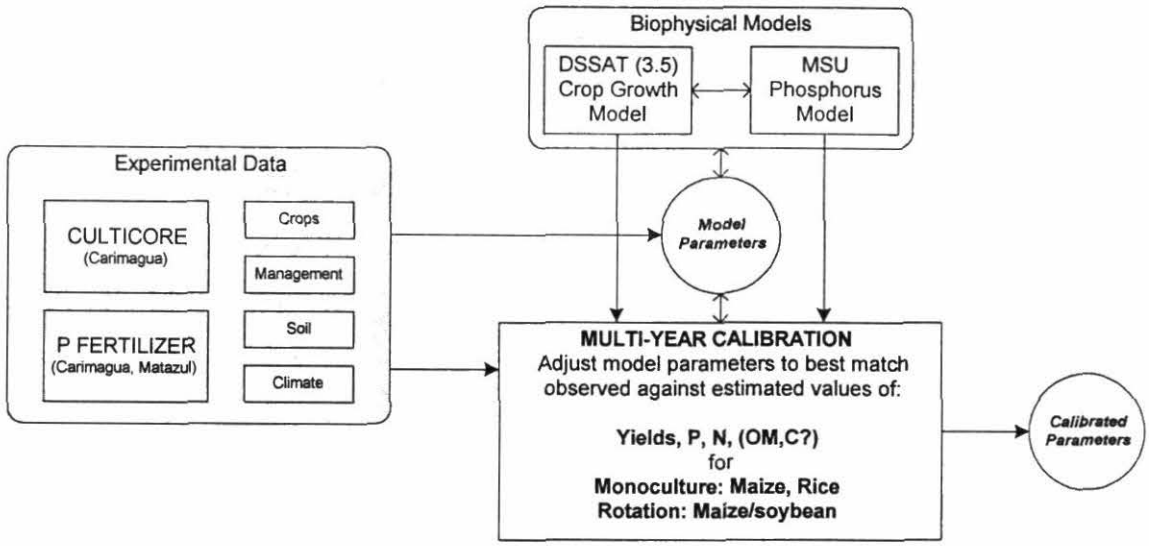
- Hold a technical review and work planning meeting at IFPRI (Washinton DC) (IFPRI, CIAT, IFDC, MSU)
    - Review progress on calibration of DSSAT
    - Plan for integration of the phosphorus model
    - Prepare a schedule of biophysical simulations
    - Decide on temporal and spatial extrapoaltion approaches and allocate implementation responsibilities

- Complete biophysical simulation work at both Cariamgua and for Meta Department (CIAT, MSU, IFDC)
- Prepare data for units of analysis in the economic simulation (municipio by agroecological zone units). (Hernandez, Mosquera, Wood, IFDC)
- Design a range of evaluation scenarios that encompass policy, trade and technology issues (see research questions above) as well as incorporate the agreed biophysical scenario (Wood, Hernandez, Mosquera)
- Make preliminary economic analysis for Meta Department (Wood, Hernandez, Mosquera)

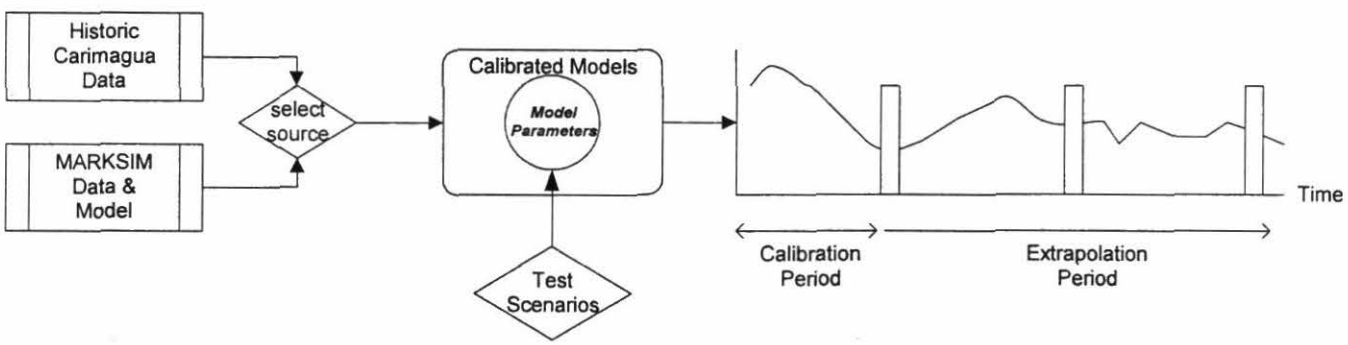
January - March 2000

- Write up results, perform additional analyses as guided by the results and make recommendations on the technical and institutional feasibility of the approaches developed (IFPRI, CIAT, MSU, IFDC)
- Submit report to CIAT/IFPRI management and the donor IDB (April 2000)

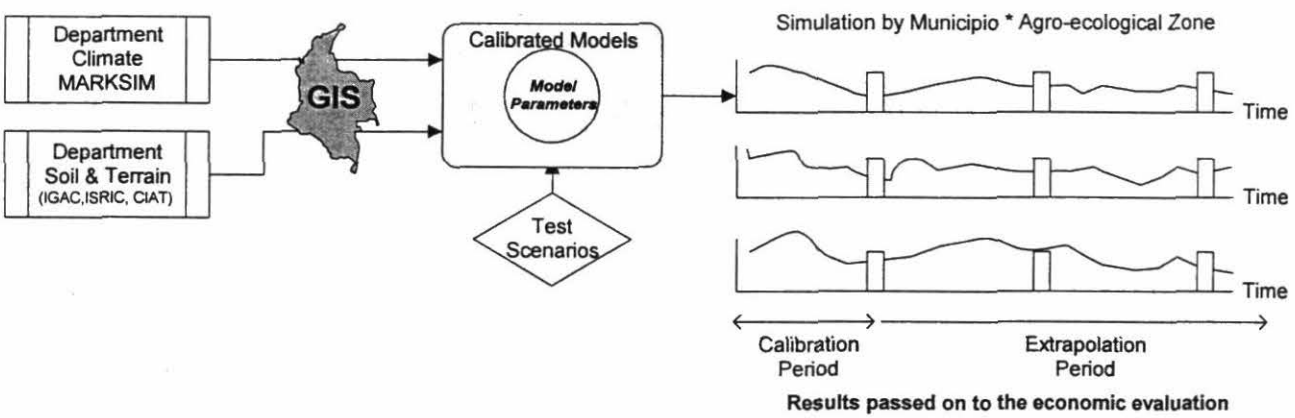
Biophysical Modelling Activities for CIAT/IFPRI Project on Assessing the Economic Consequences of Technical Change having both Productivity and Natural Resource Impacts



Simulations based on extrapolation of Carimagua results using long term climate data



Simulations for Meta Department using spatially extrapolated climate and soil files



92 522

OUTPUT IV: INSTITUTIONAL CAPACITY FOR IMPACT ASSESSMENT ENCHANCED- *by: D. Pachico*

- Assisted process of developing impact assessment indicators and data collection system for CIAT Ecoregional reference sites.
- Conducted workshop for COLCIENCIAS (Colombian National Science Research Council) on methods of assessing research impact.
- Managed process of introducing log frame planning system into CIAT projects in order to have better performance monitoring indictors.
- Supervised thesis of three students in Bolivia and research of student from University of California, Berkeley.

V. LIST OF DONORS 1999

- CGIAR Core Donors[1]
- CIDA, Canada[2]
- Colombian Ministry of Agricultura and Rural Development[1]
- Impact Assessment Evaluation Group, CGIAR[1]
- Inter-American Development Bank[1]
- Rockefeller Foundation[1]
- The CGIAR's Impact Assessment and Evaluation Group (IAEG).
- Swiss Development Corporation[2]
- United Nations World Food Program[1]
- USAID[2]

---

[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 INSTITUTIONS, 1999

- ARI, Tanzania.
- COLCIENCIAS, Colombia National Science Foundation, Santafé de Bogotá
- CORPOICA, Bogotá, Colombia.
- Empresa de Asistencia Técnica y Extensión Rural Ceara, EMATERCE, Fortaleza, Ceara, Brazil.
- Empresa Brasilera de Pesquisa Agricola: Centro Nacional de Pesquisa de Mandioca Frutas, EMBRAPA-CNPAF, Cruz das Almas, Bahia, Brazil.
- EMBRAPA-CPAC, Brasilia.
- Impact Assessment and Evaluation Group, (IAEG), CGIAR.
- International Food Policy Research Institute. (IFPRI), Washington, D.C., U.S.A.
- Secretaria de Desarrollo Rural, SDR, Fortaleza, Ceara, Brazil.
- Universidad Autonoma Gabriel Rene Moreno, Santa Cruz de la Sierra, Bolivia.
- University of Arizona, Tucson, Arizona, U.S.A.
- University of California, Berkely.
- Yale, University, New Haven, Conneticut, U.S.A.

VII. STAFF LIST 1999

• James A. **García**, MS	Statistician/Data Base Specialist
• Albert **Gierend**, PhD	Economist, Postdoctoral Fellow
• Nancy **Johnson**, PhD	Economist, Rockefeller Foundation Fellow
• María Verónica **Gottret**, MS	Economist, Research Associate
• Yanet **Oturbé**	Student, Universidad Gabriel René Moreno - Bolivia
• Douglas **Pachico**, PhD	Economist, Project Manager
• Gloria **Posada**	Bilingual Secretary
• Libardo **Rivas**, MS	Economist, Research Associate
• Leonel **Rosero**	Technician
• Norha **Ruíz de Londoño**, MS	Economist, Consultant
• Stanley R. **Wood**, MS	IFPRI, Associate Member of Staff
• Melanie **Raymond**	Student, University of California, Berkeley

VII. PUBLICATIONS AND PRESENTATION LIST

Gottret, M. V., Ospina, B., Pachico, D., and Leite-Cardoso, C.E. (1999) "Integrated Cassava Research and Development: A replication of CIATs experience in Northeast Brazil." Paper to be presented at the meeting of the Brazilian Cassava Society to be held in Manaus, Brazil 13-17 October 1999.

Gottret, M. V., Raymond, M. (1999) "An Analysis of a Cassava Integrated Research and Development Approach: Has it Really Contributed to Poverty Alleviation?" Paper presented at the International Workshop on Assessing the Impact of Agricultural Research on Poverty Alleviation. 14-16 September 1999, San José, Costa Rica.

Hertford, R. y García, J. A. (1999) "Competitividad de la agricultura en las Américas." Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 88 p.

Johnson, N. L. and J. Klass (1999) "The impact of crop improvement research on rural poverty: a spatial analysis of BGMV-resistant beans varieties in Honduras, paper presented at the International Workshop on Assessing the Impact of Agricultural Research on Poverty Alleviation, Sept. 14-16, San Jose, Costa Rica

Johnson, N.L. and M.E. Baltodano (1999) "Valuation of water resources in a hillside community: an *ex ante* impact analysis of strengthening local potable water associations" International Center for Tropical Agriculture (CIAT): Cali, Colombia, mimeo (Spanish).

Johnson, N.L. (1999) "The production and impact of new varieties of rice, beans, and cassava: a progress report on the IAEG germplasm evaluation study," presented at the IAEG Working Group Meeting, Nashville, Tennesse, USA, August 7-8, 1999

Ospina, B., Gottret, M. V., Pachico, D., and Leite-Cardoso, C.E. (1999) "Integrated Cassava Research and Development Strategy: A Case Study on Adoption and Impact in Northeast Brazil." In: Sechrest, L., Stewart, M., and Stickle, T. A Synthesis of Findings concerning CGIAR Case Studies on the Adoption of Technological Innovations. CGIAR Impact Assessment and Evaluation Group, FAO: Rome, Italy. 110 p.

Pachico, D. (1998) "A Log Frame for Strategic Planning." Presented at CIAT Annual Review, November 30, 1998.

Pachico, D. (1999) "Preliminary Report of Findings of an International Workshop on Poverty Alleviation." Presened at International Centers Week, Washington, D.C., October 25, 1999.

Pachico, D. (1999) "Geographical Information Systems." In W. Janssen, editor, Sourcebook for Research Planning. ISNAR, forthcoming.

Pachico, D. (1999) "Marco Conceptual de Evaluación del Impacto." Taller COLCIENCIAS Metodologías de Evaluación del Impacto, Santafé de Bogotá, Septiembre 10, 1999.

Pachico, D. (editor) (1999) "Impact Assessment: Annual Report for Project BP1." (CIAT).

Pachico, D. and J.A. Garafulic (1999) "Doing Research Together: An Update of CIAT's Medium Term Plan 2000-2002." CIAT.

Rivas, L., J.A. García, C. Seré, L.S. Jarvis, L.R. Sanint and D. Pachico (1999) "MODEXC Release 4.1 - A Friendly Computer Model" (CIAT).

Rivas, L. y Pachico, D. (1999) "Perfiles de la Pobreza y la Desigualdad en América Latina, Resumén Bibliográfico, CIAT, Primer Borador, Marzo.

Rivas, L. (1999) "Desarrollo Tecnológico y Crecimiento Económico en la Amazonia y Orinoquia de Colombia, Convenio de Cooperación Técnica y Científica MADR – CIAT," primer borrador, Cali, Junio.

Rivas, L., J. García (1999) "Tendencias y Evolución de la Ganadería Vacuna en Asia y Africa," CIAT, Primer borrador, Septiembre.

Rivas, L. (1999) "Metodologías y Estudios de Adopción de Nuevas tecnologías Agropecuarias." Taller COLCIENCIAS –CIAT, Bogotá, Septiembre 10.

Sanint, L. R., L. Rivas (1999) "Tecnologías de Mejoramiento de Germoplasma que Benefician al Consumidor: Los casos de ganadería vacuna arroz en América Latina y el Caribe." Trabajo presentado en el taller "*Assessing the Impact of Agricultural Research on Poverty Alleviation*", San José, Costa Rica, Septiembre 14-16.

IX. REFERENCES CITED IN REPORT

Baltodano, M. E. 1999. Personal communication.

Barreto, H. et al. 1997. Proyecto CIAT Laderas America Central: Reportes de Progreso, CIAT.

Best R., Sarria H; Ospina B. 1991. Establishing the Dry-Cassava Agroindustry on the Atlantic Coast of Colombia. In: Pérez-Crespo C A ed. Integrated Cassava Projects. Cali, Colombia: CIAT. pp. 112-127.

Binswanger, H. 1980 "Attitudes towards risk: experimental measurement in rural India," *American Journal of Agricultural Economics,* 62:395-407.

Boltvinik, J. 1996 "Poverty in Latin America: a critical analysis of three studies," *International Social Sciebce Journal,* 148:245-260.

Borbon Castro, E. and W. Janssen. 1987. Estudio de adopcion de variedades mejoradas de frijol en las regiones I y IV de Nicaragua. Cosecha Veranera, 1987.

Brunt, A.A., Crabtree, K., Dallwitz, M.J., Gibbs, A.J., Watson, L. and Zurcher, E.J., (eds.)(1996 onwards). Plant Viruses Online: Descriptions and Lists from the VIDE Database. Version: 16th January 1997.
URL http://biology.anu.edu.au/Groups/MES/Vide

Cock, J.H. 1985. Cassava: New Potential for a Neglected Crop. Colorado, USA: Westview Press.

DANE (Departamento Administrativo Nacional de Estadística). 1974. Censo Nacional Agropecuario. Santafé de Bogotá, Colombia: DANE.

DANE. 1985. Censo Nacional. Santafé de Bogotá, Colombia: DANE.

DANE. 1993. Censo Nacional. Santafé de Bogotá, Colombia: DANE.

de Janvry, A., E. Sadoulet (1996). Growth, Inequality and Poverty in Latin America: A causal analysis 1970-1994. Working Paper No. 784, California Agricultural experiment Station, Giannini Foundation of Agricultural Economics, February.

Diamond, P and J. Hausman. 1994 "Contigent valuation: is some number better than no number? *Journal of Economic Perpectives, 8:1-20.*

Dillon, J. and P. Scandizzo. 1978 "Risk attitudes of subsistence farmers in Northeast Brazil," *American Journal of Agricultural Economics*, 60:425-35.

Drangert, Jan-Olaf. "Rural household water—crucial and insignificant," *IDRC Currents, No. 12.*

FAO Database on agricultural production statistics, 1960-1998.

Gottret M.V., G. Henry, and I.D. Mullen. 1994. Returns of the Integrated Cassava Research and Development Project in the Atlantic Coast of Colombia. Unpublished Working Paper. Cali, Colombia: CIAT.

Gottret, M. V., and M. Raymond. 1999. An Analysis of a Cassava Integrated Research and Development Approach: Has it Really Contributed to Poverty Alleviation? Paper presented at the International Workshop on Assessing the Impact of Agricultural Research on Poverty Alleviation. 14-16 September 1999, San José, Costa Rica.

Greene, W.H. 1993. *Econometric Analysis*, Macmillian Publishing Co., New York.

Hardner, J.J. 1996 "Measuring the value of potable water in partially monetized rural economies," *Water Resources Bulletin,* 3296, pp. 1361-1366.

Henry G., D. Izquierdo and M.V. Gottret. 1994. Proyecto Integrado de Yuca en la Costa Atlántica de Colombia: Adoption de Tecnología. Working Document No. 189. Cali, Colombia: CIAT.

Ishikawa, Y. 1999 "The profitability analysis of bean production in Nicaragua," MS research paper, Michigan State University, Department of Agricultural Economics.

Janssen WG. 1986. Market Impact on Cassava's Development Potential in the Atlantic Coast Region of Colombia. Cali, Colombia: CIAT.

Jones, P. and A. Gladkov. 1999. FloraMap. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Jones, P., S.E. Beebe, J. Tohme and N.W. Galwey. 1997. The use of geographical information systems in biodiversity exploration and conservation. In *Biodiversity and Conservation.* **6**. 947-958.

Klass, J., G. Leclerc, F. Morales and J. Wellens. 1999. Using GIS Techniques to Aid in Predicting a Plant Virus in beans, Working Paper, CIAT, Cali, Colombia.

Lynam J.K. 1987. Global Cassava Research and Development: The Cassava Economy of Latin America: A Food Staple in Transition. Draft version prepared for TAC for the Nairobi meeting, June 21-July 1, 1987.

Martel, P. and R. H. Bernsten. 1995. Food Markets, Policy and Technology: The Case of Honduran Dry Beans, Bean/Cowpea CRSP, (mimeo), Dec. 15, 1995.

Mitchell, R. and R. Carson. 1989 "Using surveys to value public goods: the contigent valuation method," Resources for the Future, Washington, D.C.

Morales, F. J. (ed). 1994. El Mosaico Dorado del Frijol: Avances de Investigacion. CIAT, Cali, Colombia, 193pp.

Moscardi, E. and A. de janvry. 1977 "Attitudes towards risk among peasants: an econometric approach,"American Journal of Agricultural Economics," 59: 710-16.

Oyana, T., J. P. Couillard, G. Leclerc, R. Knapp, and W. Bell. 1998. Processing Social Indicators at Indivdiual, Household Level and its Localization at Different Scales, Poverty Mapping Project, CIAT Working Paper, Cali, Colombia (draft).

Pachico D. , W. Janssen, and Lynam J. 1983. Ex-ante Analysis of New Technology: A Comparison of Cassava for Feed and Fresh Markets in Colombia. Agricultural System 11:131-142.

Pachico, D. and N. L. Johnson. 1998. The Release of Germplasm from CIAT 1967-1998, An Interim Report, Impact Indicators, CIAT: Cali, Colombia.

Pachico, D. 1983 "Bean technology for small farmers: biological, economic and policy issues," *Agricultural Administration: An International Journal*, 15:71-86.

Pachico, D. 1987a. Trends in CIAT Commodities, CIAT.

Pachico, D. 1987b. La investigacion de frijol en campos de agricultores de America Latina, Memorias de un Taller, CIAT, Feb 16-25.

PE-4 (Information Systems-GIS) Annual Report, 1997, CIAT, Cali.

PE-4 (Land use studies) Annual Report, 1998, CIAT, Cali.

Randall, A., J. Hoehn and D. Brookshire. 1983. Contigent valuation surveys for evaluating environmental assets, *Natural Resources Journal,* 23:635-648.

Ravnborg, H. et al., 1999 – get citation for final report from gregoire.

Ravnborg, H. 1988. The Different Faces of Poverty—What Conventional Poverty Measures Do Not Tell, CIAT mimeo, August (replace with 1999 report when final).

Ravnborg, H., R. Escolán, M. A. Méndez, F. Mendoza, and P. Urbano. 1998. Scaling up from Local Perceptions of Poverty to Regional Poverty Profiles—Developing a Poverty Profile for Honduras, CIAT mimeo, July.

Rodriguez, F., O. Diaz and Escoto N.D. 1994. Situacion actual del mosaico dorado del frijol en la America Central: Honduras. Pp 45-50. In: F.J. Morales (ed.). El Mosaico Dorado del Frijol: Avances de Investigacion. 1994. CIAT, Cali, Colombia.

Roe, T. and T. Graham-tomasi. 1986 "Yield risk in a dynamic model of the agricultural household," in Singh, I. L, Squire and J. Strauss, *Agricultural Household Models: Extension, Applications and Policy*, Johns Hopkins University Press, Baltimore, MD.

Rosas, J. C. 1999. Personal Communication at Zamorano University, Honduras.

Saez, R. y R.P. de Andrade (1990) Impactos Técnicos Económicos de *Adropogon gayanus* en los Cerrados de Brasil. Empresa Brasilera de Pesquisa Agropecuaria (EMBRAPA) y Centro Internacional de Agricultura Tropical, CIAT. Brasilia, Brasil, Marzo.

Sanint L.R., L. Rivas, M.C. Duque and C. Seré. 1985. Análisis de los Patrones de Consumo de Alimentos en Colombia a partir de la Encuesta de Hogares DANE/DRI de 1981. Revista de Planeación y Desarrollo XVII(1985):38-68.

Sanint LR., L.Rivas, M.C. Duque and Seré, C. 1985. Análisis de los Patrones de Consumo de Alimentos en Colombia a partir de la Encuesta de Hogares DANE/DRI de 1981. Revista de Planeación y Desarrollo XVII(1985):38-68.

Schoonhoven, A. van, and D. Pachico. 1998. Rice and Beans in Latin America: A Summary report of the Economic Impact of Improved Varieties, CIAT.

Shultz, S. 1997. Non-market valuation of natural and environmental resources in Central America and the Caribbean. CEPAL. Journal, No. 63, December, 1997.

van Zyl, J., Barbosa, T., Parker, A. N., and Sonn, L. 1995. Decentralized Rural Development and Enhanced Community Participation: A Case Study from Northeast Brazil. World Bank: Washington, D.C.

Vernooy, R. (1997) "Memoria del taller "Manejo sostenible de Cuencas: Una Introducción, "CIAT-Laderas, Managua, Nicaragua.

Viana, A. and D. Pachico, 1985 "Un estudio de aceptabilidad de variedades mejoradas de frijol en el sur oriente de Guatemala" presented at the XXXI Annual meeting of PCCMCA, San Pedro Sul, Honduras, April 19.

Viana, A. 1988. "Flujo de germoplasma e impacto del PROFRIJOL en Centroamérica:1987-1996, PROFRIJOL, Guatemala.

Viana, A. et al. 1994. Estudio de seguimiento en la region Sur-oriental de Honduras al proyecto de producion artesanal de semilla de frijol, RRNN-PROFRIJOL Trabajo Socioeconomico.

Viana, A., M. A. Contreras y C. Perez. 1995. Adopcion de la variedad de frijol CENTA Cuscatleco en la region occidental de El Salvador, CENTA-Profrijol.

Viana, A. and J. Martinez. 1996. Factores que inciden en la adopcion de nuevas variedades de frijol: el caso de Jutiapa, guatemala, ICTA/PROFRIJIOL.

Viana, A., F. Rodríguez and D. Escoto. 1997. Adopción de la variedad Dorado región Centro-Oriental de Honduras, 1996, Dirección de Cienca y Tecnología Agrícola, Programa Regional de Investigación en Frijol (DICTA-PROFRIJOL), Honduras.

Whittington, D., X. Mu and R. Roche. 1990. Calculating the value of time spent collecting water: some estimates for Ukunda, Kenya, *World Development,* 18(2) pp.269-280.

Whittington, D., J. Briscoe, X. Mu and W. Barron (1990). "Estimating the willingness to pay for water services in developing countries: a case study of the use of contigent valuation surveys in southern Haiti, *Economic Development and Cultural Change.*

World Bank Water Demand Research team, 1993, "The demand for water in rural areas: Determinants and policy implications," *The World Bank Research Observer,* (8), pp.47-70.

Young, R.A. 1996. Measuring Economic Benefits for Water Investments and Policies, World Bank Technical Paper No. 338, Washington, D.C.