Project PE-5 Sustainable systems for smallholders:

integrating improved germplasm and resource management for enhanced crop and livestock production

Strategy

CIAT's mission is:

To contribute to the eradication of hunger and poverty in tropical developing countries by generating technology and information with partners through scientific research and dissemination that leads to lasting increases in agricultural productivity while preserving the natural resource base.

PE-5's contributes to this mission by collaborating with a range of partners to develop sustainable and productive technologies that integrate improved germplasm with conservative land management practices.

Improved germplasm is taken from **germplasm improvement** projects at CIAT and other sources and incorporated with improved management practices through farmer participatory research to develop generic **technologies** at the farm level.

Alternative technologies from CIAT and other organizations are evaluated at the watershed level for their biological, social and economic effects on productivity and resource management. An analysis of trade-offs between productivity and environmental benefit offers a range of **integrated options** for local and national policy makers.

Process

Research is conducted in a systems context.

In developing generic technologies at the farm/community level, there is diagnosis and evaluation of opportunities for new technologies within the overall farming system, participatory development of the technology with farmers and local partners, monitoring and impact assessment, feedback to applied researchers, and dissemination of the results.

Developing a range of integrated options at the watershed level, involves facilitating the formation and operation of multi-disciplinary research teams from organizations working in the area, characterization of the area, diagnosis of problems and opportunities, facilitating adaptive research to work on priority issues, monitoring and impact assessment. Concurrently there is an analysis and synthesis of results for community, researchers and policy makers.

Research focuses on both improving productivity and environmental protection with a balance between intervention in the evaluation of potentially useful technologies, and modeling to target research, integrate results, assess impact and extrapolate results.

We have a team of agronomists, livestock specialist, soil scientist, agricultural anthroplogist, resource economist, systems modeler and specialist in participatory research. Individual team members work on developing component technologies and integrated options at the watershed level. The research is dependent on effective partnerships within CIAT and with national and international organizations.

Strategic outputs

- Integrated land use options that contribute to sustaining the natural resource base
- Appropriate generic technologies, particularly in areas for which CIAT has a mandate
- Decision support tools for use by farmers and researchers at the local level and planners and policy makers at the local and national levels
- Increased capacity of national institutions to conduct component and systems research using participatory approaches

Where we work

We work in upland areas where there is a high incidence of poor rural families, low productivity and problems of resource degradation. At present, PE-5 in involved in the development of component technologies for cassava, forages and rice in the forest margins, hillsides and savannas of Latin America, Asia and Africa and in watershed level research in the forest margins, Pucallpa, Peru and a steep upland watershed in Vietnam.

Project Log-frame

CIAT

Area: Natural Resources

Project: PE-5 – Sustainable Systems for Smallholders: Integrating Improved Germplasm and Resource Management for Enhanced Crop and Livestock Production

Manager: Peter Kerridge

Narrative Summary	Measurable Indicators/Milestones	Means of Verification	Assumptions
Goal Knowledge, tools, technologies, skills and organizational principles that contribute to the improved management of natural resources are accessible to NARS and beneficiaries	- Use of CIAT NRM research outputs in 3 reference sites in 5 years, related to changes in land management and associated with increases in per capita income and food availability, improved soil-water-nutrient use efficiency, increased biodiversity in production systems, and stakeholders participating in land use planning. - Use of the CIAT NRM research outputs beyond the 3 reference sites in the 3 target agroecosystems (savannas, hillsides, forest margins) by stakeholders in 5 years. - CIAT NRM research outputs applied by at least 3 other institutions outside LAC by the end of the 5th year.	Projects, plans and reports of national sector agencies, donors, NGO's and community-based organization in the 3 reference sites in LAC mandate agroecosystems which refer to use of CIAT's NRM research outputs.	CIAT's partners are willing to use these research outputs to improve NRM.
Purpose To collaborate with national organizations in developing integrated crop, livestock and arboreal technologies that are adoptable, productive and sustainable	- % increase in income of smallholders - no. of new component technologies - % decrease in soil loss, and increase in soil fertility & water retention - changes in functional aspects of biodiversity - decreases in deforestation and burning - widespread adoption of sustainable practices	- impact evaluation studies	- donor and client support for sustainable land use research

Outputs

Narrative summary	Eco.	Personnel	Indicators (Intermediate impact) / Milestones	Means of Verification	Assumptions
Outputs 1.			Synthesis of research outputs available for local and national planners		
System components assessed to provide alternative land use options	FM	DW	02 Land use alternatives assessed for use in local and national planning for the forest margins	- Workshop and technical reports	- collaboration and integration of research activities in Pucallpa
	Asia	PK	01 Community involved in improving productivity and management of resources at a mountainous site, central Vietnam	- technical report	- Continued donor support
	H, S FM	CEL. FH	00 Options and incentives necessary to develop and utilize feed resources in a sustainable manner in dual-purpose cattle systems in Latin America	- workshop and technical report	- Continued collaboration with NARS partners
			01 Determinants of health and nutritional status in the Aguaytia watershed		- Additional financial support obtained
	FM	TM	01 Community action plans developed in relation to health goals of individuals and communities in the Aguaytia watershed	- final report to donor	
			01 Synthesis of results of research on health and nutrition conveyed to national health authorities		
			02 Synthesis of options for an integrated approach to improving feed resources for livestock in SE Asia		
	Asia	PK	04 A synthesis of options for sustainable management of cassava-based systems in Thailand, Vietnam and China	- operational plans of government agencies	- Maintenance of close relations with NARS
	Asia	RH		- Final report to donor	- IP-3 continues to support R&D in Asia
Activities (CIAT collaborators)			**Milestones**	- Annual report PE-5	
1.1 Characterize and diagnose problems and opportunities at the system level through community participation (with PE-2, PE-4, SN1, SN3)	FM	SF, DW,GH,	00 Synthesis of stakeholder analysis of farmer needs and research issues in land use in the Aguaytia watershed		
	FM	GH, DW	00 Analysis of poverty and land use in the Aguaytia watershed		
	FM	SF, DW, FH	00 Diagnose of needs and opportunities in Moyobamba site		
		DH,DW, RL	00 Examine farmer decision making through participatory mapping		
	LAC	FH	00 Economic impact of spittlebug in Brachiaria pastures		
	Asia	Univ. Hue	00 Interpretation of data on characterization in Hong Ha watershed and research opportunities diagnosed with Hue team		
1.2 Assess biological and socio-economic impact of alternative land use options (PE-2, PE-4, BP-1)		SF, PK, LVA			
	FM	DW	00 Analysis of economic benefits to farmers associated with alternative land use options in Aguaytia using profit-maximization		
		DW,GH	01 Riverine flood risk mapped in Aguaytia watershed		
		FH	00 Analysis of intensification of milk prod.systems, Colombia		
1.3 Determine social indictors of health in Aguatyia watershed	Asia	UnivHue,PK	00 Economic analyses of crop alternatives in Hong Ha, Vietnam		
	FM	TM, SF, PK, DW	00 Collect and analyze data on current health and nutritional status of 8 communities in Ucayali Department, Peru		
			00 Conduct enthographic study at 3 sites in the Ucayali, Peru		
1.4 Evaluate social and private trade-off of alternative land use options (BP-1)			00 Develop plans for a course in ecosystem approaches to human health		
			00 Analyze of economic value of fallow periods in Aguaytia watershed		
	FM	DW	00 Evaluate the impact of open-access land policy upon NR use and economic viability of farm settlers in comparison with those in Brazil		
1.5 Synthesize results to show implications of various policy options (PE-4, BP-1)		DW			
	LAC	FH, CEL	00 Analyse impact of new forage technology options for dual-purpose cattle in LAC in relation to market and policy incentives		
		bbb			

Narrative summary	Eco.	Personnel	Indicators (Intermediate impact) / Milestones	Means of Verification	Assumptions
Output 2. **Generic technologies for sustainable production developed through farmer participatory research**			Farmers using new technologies that are more productive and conserve natural resources		
	FM	DH	02 New technology options developed for Aguaytia watershed	- Annual report	
	Asia	PK	01 New technologies being used by farmers in Hong Ha, Vietnam	- Annual report	
	H	CEL	00 30% increase in milk production in dry season, CA	- Report Tropileche	
	H	MP	02 Increased use of forage legumes by small farmers in CA and Asia	- Annual report	
	S	CEL	03 New forage options for Llanos	- Annual report	
	Asia	RR	02 A core group of farmers using productive and sustaionable forage technologies at 6 sites, one each in Indonesia, Lao PDR, PRC, Philippines, Thailand and Vietnam.	- Impact evaluation	
	Asia	PH	05 New forage and livestock technologies integrated into upland farming systems in Lao PDR to increase farmer livelihood and improve NRM	- Impact evaluation	
	Asia	RR	02 Seed and planting materials of promising forages easily accessible to farmers at 6 sites (as above)	- Monitoring report	
	Asia	RH	04 Increased net benefits to farmers at 15 sites with less erosion in cassava-based systems in Asia	- Impact evaluation	
Activities			**Milestones**	- Annual report	
2.1 Farmer experimentation to adapt technologies	FM	DH	00 FPR Rice and plantain trials evaluated		
			00 Development and evaluation of DRAU to conduct demand-driven systems research and extension		
		DW	00 00 Application of economic model for analysis of technology alternatives in the Aguytia watershed		
	Asia	PK, RH	00 A range of system options being evaluated by farmers at watershed site, Hong Ha, Vietnam		
2.2 Improving feed quality and resource management in dual-purpose cattle production systems (IP-5, PE-2)	H, FM	FH,PJA,	00 Continued farmer evaluation of new forage technologies		
	H	FH	00 Commence scaling up of new technologies in benchmark sites		
	H	PJA	00 Study impact of on-farm research on NRM indicators in CA		
	H	MP, FH	00 Study on early adoption of Arachis pintoi in CR		
	H	PJA,FH	00 Introduce technologies to other countries		
	H	CEL	99 On-farm trials maintained for evaluating new forages, Llanos		
2.3 Evaluating legumes for feed supply, nutrient cycling and improved fallows (IP-5, PE-2)	Africa	MP, PJA	02 Increased use of forages legumes by small farmers in CA.		
		MP, PJA	00 Pilot sites established.		
	Asia	RR	00 New legumes being evaluated for soil fertility improvement and feed supply		
2.4 Developing sustainable forage technologies for upland farming systems	Asia	RR. PK	00 Implementation of new ADB project, site selection and partner identification		
2.5 Developing improved soil management practices in cassava-based systems		RR	02 Role of natural feed resources in feeding systems in Asia		
	Asia	RH	00 FPR trials to investigate the effects of new varieties, intercropping, fertilizer and erosion barriers on cassava prodn.establ. at 6 sites		
2.6 Establish and maintain databases of information and results			00 Investigation of improved surface management at 2 sites		
	All	Team	00 Databases maintained		

Narrative summary	Eco.	Personnel	Indicators (Intermediate impact) / Milestones	Means of Verification	Assumptions
Output 3. **Models/frameworks developed to target research, integrate results, assess impact and extrapolate results**			Farmers and technicians using models/approaches that assist decision making at the farm and watershed levels		
	FM	DW	00 Economic model available for ex-ante evaluation of research proposals in Pucallpa, Peru	- Working document	- Collaboration with PE-3 and funding available
	FM	DW	00 Indicator framework linking immediate outputs and development goals forest margins, Pucallpa	- Working document	- Data available
	All	Team	02 New approaches for use in FPRParticipatory		- Collaboration with partners
			00 evaluation and monitoring framework - Asia	- Final report	
			02 Methodology for scaling up technologies - Asia	- Final report	- Need perceived by partners
	H	MP, LHF	01 GIS-based DSS of forage adaptation in CA used by extension staff	- Working document	
	Asia	Asia team	01 Decision guides available for new technologies	- Extension material	- Partners trained
Activities			**Milestones**	- Annual report	
3.1 Develop economic models to assess technology/land use options	FM	DW	00 Economic model for ex-ante evaluation of research interventions in Aguaytia watershed		-
	FM	DW,GH,RL	00 Economic model developed to assess potential of riverine plains in Ucayali		
	FM	DW,SV,CC, WG	00 Coordinate modeling approaches with ASB-Brazil researchers		
3.2 Framework for monitoring and assessing impact of research in the forest margins	FM	DW,GH DH,AI	00 Provide lead in refining impact assessment framework Synthesize with other benchmark sites		
3.3 Develop FPR methodologies					
A. Develop participatory monitoring and evaluation methods for technology development (SN-1, PRGA)	Asia	TP, PK	00 Participatory evaluation and monitoring framework to assess FPR technologies		
B. Development of a framework for scientists working in the Forest Margins that will lead to more effective interaction among scientists, extension workers and farmers	FM	DH	00 Workshop on application of this framework 00 Experience based learning strategy 00 Nucleus PR team that provide mutual support 00 Introduction of techniques for open process evaluation 00 Farmer group initiating research		
C. Develop methodologies for scaling-up FPR technologies	Asia	Asia team	00 Workshop held, report on alternatives		
3.4 Integrate information on variety adaptation and appropriate technologies with GIS databases to target germplasm use (IP-5, PE-4)	H	MP, LHF	01 GIS-based DSS for forage adaptation 00 Secondary sites established for verification		
3.5 Develop decision guides (PE-2)					
	Asia	RH	01 Utility of information on soil fertility management packaged for use by extension staff and farmers evaluated		
	Asia	WS, PH	00 Manuals on forage species, Forage Agronomy		

Narrative summary	Eco.	Personnel	Indicators (Intermediate impact) / Milestones	Means of Verification	Assumptions
			Organizations with trained staff using new strategies for R&D		
Output 4 .					
Increased effectiveness of CIAT					
and partners to conduct	All	JAA, PK	00 Coordination of systems oriented research	- Annual report, CCER	- Consensus within team
appropriate research for	All	PK, DH	00 A multi-institutional and participatory approach to R&D accepted by NARS in Pucallpa and operational at Hue, Vietnam	- Site visit	Approach achieves successes Need and collaboration
developing productive and					
sustainable land use practices	FM	Team	00 Functional partnerships – Tropileche, DEPAM, SEAFRAD, Cassava R&D network, Univ. Hue	- Annual report	
	FM	DH	00 Alternative institutional models for effecting changes in NRM	- Working document	Special project funding maintained
	Asia	Team	02 New materials and training approaches for NRM-related research	- Manuals available	
	All	Team	00 Effective communication of results	- Publications	
Activities			**Milestones**	- Annual report	
4.1 Funding and coordination of PE-5	All	JAA	00 Funding obtained for on-going and new activities		
		DW	00 Coordinate local CIAT activities in Pucallpa		
		PK	00 Coordinate CIAT activities in Asia		
		Team	00 Project development for Special Project funding		
4.2 Facilitate multi-institutional research at the watershed level for R&D	FM	DH, DW	00 Regular meetings and collaboration within DEPAM team		
(SN-1, SN-3)	Asia	PK	00 Facilitate research at watershed site, Vietnam		
4.3 Facilitate regional partnerships/ networks (IP-3, IP-5)	All	RR	00 Coordination meetings of FSP		
		FH	00 Coordination meeting of Tropileche		
		DW	00 Facilitate private partnerships for Tropileche		
		DW	00 Coordination of CIAT activities in Pucallpa		
4.4 Compare effectiveness of different institutional models for effecting changes in NRM	All	DH	00 Analysis of results of action research and content analysis in output		
4.5 Develop training approaches and materials on targeting, development and diffusion of new technologies and land use systems, and provide training for partners (SN-3)	FM	WWS	00 Manuals on FPR approaches		
		DW	00 Training provided on use of economic model in Peru and in CIAT		
		DH	00 PR training courses in Pucallpa		
		DH	00 Learning project		
	Asia	RH, SF	00 FPR courses in Vietnam and Thailand		
4.6 Communicate results through networks, workshops and journals	All	RH	00 Workshop – Asian Cassava Research Network		
		RR	00 FSP Planning workshop		
	All	Team	Yearly output of papers, newsletters and internet		

Output 1. Alternative land use options for agricultural systems assessed

2002 Characterize and diagnose problems and opportunities at the system level through community participation

Milestone 2000: Understanding Migration in Pucallpa

Highlights

Preliminary results show that farmers in Pucallpa are highly migratory within the forest margin, with a half-life of 5 years in any one area before moving to a new area. Most migration is due to social, not biophysical reasons.

Purpose

Preliminary study to quantify and understand reasons for migration of farmers at the forest margins.

Rationale

The transience of farmers in the forest margins has been an implicit problem in field research projects; whole villages move or fragment. In some local research projects, only around half of the farmers who start a project are still living in the area by the end of the project. This limits the types of technologies that farmers want to adopt. Can technologies stabilise part of this migration, or is stability necessary before management-intensive agricultural technologies will be adopted?

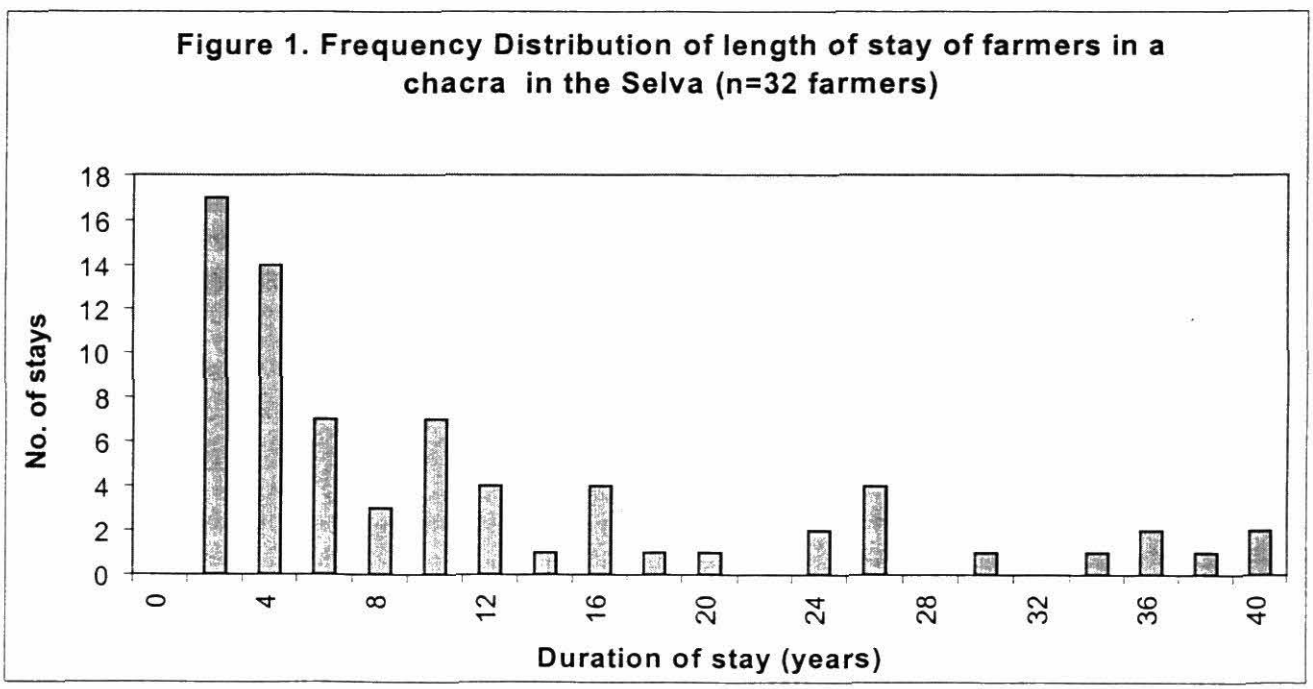
Methods

Preliminary interviews were conducted with 32 farmers from four areas: an established *caserio* growing perennial crops, a forest-margin area, and two riverine *caserios*. Farmers were asked all the places that they had lived since birth, and the reasons for these movements were discussed.

Outputs

Since arriving in the *selva baja* (lowland forest), farmers had migrated an average of 2.3 time between different *chacras*, with a half-life of 5 years in any one *chacra* (figure 1).

Figure 1. Frequency Distribution of length of stay of farmers in a chacra in the Selva (n=32 farmers)



Where a migration had a clear primary reason, 52% of the migrations between *chacras* were for social reasons. The most common social reasons, in descending order of frequency, were to find non-farming work or study, to be with (non-immediate) family members, and bereavements. 32% were for biophysical reasons: chiefly to find better quality soil, to leave land that floods, or to find more land. Other reasons included to find a site with better access, and health problems. Most farmers intend to stay in their current site, but move on for unforeseen reasons. However, "farmers" may be an inappropriate term for many land-users, as a majority would abandon farming if other opportunities arose.

Impact

This study is preliminary, but the results suggest that land users in the forest margins are more migratory than previously considered. If verified, implications for research would include:

- Impact measurements of agricultural technologies should include effects on migration (e.g. migration foregone to use the technology). Long-term, sustainable NRM technologies may play a part in stabilizing the shifting frontier, or may be not possible to adopt by those who are transitory.
- Measurements of deforestation should be separated into within-farm deforestation by relatively stable settlers, and creation of new farms at the forest margin

Contributors

Dean Holland, Efraín Leguia, Jhon Aviles, Rafael Urquia-Cairuna, Jose Sanchez (all CIAT).

2002 Biological and socio-economic impact of alternative land use options assessed

Milestone 2000: Analysis of farmer economic benefits and trade-offs associated with alternative land use options in the Aguaytia watershed Perú

Highlights

New crops in the forest margins region of Peru may be either competitive or complementary with respect to the labor demands of traditional farming systems. If labor-competitive, technology adoption may be difficult; whereas if labor-complementary, there is greater likelihood of a negative impact upon forest cover. Efforts to intensify production will continue to be problematic without integrated agricultural, forest, transport and trade policy measures.

Purpose: To examine how new technology options can lead to an environmental-economic trade-off in terms of impact upon forest cover and household food security

Rationale: In the Peruvian Amazon, smallholder farmers face agronomic and market challenges ranging from rapid soil fertility loss to unstable product prices and high transport costs. Farmers respond to this environment by balancing the adoption of new market-oriented crops with traditional crop production. Yet for many new technologies, adoption rates remain low and subsistence production predominates.

Wherever the location, farmers decide how to best invest their labor, land and capital resources to reach the goals of high profit and household food security. However, there often exists a trade-off between these goals. Crop selection depends upon a variety of factors such as the needs and resources of farmers together with agro-ecological factors and market prices. How agricultural research and government policy affect planting decisions, farm profit and food security are best examined within a framework of the entire farming system. Modeling of farming systems permits an *ex ante* analysis of potential environment/human welfare implications caused by the introduction of new technologies.

Outputs: A conference presentation for the International Farming Systems Association (IFSA), Santiago Chile, November 2000 that provides more detailed analysis of the following summary. (Also please refer to Activities 2.1, 3.2 and 4.8)

Throughout the Aguaytia watershed, seasonal rainfall and river height affect farm activities (Figures 1-3). Preliminary results of an agro-economic model demonstrate marked differences between uplands and riverine agriculture especially in terms of labor use (Figure 1). Allocation of labor is a central component of this research, since along with capital, it is a scarce resource that restricts agricultural activity in this land-abundant region.

The seasonal nature of agricultural crops and farming systems requires the close examination of how labor demands are affected by new technological interventions. Promotion of improved varieties and exotic crops by national and international institutions will affect farmer cropping decisions and thus influence both household earnings and forest cover. For example, if a new technology were *complementary* to the labor demands of traditional farming practices, incomes would likely rise since farmers could continue with traditional subsistence crop production and add new activities. That is, labor-complementary technologies are likely to have higher adoption rates since the commonly binding constraint of labor is little affected. Yet these new agricultural activities may demand more upon land resources. With labor-complementary technologies, there

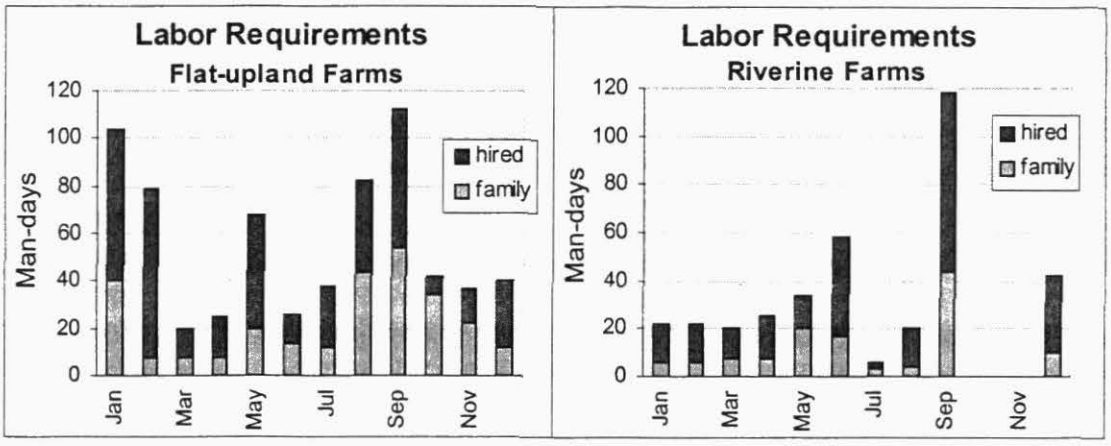
is a higher probability that forest cover is detrimentally impacted as both traditional and new technologies can be employed on the farm.

On the other hand, if new technologies were *competitive* with respect to labor demands, forest cover may tend to be preserved, but household food security could be threatened. Traditional subsistence crops would likely lose prominence to market-oriented crops, which have may have higher but more volatile prices. If the new crop were more profitable yet prone to unforeseeable price swings, farm household food security could be gravely reduced if subsistence food production has decreased. In this case, labor dedicated to the market crop would not only lead meager earnings, but also to lower levels of household subsistence crop production.

For the Aguaytia region (Figure 1), technologies that require large amounts of labor input in the already busy months could be considered as being competitive to traditional agricultural practices (January, February, August or September in the uplands; May, June or December in the riverine areas). In the extreme cases of labor competitiveness, adoption of the new technologies would likely be difficult to realize. Farmers would be unwilling to sacrifice their stable traditional crops for the new and often unproven technologies.

Peach palm and pineapple provide clear examples of this inherent trade-off. Since, farmers in the uplands plant rice, maize, cassava, plantain and beans mainly to ensure food security, they allocate their resources accordingly among this crops. As the results of the model demonstrate (Table 1 in Activity 2.1), farmers would not adopt new areas of peach palm or pineapple because of scarce available labor in months subsistence crops require labor resources. Peach palm requires labor inputs for the months of September and January (installation and weeding activities respectively), while at the same times subsistence crops must be sown and then harvested.

Figure 1. Labor requirements by month of average flat-upland (20 ha) and riverine (18 ha) farms



The price variability of primary agricultural crops (rice, cassava, plantain, maize) is related to the seasonality of the region. During the distinct harvest periods, prices drastically fall. With rice, for example, the upland harvests are in January and riverine area harvest occur in September (Figure 2). Such a market climate severely affects the earning potential of rural households since few farmers have crop storage capability and wish to quickly sell their harvest in order to obtain much-needed cash.

Figure 2. Monthly prices for traditional crops Ucayali

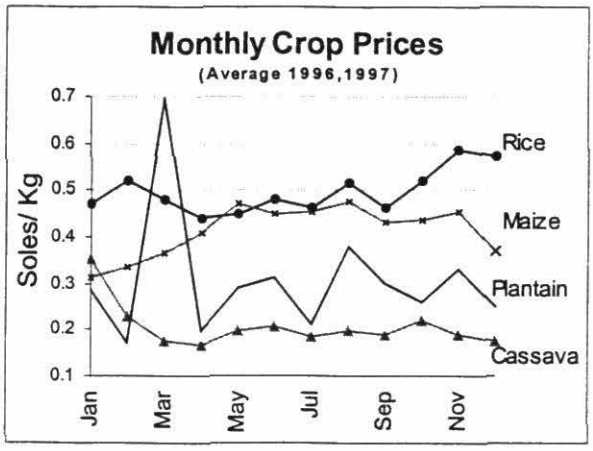
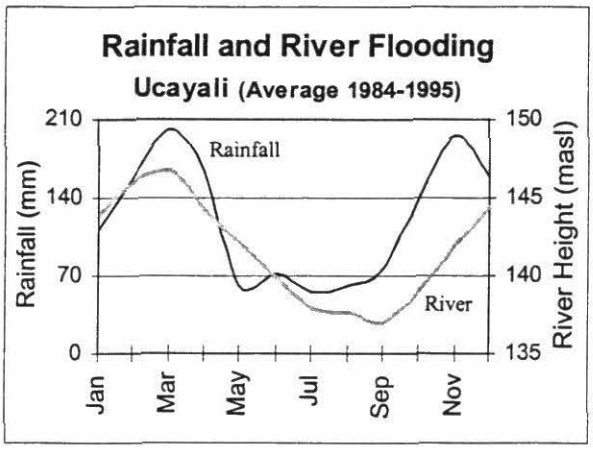


Figure 3. Rainfall and river flooding in



Data: Ministry of Agriculture-Ucayali, Universidad Nacional del Ucayali

Impact: Since farmers select from a variety of crop alternatives, the trade-offs between economic and environmental goals are best examined by commencing analysis at the farming system level. Both agricultural research and government policy initiatives can be modeled in an *ex-ante* manner to foresee the likely implications upon farmer income, household food security and forest cover.

Price variability of primary agricultural crops could be an advantage if crop storage were an alternative for farmers. Future research should examine farmers interest in storage and the benefits versus the costs (potential pest damage, capital investment required). These benefits and costs should also be compared against improving yields of traditional agronomic crops.

Contributors: Douglas White, Ricardo Labarta, SN-1, INIA, MinAg-Ucayali, DEPAM, ICRAF

2001 *Determined* indicators of human nutrition and health in the Aguaytia watershed

Milestone 2000: Completion of Field Work to Develop Indiscators of Human Nutrition and Health

Purpose: This project is developing and testing a participatory ecosystem approach to human health assessment that provides insight into the causal linkages between natural resource use, biodiversity, health and nutrition.

The following hypotheses are being evaluated:

- A more productive ecosystem results in higher nutritional status
- Greater biodiversity on and surrounding the farm results in higher nutritional status
- Nutritional status will vary between native and colonist communities due to differences in culture and local knowledge of biodiversity and ecological resources
- The shift from more subsistence-oriented to commercial production systems does not necessarily result in an increase in nutritional status
- The shift to commercial production affects the role of women in the household, their time allocation and involvement in health and nutrition decisions
- Nutritional status will vary by age and sex within the household
- Nutritional status will vary throughout the year due to seasonal differences in nutrient intake

Rationale:

Ucayali and the surrounding upper rainforests are of great biological significance, containing 23% and 44% of known tropical plant and bird diversity in the Neotropics (IUCN 1996). Despite the natural diversity and fecundity of the setting, rural communities face a range of nutritional and health problems. Chronic malnutrition affects 47% of rural children below age five (INEI 1997), anemia and vitamin A deficiencies are widespread and incidence of malaria, dengue fever and persistent diarrhea continues to rise (Direccion Regional de Salud 1997). Health research has demonstrated the importance of nutrition to child development and human health (Pelletier et al. 1993; Bailey et al. 1998). In the study area, agricultural production, fishing and wild food extraction, provide the main sources of food consumed. Nutritional status and human health is therefore dependent on the family's ability to ensure sufficient nutrient intake through a diversity of production activities. Exploitation of resources in the surrounding ecosystems result in diverse seasonal combinations of farming, fishing, logging, and hunting and gathering activities. Within such populations, the relationship between household production, income level and nutrition is complex and poorly understood (Leonard et al. 1993). More specifically, the nutritional status of Amazonian populations in Peru has largely been ignored, and the impact on nutrition, and particularly gender relations, of recent shifts to commercial production, has yet to be explored

Methods:

Research Activities Include:

1. Characterization and assessment of the livelihood systems of riverine and upland communities with respect to:

    i) Diversity of food and income sources
    i) Agricultural diversity and biodiversity of wild foods gathered from surrounding forests
    ii) Contribution of different land uses (fishing, farming, hunting and gathering, logging) to dietary quality and food security

2. Assessment of household food security and nutritional status of individual men, women and children, with emphasis on seasonal changes in nutrient intake and deficiencies of micronutrients (iron, zinc, vitamin A, B and C)

3. Characterization of child morbidity patterns and disease periodicity

4. An ethnographic study of local beliefs, knowledge and decision-making processes that affect the selection of foods and the treatment of illness.

Once the above field activities are complete, the project will:

- Determining the significant correlates of nutritional status and identify the causal linkages between natural resource use, health and nutrition through bivariate and multivariate analyses,
- Development each community their own definitions and indicators of individual and community health using participatory methods
- Develop and implement Community Action Plans (CAPs), drawing on the problems and opportunities identified through the research and the community's own definitions of health.

Building institutional collaboration

From the outset of the project, local representatives of government and non-governmental organizations have been involved in refining the research objectives, designing the specific methodology and carrying out the research. Initially, focus groups and key informant interviews were held with all relevant organizations to confirm the key health issues in the region and provide a richer description of the institutional setting and current efforts in the health arena. These meetings included; the Ministries of Health, Fisheries, and Agriculture, AMUCAU (Asociación de Mujeres Campesinas de Ucayali), AIDESEP (Asociación Interectnica para el desarrollo de la Selva peruana) and FECONU (Federación de Comunidades Nativas de Ucayali), OMIAP (Organización de Mujeres Indigenas de la Amazonía Peruana) and IIAP (Instituto de Investigaciones de la Amazonia Peruana). At this time inter-institutional agreements with CIAT were formalized. Futhermore, this year two new agreements was made with Universidad Nacional de Ucayali for short curse development for students in Faculty of Agronomy and Health based on insights gained research, and Ministry of Health Region Ucayali for implement two SERUM (Servicio Urbano Marginal de Salud) that are excuting on field.

The Research Team

The core research team is four full-time staff; In addition, two recent graduate from the nursing program is conducting her one-year rural residency (SERUM) with the project; a larger team of local representatives was established until last round surveys. This group meets regularly, providing feedback on research activities and advice on future work. More importantly, the direct involvement of these representatives in the implementation of the research (household surveys) has contributed greatly to the exchange of information, training of local researchers, complementarily of research efforts and a greater interest and sense of local ownership over the research and its findings. Through the formal agreement with the Ministry of Health, they have provided an environmental health expert for testing the quality of water sources and for taking stool samples for parasitic infections The Director of FECONU was leading the study on the role of the fisheries in nutrition and facilitating community participation in the native sites. And lastly, two health promoters from the government nutrition program (Kusiayllu) and AMUCAU was conducting the anthropometric assessments at all sites.

Site selection
Was a critical step in the research. Specific criteria were identified in order to capture the heterogeneity of the region and all local partners were involved in the process. Eight sites were selected based on differences in;

- ecosystem type (riverine versus upland forests)
- ethnicity (native versus colonist)
- access to markets and involvement in market economy
- time of settlement (early versus old frontier)
- dominant land use strategy (slash and burn agriculture, fishing, cattle ranching and oil palm plantations).

The research sites include;

Riverine communities:

Upper Ucayali River:	**Cunchuri *(mestizo)**
	Puerto Belén (native)
	Caco Macaya* (native)
Aguaytía River:	Santa Rosa (native)
	Naranjal* (mestizo)

Upland communities:

Palmeros*(Neshuya-Curimaná):	Oil palm growers (mestizo)
Ganaderos (CampoVerde-Km 80):	Cattle ranchers (mestizo)
Hierbas Buenas* (Km 38):	Slash-and-burn agriculture (mestizo)

* These communities was sites in the Ethnographic study.

Two research methods was used:
i) Houesehold and community surveys of all eight sites (3-4 days at each site) and
ii) Ethographic study of five sites (10-14 days at each site).

Research visits for the surveys were carried out for:

i) Household and Community surveys in June-July 1999 (dry seasen) Octuber-November 1999 (Star of the rainny season), Febraury-March 200 (height of wet season).

This captures the seasonal changes that result from the 10m rise in river levels in the rainy season. The affect of the hydrological cycle on food availability, water quality and disease incidence is critical to understanding the health and ecological dynamics of the rainforest and its inhabitants.

ii) Ethographic study research visits were in; august-September 1999 (dry season), January-Febraury 2000 (wet season)

The tables 1 and 2 indicate the frequency of collection and period of recall of each variable measured.

Within the household, the primary female and male caregivers are the main informants. Children are divided into four categories (0-23 months, 2-5 years, 6-10 years, 11-18 years) and one child is selected randomly from each category. Within each research site, between 32 and 50 families are interviewed, depending on the size of the community. In the ethnographic study, participatory research methods are used, with specific emphasis on gender dynamics, intra-household food allocation, local beliefs and knowledge of health and nutrition, ethnographic food classification and decision-making processes regarding the diagnosis and treatment of childhood illness. All community members are participants in the ethnographic study.

Actualy the team is working on building a database, the total surveys made were 334 families, this amounts to 668 surveys. On the other hand, the total children evaluated were 750 for each time, reach 2250 data. All data, measures anthropometric, weight for foods, production systems, ethnographic data, and cycles illness, are digitizing, the project plans to finish this task by the end of the year year.

The Ecosystem Approach

The goal of the Ecosystem Approaches to Human Health Program Initiative at IDRC is to improve human health by supporting trans-disciplinary research on the structure and function of stressed ecosystems on which people depend for their livelihoods and by applying this knowledge to the development of appropriate and effective interventions and policies.

In contrast to the more traditional medical model of health, the ecosystem approach focuses on the relationship between health and ecology. This shift in focus to the surrounding ecosystem and its impact on health, forces us to consider for example, how floods and poor water quality affect parasitic infections and incidence of diarrhea, how biodiversity increases dietary quality and reduces susceptibility to micronutrients malnutrition, how soil infertility and land degradation reduce household food security and how the lack of hygiene and sanitation practices facilitates the spread of infectious disease.

The ecosystem approach is guided by three principles; it is hierarchical, participatory and adaptive. Ecosystems exist in nested hierarchies; each comprised of smaller systems while at the same time being part of a larger whole. The different layers (individual, household, community, region) evolve within a variety of ecological and socio-economic contexts and constraints (Allen et al. 1982; 1993; Conway 1987). Research and intervention must therefore target all levels, recognizing that the decision-making constraints imposed by governance structures at the regional and national levels impact on the array of options available at the household level. An

ecosystem approach *is inherently participatory.* Its ultimate goal is to create a locally-driven sustainable process to assess, analyze and alleviate malnutrition. It aims to enhance local capacity to cope with key problems affecting human health, increase self-reliance and reduce the need for external funds and expertise. A participatory approach allows local stakeholders to define their own goals and develop a sense of ownership over the research findings and desired interventions. Lastly, an ecosystem approach is adaptive, recognizing that socio-ecological systems are dynamic and often unpredictable. Interventions emphasize the development of social and human capital, with the understanding that the capacity of people and institutions to adapt to sudden and unexpected stresses, is what ultimately leads to a more sustainable and resilient system.

Outputs

1. The database will allow.:

- Report of nutritional and health status of men, women and children in selected communities and the significant determinants of nutritional status
  - Analysis of the impact of seasonality on resource use activities, food availability, income levels and disease periodicity, and identification of critical periods when cycles of disease and food insecurity most severely threaten the health of women and children
  - Community Action Plan (CAPs) for each site, addressing key health and nutrition problems and incorporating local definitions and indicators of human health
  - Dietary guidelines for each community, based on the availability of local sources of nutrient-rich foods
  - Educational programs and improved nutrition programs targeting high-risk groups and critical periods when the cycles of nutrient intake and disease most adversely affect health.
  - Small-scale food production projects in each community, aimed at increasing the diversity of foods consumed, eg. family gardens, small animals, fruit orchards and fish ponds.
  - Short course developed for local university students in agronomy and health addressing the issues of malnutrition and health in Ucayali, based on the insights gained at the eight research sites.

2. Analysis of haemoglobin using HemoCue Scale Color Test from OMS, began second round, in all research sites, take sample of 800 children, this show high percentage about 80% with anemia below 10 g Fe/dl, all categories and different ecosystems evaluated, see the table 4. The impact of technologies production systems, not is reflected on quality live household farmers.

Table 4. Levels of Haemoglobin Percentages at eighth communities rural evaluated Región Ucayali, Perú.

Communities	Date	Not Anaemic	Moderate Anaemic	Marked Anaemic	Severe Anemic	number Child
Naranjal – Middle River Aguaytia	10/11/99	10	88	1	1	89
Puerto Belen - Upper River Ucayali	25/11/99	3	85	12	0	75
Cunchuri - Upper River Ucayali	28/11/99	10	84	6	0	109
Caco Macaya – Upper River Ucayali	29/11/99	9	80	13	0	93
Santa Rosa – Upper River Aguaytia	12/12/99	0	83	16	1	146
Hierbas Buenas – Road F.B km 38	18/12/99	17	81	1	1	84
Ganaderos – Road F.B. km 15-83	22/12/99	10	86	2	2	110
Palmeros – Road Neshuya-Curimana	24/2/00	31	69	0	0	94

3. Analysis of parasites *in situ*; exist 70 percent in average all sites research, over 400 samples at children, the use of a microscope on the field, was the key for establishment links with mothers and youngsters over issues relative to health and quality environmental, the impact of see your own samples and identify parasites makes them take immediate action in their homes. See Table 5

Table 5.
Analysis of Parasites in percentage at eighth communities rural of Región Ucayali, Perú

Communities	Negative	Positive	Parasites				Number of Children
			Mono	Bi	Tri	Tetra	
Naranjal – middle River Aguaytia	24	76	66	17	14	3	38
Puerto Belen – Upper River Ucayali	3	97	94	6	0	0	37
Cunchuri - Upper River Ucayali	16	84	91	9	0	0	77
Caco Macaya – Upper River Ucayali	0	100	76	22	2	0	59
Santa Rosa – Upper River Aguaytia	59	41	96	4	0	0	58
Hierbas Buenas – Road F.B. km 38	32	68	91	7	2	0	65
Ganaderos – Road F.B. km 15-83	81	19	80	20	0	0	27
Palmeros Road Neshuya-Curimana	23	77	70	20	7	3	39

Quality water test *in situ*, this analysis show not apt water at all research sites, the field equipment only registered levels of *E. Coli*, this essay take samples of houses and principals source river and wells. Any development program on rural small farms will not be successful if it does not include capacitation or intermediate technology to improve water quality.

Projected Impacts

This project has two key potential impacts. First, the resulting analyses of nutritional status will allow more targeted and effective nutrition rehabilitation programs at the regional level. At the site level, community action plans, dietary guidelines and small-scale food production projects will increase dietary quality and diversity and reduce nutrient deficiencies.

Second, the project may play an important role in the assessment of alternative land use options for the Pucallpa benchmark site. Despite a myriad of international studies, the link between

agricultural development and health and nutritional status is not yet clear (von Braun et al. 1994). Increases in production and income that result from improved technologies and agricultural intensification may, but do not necessarily, lead to changes in health and nutritional status. As one of the main goals of PE5 is to evaluate the biological and socio-economic impact of different land use options, this project provides the methods and data to broaden this evaluation and include the consequences for human health and nutrition.

Contributors

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Collaborators:
Official collaborating organizations are CIAT; Ministry of Health, Ucayali; Ministry of Fisheries, Ucayali; IIAP; Uniersity of Guelph; and the Univerity of Waterloo.

The Pucallpa project team is as follows;

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Douglas White	CIAT, Resource Economist
José Sanchez Choy	Agronomist
Felix Sánchez Zavala	Nutritionist
Yolanda Malqui	Nurse (Ministry of Health SERUM)
Ingrid Azucena	Nurse (Ministry of Health SERUM)
Maria Elena De Aguila	Data processor
Nina Rodriguez	Data processor, Intern from local Technical College

The international team of scientists involved in the project include

Sam Fujisaka	CIAT, Anthropologist
David Waltner-Toews	Univ. of Guelph, Epidemiologist
Peter Berti	PATH Canada, Nutritionist
James Kay	Univ. of Waterloo, Systems Ecologist

Local research assistants include;

Carolina Rengifo	Agronomist
Francisco Econaise	Ecologist
Dionicio Katayama	Animal science
José Martin Díaz	Agronomist
Rocio Gonzales	Health Promoter (Kusiykulu Nutrition Program)
Verónica Lopez	Health Promoter (AMUCAU)
Danica Carrión	Health Promoter (AMUCAU)
Adolfo Pino	Health and Hygiene Promoter (FECONU)
Rafael Urquia	Fisheries Ecologist (FECONU)

Aide Sandoval	Biologist (Dept. Env.Health, Health Ministry)
Wilson Cardnas	Parasitologist (Lab. Referencial, Health Ministry)

The following representatives of local organizations are active members of the research ,survey and development teams in Pucallpa;

Irma Barbaran, Nurs, Ministry of Health
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Victor Gonzales, Nutritionist, Ministry of Health
Juan Carlos Saavedra, Biologist, Ministry of Fisheries
Rafael Urquia, Director, Fisheries Ecologist, FECONU
Adolfo Pino, Health and Hygiene Promoter, FECONU

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Table 1: Data Collection for Surveys

Level	Indicators	Variables	Round 1 June-July 99	Round 2 Oct-Nov 99	Round 3 March-April 00	Methods	Freq.of collection/Period of recall
Landscape	Ecosystem productivity	Soil fertility		X		Soil tests	Once at each site
Community	Access to food	Food prices	X	X	X	Observe	3X
		Food availability	X	X	X	Observe	3X
	Access to education	Education facilities available	X	X	X	Interview with leaders & teachers	Once on initial visit/ Include changes during study
	Access to health services	Health services available	X	X	X	Interview with health worker	Same as above
Household	Socio-economic status	Wealth index		X		Recall	Once
		Non-food expenditures		X		Recall	Once. Recall period varies with item
	Nutritional status Food Security	Energy and nutrient intake	X	X	X	24 hour recall	3X for prior 24 hours
	Dietary Quality	Nutrient intake	X	X	X	Food frequency recall	3X for prior 7 days
	Dietary diversity	Food sources	X	X	X	Recall	3X for prior 24 hours
	Income level; diversity	Income by source	X	X	X	Recall	3X, round 1 for prior growing season, round 2 and 3 for period b/w visits.
	Production levels; diversity	Production and extraction outputs	X	X	X	Recall	Same as above
	Food security	Crop storage		X	X	Recall	2X, report what is in storage at time of visit
	Water access; contamination Environmental health	Water Quality	X	X	X	Water samples	Three times
		Hygiene Practices		X		Recall	Once
Child	Growth and development	Anthropometric measurements	X	X	X	Actual measurement	Three times
	Nutritional status	Energy and nutrient intake	X	X	X	Recall	3X for prior 24 hours
	Health status	Breastfeeding history	X			Recall by mother	Once on initial visit
		Diarrhea incidence & patterns	X	X	X	Recall by mother	3X, round 1 for prior 6 months, round 2 and 3 for period between visits
		Incidence and patterns of respiratory infections	X	X	X	Recall by mother	Same as above
		Morbidity patterns		X		Recall by mother	Once for prior six months and whole life
		Mortality		X		Recall by mother	Once, deaths during survey period are recorded
		Iron Status		X	X	Measurement of haemoglobin	Twice (PATH anemia strip)
		Parasitic infection		X	X	Stool samples	Twice
Women	Nutritional status	Energy and nutrient intake	X	X	X	Recall	3X for prior 24 hours
	Female fertility	Reproductive history	X			Recall	Once on initial visit
	Health status	Morbidity patterns		X		Recall	Once, deaths during survey period are recorded
	Labour demand	Time allocation	X	X	X	Recall	3X for prior 24 hours
Men	Nutritional status	Energy and nutrient intake	X	X	X	Recall	Same as above
	Labour demand	Time allocation	X	X	X	Recall	Same as above

Table 2: Data Collection for Ethnographic Study

Level	Variables	Summer Aug/Sept 1999	Winter Jan/Feb 2000	Methods	Participants ** number in brackets indicates the # of groups*	Freq. of collection/ period of recall
Landscape	Spatial mapping of ecological diversity; lakes, swamps, forests, rivers, palm forests etc.	X	X	GPS/GIS	Farmers/fishermen/ hunters and gatherers	Twice
	Spatial mapping of resource use activities; farming, fishing, hunting, gathering and logging	X	X	GPS/GIS	Farmers/fishermen/ hunters and gatherers	Twice
Community	Sources of information	X		Observe/key informant interviews	Community leaders, teachers, students	Once
	Community organization	X		Observe/key informant interviews	Community leaders, teachers	Once
	Community facilities and resources	X	X	Community mapping	2 groups of male comm. members approx. 20 people	Twice
	Hygiene and sanitation	X	X	Observation, Community mapping & Health walk	2 groups of female comm. members approx. 20 people	Twice
	Disease periodicity	X	X	Seasonal calendar (focus group)	2 groups of female comm. members approx. 20 people	Twice, summer and winter recall periods
	Historical information	X		Timeline (focus groups)	Groups of 6-9 people • Elderly (1*) • Fishermen (2) • Hunters (2) • Farmers (2) • Women (3)	Once, for entire history of community
Individual	Diarrhoea management	X	X	Key informant interv./ case histories and decision models	Interviews with: • 8-10 people knowledgeable of health issues • 10 women with children with a recent diarrhoea episode	Twice in dry and wet seasons
	Nutritional ethnography (local classification)	X		Pile sort/food attributes/attribute rating	Small groups of 2-3 people include: • women with children < 5 yrs. (5) • women > 45 yrs (5) • men (2) • adolescents (2) • teachers (2)	Once
	Health ethnography	X		Focus groups	Focus groups include: • women with children < 5 yrs (2) • women > 45 yrs (2) • men (1) • adolescents (1)	Once
	Fertility (pregnancy, prenatal care, birth, diet, contraception etc.)	X		Interviews	Interviews with 10 women of different ages	Once
	Risk Management (identification of risks, frequency, predictability and coping strategies)	X	X	Focus groups	Groups of 6-9 people • Elderly (1) • Fishermen (2) • Hunters (2) • Farmers (2) • Women (3)	Twice (recall is to the extent to which they can remember)

2002 Evaluated social and private trade-offs of alternative land use options

Milestone 2000: Fallow management strategies: economic and environmental trade-off analysis in the Aguaytia watershed

Excellent research by CIFOR has recently covered this topic. Therefore the activity has been postponed indefinitely.

Milestone 2000: Evaluate the impact of open-access land policy upon natural resource use and the economic viability of settler farms

Highlight
Research presents detailed steps of how the forest to agriculture conversion matches human land use processes first involving individuals and then more complex communities and institutions. How the lack of institutional support from the beginning can affect the amount of natural capital available to new settlers.

Purpose: to examine the implications of land acquisition policies upon the welfare of both settlers and the environment.

Rationale: Land distribution in the Peruvian Amazon is a relatively *laissez faire* process. Settlers often colonize land before obtaining formal paperwork. This government policy coupled with a relatively strict forestry law, can prohibit settlers from maximizing earnings potential since natural capital (trees) is often compromised before their arrival.

Outputs: Initial research shows that at the farm level, settlers transform natural capital into financial capital through the sales of timber, charcoal and agricultural production. Lower earnings result from greater sales of charcoal, a lower-value product than timber, because of rudimentary road access. At the community level, the settlement process starts with timber extraction, farm establishment, petitions to government for services, government recognition, and concluding with formal land title (Table 1).

Impacts: This research provides insight to the process and implications of settlement in the Peruvian Amazon. Such a baseline analysis provides a basis from which to compare with neighboring countries in terms of the welfare of rural settlers and the status of the natural capital resources. Lower quality of natural resources may prevent settlers raising sufficient financial capital to establish sedentary farms, thereby provoking migration. By understanding the implications of government policy or lack thereof, informed adjustments can be made to minimize tradeoff between environmental and poverty alleviation objectives.

Contributors: Douglas White, Ricardo Labarta, Tamsyn Murray, Francisco Econaise

Table 1. The Transition from Individual to Institutional Process Reflecting the Land Use Change Forest to Agriculture

Actions	***Principle Land Use***
I. Transitory Timber extraction	
A. Illegal (small teams-7 people)	▪ Highest value lumber
B. Legal (large teams 20-50 people)	▪ High value lumber
II. Transition from Timber to Agriculture	
A. Individual/Family	▪ Intermediate value lumber, charcoal, coca, game
B. Friends invited to become neighbors	▪ Intermediate value lumber, charcoal, game
III. Permanent Settlement	
A. Local initiatives	▪ Low value lumber, charcoal, agriculture
1) Schoolhouse construction	
2) Petition Ministry of Education for a teacher	▪ Decreasing primary forest ▪ Increasing crop land ▪ Introduction of animals ▪ Transition to pasture ▪ More cattle
3) Form committees (health, education) Elect community authorities	
B. Formal recognition process of the community	
1) Petition regional government for infrastructure	
a) Health post	
b) School director	
2) Recognition of community authorities by the regional government	
C. Private land tenure process	
1) Property lines demarcated	
2) Written certification	
3) Formal land title	

2001 Community involved in improving the productivity a management of resources at a mountainous site, Central Vietnam

Milestones 2000. Complete characterization in Hong Ha watershed

Highlights:
Characterization of the watershed and community was completed
Initial steps taken in co-management of the land and forest resource

The general characteristics of the watershed were summarized in the 1999 Annual Report. During 1999-2000 detailed studies were completed on in several areas:

Indigenous knowledge of shifting cultivation - Nguyen Xuan Hong

Gender roles in agricultural and forestry production activities in Hong Ha commune - Hoang Thi Sen

The impact of the national settlement program on the livelihood and natural resource use in the region - Hoang Huu Hoa and Truong Tan Quan

Assessment on the impact of the national program 327 on socio-economics and the environment in Hong Ha Commune - Hoang Huu Hoa and Truong Tan Quan

The system of land tenure and forestry and land use in Hong Ha - Le Quang Bao

In addition, a workshop attended by the main government stakeholders and the community was facilitated by the project.

Some of the conclusions of these studies or meetings are summarized below.

Indigenous knowledge of shifting cultivation

1. Indigenous knowledge (IK) of the Hong Ha people on shifting cultivation is profound, diverse and appropriate to farming conditions of upland areas. When awareness of modern technology is low, farmers rely on observations in their natural sphere of operation. IK may continue to play an important role even with introduction of modern methods. IK should be conserved and promoted.

2. However, the reality is that the shifting cultivation economy is not sufficient in the present age to allow the community full access to modern services. However, some of the IK can be used in intensification for sustainable development.

3. The purpose of this study of IK was to use it to develop modern farming systems based on long years of experience. It can be applied to developing new farming calendars, selection of sites for cultivation, prevention of soil erosion, protecting forests and cultivation on sloping land.

Gender roles in agricultural and forestry production activities

Conclusions. In the production systems of the region, both men and women participated in all production activities. However, there were gender-specific tasks in productive and reproductive activities. It was found that Hong Ha women contributed more time than the men to all activities of food crop production including land preparation. Poultry and pig raising were responsibilities of female farmers but cattle production was in the men's domain. In off-farm activities, there was also gender division. Gathering fuelwood and cutting *La Non* were performed by the women while hunting was a predominant activity of the men. Men and women spent equal time in planting and managing trees. In housework, women spent much more time than men who rarely assist.

In decision making, the formal survey indicated that the women had a stronger role in making decisions on activities of crop production whilst decisions on activities of tree management fall under the men's domain. In decisions related to animal production, decisions were mainly made by the men but occasionally by both men and women. For decisions relating to the household, Hong Ha men had a greater role in deciding where to construct a house. Other decisions of household activities were made by both men and women.

The formal survey also reflected that both Hong Ha men and women had access to resources. Nevertheless, in reality, gender discrimination was apparent in giving credit, land title and greater opportunity for training and education to men.

Recommendations. Community resource management can not address the issue of sustainability without human resource development. To improve community-based resource management in Hong Ha and other localities with the same social, economic and ecological conditions, the following recommendations may be useful:

Future development workers and policy makers should receive training on gender issues.
It is necessary to give both female and male farmers opportunities to join in activities in research and development projects. However, because of their different roles in the household, different measures are required for men and women. For example specific training for women could be in the areas of pig and chicken rearing, weeding techniques, as well as wild plant conservation and use.
To increase the productivity in the region while reducing pressure on natural resources, it is essential to increase the educational level (especially for young female farmers) and ensure the attendance of women in extension training. Since women have a higher workload in the dry season, training activities should be organized in the rainy season.
Improving women's access to land requires a change in the land registration procedure in the region. Certificates should bear the name of both husband and wife.
Government and non-government organizations need to extend credit support to poor women with low interest. Monitoring of loans to avoid problems of distribution for wrong purposes is also needed.
Introduce and develop new technologies such as wetland rice sowing, and tractors to reduce workload of women.
It is necessary to integrate gender knowledge and concerns in designing and implementing natural resource management based research and development projects.

Assessment on the impact of the national program 327 on socio-economics and the environment in Hong Ha Commune.

The planting program resulted in an additional 700 ha of forest being planted and another 180 ha being re-assigned as forest land. There were many associated changes during the period of Program 327 (1993-1998) and not all can be attributed to the Program. Production increases were: agriculture (100%), livestock (49%-42% from cattle), Forestry and forest maintenance (45%) while the value of forest products extracted decreased by 10%. The number of households increased from 157 to 183. There were associated increases in services. Electric power became available and 115 households were connected but only 11 had acquired TV. However, only 57 households acquired a running supply of water. Illiteracy decreased from 67 to 44%.

Program 327, implemented over 6 years in Hong Ha commune, proved that it is not only a program of planting and maintaining protective forest, specific forest but also plays an important role in ecological environment protection attached to the development of social economy, changing plant structure in forestry and agriculture, and contributing to the redistribution of labor force and residents. Through the impacts of the program, many new methods of production have come into existence, especially in forestry with some positive benefits to the local inhabitants.

However, it needs to be mentioned that during the process of implementation, many shortcomings still existed in defining and carrying out investment structure, investment progress as well as subjects to be acted upon. One of the reasons causing the above situation was weak management. Attention needs to be given to closer cooperation between functional offices and in improving implementation.

Milestone 2000: Commence facilitation of discussions between community and policy makers on access to land

Co-management meeting

The following authorities gave reports.

A Luoi District People's Committee
Office of Agriculture and Rural Development, A Luoi district
Forest Inspection Office, A Luoi district
State Forestry Enterprise, A Luoi district
Division of Forest Development, Thua Thien Hue province
Division of Settlement, Thua Thien Hue province
Hong Ha People's Committee
Bo River Management Board

In the ensuring discussion, there was a general sentiment that the Hong Ha commune needed more resources if their livelihood was to be improved. There was not enough suitable land for agriculture alone. The solution would be in them having greater access to land that was only suitable for forest, either through direct allocation of small areas of land for planting trees or sharing in harvests from planted forests.

Milestone 2000. Economic analyses of enterprise alternatives in Hong Ha, Vietnam.

This activity was not completed. However, the Hue team received training in the use of a farming systems model that was developed for conditions in Pucallpa.

Contributors: Le Van An, project leader, Le Duc Ngoan, animal nutrition, Le Quang Bao, forester, Le Duc Ngoan, animal scientist, Nguyen Thi Cach, agronomist, Nguyen Xuan Hong, sociologist, Nguyen Minh Hieu horticulturist, Hoang Huu Hoa, economist; Nguyen My Van, project secretary; Nguyen Phi Nam, Vo Thi Minh Phuong, Ngo Huu Toan, Truong Tan Quan, support staff (College of Agr.and For.,University of Hue);
Peter Kerridge, systems, Sam Fujisaka, anthropologist, Reinhardt Howeler, cassava agronomist, Peter Horne, forage agronomist, Chris Wheatley, agro-entoprise (CIAT); John Graham (IDRC).

Output 2. Component technologies for sustainable production development through farmer participatory research

2002 New technology options developed for Aguaytia watershed

Milestone 2000 Multi-institutional and participatory research being conducted in Pucallpa (DEPAM)

Highlights

- 47 Researchers from 13 institutions collaborated in 10 interdisciplinary and participatory research projects in Pucallpa, testing 8 innovative technology options jointly with farmers.

Purpose
To create a collaborative team of researchers from national and international institutions in Pucallpa who jointly plan and carry out participatory agricultural research projects. This team is the entry point in a long-term strategy to facilitate the institutionalization of collaborative and participatory research approaches among national and international centers in Pucallpa.

Rationale
Pucallpa is a difficult place to catalyze development through agricultural research. It is dynamic and transient: more than half of current farmers arrived in Pucallpa in the last 10 years (Fujisaka *et al.* 1997), yet up to a third of farmers wish to leave in search of areas with better soils (Yanggen, 1997). In frontier areas, a hectare of land can cost less than a bag of fertilizer, possibly making intensification a fantasy while cheap labor is available (White *et al.* 1999).
Effective solutions for dispersed populations in these conditions are likely to be interdisciplinary and community-implemented, yet research has continued to take a disciplinary and supply-driven approach. Through DEPAM, CIAT has facilitated the development of a multi-institutional research team to test and demonstrate the effectiveness of collaborate and farmer-participatory research among local institutions.

Outputs
1. Botanical Origins of Honey from Secondary Forests in Pucallpa
This project works with 57 apiculturalists, the majority new to honey production. The project has given training and support to these farmers, and has a core group of some 6 farmers who regularly record details on foraging behavior of honeybees, and the plant species they visit. These species have been identified, and the information shared back with all participating farmers in workshops. Participating farmers identified their characteristics for favorable plants for honey production, including: high nectar and pollen production at times when other plants are not flowering, alternative uses for the plant, easy to grow, and that the plant improves the soil. Farmers in all three areas of the project identified Guaba as their principal preferred species, and some would consider cultivating it partly to support bees. But there was little agreement between sites on other species, due to different agro-ecological conditions.
46% of the pollen in the honey was from an unidentified plant, suggesting that further studies would be fruitful to identify this primary pollen (and nectar?) source.

Project members identified the following key limitations to the project:

- Lack of diagnosis with farmers at the start to find the interests of farmers
- Not involving participating institutions from the start in project design. However, analyses by the project members of the institutional participation within the project led to changes in the way that the project members coordinated with each other and this led to a reported strong improvement in the equitable involvement of all participating institutions.

2. Production Systems involving Management of Secondary Forest Species

This project created an audit with farming families of the actual and potential economic value of species found in their secondary forests, with help from local expert farmers. Subsequently, secondary-forest species were prioritized by farmers, and farmers are conducting trials with the prioritized species, including germination rates, distances of planting, and natural regeneration (a treatment suggested by farmers).

Project members have identified the following key limitations to the project:

- Lack of diagnosis with farmers at the start of the project (a diagnosis during the project showed that participating farmers would mostly prefer to research other topics)
- Lack of involvement of two of the four institutions in the project

The funds from DEPAM for this project have now ended, but the project will continue, funded by IIAP, with continued collaboration from IVITA.

3. Secondary Forest as a Component of the Economy of small- and medium-sized Farms

A diagnosis and planning meeting with 60 farmers led to the development of strategies for management of secondary forests to realize more of their potential value. Individual action plans were developed from these with 7 individual farmers, involving different mixes of institutional resources depending on the needs of each farmer. Farmers chose to test establishment of Bolaina (*Guazuma crinita*) and improved fallows. Farmers valued wood products from their secondary forests more for the *security* of returns that these products offer than for their moderate economic value.

Members of this project identified as a key limitation the limited involvement of several of the participating institutions.

Funds from DEPAM have ended, but the project will continue within the auspice of a joint CIFOR-CATIE-UNALM project.

4. Participatory Evaluation of varieties of rice and banana *on* smallholder farms

48 farmers have tested nine new rice varieties. Yields of the new varieties were not higher than traditional varieties, yet farmers report that 2 of the varieties will be widely adopted in the following season due to superior characteristics such as early maturing, resistance to pests, and cooking qualities. Adoption of new rice varieties has not been associated with any change in the amount of forest cut by adopting farmers.

Separately, 6 villages have installed trials of new varieties of potentially Sigatoka-resistant banana following their own methods of testing, in September 1999. One village preferred a single, large, communally-managed trial, while the remainder chose to spread their resources across many farms, as a response to diversity in conditions and a lack of trust in communal activities. Within all villages, there is continuing enthusiasm to share and compare results. Monitoring activities have shown that individual farmers already have well-developed methods for collecting and testing banana germplasm, and the project has integrated with these.

An additional goal is that joint decisions involved in both of these systems will increase the ability of the groups involved to coordinate future research and development activities together.
This project identified as a key limitation the limited involvement of several of the participating institutions.

5. Participatory Research in management of maize variety Marginal-28

This project tested intensification of maize production in the relatively fertile, yet transient soils of the floodable margin of the Ucayali river. Two trials have been completed with the cooperation of farmers' groups, testing variety, fertilization rates, and plant spacing.
Farmer participation was limited to providing land for the trials, and many farmers did not agree with the fertilization levels recommended by the trials, due to costs of fertiliser. In a participatory diagnosis conducted with participating farmers during the trials, the farmers prioritized pest control and drip irrigation as topics for research, but the project did not have the freedom to incorporate these topics.

6. Participatory research in the agricultural system of Ucayali: a farm-level economic evaluation of traditional crops.

This CIAT-led project is explained in detail in sections 1.2, 2.1, 3.2, 4.8. With national collaborators, a farming system economic model has been developed that analyses impact of new agricultural technologies upon food security. Researchers can also examine how labor shortages in critical months may prevent adoption of new crops. Most crop production systems (and mixtures) found in Pucallpa are included. Data came from interviews with 100 farmers in the region. The model continues to be refined and applied with participation from research and extension organizations.
A key limitation identified by project members has been difficulty in involving other institutions.

7. Participatory Evaluation of Soil Management in smallholder farms in Ucayali

This project identified farmers' interest in soil issues through a survey, and initiated trials with 76 farmers who shared an expressed concern for the maintenance of soil fertility. Farmers chose technologies to test from the following list of options:
Fertilizer management for annual and for perennial crops, improved fallows, multi-strata systems, contour hedging, and reforestation.
32 farmers completed the trials; many of the other farmers migrated permanently or temporarily to other areas during the trials. Farmers who completed the trials gave favorable evaluations of multi-strata systems, contour hedging and agroforestry systems, and mixed evaluations of fertiliser use and reforestation. 125 farmers visited the trials in three separate field days, and all visiting farmers reported that they wanted to try at least one of the technologies.
The key problem identified by project members was equitable involvement of institutions in the project activities.

8. Soil Conservation with Agroforestry Systems in the Alexander Von Humboldt zone

This project involves 14 farmers in the design and testing of agrosilvopastoral systems, and multi-strata systems to conserve soil. The farmers participated in identifying needs, and in designing and implementing the experiments, and met to discuss results.
All four of the project staff have changed at least once during the project, and none of the current members has experience of participatory research.

Biocidal Plants in Ucayali Region

Management of pests and diseases in annual crops was ranked as the first priority of the DEPAM farmer committee. This project aims to create an inventory of plants with biocidal properties to look for innovative solutions, using local knowledge of the properties of plants. Participatory tools have been used to collect information from native farmers in a series of workshops, and field visits. 25 species with biocidal potential have been identified. Plans include domestication of the plants, and training of farmers their growth and use.
The project is seeking additional funding to continue.

Participatory Evaluation of Market Options for Amazonian Products

This project aims to understand farmers' decisions in selecting crops and markets, design a portfolio of products with market potential which are liked by farmers, and create links between smallholder farmers and markets to establish and strengthen rural agroenterprises. This project is linked with ongoing activities of the DEPAM Agroenterprise Development Unit.
Surveys and group meetings with 168 farmers in 60 communities have identified diverse priorities for farmers throughout the region. In addition to the portfolio of exotic products tested last year, farmers have prioritized a portfolio of existing products that they are keen to improve. Farmers' priorities differ markedly between road areas and riverine areas, and between native farmers and *mestizo* farmers.
To date, this project has been a diagnosis, and so has not aimed to involve farmer participation strongly to date. However, a participatory PPI has been designed to develop *cocona* from this project, integrating research, extension, private and public sector.
Project members have highlighted a key difficulty as that of achieving full participation of all institutional partners.

Impact

Three of the projects included a stage for the evaluation of uptake of the technologies, of which two have carried out such a study. To date, 44 farmers have adopted the new rice varieties, and 125 farmers have expressed interest in trying at least one soil-management practice.

The projects were described by external evaluators as "Very good on-farm research, but not participatory research". outlines the reasons for this. However, through involvement in DEPAM-facilitated workshops, members of each of the projects have developed a critical analysis regarding the level of farmer participation in their projects, and this understanding has motivated a coordinated effort by 15 researchers to learn about and institutionalize participatory approaches

.

A further key improvement is that the institutions have been able to report publicly the difficulties of institutional coordination, and members of several projects have assumed the responsibility to change and improve the mechanisms of coordination among institutions. Most of the projects

were designed by one main institution, and have met their original goals without the need for collaborations.

Contributors

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Milestone 2000 Farmer Participatory rice and Banana trials in the Aguaytia watershed, Pucallpa

Highlights

- Participatory rice trials 1997-2000 have diffused 6 introduced varieties to 44 farmers. Adopting farmers have replaced on average 0.6ha of their 1.0ha of traditional rice varieties with the new varieties. New varieties do not give significantly higher yields or profits, but are preferred for other qualities.
- Adoption of new rice varieties has caused no detectable change in the amount of forest cut by adopting farmers.
- Participating farmers are not more disposed to conducting research in groups or in more complex agroecological phenomena than before the trials.
- Trials of banana varieties with farmers have been established in six riverine communities, and integrated into the extensive existing varietal testing that farmers in the area routinely carry out. First production is expected in October 2000.

Purpose:

A 1997 survey showed that farmers wanted to solve problems associated with their upland rice and with Sigatoka in bananas. Research goals in the forest margins include solving problems not only related to shorter-term private needs (e.g., crop production) but also to longer-term system sustainability and wider social goals (e.g., biodiversity maintenance and reduction of GHG emissions). Research seeks to increase farmer participation and to gradually and in step-wise fashion widen the scope of such participation.

Rationale:

Previous projects were unsuccessful in working with farmers on improved fallows, the incorporation of legumes in systems, secondary forest management, biodiversity conservation, and other more "knowledge-intensive" technologies leading to improved systems sustainability. This project aimed to test the hypothesis that by working with farmers' expressed main priority

(diseases in rice and bananas) with a simple entry point (participatory variety trials), farmers (and NARS) would have interest to continue participatory research into more "complex" issues in NRM.

Methods:

We worked with farmers interested in testing new rice varieties. Seed was provided for small plot trials. Researchers helped farmers in the use of replications and controls, crop cut sampling, moisture correction, and yield calculations. Farmers selected varieties and trial layouts, and conducted all trial operations. Continual feedback among farmers and researchers was accomplished by field visits and field days throughout the two years and five plantings. Trials and farmer adoption of the new materials has been monitored.

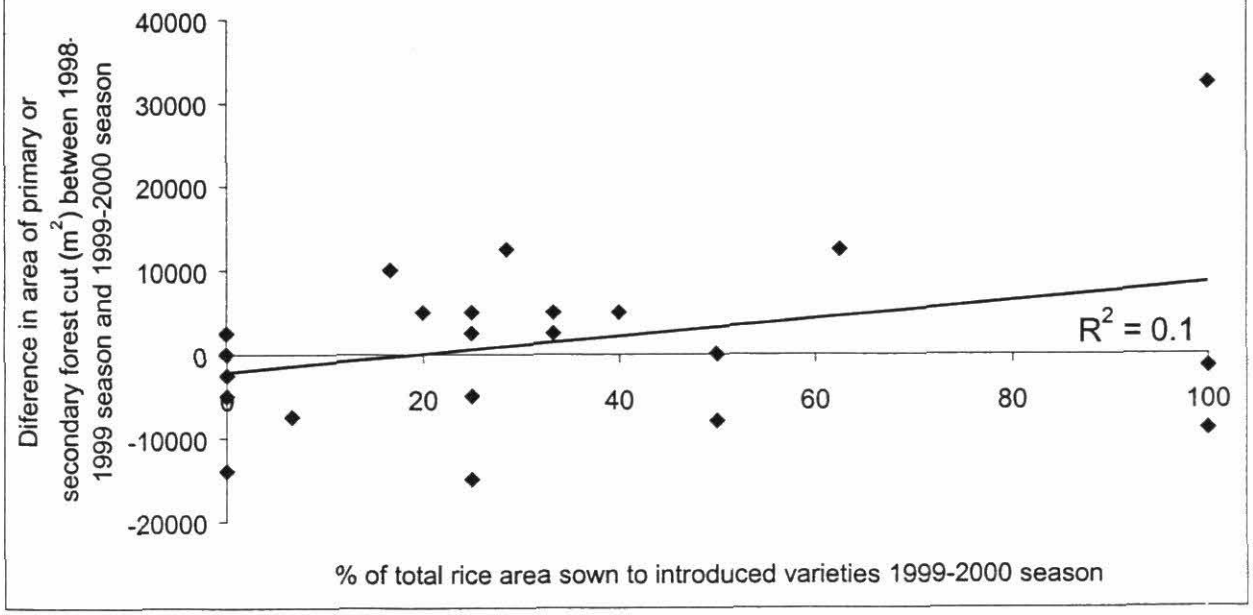
A different process has been followed with testing bananas in order to deepen the communal ownership of the trials. We identified 6 *casarios* where a majority of farmers identified sigatoka in bananas as their principal production problem. We brought to these *casarios* limited numbers of suckers of potentially sikatoga-resistant banana varieties. There were not enough suckers for all interested farmers to try all the varieties that they wanted to, hence community decisions had to be made as a group regarding how the material would be tested. Five *casarios* chose to distribute the new varieties to individuals for testing, due to insufficient trust between farmers for a communal trial. The leader in the remaining *casario* imposed a communal trial.

Output

Table 1 shows that in the growing season Oct 1999- March 2000, yields of three of the introduced rice varieties were consistently (but not significantly) higher than yields of farmers' local varieties.

Figure 2 shows that adoption of the introduced varieties of rice from previous trials did not affect the quantity of forest cut by farmers to sow crops. Interviews with farmers showed that other factors more closely determined the amount of forest cut, principally the availability of labor for forest clearance, and predictions of the availability of labor for the coming season.

Figure 2. Change in area of forest cut by farmers with adoption of introduced rice varieties, Pucallpa 1999-2000



Participating farmers expressed interest to continue with trials of other rice varieties, and to introduce similar trials with other crops. However, no participating farmer expressed interest in scaling-up to joint trials in more knowledge-intensive technologies: an entry point with relatively simple germplasm trials did not provide a first step to facilitate more complex participatory NRM studies. Similarly, it was not possible to find common agreed themes that were shared within any of the five groups of farmers; the groups of farmers were largely artificial groups who knew each other little outside of the group meetings, and members have little trust to work together.

Table 1. Rice yields (at 14% moisture content) from 4 areas of Pucallpa by variety (from harvest measurements 03/00), and number of times yield exceeded the farmers' existing varieties (from interviews with participating farmers)

Variety	Mean Yield (± 1 s.d.)	No. Farms in which Yield > Trad. var.	No. Farms in which Yield < Trad. var.	No. farmers
Introduced Varieties:				
Cirad 409	2.6 ± 1.2	17	11	28
Irat 146	2.1 ± 0.2	2	2	4
O. Sabana 10	3.3 ± 1.3	13	1	14
O. Sabana 6	3.0 ± 1.8	2	1	3
Progresso	2.5 ± 0.6	4	1	7
Maravilla	2.1 ± 1.0	2	1	4
Canastra	1.6 ± 0.1	0	6	6
Confianza	1.9 ± 0.4	1	4	5
O. Turipana	1.9 ± 0.6	2	2	4
CT-nn	2.4 ± 0.6	20	3	23
Mean (introduced vars.)	**2.49 ± 1.0**			
Traditional Varieties:				
Chancabanco	2.7 ± 0.3			8
Aguja	2.2 ± 0.7			17
Carolino	1.8 ± 0.5			3
Other variety	1.4			2
Mean (traditional vars.)	**2.24 ± 0.7**			

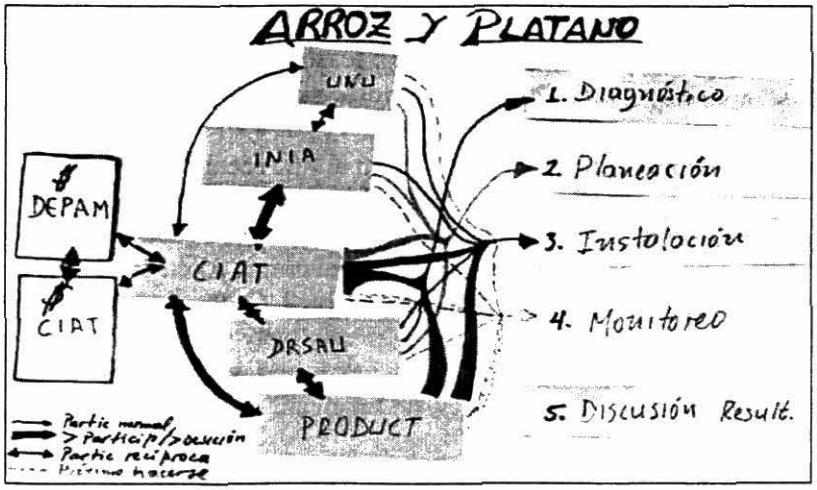
Banana varieties will be giving their first yields in September-October 2000. Monitoring visits to participating farmers has shown that individual farmers already have well-developed mechanisms for obtaining and testing new germplasm. One *casario* already has all of the varieties that the project has brought. Most farmers report that the severity of sigatoka has reduced over the past three years, but that sigatoka continues as their principal problem in banana production.

Impact

Of the introduced rice varieties, two (Cirad 409 and Sabana 10) have been adopted enthusiastically by 44 farmers following the trials, and farmers continue to trial seven of the remaining varieties. This adoption has had no detectable impact on the amount of primary or secondary forest cut by adopting farmers

Among local institutions, the project has been a showcase for participatory research. Two local institutions have asked the CIAT field staff to help design and manage field days that they conduct with local farmers.

In October 1999, institutional collaborators evaluated their participation in the project:



Thickness of lines indicates the degree of control of each institution in the project. CIAT was seen as taking the major role in most of the project activities, and the budget was re-structured to facilitate more involvement by partners.

There is potential for continuation of the rice and banana trials for developing and testing methods of participatory research in communities with low social capital. For example, by building on nucleus groups of friends to overcome trust issues, or by forcing communal decisions on the use of low-value common resources (such as soil testing and new varieties) to bring together individual farmers.

Contributors

Ricardo Labarta, Jhon Aviles, Efraín Leguia, Dean Holland, Sam Fujisaka (all CIAT) Pedro Reyes, Javier Soto (both DRAU), Isael Gonzales (UNU), Fulvio Hidalgo (INIA), Ley Freire (Food for the Hungry).

Milestone 2000 Application of a farm-level agro-economic model for ex-ante analysis of potential new technologies

Highlight:

Even though efforts have been made by research and development institutions to promote new crops in the regions, many of them remain financially unattractive.

Purpose: To examine the potential impact of proposed technologies upon complex slash-and-burn farming systems.

Rationale: When the adoption of agricultural technologies is feasible, the effect of these interventions upon farmer behavior is not easily determined. Unexpected and even undesired results may come about. These interventions can alter the distribution of land, labor and capital resources of farmers. Within a farming system there are trade-offs among agronomic options. Subsistence crops, while often less profitable, have more stable prices and assure household food security. On the other hand, market-oriented crops (palmito, oil palm etc.) may have the potential

for export and higher earnings, but unknown or fluctuating prices make them a potentially risky option. In cases where the new allocation of these scarce resources is not feasible, adoption of the new technology will be difficult without added incentives, such as subsidized credit or subsidies.

Outputs: *Ex-ante* farming system analysis demonstrates that profits from all the scenarios are nearly equal. A majority of the alternative scenarios only shows a mere 3% increase. Since, the small-scale farmer in Pucallpa is a typical risk-adverse producer, a first priority is food security and then earnings are maximized with the production of annual and perennial crops. At current prices and level of technology, only some of the interventions would be adopted. Of the five new cropping alternatives, farmers would plant cocoa, cotton and peanut, with relatively small initial area (between 0.1 and 0.2 ha). Two of the model scenarios, where palm hearts and pineapple are introduced, do not demonstrate new technology benefits. In order to be financially attractive, the threshold price of these crops would need to be higher (31 and 12% respectively) than the farmer gate price. Of interest, if given the option to enlarge the area dedicated to citrus, a farmer would plant 1.4 ha, which would lead to 17% earnings improvement. However, market conditions of citrus are unstable. A higher shadow prices for labor in August reflects the acute demand for labor to prepare land. In October shadow prices high because of weeding requirements, and January during the annual crop harvest.

Impact: There are many influences affecting agricultural decisions in shifting cultivation systems. Some of the more important include: available agronomic technologies, market possibilities and farmer resource restrictions (especially labor and capital). Modeling helps research understand the potential effect of changing influences.

Contributors: Douglas White, Ricardo Labarta, SN-1, INIA, MinAg-Ucayali, DEPAM, ICRAF

Table 1: The effect of the introduction of different new technologies (Area in hectares, Profit in Peruvian Soles)

System	Scenario 1 Base		Scenario 2 and 5 w/ palmito or pineapple		Scenario 3 w/ cacao		Scenario 4 w/ cotton		Scenario 6 w/ peanut		Scenario 7 w/ +20% rice yield		Scenario 8 w/ all changes	
	Area	**Profit**	**Area**	**Profit**	**Area**	**Profit**	**Area**	**Profit**	**Area**	**Profit**	**Area**	**Profit**	**Area**	**Profit**
1. Base														
Intercrop														
a. Rice-yuca-plantain (forest)											0.1	325		
b. Maize -frijol-yuca														
c. Maize -yuca- plantain														
d. Yuca-citrus	0.5	3253	0.5	3253	0.5	3253	0.5	3253	0.5	3253	0.5	3253	0.5	3253
Rotation														
e. Rice-yuca- plantain (forest)	1.9	9375	1.9	9375	1.9	9423	0.9	3831	1.8	8912	1.9	9431	1.8	8839
f. Maize -beans-yuca	0.4	1011	0.4	1011	0.3	660	0.3	660	0.5	1183	0.3	660	0.3	660
g. Maize -yuca- plantain							0.9	4432			0.1	190	0.1	128
Scenarios														
Intercrop														
2. Palm heart-cover crop			--	--										
3. Maize- plantain -cocoa					0.1	373							0.2	672
5. Rice-yuca-cotton							0.2	723						
4. Yuca-pineapple														
Rotation														
5. Peanut-yuca									0.1	292			0.2	453
Total	**2.8**	**13640**	**2.8**	**13640**	**2.8**	**13710**	**2.7**	**13900**	**2.9**	**13640**	**2.7**	**13860**	**2.9**	**14000**
Labor shadow price														
August		68		68		92		85		66		46		73
October		71		71		55		28		70		19		2
November														
January												55		49
Other measures														
Return to land		4854		4854		4896		4897		4670		5058		4764
Returns to labor		5.3		5.3		5.4		5.3		5.3		5.5		5.6
Actual price (in model)				0.45		3.40		1.68		2.00				
Threshold price				0.59		3.09		1.60		2.00				

2000 Improved feed quality and resource management in dual-purpose cattle production systems

Highlights:

Found that a system of direct grazing of *Cratylia* in association with a grass resulted in higher milk yield as compared to a cut and carry system.
Found that milk production with the *Brachiaria* hybrid (CIAT 36061) cv Mulato, the first hybrid to reach cultivar status, was higher than in other commercial *Brachiaria* cultivars
Confirmed in the field the high biomass yield and antibiotic resistance to spittlebug of the *Brachiaria* hybrid CIAT 36062, but found that it was susceptible to waterlogged conditions in the forest margins of Colombia.
Through on- farm trials demonstrated the biological and economical benefits of *Centrosema macrocarpum* a s a protein supplement for milking cows in smallholder farms in the forest margins of Peru.
Demonstrated the feasibility of producing high quality *Cratylia* silage for dry season supplementation for replacing purchased protein supplements
Showed that reclamation of degraded pastures in sub -humid areas of Central America and in forest margins of Peru with *Arachis pintoi* increases both carrying capacity and individual milk yield

Milestone 2000 Milk production of cows supplemented with selected shrub legumes

Contributors: P. Avila and C. Lascano

In several on-station and on-farm experiments it has been demonstrated that supplementing *Cratylia argentea* (*Cratylia*) to milking cows either alone or in combination with sugar cane or elephant grass results in milk yield increments, particularly during the dry season. In addition, work carried out in the Tropileche consortium in Costa Rica has shown the benefit of using Cratylia as silage to supplement cows in the dry season. However, economical studied have also shown that the use of *Cratylia* in cut and carry systems could be affected by high labor costs. Thus it was of interest to evaluate the use of Cratylia in direct grazing system.

Two experiments were carried out in the Quilichao research station to determine the effect of using Cratylia as a supplement to milking cows in a cut and carry system or grazed directly by cow when in association with *B. decumbens*. In an existing pasture of *Brachiaria* we introduced *Cratylia* in rows (1 m between rows and 1 m between plants within rows). In each experiment 6 cows were assigned to one of three treatments arranged in a 3 x 3 Latin Square design: T 1- Grass alone, T2 Grass + *Cratylia* cut and fed at milking (1.5 kg of DM /100 kg BW) and T3 – Grass + Cratylia in association with the grass grazed by cows. The two experiments were carried out during a period of adequate rainfall.

Results shown in Table 1 indicate that milk yield was 17 and 14 % higher when cows grazed *Cratylia* as compared to the grass alone in experiment 1 and 2, respectively. Feeding *Cratylia* at milking (cut and carry) did not increase milk yield relative to the no supplementation treatment, which is consistent with other results that have showed limited response to *Cratylia* supplementation during the wet season.

Table 1 Milk production and milk urea nitrogen (MUN) of cows fed *Cratylia argentea* in different systems

Feeding System	Experiment 1		Experiment 2	
	Milk Yield (l/cow/d)	MUN (mg/dL)	Milk Yield (l/cow/d)	MUN (mg/dL)
Grass alone	6.1 b	9.8 b	6.3 d	3.0 b
Grass + *Cratylia* Cut and Carry	6.7 b	33.6 a	6.6 d	11.6 a
Grass + *Cratylia* Direct Grazing	7.5 a	27.3 a	7.3 c	12.5 a

a, b Values in the same column with the same letters are not different ($P < 0.05$)
c, d Values in the same column with the same letter are not different ($P < 0.10$)

As expected in the two experiments, the values of MUN were higher in the treatments with *Cratylia* as compared to the grass alone (Table 8). However, MUN value in cows fed *Cratylia* were between 2 and 3 times greater in experiment 1 than in experiment 2, indicating higher legume intake possibly as a result of the lower green DM on offer in the *Brachiaria* pasture. In experiment 1 the actual amount of *Cratylia* consumed in the cut and carry system was greater than in experiment 2, which is again consistent with the higher MUN values recorded. Other milk quality parameters such as fat (3.6% and non-fat solids (8.2 %) did no differ among treatments within experiment or between experiments.

Milk yield with new accessions and hybrids of *Brachiaria*

Contributors: P. Avila , J. Miles and C. Lascano

Last year we reported that milk production had been 11% lower in cows grazing *B. brizantha* CIAT 26110 (now cv Toledo) as compared to *B. decumbens* cv Basilisk and *B. brizantha* cv Marandu and that this was probably associated with lower crude protein (CP) in the forage as indicated by low MUN values (5.4 vs 7.0 mg/ dL). Subsequent results confirmed that forage on offer in pastures of CIAT 26110 had lower CP content (3.9%) as compared to the forage on offer in Marandu and Basilisk (5.0%). However, we argued that an advantage of CIAT 26110 as compared to the commercial cultivars was its greater biomass production and fast rate of regrowth following defoliation.

To reconfirm results from last year, we carried out in 2000 a second trial (Latin Square design) during a period of adequate rainfall to compare milk yield of cows grazing *B. decumbens* cv Basilisk, *B. brizantha* cv Marandu and *B. brizantha* (CIAT 26110) cv Toledo.

Results shown in Table 2 indicate that milk yield was higher with *B. decumbens* cv Basilisk than with *B. brizantha* cv Marandu and cv Toledo (CIAT 26110), but was similar in the two *B. brizantha* cultivars.

Table 2. Milk production and milk urea nitrogen (MUN) of cows grazing commercial cultivars and a hybrid of *Brachiaria*

Pastures	*Experiment 1*		Experiment 2	
	Milk yield (l/cow/d)	MUN (mg/dL)	**Milk yield** (l/cow/d)	MUN (mg/dL)
B. decumbens cv Basilisk	7.0 a	3.6	7.6 a	4.1 b
B. brizantha cv Marandu	6.7 ab	4.2		
B. brizantha (CIAT 26110) cv Toledo	6.3 b	3.3	6.5 b	4.3 b
Brachiaria hybrid (CIAT 36061) cv. Mulato			8.1a	9.7 a

a, b values within experiments with the same letters are not different ($P<0.05$)

MUN values were not significantly different among treatments, but tended to be lower in *B. brizantha* cv Toledo, which was related to lower CP (5%) in the forage on offer as compared to CP values (6%) in the other two cultivars. The amount of forage on offer was higher in cv Toledo (2,200 kg green DM/ha) than in cv Basilisk (1600 kg green DM/ha) and cv Marandu (1200 kg green DM/ha), which again indicates that a major advantage of cv Toledo (CIAT 22610) is its high forage yield capacity, which translates into high stocking rate capacity and high animal productivity per unit of land.

This year we also compared the animal production potential of the *Brachiaria* hybrid CIAT 36061, which is now commercial and known as cv Mulato, with commercial check cultivars. Using a Latin Square design, six cows were assigned to one of the following treatments: T1: *B. decumbens* cv Basilisk, T 2 *B. brizantha* (CIAT 26110) cv Toledo and T3 *Brachiaria* hybrid (CIAT 36061) cv Mulato.

Results shown in Table 2 indicate that milk yield was 25% greater in Mulato than in Toledo and 7% higher than in Basilisk, but with this cultivar the difference was not significant. It was interesting to observe that MUN values were twice as high in cv Mulato as in the other two *Brachiaria* cultivars, suggesting a higher concentration of CP in the forage on offer. As in other experiments the amount of forage on offer in the pastures was greater in cv Toledo (4300 kg of green DM/ ha), followed by Mulato (3900 kg green DM/ha) and Basilisk (2300 kg of green DM/ha).

On -farm evaluation of forages for milk production in forest margins of Peru

Contributors: F. Holmann , Daisy Lara (FUNDAAM, Peru), K. Reategui (DEPAM, Peru) and Dante Wong (CTAR, Peru)

This section is divided in two parts: (1) The effect of using *Centrosema macrocarpum* on milk yields in the Alto Mayo region of the Peruvian Amazon, and (2) Effect on milk yield of the association of *Brachiaria brizantha* with *Arachis pintoi* in the Alto Mayo region of the Peruvian Amazon.

The effect of using *Centrosema macrocarpum* as a supplement to dairy cows in the Alto Mayo region of the Peruvian Amazon.

The Alto Mayo region covers 630,735 ha of which 346,452 ha are suitable for grasslands but only 60.2% are in use (INEI,1994). A survey carried out in March of this year indicated that the Alto Mayo region has potential for livestock activities. Additional surveys directed toward cattle owners indicated that *Brachiaria decumbens* pastures are predominately used for maintaining livestock. The area planted to *B. brizantha* and to cut-and-carry grasses has also increased, and *Centrosema* is being evaluated in protein banks. The survey also indicated that more than 50% of the interviewees plan to improve their pastures and that, among their priorities for improving the system is the improvement of the forage base, stables, and breeding herd. *Centrosema macrocarpum* is being adopted by livestock producers as a cut-and-carry forage that reduces or eliminates the need to purchase agroindustrial supplements.

The objectives of this experiment were to (1) Measure the increase in milk production and the weight gain in calves attributed to the use of *Centrosema macrocarpum* to feed dairy cows; and (2) Compare the farmers' traditional system vs a system based on *Centrosema* in terms of economic merit.

Materials and Methods: Two 1-ha plots were planted on two farms located in Nueva Cajamarca and Soritor during September 1999. Planting density of *Centrosema* in both plots was high, with 0.40 m x 0.40 m between plants and 8 kg seed/ha. The evaluation was conducted in a completely randomized design with 3 treatments and 7 cows/treatment, over a 10-week period. Treatments were as follows: T1 = Cut-and-carry grass (king grass) restricted to milking; T2 = 50% king grass; and 50% of *Centrosema* restricted to milking; and T3 = 100% *Centrosema* restricted to milking.

> Milking was done manually, once a day with calf on foot. After milking, calves were allowed to suckle for 5 minutes and then transferred to pens. Crossbreed dairy Gyr x Holstein cows were used and left to graze on the pasture 6 hours/day, after which they were taken to a pen where they received chopped king grass. For milking, cows were distributed according to treatments, beginning with the control treatment and followed by the 2 experimental treatments.

Control variables were: (1) Consumption of supplementary forage (kg DM/cow/d); (2) Milk production (kg/cow/d); and (3) Costs of producing supplementary feed. The following evaluations were carried out to calculate total volume of forage/ha/year (*C. macrocarpum* and king grass):
Forage availability (kg DM/ha). Random sampling was carried out at the beginning of each grazing cycle. A composite sample was taken to determine % DM.
Time of pasture recovery. In an area recently submitted to cutting, 1 m^2 was marked and visual evaluations of coverage conducted at 20, 45, and 60 days. Total recovery of the area was observed.
Biological-economic evaluation. Economic merit was evaluated using the following formula:

$$E.M. = \frac{\text{Cost of feeding/cow/period}}{\text{Milk production (kg)}}$$

Results

Intake of forage based supplements. Average forage intake was 0.87, 0.96, and 0.90 kg DM/cow/d for T1, T2, and T3 respectivel.y. This amount includes the forage consumed at milking, the additional forage consumed during grazing (*Brachiaria*), king grass supplied in closed pens during the day and in the afternoon. A trend to consume more grass + legume mixture was observed so it can be inferred that the inclusion of the legume increases consumption by 23% in T2 and 11% in T3.

Milk production. Average milk production per treatment is summarized in Figure x. Milk production was higher in cows supplemented exclusively with *Centrosema* (6.6 kg./c/d) as compared with the group supplemented with *Centrosema* + king grass (5.6 kg./c/d).

Milk production was lowest in cows that only received king grass (4.1 kg/c/d). When production gains were calculated in terms of efficiency, feeding *Centrosema* increased production by 10% and 20% when fed in combination with king grass and when fed alone, respectively.

When cows were grouped according to number of parturitions, there were no significant differences in milk production between cows with 2 and 3 parturitions (4.7 kg/c/d) and cows with 4 and 5 parturitions (4.4 kg/c/d). However, significant differences were observed, between the former 2 groups and first-calf cows (3.0 kg/c/d).

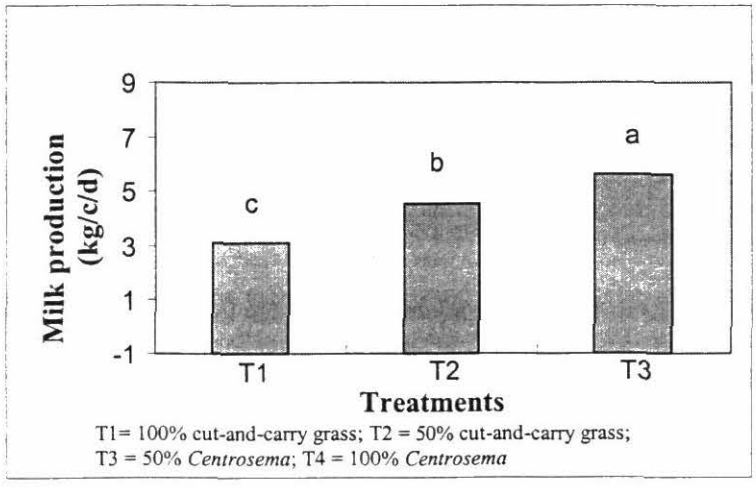


Figure 1. Milk production with cows consuming different forage-based supplements in Moyobamba, Peru

Economic merit. The cost per kilogram of dry matter for each alternative was taken into account, which included the depreciation in a six-year period, maintenance costs, and harvest costs. For the case of *Centrosema*, an establishment cost of $380/ha was used. In addition, $40/ha of annual maintenance costs and a harvest cost equivalent to 0.6 man-day per each 50 kg of fresh biomass daily was used. Annual productivity was estimated in 15 tons of DM during 5 harvests/yr. Thus, total cost per kilogram of dry matter was estimated at US$ 0.105.

For the case of king grass, estimated establishment cost was $295/ha with annual maintenance costs of $110/ha and harvest costs equivalent to 1.4 man-day for each 100 kg of fresh, daily-cut biomass. Annual productivity was estimated at 25 tons of DM during 4 harvests. Therefore, total cost per kilogram of dry matter was about $0.184.

The economic merit for each feeding alternative is shown in Table 3.

Table 3. Economic merit of different feeding alternatives in Moyobamba, Peru.

Milk production/treatment	Economic merit
T1 Milk production = 4.1	0.037
T2 Milk production = 5.6	0.035
T3 Milk production = 6.6	0.027

Although milk production improved in T2 (50% king grass + 50% *Centrosema*) as compared with T1 (only king grass), the economic merit of this treatment did not improve as result of the high intake and thus cost recorded when *Centrosema* was included in the supplement. On the other hand, the economic index improved relative to the other supplementation treatments when only *Centrosema* was fed at milking.

In general, results indicate that supplementation with *Centrosema* had a positive biological and economical impact on milk production when offered at milking to crossbred Gyr x Holstein cows adapted to prevailing conditions of the Alto Mayo region of Peru.

Effect on milk yield of the association of *Brachiaria brizantha* with *Arachis pintoi* in the Alto Mayo region of the Peruvian Amazon

The inclusion of legumes grass alone pastures such as *Brachiaria decumbens* and *Brachiaria brizantha*, predominant species in the Alto Mayo region, is considered an alternative to increase the biomass productivity and milk production . Therefore, the objective of this study was to evaluate the effect of the forage peanut *Arachis pintoi* in association with *Brachiaria* pastures in terms of milk production.

Materials and Methods: The treatments evaluated were: T1: *Brachiaria* spp. in monoculture; and T2: *Arachis pintoi* associated with *Brachiaria* spp. Plots of the associated pasture, 4 ha in size, were established on one farm from a small farmer in Soritor. Initial availability of forage, milk production and establishment costs were recorded. Crossbred Gyr x Holstein cows were used in this evaluation. These same animals grazed lots of *Brachiaria* spp. (in monoculture) and associated pastures of *A. pintoi/Brachiaria* spp.

The control area (grass alone) had 4 ha of *B. brizantha*, similar to the grass/legumepasture, and was divided into 2 paddocks each. Animals grazed, on average, 7 days in every paddock. Milk production was measured in each paddock as of day 3. The evaluation was carried out during maximum precipitation . Forage availability and botanical composition of pasture were measured

with random samplings in each paddock at the beginning of the grazing cycle.

Results: During the experimental period the producer controlled the resting period, the grazing period, number of animals grazing, and paddock area. The stocking rate of each pasture was calculated on the basis of these indicators. A stocking rate of 2.07 AU/ha was determined on pastures of *Brachiaria* spp. and 4.13 AU/ha in the associated *A. pintoi/Brachiaria* spp pasture.

Measurements in the vegetation, showed that DM in the associated pasture (*A. pintoi/Brachiaria* spp) was 7,600 kg/ha at the beginning of the grazing period, with legumes accounting for 6% and weeds for 11% of the forage on offer. The grass alone pasture (*Brachiaria* spp) produced 6,300kg DM/ha out of which 9% were weeds.

Results on milk production (Figure x) indicated that cows grazing the *A. pintoi/Brachiaria* spp. pastures yielded 6 kg/cow/day, while those on *Brachiaria* spp. pasture yielded 5 kg/cow/day, wich represents a 20% difference in daily milk yield per cow.

In general, the expectations of small producer in Moyobamba, Peru are high with the use *Arachis*-based pasture, given that the stocking rate of the associated pasture doubled that of the grass alone pastures and milk production increased by 20%. Thus, the potential impact of *Arachis*

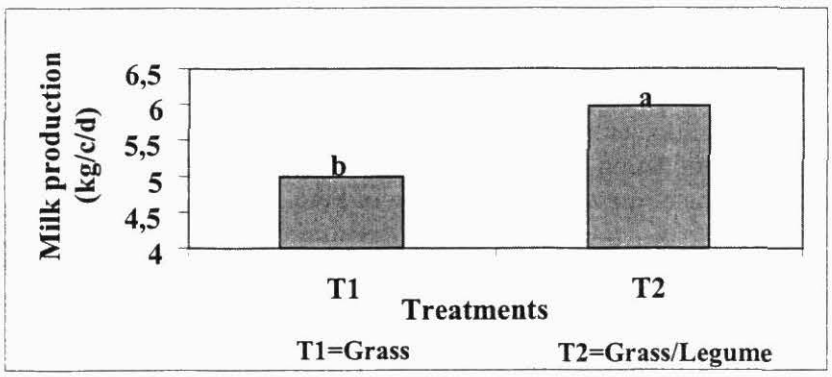


Figure 2. Milk production of cows grazing pastures of *Brachiaria* spp. alone and associated with *A. pintoi* (Moyobamba, Peru).

on livestock productivity in this region of the Peruvian Amazon can be significant.

On-farm evaluation of a pasture of *Brachiaria* spp. alone and in association with *Leucaena leucocephala* and its effect on milk production of dual purpose cows in a subhumid environment of Costa Rica

Collaborators: Marco Lobo Di Palma, Beatriz Sandoval, Vidal Acuña (MAG), Pedro J. Argel, Guillermo Pérez (CIAT's IP-5 Project).

Background. There is very little used of forage trees in the tropics of Latin America, despite the fact that a great deal of research has been conducted on species selection and animal utilization. This paradox is even more conspicuous if we have in main that the referred tropics are the center

of origin of very important multipurpose trees such us *Leucaena, Gliricidia* and *Calliandra* that play important roles in different production systems elsewhere, including grazing systems.

Part of the limited use of forage trees is due to farmer lack of knowledge on the importance and management of the trees. Tropileche is a project aimed at the improvement of animal feed supplies with emphasis on forage legumes with farmer participation, which has allowed the selection and utilization of forage trees and shrubs such as *Leucaena leucocephala* and *Cratylia argentea* in dual-purpose farms located in subhumid environments of Costa Rica.

In one farm located in Miramar, *L. leucocephala* CIAT 17263 was planted by seed in double rows separated 0.7 m between them and 0.5 m between plants to form strips that were in turn separated 5 m apart, to give a plant density of 1840 Leucaena trees/ha. Once the trees were established the grass *B. decumbens* (Basilisk) was planted to form an associated paddock of 4.0 ha.

Measurement of milk production of dual-purpose cows is underway in the associated paddock and it is being compared with a nearby non-associated paddock of *B. decumbens/brizantha.* Sixteen cows are being used for the evaluation using a Latin square crossover design under a grazing system of 10 days grazing and 35 days rest, to give an estimated stocking rate of 4.3 AU/ha. Changes in the soil will also be monitored in this experiment.

Results and Discussion. The experiment is currently in the phase of implementation. So far, forage availability in the Leucaena pastures has been in the order 1165 kg DM/ha. We have also measured high intake (8.8 kg of green foliage/cow /day) of Leucaena in an initial grazing , with trees being browsed up to a mean height of 1.5 m, above which there was little grazing. The stocking rate is being adjusted and we expect to initiate milk measurements in approximately one month.

Evaluation under grazing of new *Brachiaria* accessions and hybrids in forest margins of Colombia

Colntributors: A. Betancourt (CIAT), J. Velásquez (U de la Amazonía), G. Ruiz (U de la Amazonía), G. Mendoza (La Rueda), J. Rodríguez (La Rueda), J. Miles (CIAT) and C. Lascano (CIAT)

Background: The piedmont of Caqueta (forest margin) is an ideal site to evaluate *Brachiaria* genotypes developed by CIAT for resistance to spittlebug and for adaptation to poorly drained soils. Thus in collaboration with the U of Amazonia we established last year in the "La Rueda" farm a grazing trial to evaluate performance of selected accessions of *B. humidicola* (CIAT 16180 and 16888) and *Brachiaria* hybrid (CIAT 36062) with and without *Arachis pintoi* (CIAT 22233 + 18744)

The two *Brachiaria* accessions were selected for evaluation under grazing due to high biomass production whereas the hybrid was selected because of high antibiotic resistance to spittlebug. The materials were established in the first quarter of 1999 and measurements in the vegetation and on animal performance began in August and November of the same year, respectively.

Results and Discussion. After 10 months of grazing we have recorded differences among pastures on grass and legume on offer, reaction to heavy spittlebug attacks, tolerance to poorly

drained conditions and animal live weight gain. The amount of forage on offer has consistently been greater with the *Brachiaria* hybrid than with the two accessions of *B. humidicola* regardless of presence or absence of legume (Table 4). In addition, it was interesting to observe that *A. pintoi* CIAT 22233, which does not produce seeds, has outperformed the accession CIAT 18744 (produces seed) when in association with grasses. During the peak of the rainy season (May-July) there was a heavy attack of spittlebug and damage was recorded in pastures with the two *B. humidicola* accessions but not in the *Brachiaria* hybrid.

Table 4. Grass and legume on offer in *Brachiaria* pastures with and without legumes in forest margins (Caqueta, Colombia)

Pastures	Grass on Offer* (kg DM/ ha)	Legume on Offer* (kg /DM/ ha)
B. humidicola CIAT 16180	1088	
B. humidicola CIAT 16888	2587	
Brachiaria hybrid CIAT 36062	5759	
Brachiaria humidicola CIAT 16180 + *Arachis*	1507	264
Brachiaria humidicola CIAT 16888 + *Arachis*	1606	596
Brachiaria hybrid 36062 + *Arachis*	2182	520

* Sampling in August, 2000 (10 months under grazing)

Results on animal performance shown in Table 74 indicate that LWG recorded so far have been greater in the *Brachiaria* hybrid + *Arachis* pasture and that the relatively low animal performance in the hybrid without legume is most likely the result of poor grass quality associated with damage caused by water logging (**Photo 1**). Thus it would seem that animals compensated the poor quality of the grass affected by poor drainage by consuming more of the high quality legume.

Table 5. Liveweight gain of steers grazing *Brachiaria* pastures with and without legumes in forest margins (Caqueta, Colombia.

Pastures	LWG (g/a/day)*
B. humidicola CIAT 16180	322
B. humidicola CIAT 16888	492
Brachiaria hybrid CIAT 36062	307
Brachiaria humidicola CIAT 16180 + *Arachis*	328
Brachiaria humidicola CIAT 16888 + *Arachis*	366
Brachiaria hybrid 36062 + Arachis	524

*270 days of grazing

The effect of legume on LWG is still not evident on the *B. humidicola* pastures as it is in the Hybrid, but we expect this to change over time as the quality of the grass increases in the pastures with *Arachis*.

These results confirm the high antibiotic resistance of the *Brachiaria* hybrid CIAT 36062 as shown in glasshouse and field screenings carried by the Entomology Group (See IP5 AR 98 and 99). Unfortunately it does not produce seed and has shown to be very susceptible to the poorly drained soil of the site (Meson) where it was established (**Photo 1**), but with good recovery once the rainfall is less. The *Brachiaria* hybrid has caught the attention of producers visiting the grazing experiment and vegetative seed has been distributed through Nestle with instructions that it should be established in well -drained soils. In addition, next year vegetative material of the hybrid will be sent to the Llanos piedmont for evaluation under good soil drainage conditions.

Photo 1. Pasture of *Brachiaria* Hybrid CIAT 36062 in forest margins of Caqueta; Recently established grass (left); Grass damaged by poor soil drainage (center: initial damage; right: advanced damage)

Evaluation of legumes for cover crops in plantations in the llanos of Colombia

Contributors M. Peters (CIAT), C. Plazas (CIAT) and Oil Palm and Rubber Growers of the Colombian Llanos

Background: There is a need in the plantation industry of the Llanos of Colombia to find sustainable ways to reduce weed infestation, to maintain and improve soil fertility, to control erosion and increase the micro fauna biomass. There is currently a trend to promote plantation systems. In the rubber plantation the target group for this promotion are small to medium size farmers who want to diversify there farming operations. In the oil palm plantations plots of up to 5 ha are rented out to landless farmers to manage the oil palms for the oil palm industry. Both trials therefore are seen to have beneficial effect on the welfare of resource poor farmers.

In 1999 a range of legume accessions of the species *Arachis pintoi, Desmodium heterocarpon* and *Pueraria phaseoloides* have been sown under shade and no-shade conditions in the Meta department of Colombia. Based on results in 2000 this work was amplified by studying different establishment procedures for the most promising accession *Desmodium heterocarpon* subsp. *ovalifolium* CIAT 13651, again in comparison with the standard management of the standard cover *Pueraria phaseoloides* (Photo 2).

Methods: About 80 m^2 plots of legumes were established in commercial fresh and old rubber and oil palm plantations in the Altillanura and Pidemonte areas of the Llanos. A Randomized Block Design with three replication is utilized. Agronomic parameters and insect incidences are mediated. The following treatments were sown: *Arachis pintoi*: 17434, 18744, 18748, 22159, 22160 (seed rate 10 Kg / ha): *Desmodium heterocarpon* subsp. *ovalifolium*: 350, 13105, 13110,

13651, 23762 (0.5 Kg / Ha); *Pueraria phaseoloides*: 8042, 9900 (3 Kg / ha). Additionally a mixture of *Arachis pintoi* CIAT 18744 and *Desmodium ovalifolium* CIAT 13651 was sown.

Photo 2. Plantations of *Desmodium* heterocarpum subsp. *ovalifolium* CIAT 13651 cover crops including rubber

Results and Discussion: During the first 4 months of establishment the cover of legumes was slow, with the exception of *Pueraria phaseoloides* (Table 6).

However, 6 months after planting, the legumes were well established, with higher covers achieved in the young plantations of oil palm than rubber, which was particularly true for *Desmodium,* which performed better than *Arachis.*

Due to shading effects, legume cover was low in shaded areas of rubber plantations – i.e. old trees or directly beneath the trees while it was impossible to establish legumes under existing oil palms.

In the production phase high weed populations of more than 30 % were measured in all treatments in oil palms. Highest legume yields and percentages were achieved with *Dh* CIAT 13651, 13105, *Ap* CIAT 22160, the mixture of *Desmodium* and *Arachis* and *Pp* CIAT 9900, 8042 (Table 6). Under rubber the *Desmodium* accessions and mixtures performed best, with more than 70% and 28% cover for CIAT 13651 in young and old plantations, respectively.

Table 6. Soil cover of different forage legumes under shade conditions in plantations at two sites in the Llanos de Colombia.

Treatments	Rubber		Oil Palm	
	Young plantation	Old plantation	Young plantation	Old plantation
		%		
Desmodium heterocarpon subsp. *ovalifolium* 13105	58	25	55	.
Desmodium heterocarpon subsp. *ovalifolium* 13110	68	7	53	.
Desmodium heterocarpon subsp. *ovalifolium* 13651	72	28	72	.
Desmodium heterocarpon subsp. *ovalifolium* 23762	67	17	58	.
Desmodium heterocarpon subsp. *ovalifolium* 350	63	13	62	.
Arachis pintoi 17434	25	3	47	.
Arachis pintoi 18744	33	7	65	.
Arachis pintoi 18748	32	6	53	.
Arachis pintoi 22159	18	8	60	.
Arachis pintoi 22160	28	7	80	.
Pueraria phaseoloides 8042	33	17	65	.
Pueraria phaseloides 9900	55	5	75	.
Association Ap/Dh	67	20	77	.

Initial results indicate the potential of *Desmodium* and *Arachis* as a complement to *Pueraria* as cover crops for newly established rubber and oil palm trees. In older plantations, legume cover was much lower, but weed pressure was also low.

The trials to evaluate legume covers in plantation in the llanos is an on-going activity, but from the results so far it would seem that *Desmodium heterocarpum* subsp. *ovalifolium* CIAT 13651 is an attractive cover option, especially considering lower seed costs (much lower planting densities needed than for *Pueraria phaseoloides*).

Our hypothesis is that the advantage of *Desmodium* as a cover will further increase over time, given that it establishes extremely slow, but once established is very persistent and productive. Thus *Desmodium* could be an excellent cover until plantations are fully established and weeds are suppressed by shade. It will be also interesting to observe how the legume covers being evaluated develop under older rubber trees and how established legumes persist under higher shading conditions.

Table 7. DM yields in kg/ha of different cover legumes and weeds in rubber and oil palm plantations at two sites in the Llanos de Colombia.

Treatment	Rubber						Oil Palm	
	Fresh Planting				Old Planting		Fresh Planting	
	Open (light)		Shade					
	Legume	Weed	Legume	Weed	Legume	Weed	Legume	Weed
				kg/ha				
Dh 13105	608	769	927	0	267	289	1453	544
Dh 13110	1180	69	1187	52	57	0	980	833
Dh 13651	1064	0	537	88	319	52	1575	1003
Dh 23762	896	67	440	20	586	0	1237	623
Dh 350	1690	163	1104	0	425	0	1357	741
Ap 17434	361	315	360	109	40	93	247	937
Ap 18744	671	164	577	75	167	0	895	637
Ap 18748	537	155	669	21	396	0	727	1051
Ap 22159	396	161	725	68	231	60	1314	817
Ap 22160	791	181	637	0	229	48	1488	983
Pp 8042	824	236	739	179	309	61	1490	619
Pp 9900	675	103	323	28	116	17	1745	836
Aso*Ap/Dh*	156	61	255	21	67	0	408	581
Aso*Dh/Ap*	435	61	499	21	225	0	967	581
Control		393		283		180		1531

On- farm evaluation of new grass and legume options for livestock production in the Llanos of Colombia

Contributors: C. Plazas (CIAT), A. Rincon (CORPOICA), and J. Miles (CIAT) and C Lascano (CIAT)

Background: One major limitation for beef and milk production in Neotropical savannas is degradation of introduced grasses, as a result of nitrogen deficiencies and overgrazing. Thus CIAT's Forage Project (IP-5) has been developing improved grasses and legumes that can contribute to reclaim large areas of degraded pastures in tropical regions where livestock is a major land use system.

In collaboration with PE-5, and CORPOICA we initiated in 1998 evaluation of new grasses and legumes in representative farms of the llanos of Colombia. A total of four farms (two in the well-drained savannas and two in the piedmont) were initially selected to evaluate new grass and legume alternatives .Selected farms were representative of the two sub-ecosystems and have large areas of degraded pastures. In addition, farmers participating in the Project indicated their willingness to cover some of the cost of the work done in their farms.

Results and Discussion: The introduction of *Arachis* in degraded pastures in well- drained savanna sites was not successful, regardless of ecotype used or planting density. Even though the establishment of the legume was adequate, soon after the initiation of grazing the proportion in the vegetation dropped significantly as results of competition with the grass.
We now feel that the use of *Arachis* to reclaim degraded pastures in well drained sites in the llanos will require high use of management and fertilizer inputs an, but it is unlikely that **farmers would**

be willing to pay the extra cost. The alternative is the use of *Desmodium heterocarpon* subs *ovalifolium*, which is better adapted to acid-low fertility soils. In farms were *Arachis* failed we have successfully introduced *Desmodium* and are currently monitoring the vegetation.

On the other hand, the introduction of *Arachis* to reclaim degraded *Brachiaria* pastures in the piedmont of the llanos has been successful. Results shown in Table 8 indicate an adequate legume content in the pasture, which has been associated with high LWG.

Table 8. Botanical composition and liveweight gain of steers grazing pastures reclaimed with *Arachis pintoi* in farms of the piedmont in the llanos.

Farm (Pasture)	Botanical Composition* (%)			LWG** (g/a/d)
	Grass	Legume	Weeds	
1 (B. humidicola)	72	18	10	566
2 (*B. decumbens*)	50	31	19	NA

*16 months after establishment
**12 months of grazing

In one farm located in a well- drained savanna site with acid -low fertility soils we introduced two new *B. brizantha* accessions (CIAT 26110 and 26318). The performance of the two accessions during the dry season was not good (1300 to 1770 kg DM/ha) but recovery during the wet season was excellent, particularly with CIAT 26110 (7000 kg DM/ha). However, one limitation of B. brizantha CIAT 26110 has been low concentration of crude protein in the dry season (2.6 to 3.5%), which is consistent with results obtained in the Quilichao research station.

Thus from the initial results on evaluation of new *B. brizantha* accessions, it would seem that CIAT 226110 (cv Toledo) is marginally adapted to the very acid-low fertility soils of the llanos, which would not be the case for the piedmont with better soils. We will continue to monitor these pastures for at least one more year before making any recommendations on the use of *B. brizantha* cv Toledo in the llanos.

On- farm evaluation of selected forages as feed resources in dual cattle systems of Central America through the Tropileche Consortium (CIAT and ILRI)

Use of additives for making Cratylia silage

Background: In the dry tropics of Costa Rica (annual rainfall, 1200-1800 mm; 6 months of dry season, and altitudes ranging from 0 to 800 meters above sea level), *Cratylia argentea* has been successfully introduced into dual-purpose farms to solve the problems of low forage availability during summer months. Mixing *Cratylia* forage and chopped sugarcane has proved useful to maintain milk yields of 6-6.5 kg per cow/day, in crossbred cows Zebu x European dairy cows.

Producer's value *Cratylia*'s as a supplement for cows during the dry season, but they also consider that surplus forage in the wet season should be ensiled for use during times of feed shortage.

Thus this collaborative project with the U of Costa Rica and ECAG aims to evaluate the process of making silage from the legume *Cratylia*, using several fermentative and nutritive additives. Overall, legumes are more difficult to ensile than grasses because they have a high buffer capacity that hinders adequate acidification of anaerobic media, in addition to its low soluble carbohydrate content.

Materials and Methods: The foliage of 90-day regrowth was manually harvested and chopped to a 16-mm bite size. Microsilos made of double polyethylene plastic bags, with approximately 1.5 kg capacity, were used. *Cratylia* was mixed with three additives: cane molasses (M), pineapple pulp (PP) and chopped sugarcane (CSC). Each additive was incorporated at three levels: M, at 10%, 20%, and 30%; PP and CSC, at 25%, 50%, and 75%, all on fresh basis (w/w).

Cratylia foliage was obtained from an experimental plot at the Escuela Centroamericana de Ganadería, located in Atenas, Alajuela, at 460 m above sea level. Pineapple pulp was collected at the Del Oro plant in Santa Cecilia de la Cruz, Guanacaste, and the sugarcane was gathered at a private farm located in the Hojancha canton, also in Guanacaste.

The silos were left to ferment for 60 days and, upon opening, pH and organoleptic characteristics (odor and color) were assessed. Part of each sample was oven-dried at 60 °C and a subsample was frozen to later analyze ammonium nitrogen. Laboratory tests were conducted to determine (a) dry matter (DM), organic matter (OM) and crude protein (CP) contents; (b) ammonium nitrogen (Nam); and (c) rumen degradability of dry matter (Δ). Treatments were arranged in a completely randomized design with three replicates.

Results and Discussion: To evaluate the Cratylia silage produced with different additives we used a conventional classification scheme shown in Table x.

Table 9. Organoleptic properties of silages.

Organoleptic characteristics	1 (Poor)	2 (Intermediate)	3 (Good)
Odor	√ Butyric (rancid) √ Degraded amino acids or N sub-products (spoiled)	√ Acetic √ Alcoholic	√ Lactic √ Slightly acetic or alcoholic with lactic essence
Color	√ Dark brown √ Black √ Moldy	√ Light brown √ Yellowish	√ Original green √ Light green

Results of pH value and organoleptic characteristics (scale from 1 to 3) of the Cratylia silages are shown in Table x. All silages presented a strong lactic odor, except for those with high CSC content (75%), which presented an alcoholic odor with a lactic essence. The silage had a brown color with high levels of CSC and 25% PP

The pH correlated highly with lactic and acetic acid contents. A pH lower than 4 is considered a good indicator of superior fermentation in moist substrata such as the ones used in this project and, accordingly, of a fairly stable, good-quality end product.

Table 10. Odor, color, and pH of *Cratylia argentea* silage using three additives (M = Molasses; PP= Pine apple pulp; CSC= Shopped sugar cane).

Treatment			***Odor***	Color	pH
No.	Additive	% w/w			
1	M	10	3	3	4.12
2	M	20	3	3	4.00
3	M	30	3	3	4.05
4	PP	25	3	2.33	4.45
5	PP	50	3	3	3.90
6	PP	75	3	2.83	3.45
7	*CSC*	*25*	3	2.5	3.37
8	*CSC*	50	3	2.5	*4.00*
9	*CSC*	*75*	*2.83*	2.33	4.73

When carbohydrate levels are very high or very low, fermentation is altered, yielding final products and pH values that fall outside the optimal range. In the case of 75% CSC, the high levels of soluble carbohydrates (SC) induced fermentation tending more toward an alcoholic base, with a pH of almost 5. In the case of 25% PP, because of the high moisture content of this substratum, its SC contribution in dry basis was small, causing lactic acid production to be poor. pH was accordingly almost 4.5.

The "buffer" effect was evident in *Cratylia*, especially in Treatment 1 with 10% M. In grasses, for example elephant grass (*Pennisetum purpureum*), the addition of 10% M increases the dry matter SC content too more than 11%. Fermentation is also optimal with pH values close to 3.5. Furthermore, buffer capacity could limit carbohydrate use and lactic fermentation and, accordingly, high pH values in several other treatments, especially those with higher/lower SC contents.

Based on available data, the following conclusions and recommendations can be made:

The addition of 10% molasses should be sufficient to obtain a good final product. It is not necessary to use higher levels of this expensive additive. Additional research projects should be conducted to reduce the use of this additive. One possibility is to simultaneously work with lower amounts of molasses and inoculate the substratum with lactobacillus.

Pineapple pulp added at levels higher than 25% will improve fermentation, although transportation costs should be evaluated because it is such a watery material. Water content has an adverse effect on fermentation; therefore the convenience of draining the product upon leaving the plant and prior to ensiling should be evaluated.

Chopped sugarcane, added at 25%, should contribute sufficient soluble carbohydrates for good lactic fermentation; at higher levels, there is a risk of promoting an alcoholic process. It would be interested to evaluate the effect of inoculating the substratum with lactobacillus in the future.

Effect of supplementing fresh and ensiled *Cratylia argentea* to dual-purpose cows in the subhumid Tropics of Costa Rica

Background: Costa Rica covers 51,023 km^2 of land of which 25,000 km^2 (49.2%) are under farming and cattle raising systems. Cattle are raised on 51,000 farms, with an estimated population of 2,150,000 heads. The main problems affecting cattle development in Costa Rica include the low meat and milk productivity, low reproductive indexes, nutritional deficiency—especially because of the low availability and quality of forage during the dry season—and sanitary problems.

The aim of the study was to evaluate the use of ensiled *Cratylia argentea* in terms of milk production and to define the economical benefits of using this technology. Two experiments were carried out on two farms located in Costa Rica's subhumid tropical Central Pacific region.

Materials and Methods: A Latin square design was used, with three treatments and two animals/treatment. The trials lasted 30 days, during which animals were rotated in each treatment over a 10-day period, which was divided into 7 days of adjustment and 3 days for measurement of milk production.

Experiment 1: Six cows were selected from a herd of 45 milking cows that presented broad genetic variation, on a farm located in Barbudal de Barranca, Miramar. All cows were in their second month of lactation, third parturition, and produced, on average, 5.5 kg milk/day.

Treatments imposed were as follows: T1: Control (only grazing); T2: 12 Kg of sugarcane, 8 Kg Cratylia, 0.6 Kg of rice bran and 0.5 Kg of molasses; T3 12 kg of sugarcane, 3 Kg of chicken manure, 0.6 Kg of rice bran and 0.5 Kg of molasses.

The *C. argentea* used had approximately 4 months regrowth; with an average nutritive value of 16% crude protein and 33% dry matter.

Experiment 2: Six cows were selected from a group of 11 milking cows of third parturition, on a farm located in San Miguel de Barranca, Esparza. All cows had similar breed characteristics (3/4 Swiss Brown and 1/4 zebu), and were in their second month of lactation and producing, on average, 5.5 kg milk/day.

Evaluated treatments were as follows: T1: 12 kg sugarcane, 6 kg Cratylia silage, 0.6 kg rice bran; T2: 12 kg sugarcane, 6 kg fresh Cratylia, 0.6 kg rice bran; T3: 12 kg sugarcane, 3 kg chicken manure, 0.6 kg rice bran

In Treatment 2, Cratylia plants were manually cut at 4 months regrowth for ensiling using a chopper coupled to a tractor. Molasses was gradually added at 10% weight basis of material for ensilage as the silage was being compacted by the tractor. Silage was first used 4 months after being ensiled and its quality was determined by measuring pH, percentage of crude protein, dry matter content, and several organoleptic characteristics such as odor and color.

Results and Discussion

Experiment 1: In Table 87 we show average values of milk yield and quality, and cost/benefit ratio for the treatments evaluated. Milk production differed significantly between treatments ($p = 0.076$), with the highest production being recorded when chicken manure was offered as protein supplement. However, no significant differences in milk yield were observed when chicken manure was replaced with fresh Cratylia.

Milk production of cows not receiving a protein supplement was relatively high and this could be attributed to the high availability of fruits of the cohune palm (*Acrocomia viniferous*), which could contribute a significant amount of nutrients to the diet, as well as to the consumption of several other sources of feed available in paddocks during the dry season.

Table 11. Average production, milk quality, and cost/benefit ratio of dual-purpose cows receiving supplements of *Cratylia argentea* and chicken manure.

Treatment	Milk production (kg/cow)	Total solids (%)	Fat (%)	Diet Cost ($/kg)	Milk Income ($/kg)	C/B ratio
1	5.5 b	11.2	3.1	-	0.235	-
2	5.9 a b	11.5	3.2	0.109	0.241	2.2
3	6.3 a	11.2	2.9	0.217	0.235	1.1

Waller-Duncan test ($p = 0.076$).
T1= Control; T2 = Fresh *Cratylia*; T3= Chicken manure

A statistical comparison was not performed for milk quality, but minimum variations in averages of total solids and percentage of fat were observed among the three treatments.

The results of greatest interest are reflected in the economic indicators such as cost of supplements, income obtained from the sale of milk, and the cost/benefit ratio. Replacing chicken manure with Cratylia reduced the cost of supplementation from $0.22/kg to $0.11/kg, thus reducing supplementation costs by half.

Experiment 2: Table x shows mean values of milk yield and quality of cows supplemented with fresh and ensiled *C. argentea* (*Cratylia*) and with chicken manure. Significant differences were found in milk production among treatments ($p = 0.08$), with production being highest when fresh *C. argentea* was offered as compared to chicken manure. Milk yields was similar for cows supplemented with chicken manure and ensiled Cratylia.

The silage obtained was highly palatable and of good quality (pH 4.5, 16.5% crude protein, and 36% dry matter); these data were similar to those found by Romero and González (unpublished data). Based on trial results, silage quality can be ranked as excellent in terms of dry matter and pH.

Test animals rejected neither fresh nor ensiled *Cratylia*, with the rejection being approximately 10% (mainly woody stems) of the material offered.

Table 12. Average milk production in dual-purpose cows supplemented with fresh and ensiled *Cratylia argentea* and with chicken manure.

Treatment	Milk production (kg/cow)	Total solids (%)	Fat (%)	Diet cost ($/kg)	Milk Income ($/kg)	C/B ratio
1	5.1 b	12.3	3.6	0.164	0.260	1.6
2	5.5 a	12.2	3.4	0.109	0.256	2.3
3	5.3 a b	11.7	3.0	0.217	0.245	1.1

Waller-Duncan test (p = 0.08).
T1= Cratylia silage; T2= Fresh Cratylia; T3= Chicken manure

In general our result indicate that the use of *Cratylia* as a protein supplement during the dry season can substitute chicken manure completely, thus reducing the farmer's dependency on off-farm resource. One additional benefit of supplementing *Cratylia* is the improved quality of the milk produced by cows in terms of fat and total solids.

Profits were higher when milk production involved fresh and ensiled *Cratylia* than when chicken manure was used given that production costs were lower and the income obtained by sale of milk was higher due to better quality of the milk.

Milk production of dual purpose cows grazing *Brachiaria brizantha* cv. La Libertad alone and associated with *Arachis pintoi* cv. El Porvenir in a farm in the subhumid tropics of Costa Rica

Background: Among the main problems affecting beef cattle development in Costa Rica are low meat and milk productivity, low reproductive rates, nutritional deficiencies (especially because of the low forage availability and quality during the dry season), and health problems. Forage is the most available and inexpensive resource of feed for livestock in Costa Rica and othe central american countries; however, a high percentage of pastures are now degraded, reducing forage availability and quality.

The improvement of both the quality and quantity of forage resources through the recovery of degraded pastures is important to increase overall livestock productivity. The study aims to evaluate milk production of dual-purpose cows grazing a recovered pasture of *Brachiaria brizantha* cv. La Libertad alone and associated with *Arachis pintoi* cv. El Porvenir and *Centrosema brasilianum*.

Materials and Methods: A grazing experiment is bein carried on a farm located in San Jerónimo de Esparza, in the subhumid tropical central Pacific region of Costa Rica, at an average altitude of 250 m.a.s.l. Four hectares of *Brachiaria brizantha* cv. La Libertad were planted in a paddock where a degraded pasture of *Brachiaria ruziziensis* existed. The area was divided in half and 2 hectares were planted in association with *A. pintoi* CIAT 18744 cv. Porvenir and *C. brasilianum* CIAT 5234. The region is characterized by having well defined dry (December-May) and rainy (June-November) seasons. Average temperature is 26 °C and average annual precipitation, 2500 mm.

Forage availability (dry basis) and botanical composition of both pastures (alone and associated) were determined using the Botanal method. A group of 26 milking cows of different breeds—predominantly Brown Swiss—and weighing, on average, 450 kg were used; a Brahman bull was

also included. This group grazed the 2 hectares of grass alone pasture for 4 consecutive days and the grass/legume pasture for 5 days. Milk production was measured on days 1 and 4 in the grass alone pasture and on days 1, 3, and 5 in the legume-based pasture. Milk production from both groups of cows was compared with that obtained by cows grazing pastures sown to *Brachiaria ruziziensis*, the grass traditionally used on farms.

During the rainy season, pastures were rotated; the grazing cycle consisted of 4 to 5 days of occupation and 27 days of rest. During the dry season, grazing was continuous. The stocking rates of the local pasture, the grass alone pasture, and the legume -based pasture were calculated using the method proposed in the RIEPT, which takes into account animal units and grazing system.

Results: In Table x we show forage availability (dry basis) and botanical composition of both pastures during the rainy season over three consecutive periods. The percentage of *Centrosema brasilianum* found in the associated pasture was so low that it was not included in the percentage of legumes present in the associated pasture.

Table 13. Forage availability and botanical composition of a pasture of *Brachiaria brizantha* cv. La Libertad alone and associated with *Arachis pintoi* and *Centrosema brasilianum* during the rainy seasons of 1997, 1998, and 1999.

Year	DM availability (kg/ha)									
	Grass alone pasture					Legume-based pasture				
	kg/ha	Grass (%)[a]	*A. pintoi* (%)[b]	Legume (%)[c]	Weeds (%)[d]	kg/ha	Grass (%)	*A. pintoi* (%)	Legume (%)	Weeds (%)
1997	4,113	62	0	22	16	5,105	57	18	13	12
1998	4,483	67	0	18	15	5,408	58	24	4	14
1999	6,306	88.2	0	8.5	3.3	7,155	52.7	41.9	4.7	0.7
Mean	4,967	72.4	0	16.2	11.4	5,889	55.9	27.9	7.2	8.9

a. Mainly *B. brizantha* cv. La Libertad and *B. ruziziensis*.
b. *Arachis pintoi* cv. Porvenir
c. *Calopogonium mucunoides*, *Zornia* spp, and *Aeschynomene* spp, among others, in addition to *C. brasilianum*.
d. Mainly *Mimosa modest*, *Amaranthus* spp., *Borreria* spp., and others.

At the beginning of the trial, an average value of forage on offer (3000 kg DM/ha) in the local pasture was lower than that in the improved grass and grass/legume pastures.In addition, forage availability increased in both improved pastures over time as shown in Table x. However, the associated pasture produced, on average, 19% more biomass that the grass alone pasture. This situation is reflected in the average stocking rate estimated for the pastures. In the case of local pastures, the estimated stocking rate was 1.5 AU/ha, whereas it was 2.0 AU/ha for the grass aline pasture and 2.4 AU/ha for the legume-based pasture.

Average milk production/animal on the local pasture, and improved pastures sown during the rainy seasons are shown in Table 14. No significant differences in milk yield per cow were observed among pastures. However, when the average production obtained over the three years on the local pasture was compared with that obtained on the associated pasture, differences in milk yield were significant.The benefit of the improved pastures as compared to the local pastures was also evident in terms of milk production per hectare given there higher carryn capacity.

Table 14. Milk yield of cows grazing contrasting pastures in a farm in Costa Rica

Year	Local pasture[b]	Grass alone pasture (kg/cow/ per day[a)]	Legume-based Pasture
1997	8.6	9.0	9.3
1998	7.5	7.7	7.9
1999	7.6	7.8	8.1
Average	7.9 a	8.2 a	8.4 b

a. Average of 26 milking cows.
b. Native grasses, mainly *Brachiaria ruzziziensis*.
Comparison of averages using the Student's (t) test, p = 0.2271.

In general, our results indicate that the reclamation of degraded pastures through the establishment of improved grasses not only increases milk production per cow but also milk production per hectare due improved carrying capacity. A further benefit is obtained with the introduction of legumes, such as *A. pintoi*, both in terms of milk production and carrrying capacity.

2002 Increased use of forage legumes by small farmers in CA and Asia

Milestone 2000: New legumes being evaluated for soil fertility improvement and feed supply in Asia.

Highlights:

Cratylia argentea *showing promise in Hainan, P.R. China*

There are four on-station experiments for the development of forage technologies in Hainan, Guangdong and Guangxi provinces, China.

At CATAS in Hainan:

- New stylo accessions, GC1579, GC1480, GC1576, GC1524, GC1528, GC1557, E9, CPI18750A, GC1578, E7 (90038) were screened on-station for anthracnose resistance and early flowering, GC1579 being the outstanding accession.
- A stylo accession evaluation trial was commenced in April 2000, using stylo 184 as a control.
- An experiment for shrub legumes introduction and evaluation, started in 1999, is still in progress. Thirty-seven accessions are from CIAT and 22 from China. The results until now show that *Cratylia argentea, Desmodium velutinum, Flemingia macrophylla, Leucaena leucocephala* K636, *Gliricidia sepium* are promising species and varieties. Of them, *Cratylia argentea* is of high leaf yield and quality, very palatable for goats and rabbits.

In Dianbai, :

An on-station experiment on the evaluation of forages was commenced in April, 2000. Twenty accessions of grasses, herbaceous and tree legumes are being evaluated. *Brachiaria decumbens, Panicum maximum*, King grass, Stylo Reyan 2, *Cratylia argentea, Leucaena leucocephala* K636 are the most vigorous species.

In addition, preparations are being made for fodder tree nurseries to be established in Indonesia, Lao PDR, Philippines, Thailand and Vietnam.

2001 New technologies being used by farmers in Hong Ha, Vietnam

INTERVENTIONS IN CROP PRODUCTION IN HONG HA COMMUNE.

Background: Interventions in the Hong Ha Commune, Bo watershed, are designed to:
Improve crop and livestock yield to ensure food security and provide cash income
Increase sustainability of the farming systems
Contribute in enhancing community capacity in natural resource management

In the 1999 Annual Report for PE-5, we reported first year (1998-1999) results on farmer evaluation of new rice varieties for irrigated fields which gave average yield increases of 60% over the locally used variety. Additional yield increases of 30-50% were obtained with fertilizer addition. Farmers also expressed interest in new maize varieties and black mung bean.

Two events during the year had a large impact on the farming systems:
Abandonment of sugar production that had been forced on the community
A devastating flood that resulted in a reduction of area available for irrigated rice and waterlogging of upland fields

A survey of farmers' needs was conducted and a revised evaluation program designed. In 1999-2000 activities included: i) survey of food security; ii) survey of farmers' needs; iii) evaluation of rice varieties; iv) evaluation of maize, bean and vegetables; iv) pig production; v) fish production

i) Food situation over time

Table 1. Crop area and crop production in Hong Ha over time

Criteria	Area (ha)		Yield (ton/ ha)		Output (ton/ ha)		Rice equivalent* (kg/ person/month)			Notes
Year / **Crops**	1998 - 1999	1999- 2000	1998 - 1999	1999 - 2000	1998 - 1999	1999- 2000	1998 - 1999	1999- 2000	1997- 1998	
Rice									2,74	
Irrigated WS	14	*10,0*	3,5	3,8	49,0	38,0	2,08	1.94		4 ha covered
Irrigated SA	13	*10,0*	2,5	2,9	32,5	29,0	1,61	1,47		with sand &
Upland	10,6	*15,5*	2,0	2,0	21,2	31,0	1,07	*1,54*		stones
Cassava (fresh root)	40.0	50,0	6,0	6,0	240	300	5,14	6,57	6,49	Sugarcane was replaced with cassava
Maize	6,0	7,5	1,0	2,0	6,0	15,0	0,67	1,47	Few	Growing new variety
Banana	10	15								For sale
Beans	few	4,0	-	3,0		12		0,32	Few	Black bean for sale
Sugar cane	24	32	60	42	1440	1344				25 ha sold but no payment
Total							**10,57**	**13,31**	**9,23**	
# mths with food deficiency							*3,5*	*1,4*	*4,5*	

* 3,5 kg of cassava is equivalent to 1 kg of rice

It can be seen from the table that:
food security has increased since the project commenced, the period of food shortage being reduced from 4.5 to 1.5 mths.
area of wetland rice both in Winter Spring (WS) and in Summer Autumn (SA) were reduced (due to land being covered with gravel and stone), with the area of upland rice increasing
area of maize, banana and beans is increasing
compulsory sugarcane production did not bring a benefit to farmers.

ii) Farmers' concerns:

Through focus group discussion, farmers indicated interest in:
Having enough food, foodstuff and vegetable for their diet, in particular, to replace food crops lost during the flood.
Continuing to improve the yield of wetland rice by intensive cultivation including varieties for the summer/autumn season
Knowing more about disease and insect protection for rice, maize and beans
Finding ways to exchange areas of sugarcane growing into other crop cultivation.
Improving their homegardens for food and selling products
Continuing with improvement of pig and fish production to increase income

iii) Interventions in rice production:

Wetland rice: Following the trials in 1998-99, there was considerable exchange of the new rice varieties between farmers. In the Winter-Spring crop of 1998-1999, nearly 100 households participated in testing TH30, which gave yields of 3,5 -4,0 t/ha compared to the common variety, IR38, which gave yields of 2.0-2.8 t/ha. It was liked also for its good taste. As a result, TH30 was exchanged and grown on a large scale in Con Sam, Pa Ring, Pa hy and Arom villages in 1999-2000.

D116 and Khang Dan were only tested by one farmer in 1998-99. According to the farmer, Mr. Xuong, D116 grew very well and matured 5-7 days earlier than TH30. It yielded 3,5 tons/ha but needed close attention. Data was obtained on varieties tested/grown by farmers in the following season.

Table 2. Study of the flow of wetland rice varieties in Hong Ha community

Year	1998- 1999	1999-2000
Number of households using new rice varieties (*)		
- TH30	100	152
- D116	1	34
- Khang dan	1	9
Area (ha)		
- Winter Spring	14	10
- Summer Autumn	3	10
Yield (t/ha)		
- Winter Spring	3,5	3,8
- Summer Autumn	2,5	2,9
Output (tons)		
- Winter Spring	49	38
- Summer Autumn	32,5	29

(*) Some households used both varieties

From the above results, we realized that:

Variety D116 increased rapidly from 1 household evaluating it in the Winter-Spring crop of 98-99, to 34 households (18% of total) evaluating or growing it in the following year.

Variety TH30 was grown by 156 households (81%) though some households grew both TH30 and D116 varieties.

Khang dan variety was only tested in 10 households. It is not well adapted because of the need for use of pesticides.

These results lead us to evaluate more wetland rice varieties for increase yield and reduced crop growth period. Results are shown in Table 3.

Table 2. Yield of wetland rice varieties in Winter-Spring crop of 1999-2000, Hong Ha.

Criteria / Name	Yield experiment fields (t/ha)	Yield farmers'field (t/ha)	Growth period (days)	Characteristics of varieties
KSB_{140}	4,230	3,964	125	- High yield, big seed; - Effected by leaf roll insect
$\hat{A}H_{104}$	5,370	4,52	125	- High yield; long flower, firm grain, low disease
TH30	5,183	4,02	132	- High yield; good taste - No lodging - high insect damage
D116	5,218	4,31	125	- High yield; long grain; - Less affected by insects
Khang dán	2,630	3,26	110	- Fair yield; - Short growth time; affected much by insects because of flower type

Note: * production in small area

In Table 2 it can be seen that:
$\hat{A}H_{104}$, D116, TH30 gave high yields in both experiment fields and farmers' fields
D116 and TH30 were suitable for conditions of Hong Ha. However, the growth time of D116 was shorter than that of TH30 about 1 week, so it is suitable for the Summer-Autumn crop aimed at avoiding flood season
Variety Khang Dan had lower yield in experiment fields, due to it earlier flowering than others and heavy insect infestation.

In summary, the D116 (18,1 % households tested) and TH30 (81,2%) grow well in Hong Ha. TH30 has the best taste. For earlier crops, D116 is most appropriate. While $\hat{A}H_{104}$ gave the highest yield in both experiment fields and farmers' fields, there is a need for frther appraisal.

For the Summer-Autumn season, we are currently testing two short-term varieties, T92 -1 and 79-1 (only 95 days) in 4 households. These varieties performed well in Nghe.

Three training courses on management and disease and pest protection for rice were conducted. The Hong Ha people have cultivated wetland rice for 10 years, but their knowledge on farm techniques is still limited.

Upland rice: Due to the collapse of the sugar industry, areas assigned for sugarcane production became available for upland crops. The commune decided to grow banana, cassava, beans and upland rice on these areas. We thus tested an new upland rice varieties, including NL131, against the local control in 5 households. Results are not yet available.

(Nguyen Thë Cach, Nguyen Minh Hieu)

iii) Cassava improvement and management

In Hong Ha commune, cassava is the main reserve staple food as flat land for irrigated rice production is very limited. People eat cassava mainly in the form of boiled roots. They plant two edible varieties, San Nep (sticky cassava) and Ba Cang (3-months), which are tasty but are low yielding. Initially, farmers were not very interested in evaluating cassava ("we have too much of it!") but realized that higher yielding varieties would be useful in producing feed for livestock, in particular, for pigs.

Two sets of improved varieties were introduced from south and north Vietnam; these were multiplied and tested on farmers' fields in Hong Ha village. At the time of harvest farmers evaluated plant characteristics, yield, starch content and taste.

Table 1 shows the plant characteristics, farmers' scores on root quality and other comments. For human consumption farmers identified Xanh Phu Tho, an edible variety commonly grown in north Vietnam, as a suitable alternative to their local varieties, as it had good taste and a slightly higher yield and starch content than San Nep. Another "sweet" variety, KM98-1, introduced from south Vietnam, had a yield 74% higher than San Nep; this variety was considered a little bitter for human consumption but very suitable for animal feeding. Other varieties that will be evaluated further for animal feeding are SM 1447-7, KM 99-3 and KM99-5.

Table 1. Results of two on-farm variety trials conducted in Hong Ha village, A Luoi district of Thua Thien-Hue, Vietnam, in 1998/99.

Variety/line	Root weight (kg/plant)	Root number /plant	Root yield (t/ha)	Starch content (%)	Farmers' score	Comments by farmers
1. Xanh Phu Tho[1)]	3.01	8.52	21.89	30.6	31	Good taste, starchy; not too branched, *for eating*
2. KM98-2	2.42	10.61	23.62	29.7	7	Low yield, bitter, *reject*
3. KM94	3.21	8.63	25.71	31.1	7	Intermediate yield, too branched, bitter, *reject*
4. KM98-1[2)]	3.88	9.82	34.55	30.8	46	High yield, a little bitter; *for animals*
5. SM 1447-7	3.30	9.01	27.79	29.9	38	Rather high yield, bitter, *for animals*
6. San Nep[3)]	2.68	7.05	19.86	29.8	69	Good taste, low yield, *for eating*
7. CMR 20-75-18	3.66	9.70	32.10	27.1	0	Low starch, bitter, *reject*
8. CMR 36-08-1	3.51	9.60	30.73	29.3	15	Rather high yield, too branched, bitter, *reject*
9. KM 60	3.12	8.70	25.02	28.7	15	Rather low yield, bitter, short stems, *reject*
1. KM 99-1	2.47	8.5	19.50	30.4	7	Bitter, *reject*
2. KM 99-2	1.97	8.3	15.36	28.6	0	Low yield, rather bitter, *reject*
3. KM 99-3	2.55	9.3	21.65	31.5	38	Rather high yield, too branched, rather bitter *for animals*
4. KM 99-4	1.94	8.8	15.19	28.1	15	Bitter, *reject*
5. KM 99-5	2.58	10.1	23.82	30.0	38	High yield, bitter, *for animals*
6. KM 99-6	1.83	7.4	12.24	25.9	0	Very low yield, rather bitter, *reject*
7. San Nep[3)]	2.39	7.2	19.49	28.7	69	Good taste, low yield, *for eating*

[1)]Most common variety in north Vietnam; good to eat
[2)]High yielding sweet variety from south Vietnam
[3)]Most common local eating variety

Farmer evaluation of improved management practices has also commenced. These are designed to reduce soil erosion and include hedge rows, intercropping, and fertilizer management.

(Nguyen Thë Cach, Nguyen Minh Hieu and Reinhardt Howeler)

iv) Interventions in maize, beans and vegetable production

In the previous year, farmers showed interest in new varieties of maize, black mungbean, and vegetables. Extension activities were continued in 1999-2000.

Maize. A guide was prepared on management of maize and the area of "Bio-seed' maize increase. Yields reached 3,0-3,5 t/ha. A glutinous maize was evaluated and yielded 2,8 t/ ha dry grain.

Black Mungbean. The area planted in 1999-2000 was extended to 4 ha, much of it being grown on land once assigned for sugarcane.

Vegetables. In the past, Hong Ha people have had the custom of gathering vegetables from the forest or buying them from the lowland areas. Vegetables can be a supply of vitamins and proteinand sold to increase cash income. In 1999-2000 seed of gourd, calabash, amaranth, cabbage and other green vegetables was distributed to 50 households. Some households have sought out diiferent vegetable crops from other sources.

v) Home garden

Cross-farmer visits were made to see how gardens were organized in neighbouring communes and districts. Visits were made to A 'Luoi and Nam Âong. This resulted in introduction of pepper and pineapples.

vi) fertilizer supply

In the past, farmers in Hong Ha people did not use fertilizer for their crops. Through farmer evaluation of the effect of fertilizers and training in fertilizer management they have now begun to purchase fertilizer for high value crops. There is opportunity to expand the use of organic fertilizer.

vii) Introduction of crossbred pigs

Pig production was based on a free range system with pigs fending for themselves and not being kept in a pigsty. Productivity is low under this system. There is a large demand for pig meat and hence an intensive system with crossbred pigs was introduced to Hong Ha Commune. This was organized through the Hong Ha Women's Union with 20 farmers participating. Weight gain of Large white x Mong Cai crossbreds ranged from 5.5 to 10,5 kg/mth over 3 months while that of Co x Mong Cai crossbreds ranged from 1-6 kg/mth.

Farmers demonstrated that they could manage intensive pig systems. Ther were no deaths and disease problems appeared to be minimal. The differences in weight gain reflected the feed mix fed to the pigs. There was an inadequate protein source. More attention needs to be given to feed supply in the future including the integration of activities in crop and livestock production. More attention will need to be given to processing and stroing food produced on the farm.

viii) Fish production

The project worked with 12 families interested in fish production. Farmers prepared the fish ponds and the project supplied fingerlings of grass carp. The problem of obtaining a local source of fingerlings as solved by facilitating fingerling production by two of the farmers.

Progress was set back by the floods in November 1999 but more fingerlings were distributed to replace those lost. In most cases the fish gained well achieving weights of 360-460 g/head after 5 months. Lower weight gains on 3 of the farms were associated with low oxygen content (due to insufficient water exchange or the use of artesian water which had a low pH (5.5-6.0).

Additional capital would allow expansion of fish production. Use of artesian water should be avoided.

5. CONCLUSION:

+ From above research results, the group had technical interventions based on the essential demands of farmers. For example: improving production, increasing food output aimed at reducing food shortage situation for local community. Especially, transfering rice varieties that reached high yield for farmers included TH30, D116 and testing $\hat{A}H_{104}$.

+ Grew short term maize varieties liked by farmers into the crop variety structure of their farming system. The bio-seed maize, high yield, used for livestock industry. The varieties LVN10 (had tested in the Winter Spring crop of 1998-1999) and the yellow grain crossbreed maize were developed so as to supply more food for local people.

+ Sucessed in encouraging farmers developed vegetable in their home garden, supported variety seed and guided the techniques on growing, caring and harvesting for them aimed at improving their daily diet.

+ Had interventions on cassava on different aspects as cassava is the main crop and also the major food source for local community. The on-farm workshop had chosen cassava varieties with different purposes:

. Cassava varieties with high yield and much starch are used for livestock production and for sale, including KM98-1; SM 1447-7; KM99-3 vaì KM99-5.

. Cassava local variety and Green Phu Tho are very delicious, so they are used for human food.

+ Local people's knowledge in homegarden development is increasing. The VAC system is also paid much attention by local community

+ Training courses and farmer to farmer visits brought out many good results for local community, so they became the essenetial demand for them. Most of farmers volunteer to participate in these training courses..

Milestone 2000: A range of systems options being evaluated by farmers at watershed site, Hong Ha, Vietnam

Highlights:

Farmers identified one variety, KM98-1, with 74% higher yield than the local eating variety San Nep from a range of varities they were given to evaluate. The taste was considered slightly bitter, but suitable for feeding pigs which is an associated enterprise being developed to increase cash income .

Rationale: In Hong Ha village cassava is the main staple food as flat land for rice production is very limited. People eat cassava mainly in the form of boiled roots. They plant two edible varieties, San Nep (sticky cassava) and Ba Cang (3-months), which are tasty but are low yielding. The introduction of higher yielding varieties that are suitable for human consumption, animal feeding and/or processing could improve food security and increase income, mainly through on-farm pig feeding.

Methods: Two sets of improved varieties were introduced from south and north Vietnam; these were multiplied and tested on farmers' fields in Hong Ha village. At the time of harvest farmers evaluated plant characteristics, yield, starch content and taste.

Outputs: Table 1 shows the plant characteristics, farmers' scores on root quality and other comments. For human consumption farmers identified Xanh Phu Tho, an edible variety commonly grown in north Vietnam, as a suitable alternative to their local varieties, as it had good taste and a slightly higher yield and starch content than San Nep. Another "sweet" variety, KM98-1, introduced from south Vietnam, had a yield 74% higher than San Nep; this variety was considered a little bitter for human consumption but very suitable for animal feeding. Most other varieties were considered too bitter and would be suitable only for starch processing or animal feeding.

Table 1. Results of two on-farm variety trials conducted in Hong Ha village, A Luoi district of Thua Thien-Hue, Vietnam, in 1998/99.

Variety/line	Root weight (kg/plant)	Root number /plant	Root yield (t/ha)	Starch content (%)	Farmers' score	Comments by farmers
1. Xanh Phu Tho[1)]	3.01	8.52	21.89	30.6	31	Good taste, starchy; not too branched
2. KM98-2	2.42	10.61	23.62	29.7	7	Low yield, bitter
3. KM94	3.21	8.63	25.71	31.1	7	Intermediate yield, too branched, bitter
4. KM98-1[2)]	3.88	9.82	34.55	30.8	46	High yield, a little bitter; for animal feeding
5. SM 1447-7	3.30	9.01	27.79	29.9	38	Rather high yield, bitter
6. San Nep[3)]	2.68	7.05	19.86	29.8	69	Good taste, low yield
7. CMR 20-75-18	3.66	9.70	32.10	27.1	0	Low starch, bitter
8. CMR 36-08-1	3.51	9.60	30.73	29.3	15	Rather high yield, too branched, bitter
9. KM 60	3.12	8.70	25.02	28.7	15	Rather low yield, bitter, short stems
1. KM 99-1	2.47	8.5	19.50	30.4	7	Bitter
2. KM 99-2	1.97	8.3	15.36	28.6	0	Low yield, rather bitter
3. KM 99-3	2.55	9.3	21.65	31.5	38	Rather high yield, too branched, rather bitter
4. KM 99-4	1.94	8.8	15.19	28.1	15	Bitter
5. KM 99-5	2.58	10.1	23.82	30.0	38	High yield, bitter
6. KM 99-6	1.83	7.4	12.24	25.9	0	Very low yield, rather bitter
7. San Nep[3)]	2.39	7.2	19.49	28.7	69	Good taste, low yield

[1)]Most common variety in north Vietnam; good to eat
[2)]High yielding sweet variety from south Vietnam
[3)]Most common local eating variety

2002 A core group of farmers using productive and sustainable forage technologies at 6 sites, one each in Indonesia, Lao PDR, PRC, Philippines, Thailand and Vietnam

Milestone 2000: Implementation of new ADB project, site selection and partner identification.

Highlights:

Smooth transition achieved between Phase I and Phase II stages of the Forages for Smallholders Project (FSP) with new staff.
Active program of dissemination to the Province level has commenced from focus districts of Phase II.

Inception meeting

The inception meeting, held at Los Banos, Philippines, in February 2000, was attended by 18 people from Indonesia, Laos PDR, Philippines, Thailand, Vietnam and Australia. The objectives of the meeting were to review the achievements of the first phase of the Forages for Smallholder Project (FSP) funded by AusAID, to discuss the expectations of the second phase of FSP, and to initiate strategies for the implementation of the new project.

The first phase of the Forage for Smallholders Project

A general paper for FSP – phase I, and individual country papers were presented. The project had gone through a metamorphosis from agronomic fodder experiments on-station to participatory research on-farm. All stages were vital for the final outcome of the project, but it was repeatedly stressed that only participation of farmers in the research process has shaped the technologies in such a way that they were actually used and adopted. The second phase of the project is going to build on these experiences.

ADB's expectations of the second phase

The ADB representative presented the expected outputs of the ADB-FSP project. All outputs were grouped into the 5 components of the project:

Productive and sustainable technologies developed
Forage technologies extended to other farmers
Local planting material supply systems developed
Programmed training of NARSs personnel conducted
Information shared

Organisational structure

The participating countries are Indonesia, Lao PDR, Philippines, PR China, Thailand and Vietnam (Table 1 and 2). The ADB representative will be Dr. Tony Perez, the Project Manager Dr. Peter Kerridge, and the Project Co-ordinator Dr. Ralph Roothaert. The latter is the main resource person. The Co-ordination Committee is made up of the Country Co-ordinators (Liaison Officers), the Project Manager, the Project Coordinator and the ADB Representative. The committee will agree on the strategy of implementation of the project at the annual meetings.

Table 1. Focus sites in phase II of FSP and their dominant farming system

Country	Province	Focus district/ municipality	Dominant farming system
Indonesia	East Kalimantan	Makroman, Samarinda	Rain fed lowland, intensive sedentary upland.
		Sepaku II, Pasir	Extensive sedentary upland, grasslands.
Lao PDR	Luang Phabang	Xieng Ngeun	Extensive sedentary upland, short rotation slash and burn.
		Houay Pay	Short rotation slash and burn.
	Xieng Khouang	Nong Het	Short rotation slash and burn, intensive sedentary upland.
Philippines	Misamis Oriental	Cagayan de Oro	Extensive sedentary upland.
	Bukidnon	Malitbog	Extensive sedentary upland.
Vietnam	Daklak	M'Drak	Grasslands.
	Tuyen Quang	Tuyen Quang	Intensive sedentary upland.
	Thua Thien Hue	Xuan Loc	Intensive sedentary upland, short rotation slash and burn.
Thailand	Nakornratchasima	Sung Nuen	Extensive sedentary upland.
China	Hainan		Extensive sedentary upland.

Table 2. Countries and implementing institutions in FSP – phase II

PR China	Tropical Pasture Research Centre (CATAS), Hainan
Indonesia	Dinas Peternakan, Samarinda nd Directorate General of Livestock Services (DGLS), Jakarta
Lao PDR	Department of Livestock and Fisheries, Vientiane
Philippines	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, and Department of Agriculture, Region 10
Thailand	Department of Livestock Development, Ministry of Livestock Development, Bangkok
Vietnam	National Institute of Animal Husbandry (NIAH), Ministry of Agriculture and Forestry, Hanoi

General strategy

One or two focus Municipalities or Districts have been identified in a particular Province/s in each country. These are sites where adoption was high in the first phase of the project and they will form the basis of further forage technology development. Participatory diagnosis and evaluation are used to improve the technologies. At the same time field days and cross visits will help to spread the use to other farmers in the district.

Before dissemination activities start outside the focus districts, the new districts will be selected through a study of secondary data and through rapid rural appraisals. People will be trained at district level in participatory research and in forage technology. These training events also serve as an opportunity to assess the availability of skilled and motivated extension staff in the field.

Country strategies

Every country representative presented his (or her) views about which direction he would like the FSP to see moving in the second phase. A framework was then developed to plan activities for the individual countries, for the focus sites within the countries and for the new sites. A start was made during the meeting to identify activities, to allocate timetables and predict the outputs for the next three years. During the following months, the country teams and FSP co-ordinators further developed these frameworks into workplans. Individual countries are actively engaged in implementation. A regional review and planning workshop will be held in East Kalimantan, Indonesia in January 2000.

2002 Seed and planting materials of promising forages easily accessible to farmers at 6 sites in Indonesia, Lao PDR, PRC, Philippines, Thailand and Vietnam

Milestone 2000: Establish plans in each country for multiplication activities

Highlights:

Farmers have organized themselves into groups for multiplying promising forage materias in Indonesia

At the focus sites in Indonesia, farmers' groups have organised themselves to produce planting material of forages that are in high demand. These species are *Paspalum atratum, P. guenoarum, Panicum maximum, Setaria sphacelata* var. splendida and *Pennisetum purpureum*. The typical scenario is that the group assembles at a plot of land that one of the members has made available for multiplication of forages. All members contribute in terms of their own labour, one of the biggest inputs for the production of multiplication material. Activities consist of land preparation, planting, weeding, uprooting, splitting, distributing to neighbouring farmers and replanting. The group receives IDR 100 (US$ 0.01) for a bunch of 10 splits, paid by the FSP project. The group uses the money to finance other group activities and meetings. Tens of thousands splits are distributed this way every month to new farmers participating in the project. The demand for the planting material is high. It is envisaged that in future the group will be able to market the material directly without the need of the project to provide funds. The systems is also adopted by individual farmers and farmers' groups in the new areas where FSP is expanding. In the Philippines a similar scenario is followed. The production of vegetative propagation material is very important in these two high rainfall countries, as forages rarely produce any significant amount of seeds in these humid conditions. Seeds for stylo 184 are produced in a drier part of Indonesia and sold to the project in East Kalimantan. However, farmers are now also experimenting with the production of vegetative planting material of stylo. For this purpose, the shrub has to produce lignified (woody) material. In the Philippines, farmers are also producing small amounts of seeds of the shrubs *Desmodium cinerea, Desmanthus virgatus* and *Leucaena leucocephala* K636, and selling them to neighbouring farmers. Seed eating insects are a problem.

In areas with a pronounced dry season, such as Laos, central Vietnam, Thailand and China, seed is the most important source of planting material. Thailand has a leading role producing seed of *Brachiaria brizantha* (CIAT 16835, CIAT 6387, CIAT 6780), *B. ruziziensis, Centrosema macrocarpum* and *C. pubescens*. Most seed production is on-station or by farmers who are contracted by researchers. Seed from Thailand can relatively easily be transported to Laos and Vietnam. Farmers in Laos are producing small quantities of seeds for neighbouring farmers from *P. maximum, B. decumbens* and *B. brizantha*. In Laos thousands of cuttings are produced from a high density nursery of *Gliricidia sepium*, prov. Retalhuleu. The preferred diameter of cuttings (5 cm) are produced about one year after coppicing the mother tree.

2005 New forage and livestock technologies integrated into upland farming systems in Lao PDR to increase farmer livelihood and improve NRM

Milestone 2000: Initiate new AusAID special project

Highlights:
Strategies for training and for dissemination activities completed
A strategy for monitoring and evaluation being developed
Training conducted for staff in M&E, Gender and Stakeholder Analysis, Technical Writing and Advanced English
Planning of field activities completed

Implementation of the Forages and Livestock Systems Project (FLSP) commenced on 1 July 2000, with the official signing of the Memorandum of Subsidiary Arrangements with the Government of Lao PDR on 12 July 2000. The project is being implemented through the National Agriculture and Forestry Research Institute (NAFRI) with collaboration of the Department of Livestock and Fisheries (DLF) and the Provincal Agriculture and Forestry Offices (PAFO) and District Agriculuture and Forestry Offices (DAFO) in Luang Phabang and Xieng Khouang provinces. This project was developed as a result of the outcomes of the SE Asia regional Forages for Smallholders (FSP) Phase I project which operated from 1995-1999 and the expressed desire of Lao PDR for further research and development activities in upland Laos. Livestock production is seen as a key to increasing cash incomes of resource-poor farmers and as a step in stabilizing shifting agriculture systems.

The **Project Goal** is to improve the livelihoods of upland farming families with livestock while protecting the resource base of their farming systems.

The **Project Purpose** is to integrate forage and improved livestock management strategies into upland farming systems in selected districts in 2 provinces using participatory approaches to technology development:

- to increase income by improving the productivity of small and large livestock;
- to increase labour efficiency and reduce women's workloads in the livestock production systems;
- to enhance sustainable cropping systems by increasing soil fertility and reducing soil erosion; and
- to sustain livestock production within the national policy of stabilising shifting cultivation.

The planned **Project Outputs** are:

- Forage technologies and improved livestock management practices integrated in upland farming systems;
- Technically competent teams at national, provincial and district levels, using participatory approaches to develop and disseminate agricultural technologies;
- Monitoring and evaluation strategies developed to manage project implementation and measure impacts; and
- Efficient communication and dissemination of results

The FLSP has a strong development orientation which will allow research outputs on (i) the role of forage systems in intensification of upland farming systems and (ii) the participative process in technology generation, dissemination and monitoring and evaluation in addition.

The Team Leader of the FLSP, Peter Horne, was appointed and took up duties on 12 July 2000. Since that time activities have focused on establishing the project in Laos, identifying partners, familiarising them with with the goals, objectives, outputs and planned activities of the project and developing operational procedures.

In anticipation of official approval of the FLSP from AusAID, four key counterpart staff (Soulivanh Novaha, Phonepaseuth Phengsavanh, Linkham Duangsavanh and Chanhphone Keoboualapeth) attended a workshop in Vietnam from 20 – 25 March 2000 on "Analysing gender and interest groups in agricultural and natural resources management research" conducted by the PRGA.

Two NAFRI counterparts (Lingkham Duangsavanh and Phonepaseuth Phengsavanh) and one provincial counterpart (Hongtong Phimmisan) joined three FLSP staff (Peter Kerridge, Werner Stür and Peter Horne) in the Philippines from 14–19 August 2000 for a workshop on Monitoring and Evaluation (M&E). The main outcomes of the workshop were the development of a broad framework for M&E and the identification of some methods and tools for implementing M&E in the field. A meeting of all project consultants will be held in Laos from 13 – 17 November to further develop the Monitoring and Evaluation Strategy of the FLSP. This will be field tested in Laos in November and December 2000.

The 1st Project Steering Committee meeting was held on 07 September 2000 and the 1st Annual Partners' Meeting (comprising 22 partners of the FLSP and 20 from the broader development community) was held on 08 September 2000. Both meetings were to discuss plans for field implementation of project activities.

Following these meetings, two key field staff (Phonepaseuth Phengsavanh and Viengxay Photakoun) worked in district offices and 11 villages of Luang Phabang and Xieng Khouang provinces for two weeks to discuss the goals of the FLSP and plans for field implementation leading up to the wet season of 2001.

Two staff received intensive training – in Technical Writing Skills (Phonepaseuth Phengsavanh for 2 weeks in October) and English for Agriculture (Viengxay Photakoun for 6 weeks in November and December).

On the technical side, there has been continued input into forage technology development with farmers, demonstrations of potential options have been set up with farmers and interaction has commenced with the Intergrated Upland Agricultural Research Project (IUARP) in association with NAFRI and IRRI staff.

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2004 Increased net benefits to farmers in 26 pilot sites with less erosion in cassava-based cropping systems in Asia

Milestone 2000: FPR trials to investigate the effects of new varieties, intercropping, fertilizers and erosion barriers on cassava production established in 12 sites in Thailand, 12 sites in Vietnam and 2 sites in China.

Highlights:
Erosion control
In Thailand, farmers have extended planting of vetiver grass along 67 km contour hedgerows at the FPR sites.
In Vietnam, FPR erosion control trials are being conducted by 28 farmers at nine sites, with a total of 93 farmers adopting some erosion control practices on their production fields, mainly contour hedgerows of Tephrosia candida.

Fertilizer management
In Thailand most farmers participating in the project are now applying more fertilizers to their cassava fields, mainly 15-15-15 compound fertilizers, but in some areas they are changing to 15-7-18 when it is available as this corresponds more closely to the crop's requirement.
In Vietnam farmers are now applying less FYM but more chemical fertilizers high in N and K (80 kg N, 40 P_2O_5, 80 K_2O/ha), producing higher yields and net income.
Intercropping

In Vietnam about 80% of cassava in three pilot sites is being intercropped with peanut or black bean.
Varietal improvment
In Thailand new varieties are being evaluated in four pilot sites, and 100% of farmers in all sites are already planting new high-yield and high-starch varieties.

In Vietnam new varieties are being tested in ten sites, but in north Vietnam more than 67 farmers are already planting new varieties in their production fields.
In China new varieties are being tested in three sites, but in one site about 80% of cassava fields are now planted with new varieties, mainly ZM9057.

Background: Funds for this output are provided by the Nippon Foundation to carry out applied research on vartietal improvement and soil management practices and extend the information widely to farmers in areas where cassava is grown. It has a dual aim of increasing farmers' incomes and improving resource management. The special project funds provide a means to extend the results of 15 years of strategic research and maintain interaction with national partners of the Asian Cassava Research Netwok. The emphasis in this second phase (1999-2003) of the project is wide dissemination of results and hence a target has been set to directly benefit some 8000 farmers. This can only be achieved through active and close collaboration with national partner institutions.

Soil management and prevention of erosion under cassava can be achieved using various practices alone or in combination. More rapid growth using adequate fertilizer, intercropping, reduced

tillage, weed control and erosion barriers all contribute to improved soil managment. During evaluation, farmers often choose to evaluate one or other of the approaches though turn to a combination of practices when applying it to the whole farm. The results are presented in relation to the main focus of particular FPR trials though there is considerable overlap in practice.

Erosion control

Rationale: Soil erosion can be serious when cassava is grown on slopes, however, it can be significantly reduced by various agronomic practices. The choice of a particular practice will depend on the soil and farming system, including the ability of the farmer to use scare resources for erosion control. Hence erosion control practices are best developed with farmers taking into account their particular circumstances.

Methods: Farmers from new sites were invited either to visit demonstration fields showing a range of options on ways to control erosion, or focus sites where farmers were already evaluating and adopting erosion control practices. After discussion of the various options, some of the visiting farmers chose to participate by conducting their own erosion control trials, or immediately applying selected practices in their production fields.

Outputs: An example of a FPR demonstration trial conducted on a research station in Thailand is shown in **Table 1**. Most effective in reducing erosion were treatments with hedgerows of vetiver grass, *Paspalum atratum*, lemon grass and *Setaria sphacelata*, which reduced soil loss to less than 10% of that obtained with the traditional practices. Farmers showed most interest in treatments with hedgerows of vetiver grass or lemon grass and using closer plant spacing. Highest gross income was was obtained by intercropping cassava with pumpkin.

Table 1. Results of an FPR demonstration trial conducted on 5% slope in Khaw Hin Sorn Research Station, Chachoengsao, Thailand, in 1999/2000.

Crop/soil management treatments[1)]	Cassava		Intercrop yield (t/ha)	Gross[2)] income ('000 B/ha)	Dry soil loss[3)] (t/ha)
	Root yield (t/ha)	Starch content (%)			
1. traditional practice (up-down ridging, no fertilizers)	27.78	25.6	-	22.22	39.17
2. up-down ridging, with fertilizers	37.33	25.0	-	29.86	6.70
3. contour ridging, with fertilizers	38.67	26.8	-	30.94	6.79
4. no ridging, with fertilizers	35.89	25.8	-	28.71	4.52
5. no ridging, low fertilizer level	39.29	25.6	-	31.43	6.59
6. low fertilizer level+chicken manure	37.62	25.8	-	30.10	5.35
7. low fertilizer level+cassava peel compost	26.83	25.2	-	21.46	2.89
8. peanut intercrop , with fertilizers	13.92[3)]	22.4	1.54[4)]	17.45	12.53
9. pumpkin intercrop, with fertilizers	13.88	26.0	9.27[5)]	46.91	9.42
10. sweet corn intercrop, with fertilizers	32.01	24.8	2.28[6)]	41.41	7.91
11. vetiver grass hedgerows, with fertilizers	29.11	25.8	-	23.29	1.61
12. *Paspalum atratum* hedgerows, with fert.	38.33	21.6	-	30.66	2.00
13. *Setaria phacelata* hedgerows, with fert.	36.03	24.1	-	28.82	3.05
14. lemon grass hedgerows, with fertilizers	36.45	26.9	-	29.16	3.01
15. sugar cane hedgerows, with fertilizers	39.63	25.5	-	31.70	4.17
16. closer plant spacing (0.8x0.8 m), with fert.	41.68	25.5		33.34	4.96

[1)]all treatments except T_{16} were planted at 0.8x1.2 m; fert. = 47 N+22 P_2O_5+56 K_2O; low fert. = 23 N+11 P_2O_5+28 K_2O; chicken manure = 780 kg/ha;compost = 6.2 t/ha; all treatments except T_1, T_2 and T_3 were planted without ridges

[2)]prices: cassava baht 0.8/kg fresh roots
peanut 10/kg dry pods
sweet corn 1.0/fresh ear
pumpkin 3.0/kg fresh fruit

[3)] many cassava plants died during the dry season due to termite attack of weak plants

[4)]fresh pods; dry pods = 0.41x fresh pods

[5)]fresh fruits

[6)]fresh ears; no. of fresh ears = 15,800/ha

Table 2 shows results of FPR erosion control trials conducted in a pilot site, Sahatsakhan district, Kalasin, northeast Thailand. Intercropping with sweet corn gave the highest net income and an intermediate level of erosion control. Vetiver grass hedgerows gave the highest level of erosion control but also produced the lowest yields (average of two sites). However, after a cross-visit to another site at Sapphongphoot, where farmers have set up a "Soil Conservation Group" to plant vetiver grass hedgerows across 320 ha of sloping cassava fields (17 km of the needed 100 km having been planted), all farmers from Sahatsakhan were impressed with this soil conservation practice and 21 of them have already planted a total of 4 km of vetiver grass hedgerows.

Table 2. Results averaged across seven[1)] FPR erosion control trials conducted by cassava farmers in Sahatsakhan district, Kalasin, Thailand in 1999/2000.

	Yield		Gross income[5)]			Production costs	Net income	Dry soil loss
Treatments[2)]	Cassava (t/ha)	Intercrop	Cassava ('000 B/ha)	Intercrop	Total	('000 B/ha)		(t/ha)
1. Farmer practice	21.91	-	14.90	-	14.90	12.73	2.17	42.5
2. Closer spacing	26.06	-	17.72	-	17.72	13.87	3.85	35.3
3. Contour ridging	24.04	-	16.35	-	16.35	13.78	2.57	17.2
4. Lemon grass hedgerows	25.16	-	17.11	-	17.11	14.38	2.73	12.0
5. Vetiver grass hedgerows	18.32	-	12.46	-	12.46	13.01	-0.55	3.5
6. Sweet corn intercrop	20.28	10,830[3)]	13.79	10.83	24.62	15.41	9.21	9.6
7. Pumpkin intercrop	31.87	500[4)]	21.67	1.50	23.17	16.97	6.20	9.8

[1)]only four trials for treatment 7, and two for treatment 5
[2)]no ridging except in T3; all treatments received 312 kg 15-15-15/ha
[3)]number of ears/ha
[4)]number of fruits/ha
[5)]Prices: cassava baht 0.68/kg fresh roots (23% starch)
sweet corn 1.00/ear
pumpkin 3.0/fruit

In Sanaamchaikhet district, the five participating farmers used the same five treatments in their FPR trials. Highest net income and lowest soil loss were obtained with lemon grass hedgerows. In spite of these results, farmers considered vetiver grass hedgerows more useful and six farmers have now planted a total of 2 km of vetiver grass hedgerows.

The adoption of vetiver grass hedgerows at the various sites in Thailand is shown in **Table 3**. One of the reasons for widespread adoption is that planting material is provided to farmers by the Department of Land Development. On the other hand, while intercropping appears to give higher returns, it is not adopted in Thailand due to lack of labor for planting and harvest, and uncertainties in rainfall and marketing of the products. This is in contrast to Vietnam where farmers like to intercrop cassava with peanuts and planting hedgerows of *Tephrosia candida*, vetiver grass or pineapple, or various combinations of these three.

Table 3. Number and type of FPR trials conducted at various pilot sites in Thailand in 2000, and the extent of adoption of vetiver grass hedgerows.

Pilot site	Number of FPR trials				Adopting vetiver grass hedgerows	
	Erosion control	Varie-ties	Fertili-zation	Inter-cropping	no. farmers	km
Sapphongphoot, Nakorn Ratchasima	-	-	-	-	61	17.0
Daan Khun Thod, Nakorn Ratchasima	2	5	-	-	23	4.0
Thepharak, Nakorn Ratchasima	-	5	-	4	13	3.6
Wang Sombuun, Sra Kaew	-	-	-	-	22	20.0
Noonsawaat, Sahatsakhan, Kalasin	-	-	-	-	21	4.0
Noonnamkliang, Sahatsakhan, Kalasin	-	-	-	-	42	1.7
Noonsawan, Sahatsakhan, Kalasin	-	-	-	-	19	3.3
Khamsii, Nongkungsri, Kalasin	-	-	-	-	25	7.0
Sanaamchaikhet, Chachoengsao	6	5	5	-	6	2.0
Kaengdinso, Prachinburi	-	5	6	-	8	4.5
Total	**8**	**20**	**11**	**4**	**240**	**67.1**

In Vietnam 28 FPR erosion control trials are being conducted by farmers at nine sites and 93 farmers have already adopted various erosion control practices on their production fields, mostly the planting of *Tephrosia candida*, vetiver or pineapple hedgerows (Table 4). In Dong Rang village in Hoa Binh province, 33 farmers have planted hedgerows of *Tephrosia candida*, covering at least 10 ha of land with 20-40% slope. In addition, they have now planted lichee trees among cassava, so that in the future cassava will be replaced with fruit trees. This should result in greater income as well as less erosion.

After five years of conducting FPR erosion control trials on their own fields, farmers have become very much aware of the large amounts of soil that is lost every year due to soil erosion (see Table 5) and they became convinced that the planting of hedgerows of vetiver grass or *Tephrosia candida*, intercropping with peanut and the application of fertilizers were effective practices to reduce erosion. Due to the lack of vegetative planting material of vetiver grass and the convenience of planting *Tephrosia* from seed, most farmers have adopted the latter option.

Fertility maintenance

Rationale: When cassava is grown on low fertility soils, nutrient removal with the roots, stems and leaves can seriously deplete the nutrient reserves in the soil. Farmers sometimes apply chemical fertilizers or animal manures, but they seldom apply adequate amounts and the right balance of nutrients to sustain high yields and maintain soil productivity. On-station research and FPR trials with farmers are continuing to look for the best options to increase the efficiency of nutrient use.

Outputs: Long-term fertility trials being conducted in four locations in Vietnam, China and Indonesia have clearly indicated that high yields can be maintained for ten or more years of

Table 4. Number and types of FPR trials conducted at various pilot sites in Vietnam in 2000, and the extent of adoption of new technologies in those sites.

	Number of FPR trials						Dissemination/Adoption (no. of households or ha)			
Pilot site	Erosion control	Fertilization	Inter-cropping	Varieties	Weeding	Plant density	Erosion control	Fertilization	Inter-cropping	Varieties
Tien Phong	-	-	-	-	-	-	4 (0.2ha)		37 (2.5ha)	25(1.3ha)
Dac Son	-	-	-	-	-	-	3 (0.1ha)		2 (0.1ha)	11(0.5ha)
Minh Duc	2	1	1	3	-	-	3		many	
Hong Tien	-	-	-	3	-	-	2			
Am Thang	2	1	-	3	-	-	9	12		11
Dong Rang	4	3	-	2	-	-	33		33	(1.5 ha)
Kieu Tung	6	4	-	-	-	-	35			8
Phu Ho	3	2	-	2	-	-				
Thach Hoa	2	3	-	-	-	-			1	(>100 ha)
Tran Phu	-	-	4	5	-	-				10
Hong Ha	3	3	3	3	-	1	4			2
An Vien		4	4	4	3	-				
Dong Xoai	4	-	-	4	-	-				
Suoi Rao	2	2	2	2	-	-				
Total	**28**	**23**	**14**	**31**	**3**	**1**	**93**	**12**	**>73**	**>67**

Table 5. Results of three FPR erosion control trials conducted in Dong Rang village, Luong Son district, Hoa Binh, Vietnam, in 1999 (5th year).

1. Mr. Nguyen Van Tho: 16% slope

Treatment	Yield (t/ha)		Gross income[1)]	Product. costs[2)]	Net income	Dry soil loss
	cassava	intercrop	(mil. dong/ha)			(t/ha)
1. C+S, no fertilizer; no hedgerows	18.05	0.38	7.438	5.060	2.378	15.1
2. C+S, with fert.[3)]; vetiver hedgerows	20.00	0.32	7.848	5.811	2.037	3.3
3. C+S, with fert.; *Tephrosia* hedgerows	23.30	0.38	9.171	5.811	3.360	3.2
4. C+P, with fert.; vetiver hedgerows	21.67	0.35	8.306	6.271	2.035	0.3
5. C+P, with fert.; *Tephrosia* hedgerows	21.67	0.42	8.537	6.271	2.266	0.7

2. Mr. Bui Thanh Mai: 12% slope

Treatment	Yield (t/ha)		Gross income[1)]	Product. costs[2)]	Net income	Dry soil loss
	cassava	peanut	(mil. dong/ha)			(t/ha)
1. C+P, no fertilizer; no hedgerows (TP)	13.90	0.46	6.105	5.520	0.585	25.8
2. C+P, with fert.; no hedgerows	14.94	0.43	6.349	6.151	0.198	5.6
3. C+P, with fert.; *Tephrosia* hedgerows	17.22	0.46	7.201	6.271	0.930	8.0
4. C+P, with fert.; vetiver hedgerows	18.30	0.43	7.458	6.271	1.187	9.2
5. C+P, with fert.; *Flemingia* hedgerows	19.06	0.46	7.808	6.271	1.537	5.9

3. Mr. Bui Thi Bam: 16% slope

Treatment	Yield (t/ha)		Gross income[1)]	Product. costs[2)]	Net income	Dry soil loss
	cassava	peanut	(mil. dong/ha)			(t/ha)
1. C monocult., no fert., no hedgerows	13.12	-	4.330	3.000	1.330	50.4
2. C+P, with fert.; vetiver hedgerows	18.50	0.35	7.260	6.271	0.989	0.6

[1)]Prices: cassava dong 330/kg fresh roots; urea (46% N) dong 2200/kg; soybean 4000/kg dry grain; fused Mg-phos. (15% P_2O_5) 900/kg; peanut 3300/kg dry pods; KCl (60% K_2O) 2400/kg

[2)] C + peanut production cost-fert. costs = 5.520 mil. dong
C + soybean production cost-fert. costs = 5.060 mil. dong

[3)]Fertilizers = 40 kg N, 40 P_2O_5, 80 K_2O/ha; fertilizer costs 0.751 mil. dong/ha

continuous cassava cultivation as long as adequate amounts of N, P and K are applied annually to offset the nutrients removed in the harvest of roots, stems and leaves. Figures 1 and 2 show an

example from Thai Nguyen Univ. in Thai Nguyen, north Vietnam, where the annual application of 80 kg N, 40 P_2O_5 and 80 K_2O/ha could maintain high yields of 20-25 t/ha during ten years of continous cassava cultivation. As in many other locations, cassava responded most strongly to the application of K, followed by N and P. Even with high applications of K, the level of exchangeable K of the soil remained below the critical level, while that of available P was above the critical level (Figure 2).

On-farm trials conducted in Dong Nai and Tay Ninh provinces of south Vietnam and FPR fertilizer trials conducted in Phu Tho and Hoa Binh provinces of north Vietnam confirm the importance of adequate fertilizer (high in N and K) application to obtain high yields and net income.

When fertilizers are not available or can not be applied in adequate amounts farmers may also apply farm-yard manures (FYM), or they incorporate green manures, intercrop residues or the prunings of leguminous hedgerow species (alley cropping). Green manure experiments, conducted for 3-5 years at Rayong Field Crops Research Center in Thailand, indicate that *Canavalia ensiformis* and *Crotalaria juncea* were slightly more effective green manures than pigeon pea or *Mucuna fospeada* in increasing cassava yields (Table 6). Planting a green manure crop in the early rainy season, incorporating the vegetation after 2-3 months, followed by an 18-month cassava crop (for a 21-month cropping cycle) produced higher yields than planting the green manure either as an intercrop, to be pulled out and mulched at 1½-2 MAP, or interplanting the green manure at 6-7 MAP in the standing cassava and incorporating the residues at the next cassava planting; the latter practice actually reduced yields. The planting of green manures followed by on 18-month crop of cassava seems like a good alternative since total production in five years was higher than what can be expected from five annual crops, while costs of land preparation, weeding and harvesting will probably be reduced. Highest annual yields, however, were obtained without green manures but with application of 467 kg/ha of 13-13-26 fertilizers.

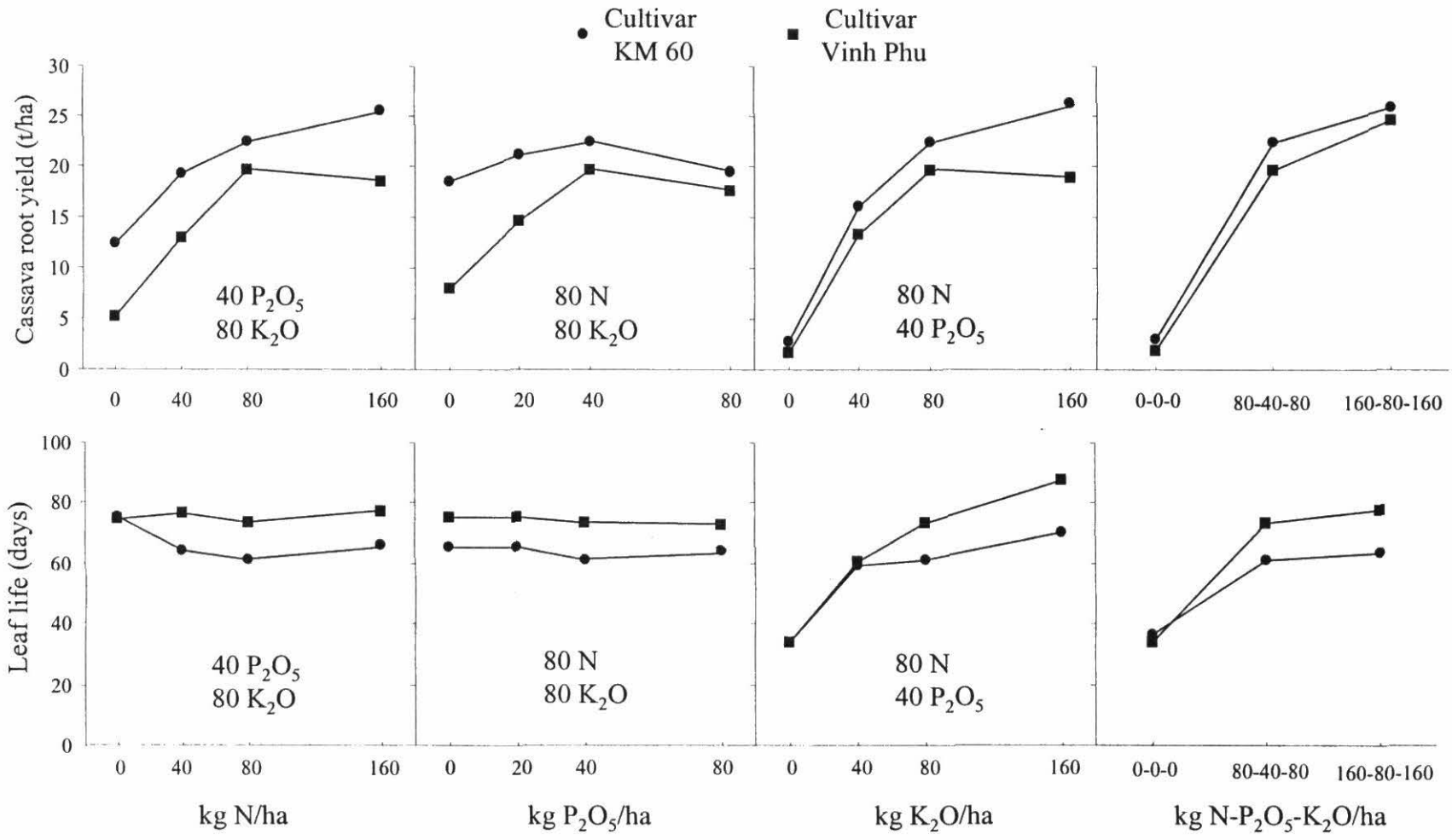

Figure 1. Effect of the annual application of various levels of N, P and K fertilizers on the fresh root yield and on leaf life at 3 MAP of two cassava cultivars grown at Thai Nguyen University, Thai Nguyen, Vietnam, in 1999 (10th year).

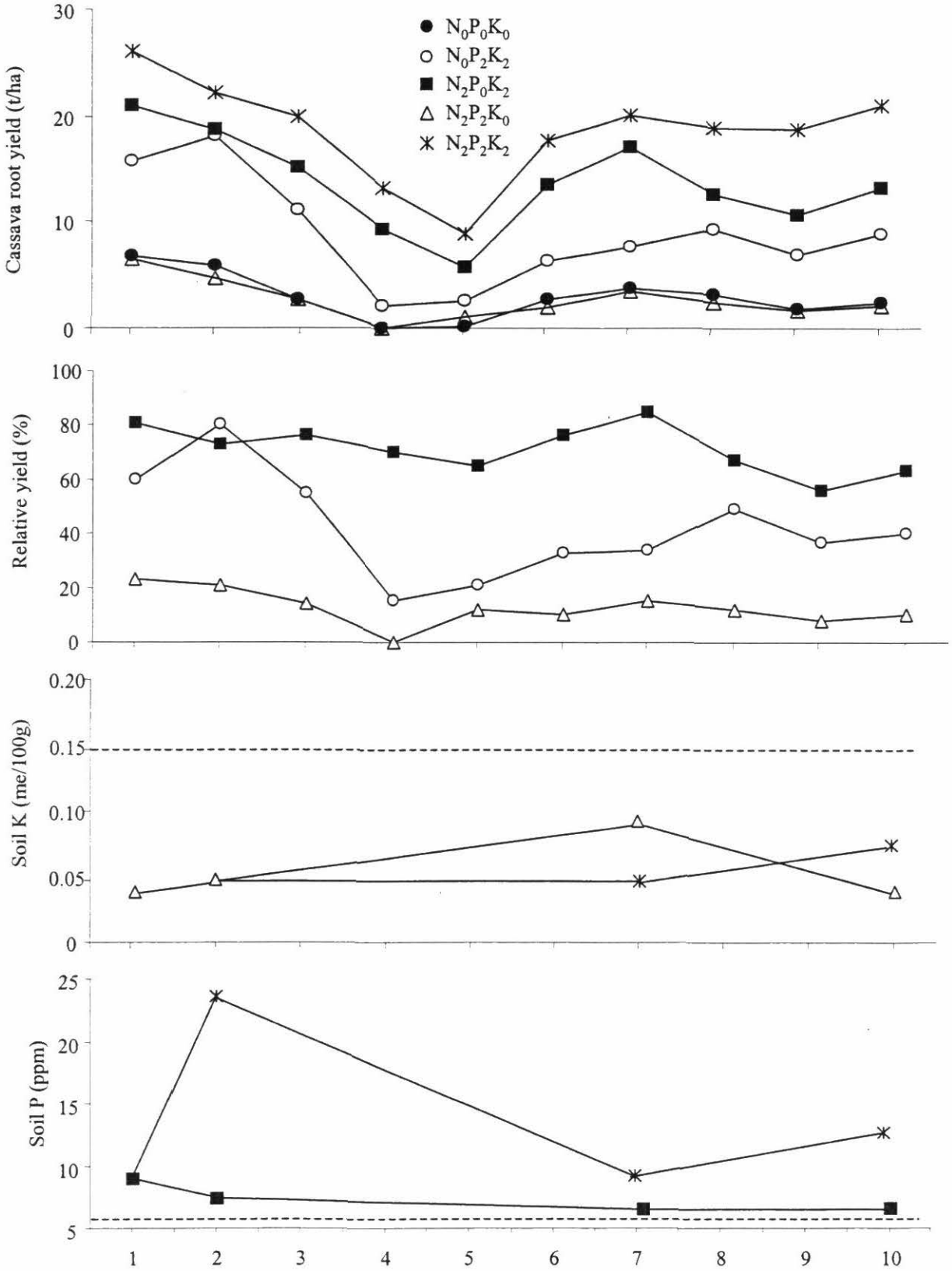

Figure 2. Effect of annual applications of N, P and K on cassava root yield, relative yield (yield without the nutrient over the highest yield with the nutrient) and the exchangeable K and available P (Bray 2) content of the soil during ten years of continuous cropping in Agro-forestry College of Thai Nguyen University, Thai Nguyen, Vietnam.

Table 6. Effect of three ways of planting four green manure species on the yield of cassava, Rayong 90, planted during three cropping cycles at Rayong Field Crops Research Center, Rayong, Thailand from 1994 to 1999[1)].

Treatments[1)]	Cassava root yield (t/ha)				
	1st cycle	2d cycle	3d cycle	Av.	Σ5 years[2)]
1. Cassava without GM, 156 kg/ha 13-13-26	17.56	30.06	14.39	20.67	103.3
2. Cassava without GM, 467 kg/ha 13-13-26	29.78	40.39	21.42	30.53	152.6
3. C+*Crot. juncea,* cut at 1½-2 months	23.75	29.19	14.02	22.32	111.6
4. C+*Canavalia,* cut at 1½-2 months	26.94	27.75	15.50	23.40	117.0
5. C+pigeon pea, cut at 1½-2 months	21.39	26.97	14.47	20.94	104.7
6. C+*Mucuna,* cut at 1½-2 months	20.28	18.75	11.31	16.78	83.9
7. C+*Crot. juncea,* planted at 6-7 moths	8.75	31.44	14.97	18.39	91.9
8. C+*Canavalia*, planted at 6-7 months	22.83	24.17	12.94	19.98	99.9
9. C+pigeon pea, planted at 6-7 months	15.86	28.81	14.27	19.65	98.2
10. C+*Mucuna,* planted at 6-7 months	17.25	27.02	14.77	19.68	98.4
11. *Crot. juncea* GM, cut at 2-3m, C 18 months	46.17	49.04	36.94	44.05	132.1
12. *Canavalia* GM, cut at 2-3m, C 18 months	42.98	43.81	34.14	40.31	120.9
13. pigeon pea GM, cut at 2-3m, C 18 months	38.81	45.97	37.00	40.59	121.8
14. *Mucuna* GM, cut at 2-3m, C 18 months	38.86	46.32	30.22	38.47	115.4

[1)]C = cassava; GM = green manure
T_1-T_{10} were planted annually from 1994/95 to 1996/97, while T_{11}-T_{14} were planted in three 21-month cycles from 1994/96 to 1997/99.
[2)]for T_1-T_{10} estimated from the average yields in the first three years; for T_{11}-T_{14} actual yields during the three crop cycles completed in slightly over five years.

Table 7 shows the effect of intercropping and alley cropping on cassava yields during the 8th cropping cycle in Dong Nai province of Vietnam. While there were no significant effects of treatments on cassava yield during the first seven cycles (when chemical fertilizers were applied), there was a significant positive effect from alley cropping with *Leucaena leucocephala* and *Gliricidia sepium* during the 8th cycle, when no fertilizers were applied. These two treatments also resulted in a significant increase in soil OM, Ca, Mg, K, and Zn. From this and previous experiences in Malang, Indonesia, it seems that alley cropping with leguminous tree species like *Leucaena* or *Gliricidia* have little benefit in the short-term, but may improve soil productivity and cassava yields in the long-term. So far, however, farmers in Thailand have shown no interest in alley cropping (requires too much labor), while farmers in north Vietnam are interested mainly in *Tephrosia candida*, as it is easy to grow, very well adapted to the local soil and climate, and appears to improve soil fertility. There are no experimental data, however, to support the latter claim.

Table 7. Effect of intercropping and alley cropping with various leguminous species on cassava root yield and starch content during the 8th cropping cycle in Hung Loc Research Center, Dong Nai, Vietnam, in 1999/2000.

	Plant height (cm)	Root yield (t/ha)	Top yield (t/ha)	Harvest index	Starch content (%)
Cassava monoculture	153 b	16.77 bc	8.44	67	27.7 abc
C + pigeon pea intercrop	165 b	15.00 bc	7.17	68	27.8 abc
C + mucuna intercrop	165 b	11.77 c	6.88	63	26.7 c
C + peanut intercrop	163 b	17.15 bc	8.23	68	26.9 bc
C + cowpea intercrop	160 b	17.92 b	7.81	70	28.0 ab
C + *Canavalia* intercrop	160 b	19.27 b	8.44	70	27.0 bc
C + *Leucaena* alleycrop	198 a	27.44 a	15.11	64	28.4 a
C + *Gliricidia* alleycrop	195 a	27.00 a	13.78	66	28.2 a
CV	7.14	18.84	19.46		2.59
LSD (0.05)	18.0	5.27	2.71		1.0

Intercropping

Rationale: Intercropping cassava with grain legumes, sweet corn or pumpkin oftentimes increases total income and reduces erosion. What crop is most suitable and what is the best way of planting depends on local conditions of soil and climate, on marketing opportunities for the intercrop, and on local traditions.

Outputs: Table 8 shows results of an intercropping experiment conducted at Thu Duc University near Ho Chi Minh city, south Vietnam. Higher cassava yields and starch contents were obtained by intercropping with peanut or mungbean than by monocropping, possibly due to the additional fertilizers applied to the intercrops. Similar to previous intercropping experiments conducted in north Vietnam, peanut was the most promising intercrop.

Table 8. Results of an intercropping trial conducted in Thu Duc University, Ho Chi Minh city, Vietnam, in 1999.

Cropping system[1)]	Cassava yield (t/ha)	Starch content (%)	Intercrop yield (t/ha)
1. Cassava monoculture	16.4 c	26.5	-
2. Cassava + peanut	20.7 a	27.2	0.6
3. Cassava + mungbean	18.0 b	26.8	0.3
4. Cassava + pumpkin[1)]	18.1 b	26.5	0

[1)]Varieties: cassava = KM 94; peanut = KL 25
Fertilization: cassava 80-60-80; peanut and mungbean 50-20-50; pumpkin 60-40-50 of N-P_2O_5-K_2O/ha.
[2)]pumpkin damaged by heavy rain at 1½ MAP.

An on-farm trial on methods of peanut intercropping conducted in An Vien village of Dong Nai province of south Vietnam indicates that planting a single row of peanut between cassava rows produced the highest net income and was most preferred by farmers. In some pilot sites in north Vietnam where labor is not a constraint, farmers have readily accepted intercropping as a useful practice, and about 80% of cassava fields in these sites are now intercropped with peanut or black bean.

Weed control

Rationale: In most countries in Asia weeds are controlled by hoeing 2-3 times during the cassava crop cycle. However, in areas where the cropped area is large and labor cost is high (Thailand and south Vietnam), more and more farmers use herbicides to control weeds. Research on different methods of weed control need to be done in different soil types to determine the most profitable practice.

Outputs: An on-station weed control experiment has been conducted for several years at Hung Loc Research Center; in addition two on-farm trials were conducted in An Vien and Hoa Duoc villages of Dong Nai province. In all three trials one application of the pre-emergence herbicide methalochlor (Dual) at 2.4-2.5 l/ha produced the highest cassava yields and net income.

Varieties

Rationale: Planting of new varieties with higher yield and/or starch content is the easiest way for farmers to increase income. In areas where cassava is used mainly for animal feeding (north Vietnam) or starch extraction (south Vietnam and Thailand) farmers are mainly concerned with yield and starch content, while root shape, color and taste are important only in areas where cassava is used for human consumption.

Outputs: In Vietnam an on-station variety trial was conducted at Thu Duc University in south Vietnam, while FPR variety trials were conducted in three sites in north Vietnam. At Thu Duc Univ., KM94 (Kasetsart 50 from Thailand) produced the highest yield and starch content. This variety is now widely planted for starch extraction in south Vietnam. **Table 9** shows that in two villages in Pho Yen district of Thai Nguyen province of north Vietnam, KM98-7 (SM1717-12) and KM95-3 (SM1157-3) produced the highest yields and net income and were much preferred over KM94. In another site in Phu Tho province of north Vietnam, farmers obtained highest yields with KM95-3 and CM4955-7, but they preferred SM1717-40 over CM4955-7 because of the poor plant type and root shape of the latter.

In Thailand, FPR variety trials were conducted at two sites. In Sahatsakhan district of Kalasin province highest root yields and net income were obtained with the recently released variety Rayong 72, previously known as CMR33-57-81. The starch content of this variety is generally below that of Rayong 90 and Kasetsart 50, but total starch yield may be higher, especially in the poor soils of NE Thailand.

In China FPR variety trials were conducted by nine farmers in two villages in Hainan using 22 varieties or lines. Table 10 shows that all breeding lines produced higher yields than the local variety SC205. About 80% of the 50 ha of cassava in Kongba village is now planted with new varieties, mainly ZM9057.

Table 10. Results of FPR cassava variety trials conducted by eight farmers in Kongba and Tapuling villages of Baisha county, Hainan, China, in 1999/2000.

Cassava varieties	No of trials in which variety is included	Average root yield (t/ha) New variety	SC205	% of SC205
1. SC205	8	-	-	-
2. OMR35-70-6	3	28.4	16.0	178
3. OMR37-14-9	0	-	-	-
4. OMR35-70-1	3	22.0	20.0	110
5. OMR36-40-9	2	31.5	23.4	135
6. OMR37-102-12	1	45.0	30.6	147
7. ZM93274	2	25.0	21.8	115
8. ZM95125	2	17.5	15.9	110
9. ZM95111	1	21.3	18.7	114
10. ZM9242	2	19.8	17.5	113
11. ZM95038	2	25.4	21.8	116
12. ZM93252	3	24.4	21.8	112
13. ZM95027	3	28.1	20.8	135
14. ZM9244	4	25.9	17.3	150
15. OMR36-63-6	1	26.9	21.4	123
16. OMR36-05-7	3	27.1	14.7	184
17. OMR33-10-4	2	27.8	15.9	175
18. OMR36-05-9	3	21.6	15.8	137
19. ZM93236	4	19.2	16.5	116
20. ZM94209	2	18.8	17.1	110
21. ZM9394	4	20.5	16.5	124
22. ZM8641	3	29.0	17.9	162

Analysis of progress:
Output Milestone 2003: Increased net benefits to farmers in 26 pilot sites with less erosion in cassava-based cropping systems in Asia.

The technical results reported here are complemented by others in training and netwok support. Activities in 1999 and 2000 have set the stage for achieving the main aim of dissemminating improved varieties and producion practices to large numbers of farmers through collaboration with national research and extension agencies.

There is still scope for further farmer adaptation of the most useful management practices, for strengthening the participatory approach in collaborating institutions and making greater use of farmer-to-farmer extension. The full implementation of monitoring and evaluation of the socio-economic as well as the technical benefits has been held back by lack of resources.

Table 9. Average results of eight FPR variety trials conducted each in Tien Phong and Dac Son villages, Pho Yen district, Thai Nguyen, Vietnam, in 1999.

	Cassava yield (t/ha)			Gross income (mil. dong/ha)			Net income (mil. dong/ha)			Farmers' preference (%)	
Variety	Tien Phong	Dac Son	Av.	Tien Phong	Dac Son	Av.	Tien Phong	Dac Son	Av.	Tien Phong	Dac Son
1. Vinh Phu	13.58	16.00	14.79	6.79	8.00	7.39	4.78	5.99	5.38	15	10
2. KM 60	16.30	18.50	17.40	8.15	9.25	8.70	6.14	7.24	6.69	65	55
3. KM 94	15.50	19.00	17.25	7.75	9.50	8.62	5.74	7.49	6.61	30	40
4. KM 95-3	20.83	18.20	19.51	10.42	9.10	9.76	8.41	7.09	7.75	60	65
5. CM 4955-7	23.00	18.00	20.70	11.50	9.00	10.25	9.49	6.99	8.24	0	5
6. KM 98-7[1)]	25.79	23.00	24.39	12.90	11.50	12.20	10.89	9.49	10.19	100	100

[1)]KM 98-7 = SM 17-17-12

[2)]The cost of fertilizers in all treatments is 2.01 million dong/ha (10 t/ha of FYM and 80 kg N + 40 P_2O_5+80 K_2O/ha)

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Output 3. Models/frameworks developed to target research, integrate results, assess impact and extrapolate results

Milestone 2000 Developed analytic models to assess technology/land use options

Economic model for ex-ante evaluation of research interventions in Aguaytia watershed

Highlights:
A user-friendly agro-economic computer model, using common electronic spreadsheets, is functioning and being fine-tuned by local researchers and extensionists. Preliminary results of the model demonstrate stark differences between farming systems in the uplands and riverine. While the land use among riverine farms is more profitable than the upland ones, farmers along the rivers have higher risk conditions (floods) in their farming system..

Purpose: To provide an opportunity for local researchers and extensionists to examine effect their technological (crop) interventions within complex slash-and-burn farming systems, and to compare two important farming systems: riverine and uplands.

Rationale: National and international institutions in the Ucayali have developed many technological alternatives for small farmers, but the adoption of these alternatives has been mixed at best. Even though researchers and extensionists have expertise in one or more crops, they commonly have an incomplete understanding of the farming system functions with respect to scarce inputs such as land, labor and capital. Moreover, policy makers (local and national) have little knowledge about how a policy or technology intervention could affect different farmers with different agroecological conditions.

Methods: Modeling of the region's farming systems involved three stages of research. First, crop- and farm-level data were collected to create enterprise budgets. These data were then used for the second modeling stage of farming systems. A third stage of model refinement and the interpretation of results is being conducted with local researchers.

Crop and farm system information came from two sources. The first source, national and international researchers, provided agronomic and price data. The second source consisted of direct information provided by farmers about their resources and returns. Model parameters for the principle crops of the two farming systems were determined by surveying 70 flat-uplands farmers and 40 riverine farmers (Table 1).

Table 1. Principal crops and agricultural and production activities in the Ucayali Region, Peru

Flat Uplands	Rice, Maize, Plantain, Cassava, Bean, Peanut, Citrus, Oil palm, Pineapple, Peach palm, Cocoa, Cotton, Pasture/Cattle, Poultry
Riverine	Rice, Maize, Plantain, Bean, Soybean, Cowpea, Peanut, Camu- camu, Watermelon, Fishing

The agro-economic data also included specific information regarding crop benefits and costs. A key component of the enterprise budgets was information regarding monthly labor requirements. All agro-economic information was organized in electronic spreadsheets and serves as parameters for the farming system model. The model uses two labor sources in order to calculate the maximum labor available in an average farm. The first, family labor, is based upon the number of persons older than 14 years who can conduct farm activities. The second source is hired labor. For example, in the Ucayali there are several months (January, February, May, July, August and September) when upland farmers often hire large amounts of labor. (Figure 1 in Activity 1.2)

Output: A user-friendly agro-economic model constructed within electronic spreadsheets for use by local researchers and extensionists. The linear program model determines the optimal mix of cropping activities, with the objective of maximizing farm profit subject to restrictions of land, labor and capital. To reflect the local situation of slash-and-burn farming, the model includes other restrictions such as a minimum land area for subsistence crop production.

One example of regional farming system difference is with maize. In riverine areas, a farmer can earn approximately 306 soles per ha, while an upland farmer loses 103 soles per hectare. However, if the riverine farmer does not plant the maize early, he/she runs the risk of losing the entire harvest due to a unexpected river level increase. For local partner training of the model, see Activity 4.8.

Impact: The use of an agro-economic model permits a more complete understanding of how the scarcity of production factors (land, labor and capital) can affect farming systems. Furthermore, the model measures the impact of technological changes, such as new crops and varieties, upon farm earnings. This would be a powerful tool for local policy makers , who are responsible for the planning of the farming activities in the region. They can predict the impact of specific policies within different agroecological systems.

Contributors: Ricardo Labarta, Douglas White, SN-1, INIA, MinAg-Ucayali, DEPAM, ICRAF

Milestone 2000 Spatially analysis of the role of socio-economic and bio-physical factors upon technology adoption

Highlight: a novel approach was developed to determine adoption factors of intensive agriculture technologies, using forages as a case study. Rather than employ the conventional bio-physical/socio-economic disciplinary approach, a dual research process takes place simultaneously at two scale levels. Therefore, relatively expensive efforts that gain local insights from participatory field research can be balanced with the use of less costly, more generalized technical knowledge employing secondary data (e.g. climate, soils, market).

Purpose: to achieve a more effective and cost-efficient understanding of intensification processes. The procedure will permit more accurate targeting of forage technologies in a range of bio-physical and socio-economic environments.

Rationale: The intensification of agriculture is an important strategy to improve the well-being of farmers while reducing pressure on previously forested and degraded lands. However intensification is not merely the introduction of new technologies. Rather farmers must invest scarce labor and/or capital in order to realize future gains. Hence, intensification may not be technically feasible nor desired. Since an incomplete understanding of how and where intensification occurs, the application of improved technologies continues to be frustratingly ineffective. A central challenge is to more accurately match a supply of improved agricultural technologies with where farmers currently and/or are likely to demand them in the near future.

The reproducible methodology developed by the project can contribute to the design of a technology-targeting framework applicable to other intensification strategies. In close collaboration with partners, we plan to (1) establish a knowledge base that integrates both disciplinary and scalar information, and to (2) create DSTs with the knowledge base that identifies conditions where there is a higher probability of forage technology adoption.

NRM 5 : Organizational Models

Goal and Objectives	Key results desired and underlying development assumptions	Process/Product Indicators	Activities
		CIAT Output 5.A: Principles for the facilitation of inter-institutional co-ordination and co-operation.	
1. To improve collaboration between NAR's, Universities, GO's and NGO's.	• Increased synergy of activities • Decreased duplication of activities • Improved coverage • System level rather than component level research • Improved dialogue and co-ordination between institutions In order to: • Generate more relevant research • Improve efficiency	1. Brochure of CIAT activities and research strengths produced to share with and receive input from national partners by 05/00. 2. Collaborative planning meeting to receive input from partners on CIAT research priorities held by 05/00. 3. % organizations active 4. Feasibility study re DRAU/CIAT participatory training unit (PTU) undertaken by 06/00 5. CIAT/DRAU joint diagnosis for a participatory research project undertaken by 08/00. 6. DRAU/CIAT PTU established by 11/00 7. At least one CIAT-initiated collaborative research proposal developed with partner institutions by 11/00. 8. Ongoing participation in CIAT group to reflect on and draw lessons from institutional strengthening work.	Include professionals from NARs, Universities, NGOs in research teams and involve them directly in research activities Design research and development activities that require the collaboration of several local organizations

2. To strengthen partner institutions (both organizational and research abilities).	• More connected and informed • Better able to 'deliver' on research (improved human capital) • More able to identify important research topics • Decreasing frequency of politically led research agendas • Improved resource security • Improved leadership (visionary, transparent, fair, unifying) In order for: • Institutional self-determination • Better relevancy, and therefore utility, of research	1. Inter-institutional 'research methods' professional development group established by 06/00. (see NRM 6) 2. Training provided for professionals of partner organisations by 12/00 on: – Agro-economic modeling – GIS – Impact analysis – Qualitative research – Social capital – Health and eco-system research? – PPIs (agro-empresas) 3. At least 12 researchers from at least 6 local institutions participate throughout 00 in reflective learning project to develop research abilities	Share resources (videos, software, database, literature) with partner organizations Present seminars
3. To identify existing local community groups and to a) strengthen these, and/or b) form new ones (where there are gaps).	• *Structures exist for unifying/collectivizing the 'voice' of farmers.* • Increased awareness of the existence and purpose of other groups • Increased ability of groups to represent the interests of their members	1. Existing directories of Pucallpa institutions obtained, collated and analyzed for gaps 05/00. 2. Training on group development processes for agricultural researchers incorporated into participatory research course by 11/00.	Conduct brief interviews and compile list of institutions with their goals and activities.

2000 Developed framework for monitoring and assessing impact of research in the forest margins

Milestone 2000: Impact analysis framework for the forest margins

Purpose: to establish a long-term impact evaluation process in the CIAT reference sites that:

- Improves the chances of long term development impact of research conducted by CIAT by elaborating detailed causal uptake paths with key stakeholders.
- Guides research process through the participatory development of a clear vision, objectives and research paths and milestones.
- Provides critical feedback of research processes that permits adaptation of current efforts and identification of new research priorities.

Rationale: With its world-renowned contribution of increasing agricultural productivity, current and future expectations of the Consultative Group on International Agricultural Research (CGIAR) remain high. Yet while advances of the Green Revolution have led to enough food being produced to feed the world, problems of poverty and natural resource degradation persist (CGIAR 1995). In response, the CGIAR has expanded its mandate to address these pressing issues by introducing Integrated Natural Resources Management (INRM) research in its agenda. As such, "INRM research and development activities within the CGIAR provide the basis for the development of sustainable agricultural landscapes within which the products of the genetic improvement programs can gain maximum impact for the benefit of the poor" (INRM, 1999).

The introduction of the INRM concept challenges scientists of the CGIAR. Increased complexity of research and development (R&D) interventions[1] as well as more stringent and rapid reporting of results by the donor community lead to a need to monitor and evaluate social, economic, environmental and biophysical change. The current situation poses special challenges for socioeconomic and impact assessment (IA) research, particularly as this change has increased the demand for a more holistic IA[2] approach beyond traditional economic surplus analysis.

Difficulties of assessing the impact of INRN research stem from its own definition, as there is not a universally accepted one. Proponents (from the Bildeberg Consensus) generally perceive the term to represent a responsible and broad-based management of the land, water, forest and biological resources base (including genes) needed to sustain agricultural productivity and avert degradation of potential productivity (INRM, 1999). Izac (1998) emphasizes that INRM is not a straightforward concept as it embraces social, economic, environmental and biophysical components. INRM changes (at different spatial and temporal scales) and is assessed in terms of multiple objectives (e.g. poverty alleviation, resilience, natural resource conservation, economic growth, human and social development) that reflect the needs and expectations of different stakeholders (Izac and Sanchez, 1998). Therefore, INRM research requires a wider geographic scope (manageable plot and farm level analyses expand to more unwieldy scales of community, watershed and even larger areas), which brings numerous complicating ecological, social, cultural, institutional, economic and political factors. Furthermore results are rarely visible in a

[1] R&D focus has changed from classical agronomy to ecological sciences, from analytical research to systems dynamics, from top-down to participatory approaches, and from factor-oriented management to INRM.

[2] Guijt (1998) defines the term "Impact" as "the effects of an intervention on its physical surroundings, the people involved, and/or the organizational context. This refers to short term outputs of products, medium term results, and longer term consequences or outcomes."

short time frame such as the agricultural cycle, and it is still not clear how far the scientists should work across the research-development continuum in order to increase the probability of achieving impact.

The second difficulty of INRM research is that IA arises from its requisite inclusion of multiple stakeholders. The CGIAR Centers have two sets of clients to whom they are ultimately held accountable: beneficiaries of research and the donor community. Research beneficiaries include rural dwellers, NARs, NGOs and other partner institutions, each with their own perspectives and interests. In order for INRM research to affect change in terms of sustainable natural resource use and poverty alleviation, ultimately local people must alter their livelihood strategies3. How this is most "efficiently" accomplished often runs counter to the constraints placed by the external donors. Furthermore, not only should results be effective in a research site but they need to be replicable and scaled up (or out) to other locations. Scoones (1997), analyzing the feasibility of scaling up success stories, concludes that the major lesson is that no blueprint can be provided. Change occurs as a result of an unpredictable combination of contingent circumstances, which are historically specific and relate to a range of imprecise political, economic, social and personal factors.

However, efforts to scale up and generalize are anathema to a countervailing group of development practitioners, (many within the donor community) who espouse the importance of local experience, understanding and decision-making. This group emphasizes that rural dwellers are more than mere recipients of INRM research, but are the true clients who express their demands accordingly. These processes of local awareness and prioritization are the actions that drive development (Guijt and Shah, 1998). INRM practitioners need to be ready to accept a low priority ranking by locals for their activities, perhaps only initially, as other needs such as education and health care could be deemed more important.

A third issue concerns tradeoffs amongst the multiple stakeholders. With the reach of INRM expanding beyond the farm or household level, the possibility and gravity of conflict increases. Many of the problems related with INRM - pest, water and soil management - move beyond the farm level because of their biophysical characteristics and multiple actor decision-making process. Management affects the natural resources that are common to a group of people who live locally, and to an external population who are affected, albeit sometimes indirectly. Understanding and properly addressing both private and public incentives are the key difference between previous CGIAR efforts and those of INRM. As a result, optimal decisions require an analysis of tradeoffs, as well as a careful negotiation and collective action amongst them (e.g. individual farmers, households, communities, and policymakers).

Output: A paper by M. Gottret and D. White (2000) presents advances of CIAT scientists as they develop and implement an impact assessment framework for three ecoregions in Latin America (CGIAR INRM workshop, Penang Malaysia, August 2000).

The impact assessment process started by developing our vision or final development objectives of the research output defined in the conceptual framework for the CIAT-NRM division. These were redefined and discussed at a two day seminar on organizational process held in Cali with the objective to interchange experiences between the researchers in the reference sites in Pucallpa, Cauca, San Dionisio y Yorito. Causal uptake paths were developed for each of the outputs reflecting the step required between a research output and a desired development impact. Intermediate indicators for each step in the causal uptake path were chosen, as well as final "development indicators". (See BP-1 Output 4.1) The below figure demonstrates the inter-relationship amongst the six CIAT NRM logframe outputs. The following tables are an organic, ever-changing, forest margins impact assessment framework.

[3] A term employed by the Sustainable Rural Livelihood approach of IDS/DFID (Scoones, 1998). According to the author, three broad clusters of livelihood strategies are identified. These are agricultural intensification/extensification, livelihood diversification and migration.

At the local scale, development sociologists guide and integrate the research process while geographers do so at the general or external scale. Traditional agricultural research projects leaders (agronomists, soil scientists and economists) now act as consultants to the sociologists and geographers who can best manage and synthesize research at each respective scale. This approach permits rapid integration of the thematic information from all involved research domains. For example, participatory research approaches have shown that through adaptation of improved technologies to local needs, intensification processes can be supported. However, without indicators representing key factors of successful implementation, new participatory research projects benefit little from the results of former participatory research efforts.

Outputs: A detailed concept note delivered to BMZ.

Impacts: In order to assure the validity and use of the research results, national research institutions, development projects and NGOs are part of the research process from the initial project phase. This approach permits scaling up of research advances to a larger audience and leads to "ownership" by local organizations- a trait that is crucial to future use. Successful implementation of this project will permit policymakers and extension personnel to make more informed choices and thus more effectively use public funds dedicated to agricultural and environmental causes.

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Collaborate with ASB-Brazil researchers to coordinate modeling approaches

Highlight: a research synthesis and planning meeting for the western Amazon basin of Brazil and Peru fortified efforts to conduct comparative regional analyses.

Purpose: to improve the quality and applicability of quantitative farming system/NRM models developed for the Amazon region.

Rationale: The Latin America region of the CGIAR systemwide ASB program has been plagued by isolated research efforts. In the last year, integrative efforts at the Peru level have started a long-desired trend to link social science research efforts with neighboring Brazil. A book chapter "ASB in Peru: Challenges, Research, Impact" in the American Society of Agronomy (ASA) publication: *A Scientific Review of Alternatives to Slash-and-Burn Program*, is the first comprehensive review of research conducted in Peru (White, et al. 2001). With this basis and other chapters representing research conducted in other countries, consortium scientists can better access advances and propose collaborative efforts. These joint projects will provide a more complete understanding of forest conversion processes.

Quantitative modeling research spans a range of complexities. More accurate and complex models are difficult to understand, and manage and interpret. Whereas more simple and less realistic models are easier to use by the less experienced, the results may not be completely accurate. Therefore modeling efforts need to be matched with the informational needs and human resource capacity. A range of models from the simple to the complicated will improve the probability the local scientist can use them to their advantage.

Outputs: an integrated multi-institutional research plan for the Amazon region of both Brazil and Peru.

Impacts: Quantitative models help researchers and policymakers understand complex processes of land use change. These tools permit an analysis of different outcome scenarios according to changes in

agriculture technology and/or government policy. By being better informed of potential land use implications, better policies can be developed.

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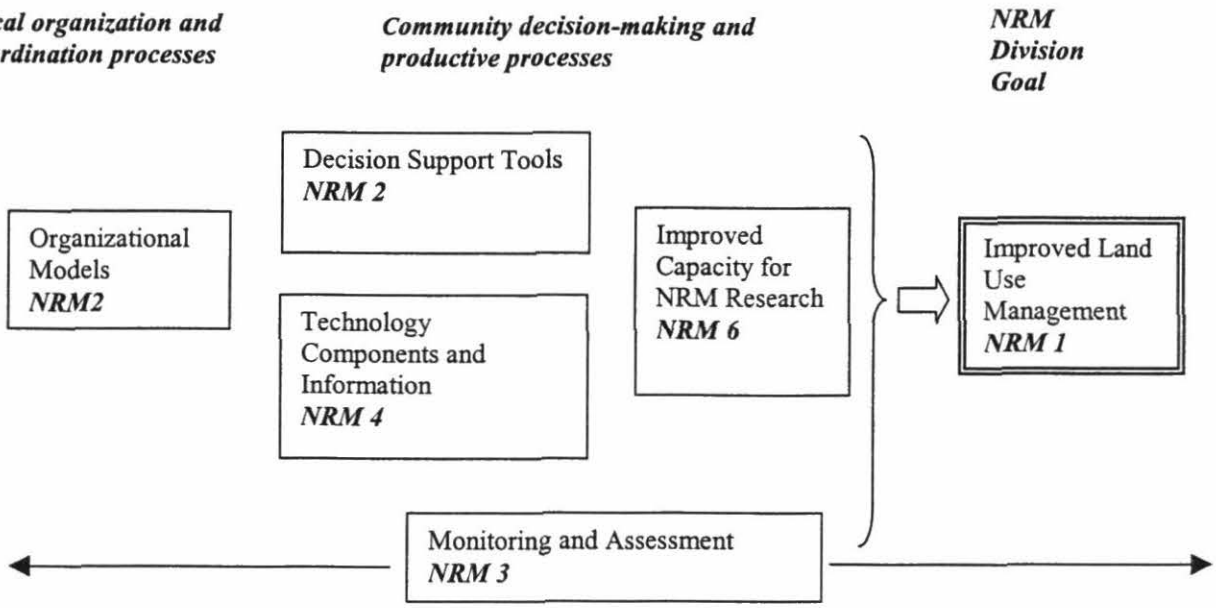
Figure 1. Relation of Logical Framework Outputs: Processes and Products Toward the Goal of CIAT NRM Research



NRM 1: Improved Land Use Management

Goal and Objectives	Causal Pathway	Development/Environment Indicators	
1. To facilitate the development of sustainable community-managed landscapes 2. Alleviate health problems and malnutrition through improved NRM in rural communities	1. Sustainable technologies and information available (see NRM 4) National policies support sustainable NRM practices (see NRM 3 & 5) 2. Community organizations exist (see NRM 5) 3. Collaborative efforts btw institutions and communities (see NRM 2 & 5) Diagnosis of problems and opportunities (see NRM 2 & 5) Land use options and implications understood (see NRM 2) 4. Management plans and agro-enterprise developed (see NRM 5 & 6) 5. Training in participatory methods and sustainable technologies (see NRM 4 & 6) 6. Adoption of sustainable practices (see NRM 6) 7. Monitoring and feedback loop (see NRM3)	• Increase family income • Biodiversity maintained • Forest area : on farm, landscape Primary/Secondary • Sustainable practices (%hh) (%area) • Decrease in degraded areas. • Increase of the net agricultural productivity/ha of the municipality or community • increase in health conditions (decrease in childhood mortality) • hh food security • dietary quality	

4. To promote a) collaborative efforts between institutions and community groups b) the participatory diagnosis of problems and opportunities.	• *Stakeholders are familiar with the benefits and methods of participatory diagnosis* • *Structures to promote collaboration exist where necessary* • *Health interventions driven by the community are more sustainable* • Increased ability to address issues of common concern • Duplication minimized and efficiency improved • Stakeholders develop a common vision, goal and strategy to inform their work with farming and professional communities In order to : • Get minority voices represented and heard • Challenge top down models of institutional working • Promote farmer capacity (they can do it!) • Improve relevance of research and associated interventions	1. Learning project continues with agricultural researchers including participatory diagnosis with communities in 00 2. Participatory diagnosis of social capital undertaken with 3 communities by 06/00. 3. Field-based application of economic model, facilitated by CIAT- DRAU-ICRAF and a local community by 11/00. 4. See also indicator 1.3 5. Community action plans (with health topics) developed with 8 communities by 11/01	Facilitate learning project Facilitate agro-economic model use

To improve stakeholder participation in the design, application and adoption of sustainable technologies and NRM technological options.		***CIAT OUTPUT 5.B Principles of stakeholder participation and improve participatory research methodologies***	
1. To train stakeholders in participatory methods (from policymakers to farmers).	• Increased number of farmers trained in research process • Increased number of researchers trained in participatory research • Improved understanding by stakeholders of participatory research methods In order to: • Increase chance of demand-led research • Increase relevance of research and the feasibility of its application • Provide opportunities for strengthening community stakeholders through the use of participatory methods • Promote flexibility in the research process and to encourage multi-disciplinary and sectoral working.	1. At least 3 groups of farmers carrying out participatory research in rice and bananas by 11/00. 2. 4 additional training sessions in participatory research held with agricultural researchers by 11/00. (continuation of IP course 99) 3. SWOT analyses of issues of institutionalizing PR undertaken with 3 National partner institutions by 08/00. 4. Beer and participatory research video night held with local research directors, to strategize a conscientization process of implementing PR by 07/00. 5. Meeting held in Lima with CIP/CARE/MF to share PR case studies with national directors of NARS/UNALM/MAG by 10/00. 6. Impact of learning project systematized and published by 03/01	

2. To develop feasible and sustainable technologies and NRM technological options through the use of participatory research techniques.	• Improved technologies • Increased participation in the research process • Improved levels of adoption of sustainable production and NRM technologies • Increased awareness of the inter-dependency of the social context and both the relevance and sustainability of technologies. • Improved applicability (scope) to landscape level	1. Process for the participatory diagnosis of social capital developed by 06/00. 2. Analysis of lessons learned from 8 individual DEPAM sub-projects for conducting PR in forest margins by 11/00 3. Farmer feedback of CIAT germplasm compiled and directed to CIAT and other plant breeders by 05/00 4. Effectiveness assessed of using germplasm and other limited resources as entry point to participatory research in natural resource management by 11/00	
To be filled in by Agroempresas		***CIAT Output 5.C: Principles/models for the supply of support services for rural agroenterprise development.***	

Output 2: Decision Support Tools

Goal and Objectives	Key results desired and underlying development assumptions	Process/Product Indicators	Activities
To promote the application of the land-use dynamics modeling tools and scenario analyses to farm level decision-making processes.		***CIAT Output 2.A: Application of land use model for decision-making at farm level.***	
1. Development, training and refinement of model with stakeholders.	• Increased ability to define cause and effect relationships • Improved understanding of the impact of various land use options on both land and income (by policy-makers, researchers and extension staff) • Increased awareness of the context of technologies • Improved decision-making about land-use (relevance/sustainability) • Increased number of policy-makers formulating and implementing policies that facilitate sustainable land use. In order to: • Achieve more sustainable land use	1. Agro-economic model working group developed by 06/00 with the participation of at least 6 partner *institutions.* 2. 20 local scientists and extensionists trained in the application of the model by 05/00 3. 6 local institutions with staff trained in the application of the model 05/00 4. Number of times model is integrated into national research or extension planning/activities by 02/01.	Develop and refine model Organize training sessions Include feedback
To be filled in by Agroempresas		***CIAT Output 2.B: Methodology for market opportunity identification and evaluation.***	
		CIAT Output 2.C: Methodology for the design of PPIs and principles for their execution.	

To improve the capacity of agricultural researchers to design relevant, grounded and participatory projects		***CIAT Output 2.F: Framework and methodology for the participatory diagnosis of social capital in communities (at farm level).***	
1. To determine what processes agricultural researchers can use with community members to identify the degree, nature and distribution of social capital in their communities. 2. To investigate how community members define the degree, nature and distribution of social capital in their communities. 3. To investigate what activities or interventions create or change social capital between individuals, organizations and communities	• Improved understanding about how the extent and nature of social capital present in a community can impact the sustainability of participatory projects. • Improved understanding and recognition of the inter-relatedness of social capital and participatory research. • Increased awareness by agricultural researchers of the impact of their research activities on social capital. • Better understanding of social capital as defined and utilized by community members (farmers).	1. A replicable strategy for the participatory diagnosis of social capital developed by 06/00. 2. A practical guide for Agricultural Researchers on how to 'action' the social capital framework developed by 06/00. 3. 'Good practice guidelines' for interventions/activities that create and support social capital developed by 07/00 4. Description of social capital developed with 3 communities by 06/00. 5. 'Social capital' concepts and application integrated into at least 2 CIAT research activities in Pucallpa by 11/00.	

Output 4: Technology Components and Information

Goal and Objectives	Key results desired and underlying development assumptions	Process/Product Indicators	Activities
To utilize germplasm technology components as an entry point for the development of organizational models and to improve capacity for NRM research.		***CIAT Output 4.A: New and improved germplasm for rice, plantains, beans and forages.***	
1. To make new and improved germplasm available to stakeholders.	• Broadening of land use options (through increasing adoption of new varieties) • Increased number of varieties evaluated by farmers with results fed back to NAR's, CIAT. • New entry points for farmer participatory research In order to: • Catalyze farmer research (experimentation) and the development of farmer learning organizations. • Catalyze the diversification of farmer income sources.	• Number of NRM research projects established by CIAT or partners through germplasm entry points in Pucallpa by 11/00 • Number of farmers using CIAT germplasm • Farmer feedback of CIAT germplasm compiled and directed to CIAT and other plant breeders by 05/00 • Number of farmers changing their use of land due to project interventions	
2. To foster linkages between NAR's and IARCs for germplasm exchange.	• Improved access by NAR's and IARCs to CIAT's germplasm bank. • Improved collaboration between NAR's and IARCs (See Output 5)	Number of requests for CIAT germplasm from Peruvian partners	

To alleviate health and malnutrition problems through improved NRM research		***CIAT Output 2.D: Model of causal relationships between health, nutrition, NRM and biodiversity***	
1. To provide insight into the causal linkages between health, biodiversity and natural resource use.		Identification of the causal linkages between natural resource use, health and nutrition	Conduct bivariate and multivariate statistical analyses Spatial modeling
2. To expand evaluation of land use technologies to include health and nutrition indicators		# hh surveyed # of livelihood systems characterized Comparative analysis of food and income sources; agricultural diversity and biodiversity of wild foods gathered from surrounding forests; the contribution of different land uses to dietary quality and food security. Analysis of seasonal effects upon nutrient intake and deficiencies of micronutrients Gendered assessment of household food security and the nutritional status	Collect field data Characterize and assess the livelihood systems of floodplain and upland communities
To alleviate health and malnutrition problems through participatory methods		***CIAT Output 2.E: Participatory ecosystem approach to human health assessment***	
1. Determine when and where NRM technologies are most needed to reduce nutrient deficiencies	Promotion of landscape level planning facilitates adaptive and diverse livelihood strategies		
2. Determine relationship between environmental change and transmission of infectious diseases	Target interventions at critical periods of illness Increase understanding of the effects of hydrological cycle and human activity on water quality	• Improvement in water quality in X communities with respect to: Coliform counts, pH and turbidity • X communities monitoring their water quality • # maps	Map the area from which the community draws resources, as well as the diversity of biotas/biotypes upon which they depend for food sources Characterize patterns of maternal and infant mortality, general morbidity

		• Analysis of maps	and disease periodicity of men, women and children Determine prevalence and incidence of parasitic infections in children and hemoglobin levels in women and children Test water quality used for drinking and bathing at different times in the year.
3. To determine how local beliefs, knowledge and decision-making processes affect the selection of foods and the treatment of illness			Use ethnographic techniques

To utilize information technology components as an entry point for the development of organizational models and to improve capacity for NRM and health research.		***CIAT Output 4.B: New and improved information technology***	
1. To improve the understating of health-environment linkages in remote rural communities	• Increase access to health technologies designed for field diagnostics by Ministry of Health • Reduce incidence of water-borne parasites that affect malnutrition in young children	New field testing of X implemented by the Ministry of Health in Y communities by Z time # of new technologies # of children with parasites # of children malnourished	Facilitate links between WHO, PATH and Ministry of Health. Disseminate 10,000 HemoCue Color Scale tests to Ministry of Health for anemia testing Disseminate solar treatment systems for water
2. To develop, maintain and share a database of research results.	• Decreased duplication of research efforts	• Database of scientific results and papers established and maintained by 11/00 • Number of people using the database • Website created for Pucallpa research by ?	

Output 3: Indicators for Sustainability

Goal and Objectives	Key results desired and underlying development assumptions	Process/Product Indicators	Activities
To develop and apply a monitoring, evaluation and impact assessment methodology to CIAT's NRM program.		***CIAT Output 3A: Methodology for monitoring, evaluation and impact of NRM research and interventions.***	
1. To develop a conceptual framework for monitoring, evaluation and impact assessment.	• Increased ability of CIAT staff to generate impact indicators for their research and related activities. • Improved data collection for impact assessment (relevant, focused) • Increased awareness of the impact of CIAT's NRM activities, internal to the organization and amongst external stakeholders In order to: • Improve processes of knowledge generation • Improve interventions in response to feedback	Number of projects with impact indicators Number of collaborators in development of each project's indicators	
2. To train people in the application of the methodology (i.e. collection and management of data).	• Improved integration of evaluative processes into project level activities		
4. To evaluate the applicability/appropriateness of both the process and indicators with other stakeholders.	• Establishment of continuous assessment and feedback process • Improved data on the impact of NRM technologies and activities		
Determine local indicators of community and individual health through and ethnographic and participatory health assessment	• Local indicators of health will be incorporated into the health programs and used to evaluate health interventions		

Output 6: Improved Capacity for NRM Research

Goal and Objectives	Key results desired and underlying development assumptions	Process/Product Indicators	Activities
		CIAT Output 6A: CIAT research products known by the public	
1. To disseminate/ communicate research results through networks, workshops and journals.	In order to: • Increase the relevance of research and the probability of its application • Improve integration of cross-disciplinary perspectives	• 4 Internationally peer-reviewed publications 11/00 • Quarterly research seminars jointly with CIAT partners in Pucallpa through 00 • Bi-monthly peer supervisory meetings within CIAT office	
		CIAT Outputs 6B: Documents of CIAT NRM- research affecting curriculum content	
1. Develop transdisciplinary university course on Ecosystem Approaches to Human Health	Train professors as well as students in the theory and methods underlying research linking health and land use	Course developed by x date # of students in course	

		CIAT Outputs 6C: CIAT scientists and partners trained	
1. To develop the capacity of local researchers (thesis students/NAR's/IARCs).	In order to: • Develop local knowledge base • Enhance the sustainability of the effects of project work	• Literature search of libraries dedicated to tropical agriculture and the Amazonia by 4/00. • One local researcher trained in the application of the social capital framework and participatory diagnosis of SC by 06/00. • One local researcher trained in the analysis of qualitative data by 03/00 • (see also output 5)	
2. To improve the capacity of the Ministry of Health to diagnose and treat illness	Training in the use of new technologies (see NRM 4B)	•	
3. To promote and strengthen team work within CIAT-puc projects.	• Regular fora for discussion of impact and reflection/evaluation of work established • Improved understanding of the link between individual research activities and the objectives of the NRM program • Increased co-operation amongst staff • Improved motivation of staff	• Bimonthly meetings	

Impacts: more effective and coordinated CIAT research within and amongst the reference sites.

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2002 New approaches for use in FPR

Milestone 2000: Evaluation and monitoring framework to assess FPR technologies

Introduction: This activity was carried out under an ACIAR-funded project granted to the PRGA program " Participatory Monitoring And Evaluation (M&E) of New Technologies Developed With Smallholders". The objectives of the project are to:

Develop a framework to monitor and assess the on-going and ex-post impacts of new forage technologies developed through farmer participatory research.
Study the process of farmer technology testing, adaptation, and adoption using participatory monitoring and evaluation methods and taking into account gender and wealth differences among potential adopters.
Compare participatory and conventional approaches to and impacts of forage technology development.

In 2000 fieldwork for the project was completed and an international workshop was held at which project findings with regard to M&E were presented, combined with inputs from other presenters, and applied to the development of M&E plans for the FSP and related projects. Thus a synthesis of the workshop proceedings effectively summarizes the main outputs of the project to date with regard to the first objective. A full report of these proceedings is in preparation. A second report is also being prepared which will present the project's findings with regard to the second and third objectives. These reports will be finalized by December 2000.

The M&E workshop was held at Cagayan de Oro, Philippines, 14-18 August 2000.
The objectives of the workshop were:
To develop a framework and guidelines for undertaking M&E.
To strengthen participants' capacities to plan and implement M&E.

The specific content of the workshop included:
Sharing information and experiences from the ACIAR and FSP M&E studies.
Exploring concepts and methods for M&E, with particular emphasis on participatory approaches (PM&E).
Discussion on a framework for M&E in research projects such as the FSP.
Integrating M&E into the project cycle.
Using PM&E to motivate and create a clearer vision for farmers, technicians and supervisors.
Obtaining field experience in carrying out PM&E.

The following sections summarize the key issues, concepts and practical conclusions of the workshop.

What is the role of monitoring and evaluation?

Monitoring and evaluation are essential to the management of development activities (projects, programs, organizations). If we are to manage our activities adaptively, responding to changes as

they occur, we need feedback. This is true for farmers, local project workers, and staff of research institutes and development organizations, both government and non-government. M&E also enables us to document and evaluate our progress with new forage technologies and the participatory technology development process. In fact, M&E is an integral part of participatory research.

In conventional terms, monitoring and evaluation (M&E) are distinct activities related to the project cycle. Having identified, planned and initiated a project, we need to monitor its implementation and evaluate its achievements. Thus *monitoring* is part of project management and occurs during the life of the project, whereas *evaluation*, while it may begin during the project, will extend beyond the project's life and focus area. In the present context, the primary concern is not with routine monitoring of project activities, such as employment of staff or acquisition and disbursement of inputs, but with the continuous or periodic assessment of *project impacts* – that is, with impact monitoring or ongoing evaluation – as well as evaluation in the *ex post* sense.

Why participatory monitoring and evaluation?

Participatory approaches to M&E have been motivated by *functional* concerns, i.e., improving the effectiveness of M&E, as well as concerns for the *empowerment* of disadvantaged groups. The following table, adapted from Mikkelsen (1995:170-1), summarises the differences between conventional and participatory evaluation.

	Conventional	Participatory
Who	External experts	Farmers, project staff, facilitators
What	Predetermined indicators of success, e.g., production, income	People identify own indicators of success
How	Focus on scientific objectivity; distancing of evaluators form other participants; uniform complex procedures; delayed, limited access to results	Self-evaluation; simple methods adapted to local culture; open, immediate sharing of results through local involvement in evaluation processes
When	Usually upon completion; sometimes also mid-term	Merging of monitoring and evaluation, hence frequent small-scale evaluations
Why	Accountability, usually summative, to determine if funding continues	To empower local people to initiate, control and take corrective action

Estrella and Gaventa (1998) identify five general purposes for which PM&E is being used in practice:
Impact assessment
Project management and planning
Organisational strengthening or institutional learning
Understanding and negotiating stakeholder perspectives
Public accountability
As indicated above, the primary emphasis in this report is on impact assessment, though PM&E conducted for this purpose can clearly contribute to one or more of the other functions. PM&E for

impact assessment is also referred to as participatory impact monitoring (PIM) or participatory impact assessment (PIA). It can be characterised as 'a process of evaluation of the impacts of development interventions which is carried out under the full or joint control of local communities in partnership with professional practitioners. Community representatives participate in the definition of impact indicators, the collection of data, the analysis of data, the communication of assessment findings, and, especially, in post-assessment actions designed to improve the impact of development interventions in the locality' (Jackson 1995:6).

Who are the 'participants' in participatory M&E? Farmers, field workers, local project managers, international project managers, donors, other actors outside the immediate project frame (mayors, businessmen) are all potential stakeholders in the project and its activities. A participatory approach can be seen as one which involves all these actors as partners. However, each actor will have his or her own view regarding the benefits and costs of participation.

What to monitor and evaluate?

There are many aspects or effects of a participatory technology development project such as the FSP which we may need to monitor and evaluate – some of them immediate, some intermediate, and some longer term. Following Bennett and Rockwell (1995), the more immediate effects are to do with the *process* we are involved in:
Resources (e.g., time and money expended to raise farmers' awareness of forages)
Activities (e.g., awareness-raising activities such as field days and cross-farm visits)
Participation (e.g., involvement of farmers in these activities)
Reactions (e.g., what farmers thought about these activities)

Then there are the *impacts* of the project, that is, the intermediate and longer-term things that happen as a result of the above process:
Knowledge, attitudes, skills, aspirations (e.g., farmers' knowledge about new forage varieties, their attitude to experimenting with these varieties, their skills in establishing and managing forage plots, their aspirations to expand their forage and livestock activities).
Practices (e.g., farmers' adoption and adaptation of forages and forage systems, such as hedgerows of napier grass)
Social, economic, and environmental outcomes (e.g., adoption of napier grass hedgerows may result in more work for men to cut and carry the grass (social outcome), more income from the sale of fatter livestock (economic outcome), and less erosion from the field in which the hedgerows are planted (environmental outcome)).

As Bennett and Rockwell (1995) point out, the further down this list we move the longer it takes for the change to occur, the harder it is to measure the change, and the harder it is to attribute the change to the project. We may have to be content to monitor something higher on the list and use this as indirect evidence of producing a change further down the list. For example, soil erosion and its off-site impacts (such as sedimentation in streams) are very difficult to measure and it may take some time for these impacts to become noticeable. However, we know that hedgerows (even one grass strip) can significantly reduce soil erosion. Hence we may use farmers' *knowledge and skills* regarding hedgerows and the extent to which they actually adopt hedgerows (an observable

farming *practice*) as a way of assessing the reduction in soil erosion (a longer-term environmental *outcome*).

Another, complementary way of looking at the different effects or 'products' of a participatory technology development project is as follows (McAllister 1999; McAllister and Vernooy 1999):
Process – the participatory research approaches used or developed in the project, such as farmer focus groups to identify and rank research needs.
Outputs – the immediate outputs of project activities, such as the number of people trained in forage technologies or participatory research, the number of research reports produced, or the range of new forage technologies developed.
Outcomes – the short-term or intermediate effects of the participatory research process, such as farmers planting forage plots and acquiring more animals (a positive outcome), or reduced food crop production due to the use of land for forages (possibly but not necessarily a negative outcome). Some outcomes (both positive and negative) may have been unexpected when the project began, such as using forages to feed fish in Vietnam, or forage plots harboring rats and snakes in the Philippines.
Impacts – the overall, long-term changes in the project area (positive or negative) which result, at least in part, from the participatory research project, such as reduced poverty, greater gender equity, and improved natural resource management. These are very difficult to measure and attribute to the research process, so to evaluate the project we generally have to focus on the outcomes as intermediate measures of impact.
Reach – the wider, 'ripple' effects induced by the project, such as on the capacity of farmers and local researchers to initiate and implement their own activities and projects to deal with new problems and needs. For example, field workers may use or modify the participatory appraisal methods learned during a forages project to help another group of farmers tackle a completely different problem, e.g., a village water supply problem.

How to develop a monitoring and evaluation plan?

Estrella and Gaventa (1998) outline four major steps in applying PM&E:
Planning or establishing the framework for a PM&E process, including identification of objectives and indicators
Gathering data
Data analysis
Documentation, reporting and sharing of information.

The steps involved in developing a M&E plan are indicated by the following list of questions – an adapted and expanded version of those used by the International Potato Centre (CIP):
What are the project objectives?
Who is potentially affected by these objectives?
What are the M&E questions that follow from these objectives?
Who needs answers to these questions?
What are the best indicators to help us answer these questions?
What are the units in which these indicators are measured?
What are the best methods/tools to obtain this information?
What/who is the source of this information?

When does this information need to be collected and at what scale?
Who is responsible for collecting this information?
How will the information be analysed?
How will the information be utilised?
Who is responsible for collecting, analysing and utilising the information?

Particpatory M&E requires that the development of a M&E plan be itself conducted in a participatory manner. Developing such a plan requires facilitation, using many of the methods and tools listed below. For example, to determine the important M&E questions, it may be necessary to form a focus group (or groups) of the key stakeholders and use PRA techniques to elicit and rank the questions. The context for many of these M&E activities may be regular farmer, village and project meetings; i.e., they need not be special exercises. As far as possible they should be woven into the normal activities of farmers and project staff.

Central to the development of a M&E plan is the identification of appropriate indicators and of procedures to measure them. A good indicator is determined by its
usefulness
ease of collection
the number of stakeholders benefiting from the information it provides.
Usefulness, in turn, is a function of the indicator being:
Valid
Reliable
Relevant
Sensitive
Specific
Cost-effective
Timely
Estrella and Gaventa (1998) use the acronym SMART to refer to indicators which are: specific, measurable, action-oriented, realistic, and time-framed.

What methods can be used for monitoring and evaluation?

There are many different methods and tools which can be used in M&E, described in numerous manuals such as Casley and Kumar (1988) and Mikkelsen (1995). These can help the project's stakeholders to:
establish and clarify project objectives,
identify and rank M&E questions,
develop measurable indicators, and
obtain and communicate the information needed.

It is not very helpful to label these methods and tools as either 'participatory' or 'conventional'. They are merely techniques which may or may not be used in a participatory way. For example, a community mapping exercise may be used to extract population or land-use information for a national planning agency, with no feedback or immediate benefit to the community concerned. Alternatively, a map may be developed as a community resource, retained in a community

meeting room, to help local farmers plan and monitor their own progress in watershed management. Both these uses may have their justification.

It is useful to distinguish between *methods*, that is the overall context or setting in which information is elicited, and *tools*, that is the specific means of eliciting information within that setting. The main methods used in M&E of the FSP have been:
Focus Groups
Farmer Case Studies
Questionnaire Surveys
The main tools used within these methods can be grouped as follows:
Mapping and diagramming tools
Ranking and scoring tools
Wealth ranking tools
Interviews (structured and semi-structured)

These methods and tools can be combined in various ways, depending on the task at hand. For example, mapping is a tool which can be used in a variety of settings:
Mapping can be used in a focus group meeting (e.g., a forage farmers' group) to elicit and record information about the location, extent and species composition of members' forage plots.
Mapping can also be used in a case study to depict the layout of the case study farm and record various attributes of the farm.
Similarly, asking respondents in a questionnaire survey to draw a simple diagram of their farm layout and to record information about each plot (e.g., area, tenure status, crops grown, etc) can be a more 'user-friendly' reliable way to obtain this information than simply asking questions and recording answers in a questionnaire table.

Mapping may also be combined with other tools in a given setting, say a focus group meeting. For example, having constructed a community map, showing the location of households, farms, and community facilities, a wealth-ranking exercise might be conducted in which participants agree on wealth categories and collectively assign each household to a category, the resultant rank then being recorded on the community map.

The use of each of the methods and tools listed above involves three phases:
An elicitation phase, in which information and opinions are expressed and recorded; for example, farmers' knowledge about their local landscape is expressed in the form of a community resource map;
An analysis phase, in which the information is summarised, aggregated, correlated, or otherwise analysed to make it more useful for monitoring and evaluation; for example, the forage plots recorded on the community map may be counted and the number in each sub-village written on the map or in a table or chart, to indicate the extent of forage adoption by location.
A utilisation phase, in which the information is communicated to those who need it to make decisions; for example, a local project team may use the information about number of forage plots by location to evaluate the suitability of the forage species being offered to farmers.

Methods vary according to whether these phases are conducted at one time (e.g., a single meeting of a farmer group) or at separate times (e.g., analysis and utilisation of the information involves some delay);
are conducted in one place (e.g., a community meeting place) or several places (e.g., analysis is conducted in the researcher's office and the information communicated to headquarters);
involve the same people (e.g., farmers and project workers) or several groups (e.g., analysis is conducted by specialist staff and the information is utilised by project managers).
The process of M&E will be more participatory the more the three phases come together. Nevertheless, a given method may serve several purposes at once, e.g. a farmer planning meeting may generate information upon which farmers are able to act but which can also be communicated to project staff at various levels.

Regardless of the methods used, or the degree to which they can be considered participatory, the information generated is inevitably woven into a *story* of some sort which places indicators and other data in context and communicates this information in order to make some point, whether to urge fellow project participants to take corrective action or to persuade donors to continue providing support. More explicit and systematic attention in M&E needs to be given to the stories emerging from participants' experiences and observations (e.g., Davies 1996, Dart 1999).

In any case, for now, this is our story and we're sticking by it!

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Robert Cramb (University of Queensland)

An Operational Framework for Monitoring and Evaluation

The Operational Framework developed by CIP was taken as a model to develop one for the Forages for Smallholders Project. Inputs were obtained from three working groups representing (i) Development Workers, (ii) FSP-Country Coordinators and (iii) Researchers and Project Managers. Results were then combined into one framework that might be applied in the Forage for Smallholders Project (Table 1).

The key to composing the framework was obtaining agreement on a set of M&E Questions (Table 1) against the FSP Outputs/Objectives/Components. In general Indicators and Measures (of indicators) will be set with the participation of farmer focus groups and development workers. In this example they were obtained during a field visit with farmers and development workers at one of the FSP sites.

One condition is that information collected should be able to be recorded by the person who collects it in a form compatible with entry into a computer database. With time we would expect that those who collect data also enter it into the database themselves.

The framework is a guideline and should not be regarded as complete but one that can be adapted for different situations. We would like to retain a common set of M&E questions across the region.

Information to provide answers to some of the M&E questions (e.g.T1 'Which forage systems are being adopted?') can be obtained by Development Workers during their regular visits to project sites. In fact, district extension staff present at the workshop said that they were already obtaining information asked for in T1 but were not recording it in a formal manner.

District and Provincial staff need to regularly monitor progress in dissemination (D1 'Where is dissemination occuring?' and D2 'How is dissemination occurring?') and availability of planting material (M1 'Are forage multiplication systems effective?') and this can be collected in a form that can be entered into a database.

The other M&E questions might best be addressed through an annual survey of representative farmers, and district and provincial officers. Some might best be answered using a case study approach. Again other M&E questions might be considered optional (e.g. T6 'What has been the impact on the farming system?').

When collecting this information it is essential to maintain awareness and disaggregate data for wealth class, gender and ethnic group.

(Peter Kerridge)

See Workshop details for collaborators.

M&E OPERATIONAL FRAMEWORK for FSP Project. Incorporates views of Development Worker, Coordinators and Project Managers

Project objectives	**M&E questions** (common set)	**Indicators** (examples)	**Measures** (examples)	**Methods/ Tools**	**Source of information**	**Timing and scale**	**Who will use**	**Who inter-prets**
1. Develop forage technologies	T1 Which forage systems are being adopted?	- Farmers evaluating - Type of forage system being developed* & species used - Expansion of particular forage system above threshold value e.g. < 200m^2 sward, 100 meters of fence line - How forages are being utilized	- # farmers - Name system, species - # farmers expanding forage systems - When, where, for what and by whom	Field reports by DW - survey	All farmers Focus groups	Information collected during regular visits by DW to each village Summarised in 6-monthly reports	All F, DW,CC,P, PR, D	DW
	T2 Has animal production system been improved?	(Indicators agreed to by focus groups e.g. - Fatter animals - More animals - Stronger draft animal - Fewer deaths - Reduced labor requirement - Less theft - More milk	Measure set by farmers - Score body condition - # calves, adults - area ploughed/day - # dying by class animal - labor hrs to feed animal - # thefts - kg milk produced	Survey Focus groups Case studies	Farmers in focus groups	Annual survey of adopters and non-adopters	F, DW,CC,P, PR, D	CC, P
	T3 What are the environmental effects of introduction of forage systems?	Indicators will vary with forage systems e. - Reduced soil erosion due to establishment of hedgerows - Reduced soil erosion due to use of stoloniferous forages for soil cover - Gully erosion reduced - Improved water quality & stream flow - Increase in soil fertility	-length of hedgerow established (m) - % soil cover - proportion of gullies stablised - farmer observation - higher crop yield	Village maps Combine with data on forage system. Soil, water analyses	Focus groups, DW, Project study	Bi-annual survey of adopters and non-adopters	F, DW, CC, P, Pr, D	CC, P
	T4 What has been the improvement in livelihood?	- Total cash income - Income from sale of livestock products - Funds available for education & health	- farm records - farm records - interview	Survey	Farmers	Annual survey of adopters and nonadopters	DW, CC, P, Pr, D	P. Pr
	T5 How effective has been the process of forage systems development?	- Problems are being solved - Relationship between DW's & farmers - Spontaneous adoption - Benefits to men and women	- question in interview - Feedback to district officer - # new farmers adopting - answered in T1.4	Survey Case study	Farmers	Annual survey	DW, CC, P, Pr, D	P,
	T6 What has been the impact on the farming system?	- Change in use of feed resources over time - Land use change over time - Productivity increasing or decreasing	- Type of feed system used - change in area used for different enterprises - District records	Case study Mapping	Farmers, District office	Bi-annual survey	DW, CC, P, Pr, D	P

Project objectives	M&E questions (common set)	Indicators (examples)	Measures (examples)	Methods/ Tools	Source of information	Timing and scale	Who will use	Who interprets
2. Increased dissemination of forages	D1 Where is dissemination occurring?	- New villages and districts where forages are being evaluated	- names of villages and districts and # farmers evaluating	DW reports	District	6-monthly	P, Pr	P, Pr
	D2 How is dissemination occurring?	- Strategy for dissemination - Number and names of development workers involved - Number of farmer-to-farmer visits	- strategy paper accepted at provincial level - schematic plan of who is involved in dissemination - record of F-to-F visits	- Paper - District data - District data	P, Pr - DW reports - DW reports	- Annually update - 6-monthly - 6-monthly	- P, Pr -P, Pr - D, P, Pr	- CC, P, Pr - Pr, CC
	D3 Is the approach for disseminating forage systems effective?	- High activity in dissemination (evaluation & adoption)	- Demand for planting material - Information on forages and forage systems available to DW's and F's. - *Interviews with F, DW*	- Survey - survey	F, DW	- Annually	- DW, P, Pr	P
3. Increased capacity at all levels	C1 How effective has been the training in FPR and forage agronomy?	- Capacity in PA improved	- # of persons trained in PA - improved skills in PA - increased ability to use skills	-self-evaluation - Reg. Coord. Report	F, DW, CC, P	Annual	CC, P, D	CC. P
		- Capacity in forage agronomy improved	- # of persons trained - farmers receiving information			Annual		
	C2 Has the participatory process been institutionalized?	- Provincial policy for supporting PA - Recognition of role of PA by supervisors - Demand driven R&D	- Prov. policy paper - resource allocation for PA - refresher training -% staff using PA - Attitude, rewards for DW - use of F-to-F extension - # projects adopting PA	Self-assessment	D, Pr officers DW, supervisor			
	C3 Has capacity among farmers been improved?	- Farmers receiving training - Farmers forming interest groups to provide mutual support - Farmer needs have been met - Farmer extension workers	- # farmers - Number of interest groups - survey # extension workers	*Field reports by* DW's -survey	DW's	6-monthly summary annual survey	D, P, Pr	D & Pr officers
4. Improved availability of planting material/seed	M1 Are forage multiplication systems effective?	- Farmer managed forage nurseries - Profitability of multiplication systems - Adequate supplies of seed and cuttings	- # multiplication nurseries - profit earned - amount of material distributed/sold - Surplus material/seed available	-Field reports of DW's - Survey	F, DW	Annual survey	D, P, Pr	Provincial officer, CC

T1, D1, D2 and M1 collected on regular farm visits by DW's.

Farmer (F), Development Worker (DW), Coordinator/Manager (CC), Province (Pr), Project or Researcher (P), Donor (D)

2002 Methodology for scaling up technologies developed using FPR

Milestone 2000: Workshop on scaling-up

A contribution was made to a workshop on scaling-up organized by IIRR in the Philippines. The issue of scaling-up will also be addressed at the Regional Meeting of the Forages for Smallholders Project (FSP) to be held in Indonesia in January 2001. The following is a reflection on the scaling-up process in the FSP.

Scaling up and out - dissemination

There are several aspects to 'scale'. Many scientists are interested in relationships between properties or processes from the plot, to farm, district, regional and agroecosystem scales. Those of us involved in technology development are interested in scaling up and scaling out to increase adoption. While a lot of attention has been paid to the use of tools, such as GIS, to enable scale comparisons within similar environments, there are also other elements that are important in scaling up and scaling out of agricultural technologies. These include:
having 'robust' options
the ability to readily multiply varietal material
trained personnel with support of their organization
institutional and policy elements that create the right incentives for extension workers and farmers
focus sites appropriately situated, geographically and institutionally.

With respect to scaling up in the FSP, the first two elements have largely been achieved. The recommended grass and legume options are widely adapted over different climatic and soil conditions. Most of the species selected can be multiplied at local levels, either by vegetative multiplication or through seed production though local seed production systems are still being devised. The training element needs to increased and much more attention needs to be devoted to institutional and policy elements. We have begun to involve staff at different administrative levels in government organizations in planning, training and assessment. Human resources are critical. i.e. trained and motivated extensionists, researchers and administrators who make decisions and financial resources available.

There is also another element that needs to be given more attention in the future when choosing a focus site and partners for developing a new technology. The site and persons should be appropriately situated, geographically and institutionally, for participating in scaling up and dissemination. The early phase in developing forage technologies involved having local 'champions'. This worked well while we were focusing on evaluation of species and initial evaluation of forage options by farmers. However in the present phase of scaling out there is a need to involve a wider range of participants. The early champions should become facilitators - involving other development workers in the process, organizing farmer-to-farmer exchange and ensuring planting material is available. Are our champions in the right position to have influence on decision makers? In some cases yes and in other cases no. A champion at the district level can have a major impact on the district but is not in a position of authority where he/she can move freely in other districts. That is, the project will have to take a proactive role in scaling up in such

a situation. On the other hand, if a champion is situated at the provincial level, he/she is in a position to move freely across the province. The need for outside input into scaling up is reduced.

Again are persons willing to devolve responsibility? Indeed we have found that persons with leadership capacity, often from universities, have been able to devolve responsibility to provincial agriculture departments and provide initial training and support to extension workers.

We are finding that we have been effective at developing capacity at an individual or personal level but less effective in developing capacity at an institutional level. Capacity at an institutional level is necessary for scaling-up to be effective.

(Peter Kerridge, Ralph Roothaert)

2001 Decision guides available for new technologies

Milestones 2000: Manuals on forage species and forage management.

Highlights:
Manual on forage species completed and published in English
Drafts of forage species manual completed in Lao, Thai, Chinese, Indonesian and Vietnamese
Final draft of manual on management of forages completed and submitted to publisher for pre-press work

The first booklet in this series was published in English in May 2000.
(Horne, P.M. and W.W. Stür (2000). Developing forage technologies with smallholder farmers – how to select the best varieties to offer farmers. ACIAR Monograph No. 62. 80pp. (ACIAR, Canberra)) was published in English in May 2000.
Translations of the English version into Lao Thai, Chinese, Indonesian and Vietnamese have been completed and are with the publisher.

The second booklet has now been finalised and is with the publisher for pre-press work.
Translations will be completed by December.
(Stür, W.W. and P.M. Horne (in press). Developing forage technologies with smallholder farmers – how to grow manage and use forages. ACIAR Monograph No. XX.).

The third booklet will be completed in January 2001.
(Horne P.M. and W.W Stür. (in preparation). Developing agricultural solutions with smallholder farmers – participatory approaches for getting it right the first time. ACIAR Monograph No. XX)

(Werner Stür and Peter Horne)

Output 4. Increased effectiveness of CIAT and partners to conduct appropriate research for developing productive and sustainable land use practices

2000 Effective coordination of systems oriented research

Milestone 2000: Coordination in Asia

Highlights:
Two new Special Projects have been initiated in the area of Forage Systems
A regional office is being set up in Vientiane, Lao PDR.
Contacts have been made with regional donor offices

Peter Kerridge terminated as Project Manager PE-5 in December 1999 and was relocated to Asia. Responsibilities are to coordinate PE-5 activities in Asia, establish a regional office, and seek opportunities for linkages between HQ-based projects that would extend research outputs from Central and South America to Asia.

Coordination of PE-5 activities in Asia.:

Activities have included:

Initiating the new ADB-funded Phase II of the Forages for Smallholders Project (FSP) with the newly appointed Regional Coordinator for the FSP, Ralph Roothaert.
Obtaining Letters of Understanding to operate in the six countries, P.R. China, Indonesia, Lao PDR, Philippines, Thailand and Vietnam.
Writing a proposal for and finalizing a contract with AusAID for a Forages and Livestock Systems Project (FLSP) in Lao PDR.
Recruiting a Team Leader for the FLSP.
Providing support to the CBNRM project in Vietnam.
Assisting in the organization of regional workshops

- PRGA workshop on 'Incorporation of Gender Issues and Stakeholder Analysis in the Project Cycle' in Hanoi, Vietnam, April, 2000
- Developing a Monitoring and Evaluation Framework', in Cagayan de Oro, Philippines, August 2000.

Reviewing progress in the project 'Integrated Cassava-based Cropping Systems in Asia: Farming Practices to Enhance Sustainability'.
Liaison with the PRGA Regional Coordinator for Asia.

Regional Office:
The CIAT regional office was initially located at IRRI, Los Banos, Philippines, while the permanent site for the regional office was determined. CIAT policy is to locate offices within national programs where possible so as to ensure close contact with national priorities and to provide support in institutional capacity building.

An initial approach was made to locate the office within the Ministry of Agriculture and Rural Development in Hanoi, Vietnam. A formal letter was sent to the Minister MARD from the DG of CIAT in October 1999. However, following a couple of more visits to the Ministry, there had been no formal response action by the Vietnamese authorities by July 2000. Hence it was decided to look for an alternative site for the regional office. IARC's which operate in Vietnam do so under specific projects rather than just as an institution. Thus though CIP has signed an MOU and obtained agreement on implementation of the MOU, a permit to set up a Regional Office has not been granted. IRRI and IFPRI have offices within MARD but operate under the guise of special projects.

A visit was made to Lao PDR with the Director-General in late July and a Letter of Intent to sign a Memorandum of Understanding and establish a Regional Office in Vientiane was signed with the Minister of Agriculture. Peter Kerridge transferred to Vientiane in late September. A draft MOU is still under consideration by the Lao authorities but they have granted a residence permit and multi-entry visa for the Regional Coordinator. Agreement on an MOU to operate a Regional Office s expected by the end of 2000. CIAT proposes to set up its Regional Office within the National Agriculture and Forestry Research Institute (NAFRI).

Linkages with other CIAT-HQ Projects:
CIAT strategy in Asia is to (i) continue systems-oriented research on upland systems where cassava and forages are grown, with a view to developing generic technologies, and (ii) to undertake systems research at the watershed level in upland areas with a focus on improving management of natural resources. In the mountainous areas of Lao PDR and Vietnam and upland areas in Cambodia these NRM problems are largely associated with shifting agriculture. There is also the associated problem of poverty which needs to be addressed concurrently.

There is a good opportunity to link with the Hillsides Project in Central America. A start was made with instruction of the Decision Support Tool on Stakeholder Analysis at the Workshop in Hanoi. It is planned to introduce, evaluate and modify these DS tools for Asia. There are other opportunities to link with the Land Use, Soils, Agribusiness and Participatory Research CIAT-HQ Projects as new projects commence in Asia.

Initially we will link our NRM research in Lao PDR with the Integrated Upland Agriculture Research Project (IUARP) led by NAFRI and supported by the Lao-IRRI project funded by SDC. Research will continue in Vietnam with the University of Hue under the IDRC-funded CBNRM project. CIRAD have expressed interest in close collaboration in production systems research in Indochina.

The key will be to obtain funding to support more research personnel. We would like to have more capacity in areas of Resource economics, Rural sociology/anthropology, Soils and Land Use and Smallholder Agribusiness. Initial inquiries have suggested support for

adapting the DS tools developed for Central America, and research on the process of adoption of new technologies.

Linkages are also being made with the Germplasm Projects. A proposal is being developed for a Cassava Improvement and Biotechnology Network in association with the Cassava Improvement Project (IP3). Beans in Africa (IP2) are providing germplasm for an ACIAR-supported project in East Timor.

(Peter Kerridge)

2000 A multi-institutional and participatory approach to R&D accepted by NARS in Pucallpa and operational at Hue, Vietnam

Milestones 2000. Supporting Community Based NRM research, Bo River watershed, Vietnam.

CIAT was invited by IDRC and the University of Hue to collaborate in a project on community management of natural resources through providing improved germplasm, technical input, and training and advice in problem diagnosis, setting research priorities, interpreting data and reviewing research.

:

Specific inputs by CIAT in 2000 have been:

Reviewing the research in 1999-2000 and planning research for 2000-2001.
Providing input into varietial evaluation and soil management for cassava.
Initiating and assisting in a meeting of stakeholders to discuss co-management of the forest resource.
Introduction and training in a farming systems model
Support for obtaining a land use map for the project area

The University of Hue team completed characterization studies on the impact of national program on the community and on indigenous knowledge associated with shifting agriculture. Interventions have continued with improving crop and livestock production. These are reported elsewhere. The efforts of scientists from different departments in the University are now well coordinated by the Hue Team Leader. Stronger linkages could be made with other project groups working in community management of resources in Vietnam and integrating efforts from other individuals and projects within the University of Hue. There is opportunity for this to occur in the design for the Phase II of the project which is being prepared.

This collaborative experience in community-based natural resource management has provided CIAT with knowledge and ideas for extending this type of research to other areas. CIAT has good experience in research in upland agronomy in Asia. It has also been demonstrated that it can bring in specialist skills in participatory approaches in research, in agro-enterprise development, and resource economics to complement the knowledge we have in the region.

Le Van An (Team leader, University of Hue) P. Kerridge, R. Howeler, D. White (CIAT).

2000 Functional partnerships – Tropileche, DEPAM, FSP, Cassava R&D network, Univ. Hue

Milestone 2000: Coordination of Forage for Smallholders Project

Highlights:
Effective coordination has been achieved through a combination of regular visits, attendance at regional workshops and e-mail connection

The FSP phase II commenced with an Inception Meeting in the Philippines in February 2000, which most country coordinators and key implementers of the project attended. The inputs needed to meet the objectives and expected outputs of the project were discussed, country workplans developed and research contracts made with each site manager.

Most coordinators also attended two regional meetings. The first was in Hanoi in April on 'Integrating Gender Analysis and Stakeholder Analysis into the Project Cycle'. The second was on Developing Guidelines for Monitoring and Evaluation of Forage Research and Development Projects in SE Asia'. These meetings also provided opportunity to review workplans.

Visits were made to all sites on at least one occasion:

China by Peter Kerridge in June and by Peter Kerridge and Ralph Roothaert in September.
Indonesia by Ralph Roothaert in February and June and Peter Kerridge in October.
Lao PDR by Peter Kerridge in February, April and July, and by Ralph Roothaert in October.
Philippines (Mindanao) by Ralph Roothaert in May and July.
Thailand by Ralph Roothaert and Peter Kerridge in April.
Vietnam by Ralph Roothaert and Peter Kerridge in March and August, and Peter Kerridge in June and October.

Arrangements were made to ensure that all country coordinators are connected with local internet providers so that contact can be made through email. A SEAFRAD newsletter was produced with articles contributed from various countries.

(Ralph Roothaert)

Milestone 2000: *Maintain an active Asian Cassava Research Network*

Higlights:
6th Regional workshop held of the Asian Cassava Research Network

Rationale: Cassava programs in national research institutions in Asia are often small and have limited budgets for research. By exchanging cassava germplasm and

information, and by coordinating research, the efficiency of these programs can be markedly improved.

Methods: The Asian Cassava Research Network, established in 1984, has stimulated inter-country and inter-institutional collaboration and exchange of ideas through regional cassava workshops held every three years. The site for the workshops rotates among the five major cassava producing countries in Asia so that every country has a chance to host the Workshop and show their work, while members of the network have a chance to see cassava research and production in different countries. This often stimulates new ideas and new approaches. The 6th Regional Workshop was held in Ho Chi Minh city, Vietnam from Feb 21-26, 2000.

Outputs: The 6th Regional Workshop in Ho Chi Minh city had 78 participants from Japan (1), Thailand (16), China (7), Philippines (4), Malaysia (1), Indonesia (6), India (4), Vietnam (34), Colombia (4) and Venezuela (1). The Workshop was financed mainly by the Nippon Foundation in Japan with some contribution from the Vedan Starch Factory in Vietnam and the Thai Tapioca Development Institute. The 44 papers presented at the workshop summarized research on cassava breeding and agronomy conducted in each of the seven Asian countries over the past 15-25 years, farmer participatory research conducted in four countries over the past six years, new products and innovative uses of cassava, and an overview of cassava production and use in each country with an analysis of its future potential and the research strategies necessary to attain that potential. There were field visits to Hung Loc Agric. Research Center and surrounding cassava growing communities, and to the Vedan Starch Factory in Binh Phuoc province. Papers will be published in a Workshop Proceedings.

Analysis of status of the Asian Cassava Research Network: Funding and facilitation of the Network has depended on financial and personal input from CIAT. Last year funds came from the NIPPON Foundation Special Project. This is not an ideal as the main aim of the Special Project is dissemination of results to farmers and not maintenance of a research network. We are in the process of seeking funds for a local coordinator for a Regional Cassava Improvement and Biotechnology Network which might be associated with a new ASEAN Working Group on cassava.

(Reinhardt Howeler)

2002 New materials and training approaches for NRM-related research

Asia

Activity milestone 2000: *Partners in national programs and pilot sites trained in participatory technology development and dissemination*

Main achievements:
Regional courses held on:

- "Analyzing Gender and Interest Groups in Agricultural and Natural Resources Management Research"
- " Developing a framework for Monitoring and Evaluation of technologies developed through participatory research"

In -country courses

- 60 researchers and extensionists working on cassava in Vietnam and Thailand attended refresher courses in farmer participatory research and extension.
- Local extensionists and key farmers from each pilot site in the cassava project in Vietnam and Thailand were trained in participatory technology development and in the setting up of community-based organizations to improve local management of natural resources.
- Courses in participatory research and forage agronomy were held for technicians in Indonesia, Philippines, and Vietnam
- Training courses in forage management were held for farmers in all countries

Training Manual on FPR completed

Introduction: Training efforts in participatory research are coordinated where possible between the various special projects in Asia, the NIPPON-funded Improved Cassava Management project, the ADB-funded Forage for Smallholders Project and the AusAID-funded Forage and Livestock Systems Project, and the Participatory Research and Gender Analysis Program. In particular, this applies to development and introduction of new methods and approaches and the training of trainers on a regional basis. There is also some collaboration on in-country courses. CIAT has collaborated closely with CIP in training in various aspects of participatory research.

Training-General: Participatory Research

"Analyzing Gender and Interest Groups in Agricultural and NRM Research"
Hanoi, Vietnam. March 20 - 25, 2000

There were 30 participants associated with CIAT and CIP projects in Indonesia, Lao PDR, Philippines, Thailand, and Vietnam. The objectives of the workshop were how to:
Incorporate a gender and equity strategy into the process of the farmer participatory research
Take account of multiple interests in natural resources management.

The stages in the project cycle, namely, Design, Planning, Implementation and Impact, were used as the basis for learning how to incorporate a gender strategy into a project. The first stage involves an analysis of gender, the second incorporating this knowledge into the design to ensure that women and children as well as men received benefits from the project, the third monitoring to provide feedback on the process and the third to evaluate impact.

Stakeholder analysis was taught using a case study of conflicts in water usage in a watershed.

It has been observed that staff involved in CIAT projects are now taking the issue of gender into account, in particular, during the participatory diagnosis process and planning activities.

Facilitators: Dai Peters (CIP - Hanoi); Peter Kerridge, Ralph Roothaert Olaf Westermann (CIAT); Barun Gurung, Jeanette Gurung PRGA-Nepal

Training-General: "Developing a Framework for Monitoring and Evaluation of technologies developed through participatory research"
Cagayan de Oro, Philippines. 14-18 August 2000

There were 24 participants, including presenters, researchers and field technicians from the Forages for Smallholders Project (FSP) sites in Indonesia, Lao PDR, Philippines, PR China, Thailand and Vietnam. The objectives of the workshop were:
To develop a framework and guidelines for undertaking M&E.
To strengthen participants' capacities to plan and implement M&E.

The specific content of the workshop included:
Sharing information and experiences from the ACIAR and FSP M&E studies.
Exploring concepts and methods for M&E, with particular emphasis on participatory approaches (PM&E).
Discussion on a framework for M&E in research projects such as the FSP.
Integrating M&E into the project cycle.
Using PM&E to motivate and create a clearer vision for farmers, technicians and supervisors.
Obtaining field experience in carrying out PM&E.

The workshop program was:
Day 1 – Experiences from M&E studies associated with FSP
Day 2 – Building a conceptual framework for M&E
Day 3 – Field exercises in FSP sites in Cagayan de Oro
Day 4 – Reporting on field exercises; developing operational frameworks for M&E
Day 5 – Refinement of operational frameworks; wrap-up

Workshop outputs have been summarized under Output 3 'Models/frameworks developed to target research, integrate results, assess impact and extrapolate results'.

Participants: Robert Cramb, Tim Purcell (University of Queensland); Dindo Campilan (CIP); Karen McAllister, Stephen Morin (IRRI); Doug Gray (ILRI); Barun Gurung (PRGA); Peter Horne, Rienhardt Howeler, Peter Kerridge, Ralph Roothaert, Werner Stur (CIAT); FSP Partners: Ibrahim, Munief Muchsinin (Indonesia); Phonepaseuth Phengsavanh, Hongthong Phimmasan, Linkham Douangasavanh (Lao PDR); Yi Kexian (P.R. China); Perla Asis, Francisco Gabunada, Edeudo Magboo, Willie Nacalaban (Philippines); Supachai Udchachnon, Wilawan Vongkasem (Thailand); Le Van An, Bui Xuan An (Vietnam).

Training - Cassava

To extend the work to many sites requires training of additional researchers and extensionists to help farmers conduct the trials, as well as training of local extensionists and key farmers that may help others in the community and surrounding areas to experiment with or adopt effective cassava production practices that will increase yield and income and protect the environment.

One-week training courses in FPR and FPE methodologies were held for researchers and extensionists in Vietnam and Thailand during Jan 10-15 and Jan 17-22, 2000, respectively. The course in Vietnam, held in Ho Chi Minh city, had 29 participants, mainly researchers and officials from provincial extension offices in south Vietnam. The course was taught by five Vietnamese resource persons (including two from the FSP project), as well as resource persons from CIAT-Cali, CIP-Vietnam and CIAT-Bangkok. A training manual in FPR methodologies (in Vietnamese) was prepared for this course by the Vietnam project coordinator.

The course in Thailand, held in Prachinburi, had 30 participants, mainly researchers and extensionists from DOA and DOAE, as well as provincial and district-level extensionists. The course was taught by four Thai resource persons as well as from CIAT-Cali, Care-Laos and CIAT-Bangkok. A training manual (in Thai) was prepared for this course by the resource persons from DOAE.

Five day training courses in FPR and FPE methodologies were also held for the local (subdistrict-level) extensionist and two key farmers from each pilot site in Vietnam and Thailand during June 5-9 and Oct 2-6, 2000, respectively. The course in Vietnam, held in Thai Nguyen city in north Vietnam, had 33 participants and was taught by four Vietnamese resource persons from Thai Nguyen Univ. and the National Inst. of Soil and Fertilizers (NISF). The course consisted of three days of lectures and field practices and two field trips.

The course in Thailand, held at the TTDI Research and Training Center in Nakorn Ratchasima, had 58 participants and was taught by four Thai resource persons and one from CIAT-Bangkok. The course consisted of three days of lectures and field practices

and a one-day field trip. The emphasis in this course was on the basic principles and some tools in participatory technology development and on practical aspects of conducting FPR trials, setting out contour lines and planting contour hedgerows of vetiver or other grasses. Farmers were very enthusiastic about the training course and the participatory approach used in the project.

Training: Forages

Vietnam

M'Drak. Six cross visits were organized involving 200 new farmers who visited farmers at the focus sites. One hundred and thirty-eight farmers in 7 villages were trained in forage management, and practiced sowing of forages. A booklet was developed for farmers about management and utilization of 4 forage species, and was distributed to 200 farmers. Another training course for 30 farmers was conducted on livestock management and nutrition. A training course on "Developing forage technologies with farmers" was conducted in M'Drak for 17 technicians, researchers and extension workers, in June 2000.

Tuyen Quang. Three extension workers were trained in forage husbandry. Seventeen people from the province, districts and communes were trained in communication, participatory diagnosis and forage technologies in July 2000.

Thua Thien Hue. Farmers were trained in the use of legume trees as supplementary feed.

Indonesia

A 2-weeks course on forage agronomy, management and participatory research was held at Samarinda from 20-29 June 2000, for 15 extension workers from East Kalimantan.

Philippines

Bukidnon. A training course on forage agronomy, management and participatory research was conducted for 25 technicians, officials and scientists at Malaybalay, in July 2000.

Cagayan de Oro. Four informal training activities were organized involving 88 farmers. They were trained in forage technologies and animal nutrition.

A training course on Gender Analysis is planned for November.

Laos

Training sessions on participatory diagnosis were conducted in Luangphabang and Xiengkhuang where 7 district staff attended.

Thailand

Informal training on forage establishment, management and utilization was conducted for 10 farmers participating in the evaluation of new grasses varieties. A training course is planned for November.

(Ralph Roothaert)

Training Manual:

The first iteration of a training manual on approaches for applying PR in SE Asia was developed in 1995 with assistance from CIAT. In 1996 and 1997 another training manual was developed on Forage Agronomy. With experience we realised that these two issues could not be separated, so we worked to combine the manuals into one training course. This was completed in 1998. Subsequent testing of the manual has resulted in revisions and the release of the final version as:

Stür, W.W. and P.M. Horne. (2000). Developing Forage Technologies with Farmers – A Training Manual. Forages for Smallholders Project, Los Baños, Philippines.

(Werner Stür and Peter Horne)

2000 Effective communication of results

Milestones 2000 - Asia

Regional workshops

Asian Cassava Research Network:
Sixth Regional Workshop, Asian Cassava Research Network, Ho Chi Minh city, Vietnam Feb 21-26, 2000 (see Partnerships above)

Forages for Smallholders Project:
An Inception Workshop was held in Los Banos, Philippines in February 2000 (see Output 2 for details).

Newsletters:

A SEAFRAD newsletter was published by Vietnam in June 2000 and distributed to all countries.

Publications: **See section on Publications**

Facilitate multi-institutional research at the watershed level for R&D (SN-1, SN-3)

Milestone 2000: Facilitating inter-center collaboration in the forest margins, Pucallpa

Title
Multi-institutional research in the Aguaytia watershed – DEPAM in Pucallpa, Peru

Highlights
- DEPAM has created an awareness of and skills in participatory research, and a strong demand for multi-institutional and participatory research among a group of 20 Pucallpa-based researchers, coupled with an increased ability on the part of researchers to analyze and improve collaborations within projects. Interested researchers are independently working to mainstream participatory and multi-institutional approaches.
- The externally-imposed management committees of DEPAM have not been active, and have been unsuccessful in promoting multi-institutional and participatory research.

Purpose
To test processes for developing a multi-institutional and participatory research model involving international and national research centers in Pucallpa, Peru.

Rationale
Researchers from 10 institutions in Pucallpa have identified a lack of inter-center collaboration as a key constraint to research success in four meetings in 1998, 1999 and 2000. Staff are highly transient: the research directors of 8 of the 11 local research institutions have changed in the last 18 months, and field-level researchers have a half-life within projects of just 10 months.
In response, CIAT catalyzed a multi-institutional and demand-driven approach to research in Pucallpa in two complementary ways: through taking the role of lead agency in direct coordination with local institutions, and through collaborative assistance to the locally-owned project DEPAM (Participatory Development in the Amazon), the focus of this activity.

Methods
DEPAM provides a vehicle for influencing the following levels of activity relating to agriculture:

1 **Farmer Capacity and Control**	2 **Researcher Professional Development**	3 **Improving Research Design and Implementation**	4 **Organizational Space**
• Supporting the development of farmer organizations • Awareness-raising of technologies, resources and institutions available • Linking farmers around needs and resources	• Tools for Participation • Processes for Evaluation • Helping people to do participation, and to know *if it* has worked • Bringing a gender focus • Bringing a community focus	• Support in participatory project design and implementation • Putting participation in the picture	Creating space to institutionalize participatory and multi-disciplinary research

The approaches at all levels are similar: to open spaces for action, critical reflection, and deliberate learning strategies based on experience. DEPAM currently focuses its systematic activities on levels 2, 3, and 4, but all levels are closely linked in practice.
For professional development in 1999-2000, CIAT facilitated a four-part experience-based course in farmer participatory research approaches, with 22 local agricultural researchers and extension agents between August 1999 and March 2000. Following demand from research directors, a parallel course was held for research directors, and the two courses shared a joint workshop in October 1999 to analyze the impact and limitations of DEPAM.
CIAT has provided continual field level support and mentoring to DEPAM projects through staff in Pucallpa. The focus of CIAT's involvement in the year 2000 has shifted away from the structure of DEPAM to the individual researchers.

The effects of these interventions alone and in combination form the basis of action research into strategies for sharing multi-institutional and participatory approaches in Eco-Regional sites.

Outputs
The intended structure of DEPAM was not realized. The members of the farmers' committee (Comité Directivo; meant to oversee the development and execution of DEPAM projects) say that they have been excluded from all decisions in the process, and that they do not represent the farmers of the DEPAM sub-projects. Similarly, the Comité Directivo of research directors last met in April 1999, and has not played any role in the project since this time.

The individual participatory research sub-projects that form the focus of DEPAM are detailed under activity 2.1. These sub-projects have mostly finished. Participating research and extension staff identified that levels of farmer participation in these DEPAM sub-projects were low, and named the key constraints to following participatory and multi-institutional approaches as:

- Lack of institutional freedom (permission, time and resources) to follow participatory approaches within DEPAM projects
- Lack of farmer diagnoses at the start of DEPAM projects; projects came from institutional meetings
- Lack of knowledge about participatory research
- Inequality among institutions, stemming from the planning of DEPAM projects principally within one institution.

Research directors independently confirmed these findings: all those who participated in the participatory research course did not want farmers or researchers to have more control over research directions (figure 1 gives an example from one research director of a local institution). Research directors largely did not understand the implications of

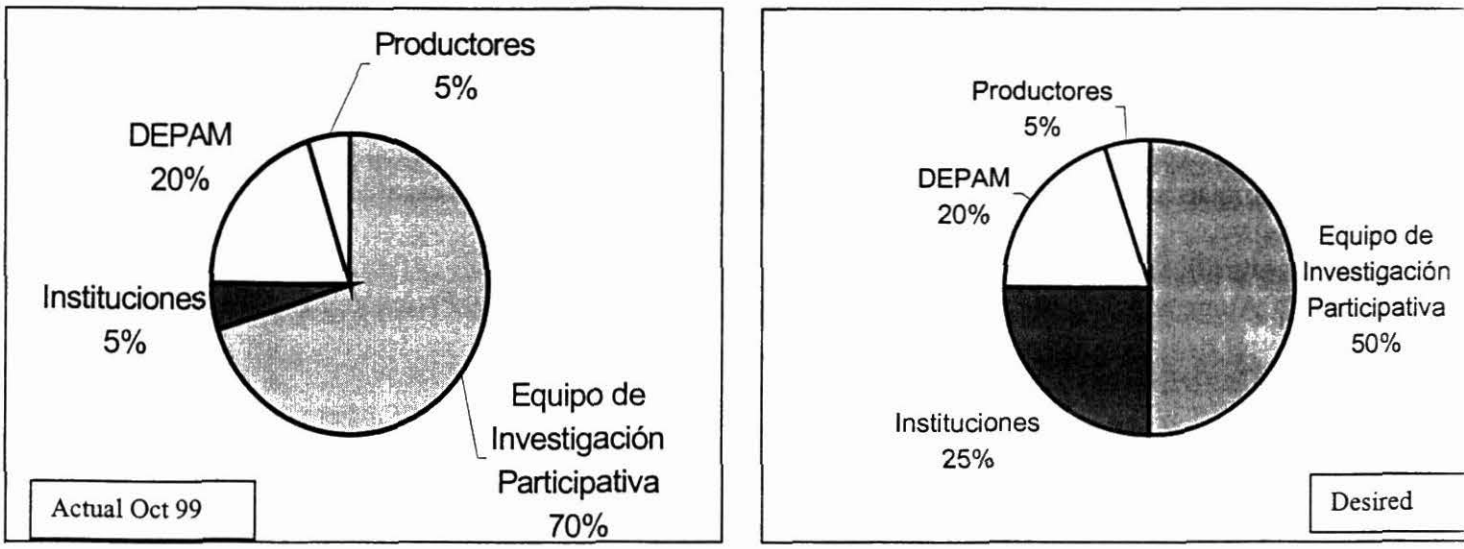

Figure 1. Control of Decision-Making in IIAP for DEPAM Projects, according to then director of IIAP. Left-hand diagram represents actual division of decisions, right-hand diagram is the directors' view of the ideal division of decisions. Farmers have 5% of the decisions in both diagrams.

participatory research when agreeing to it at the start of DEPAM. They highlighted their difficulties to supporting multi-institutional and participatory research as:

- Creating political support for participatory research
- Gaining flexibility in institutional structure (e.g. financial)
- Lack of incentives for researchers to carry out participatory research.

Results show that field-level researchers and research directors had differing understandings of DEPAM projects.

In addition, DEPAM project research staff showed a very high turnover, with an average researcher half-life within projects of 10 months. Of the 17 non-CIAT participants in the participatory research course of October 1998 for DEPAM researchers, only 4 were still actively involved in DEPAM projects at the end of these projects (July 2000).

Impact

Researchers and research directors are aware of participatory research, and a strong demand for participatory research has been generated in a core group of 20 researchers; 12 of these researchers are giving their own time in addition to work time to bring participatory and multi-disciplinary research into the mainstream in Pucallpa, and are taking responsibility for their own reflective learning to do this.

Researchers have analyzed and improved their mechanisms of coordination among institutions and across disciplines in the DEPAM sub-projects, and some of these collaborations endure beyond the life of the DEPAM projects.

The externally-designed intended structure to DEPAM, with key committees of farmers and researchers supporting a broad multi-institutional research team, has not been successful. However, many of the goals of this structure (increasing farmer participation in research, creating desire for and experience of collaborative research) have been maintained through other, less formal structures among individual researchers.

The DEPAM sub-projects have provided the intended entry-point for raising awareness and experience in participatory research. However, they have not had their intended impact as a showcase for multi-institutional and participatory research.

Publication (under review)

Allan, S., and Holland D., *Sneaking Reflection into Research Practice*, PLA Notes

Contributors

CIAT projects PE-5, PE-4, IP-1, SN-1, SN-3, inter-center project Participatory Research and Gender Analysis

Dean Holland, Coralí Silva, Peter Kerridge, Douglas White, Glenn Hyman, Carlos Ostertag, Mark Lundy, Ann Braun, Maria Fernandez, Simon Carter (IDRC), Daniel Selener (IIRR)

Facilitate a policy enabling environment that ensures adoption of appropriate policies and technologies

Milestone: Institutionalizing a participatory and collaborative research approach in Pucallpa, Peru

Highlights

Development and facilitation of the action-research "learning project", a new participatory strategy to sharing and institutionalizing participatory research approaches. The project is similar to a CIAL, but the participants are local agricultural researchers, not farmers, and the technologies that they develop are tools and approaches for participatory research and its institutionalization. 12 researchers from 8 local research and extension institutions own, manage, and facilitate the project, giving both their own time and their work time. Together they are designing and conducting a participatory technology development project with farmers, and reflecting and learning both on this project, and also on how they work together as a group. Participants report a major impact on their work within their institutions, but so far, limited impact in affecting other researchers within their institutions.

Purpose

To test a participatory strategy for both experience-based training of researchers and also institutionalization of farmer participatory research approaches among agricultural research institutions in Pucallpa, Peru.

Rationale

The project DEPAM aimed to institutionalize farmer-participatory and collaborative research approaches. The key obstacle limiting the impact of the project was identified by participating researchers as a lack of institutional space (freedom, time, and resources) to follow participatory approaches in the field. Their research directors independently confirmed this, saying that they did not want to give more freedom to farmers or to their researchers. Thus local researchers had little power over their research projects to give to farmers. Researchers identified a secondary limitation as a lack of skills and experience in participatory research.

The learning project was an action-research response to these obstacles, growing out of the training activities in DEPAM.

Methods

The "learning project" is a long-term action-research activity that is owned and managed by twelve researchers and extension agents from eight institutions in Pucallpa, Peru. Their self-established goal is to learn about and develop locally-appropriate strategies and tools for participatory research, and they have chosen to do this by carrying out together a farmer-participatory research project. The learning project approach is similar to a CIAL but for researchers and extension agents, not for farmers, and the technologies that they develop are not farming technologies, but approaches and tools for participatory research. Each participant has the responsibility to create the space within their institution to carry out participatory work, and this provides a bottom-up vehicle for institutionalisation of participatory approaches. Box 1 outlines the principles on which the learning project was originally conceived.

The learning project developed out of a 7-day workshop on participatory research approaches, and still continues one year after the workshop. In order to hand control of the workshop to

Box 1. Principles of the learning project

- It is a pure "process" intervention, with no initial structure such as leaders, reporting obligations, or fixed meetings.
- The participants have complete control over the resources, and so set the timeframe, and the learning activities and style.
- Participants are accountable only to each other, in order to create a "safe", reflective space, separate from institutional hierarchies and obligations.
- Participation is the responsibility of individuals, not institutions. Participants must negotiate their own space within their institutions to participate.
- The only obligation imposed on participants is to reflect on their activities with farmers, and on the dynamics of the group of participants themselves.

participants, the budget component for field activities (US$2000) was given to the participants for them to learn about participatory research however they wished. The participants thus have complete freedom to set their learning goals, timeframe, learning activities and style (they discussed ideas such as living with farmers, buying books, creating a network of researchers to share experiences, and trying out new activities within their existing research projects, before settling on a principal activity, which would be to start a new participatory research project together). It is a pure "process" intervention, with no initial structure such as leaders, reporting obligations or fixed meetings. Participants are accountable only to each other, in order to create a "safe", reflective space, separate from institutional hierarchies and obligations. Participation is the responsibility of each individual, not of institutions. Participants must negotiate their own space within their institutions to participate.

The only obligation imposed on participants is to reflect on their activities with farmers and on the dynamics of the group of participants themselves. This provides two resources for learning:

1. The topics studied and tried in the field
2. The dynamics of the group itself in working and learning together

Our hypothesis is that the second resource would be a powerful synergist with the first: experience at being on the "receiving" end of a participatory research project will open up more insights and more opportunities for deliberate learning than field-based action alone. It aims to introduce reflection about the processes of working with farmers, and not just about the products.

The project has currently settled into a format with a meeting roughly every two weeks with all participants (there have been 25 meetings between the inception of the project in October 1999, and the date of writing, October 2000), farmer-participatory activities between some of the meetings (to date there have been six field activities), and a workshop in October 2000. In the meetings, the participants plan field activities, manage the project, and discuss and reflect on fieldwork. Participants use both their work time and their personal time for the project. CIAT facilitated the early meetings of the project (local participants have since taken over this function), and provides technical input.

Output

Participating researchers have created a safe and isolated learning environment, separate from their institutional hierarchies, which has allowed them to take control over both the traditional

methods that they inherited for work with farmers, and over the participatory tools that some had started to implement as a new orthodoxy in DEPAM projects. Participants have recognized that they had been using a "toolkit approach" to participatory research, applying pre-designed participatory approaches to non-participatory projects. They are designing and testing their own, new, participatory approaches in their joint farmer-participatory project. This project has completed extensive participatory diagnoses with 110 farmers in three communities, and is now entering the planning stage with farmers in one community.

The learning project approach takes advantage of researchers' informal experimentation and indigenous knowledge about ways of working with farmers. Researchers continuously learn about the processes of project management from planned and unplanned comparisons in unstructured experiments. Like some forms of farmer participatory research, the learning project is helping to develop this informal experimentation through naming, sharing, challenging and systematizing the processes of working with farmers. The participants are building general theory out of particular experience. The project also adds a reflective layer on the participants' own group learning, and unlocks some of the extensive knowledge that researchers already have.

The results suggest that to promote participatory action, it is just as important with researchers and extension agents as with farmers to give control, power and decisions, and to create space to reflect on experiences.

Impact

Eight of the participants report that they have made changes to their institutional research through what they have learned in the learning project, and all are striving to include more participatory research in their institutions. One research director has created a feedback system within his institution so that participants in the learning project can relate what they learn to their colleagues in that institution. Another is discussing with the participants of his institution ways to increase the institutions' capacity for participatory research. The participants have been able to negotiate space to participate in the project's activities, despite these falling outside of the programmed logframes of their institutions. Those participants with less institutional freedom to participate regularly in the project are planning to carry out more of the project activities in their personal time outside of work.

There is a new form of open and critical discussion among peers about approaches to working with farmers. The participants also have the potential (which is largely unrealized so far) to develop more professional links in order to have greater visibility and impact within their institutions. Finally, the group setting supports personal change and development, and is starting to help critical reflection on personal attitudes and behaviors.

However, the isolation of the learning project from local institutions, which is so important for adventurous, high-quality learning, also isolates much of the impact of the project to the participants themselves, and limits institutionalisation of the participatory approaches. Ten months from the start of the learning project, the participants described its impact on their institutions as "positive, but limited". Participants report that little of what they are doing and learning makes its way to colleagues in their institutions. The participants are currently designing strategies for broadening the impact to other people in their institutions, but it is unclear how this will affect the quality of the learning.

Participants have designed a new structure to the project so that it can continue independently without future CIAT support if necessary, and are looking for external support from other source.

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Collaborators

Andrés Castillo, Antonio López, Diana Pérez (all IIAP), Dean Holland (CIAT), Efraín Leguía (CIAT), Eliseo García (DRAU), Fulvio Hidalgo, Héctor Campos (both INIA), Isael Gutarra (AIDER), Javier Amasifuén (UNU), Javier Soto (DRAU), Jhon Avilés (CIAT), Keneth Reátegui (DEPAM), Coralí Silva (CIAT), María Vergara (AIDER), Miguel Valdivieso (DEPAM), Mirella Clavo (IVITA), Nelly Luque (ICRAF), Sonia Deza (CTARU), and Alfredo Riesco (CODESU).

2000 Develop training approaches and materials for targeting, developing and diffusing new technologies and land use systems, and provide training for partners

Milestone 2000 Training provided on use of agro-economic model in Peru

Purpose: To facilitate more interaction amongst Pucallpa-region economists, agronomists and extensionists via a farming system model.

Rationale: Slash-and-burn farming practices are heterogeneous and complex land use systems. Farmers produce a mix of animals, agriculture, and forest products. Furthermore crops are annual, semi-perennial or perennial in monocultures or multiple crop associations. These many facets of farming systems provide a challenging environment in which to research the implications of agronomic and policy research.

Outputs: After the development of the initial agro-economic model, two further steps are necessary 1) refining of the model with potential users, and 2) training of its use among different local institutions. During a second workshop, the model received comments about its potential use, the type of technologies that national institutions want to include and ideas on how to make it more user-friendly. Another workshop is being organized to test the addition of different agriculture technology alternatives developed by institutions and to refine parameters used the model parameter according to farmers and researcher experiences.

Impact: Two workshops took place in Pucallpa with the participation of researchers from INIA, MINAG, IIAP, UNU, IVITA, CODESU and ICRAF. All of them could use their real data, run the model and discuss the results. With this experience the model was refined and researchers are able to use this tool in their own institutional research. The next workshop will present a deeper explanation of the model and its underlying assumptions. It will also include instruction on how to organize data before it can be incorporated into the model. Sensitivity analyses will include opportunities for participants to build real-world scenarios and to adjust key parameters based upon their own experiences.

The model is of much interest to the Ministry of Agriculture, where they plan to use it with extensionists who are in close contact with farmers. In this manner, the potential impact of agronomic advances can be discerned before they are incorporated in farmer fields.

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Institutions and Location of Head Office

CIFOR- Centre for International Forestry Research, Bogor Indonesia
CODESU- Consorcio para el Desarrollo Sostenible del Ucayali, Pucallpa Perú

DEPAM- Desarrollo Paricipativo Amazónico, Pucallpa Perú
ICRAF- International Centre for Research in Agroforestry, Nairobi Kenya
INIA- Instituto Nacional de Investigación Agraria, Pucallpa Perú
MinAg-Ucayali- Ministerio de Agricultura del Ucayali, Pucallpa Perú

Publications 2000

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Funding: Health, diversity and Natural Resources use in the Western Amazonian Lowlands An Integrated agro-ecosystem approach

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Funding: Legume-based forage systems for dual-purpose cattle farm

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