CIAT HILLSIDES PROGRAM

ANNUAL REPORT

(Draft Part 1)

1995

FOREWORD

The CIAT Hillsides Agro-Ecoregional Program is an instrument for change which owes its existence primarily to the encouragement and support of the international donor community and the outstanding efforts of its contributors, visiting scientist and thesis students, who are recognized here:

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In the pages that follow, we present the Program strategy, structure and research highlights for 1995.

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CIAT Hillsides AgroEcosystem Program

IN PERSPECTIVE: 1995

Goal, justification and objectives of the Program

The Goal of the Hillsides Program is "to improve the welfare of the hillside farming community by developing sustainable, commercially viable agricultural production systems." This goal is derived from CIAT's mission statement (CIAT, 1991) "to contribute to the alleviation of hunger and poverty in tropical developing countries by applying science to the generation of technology that will lead to lasting increases in agricultural output while preserving the natural resource base." The program's goal addresses the need identified in the mission to tackle problems of poverty and environmental degradation which go hand-in-hand in the hillsides of Tropical America.

The hillsides agroecosystem in Latin America is a major contributor to food supply and is the basis of the livelihood of a large proportion of the rural poor. The total area in hillsides in Tropical America is estimated at 95 million ha of which about 25 million ha are already highly degraded. This agroecosystem supports over 20 million people. Principal countries (followed by percent of area in steep-slope agriculture) include Bolivia, Colombia (40%), Ecuador (65%), Peru (50%), and Venezuela, Costa Rica (70%), El Salvador (75%), Guatemala (75%), Honduras (80%), Nicaragua, Panama (80%), Mexico, Haiti, Jamaica and the Dominican Republic. The CIAT natural resource management definition of "well-watered" hillsides amounts to 30.25 million hectares.

Other than in Colombia, Venezuela and Peru, a significant proportion of the population of the predominantly hillside countries was rural at the beginning of the 1990's. World Bank data show a high proportion of this rural population in poverty, ranging from 45% (Colombia) to 80% (Guatemala). In addition, a significant portion is indigent (i.e., without means to meet minimal nutritional needs): 23% of Colombian rural population is indigent; 46% in Peru and 57% in Guatemala (CEPAL, 1990). Female-headed households are a high proportion of the indigent rural population (CEPAL, 1992). Thus, in most of the countries with significant proportion of area in hillsides, the locus of poverty has yet to shift from rural to urban areas. Moreover, World Bank figures for the 1990's indicate that rural impoverishment has recently increased in some of these countries.

Causes of degradation in hillside agroecosystems include deforestation (24.9 million ha) overgrazing (24.7 million ha) and agricultural activities or domestic use of vegetation (42.6 million ha). It is estimated that approximately 53 million hectares are experiencing rapid rates of degradation.

Agriculture in mid-altitude hillsides is typically based on fallow-rotation systems in which forest or bush fallow is cleared for cropping with annuals (maize, beans, cassava, upland rice) and perennials, and returned to pasture or bush fallow once yields decline to a level that is non-economic for farmers to continue cultivation. In the more densely populated and drier areas,

fallow periods have been shortened or replaced by organic or chemical fertilizers. When farmers cannot obtain or afford fertilizers, they work off farm, exacerbating the "feminization" of hillside farming, in which the real farmers are women managing subsistence or semi-commercial small farms.

Even in "well-watered" areas, erratic distribution of rainfall can lead to short but critical periods of drought stress. Pest, disease and weed control are major constraints in annual crops. Degraded fallows, largely synonymous with overgrazed pasture, occupy 40-60% of area. Large farms maintain low stocking rates and sharecrop arable land. This reflects a strategy of investing in land to protect capital. Improved production is frequently not a primary or even important objective of large landowners in the hillsides, who make up about 20% of farmers and own 80% of the land. Intensification of production on small farms is an important part of alleviating the poverty which drives migrants to colonize, deforest and degrade increasingly fragile environments.

Environmental degradation of hillsides has serious implications not only for viability of agricultural production in the agroecosystem itself, but also for "downstream" lowland agriculture and coastal ecosystems which can be affected by soil erosion and agrochemical pollution in uplands. Second, the welfare of urban populations which draw water supplies from water courses originating in hillsides is also intimately affected by soil erosion, sedimentation of dams, and major land slippage caused by deforestation or cropping without use of soil conservation practices. The third and potentially most irreversible damage due to hillside environmental degradation and that with major social cost is loss of biodiversity due to disappearance of montane forest. This amounts to between 15% of forest area in Bolivia to 57% in Guatemala. Rate of hillside deforestation is higher than in lowlands, causing a loss of 90 percent of montane forest by 1990. Montane forest has very high biodiversity, possibly higher than lowland forests, especially with respect to herbs and shrubs found between 600-3000m elevations, which are considered important for conserving wild crop genetic resources in-situ. A fourth feature of environmental degradation in hillsides is excessive use of agrochemicals which is characteristic of agricultural intensification, causing soil and groundwater pollution, ecological imbalance in pest and disease complexes, as well as chemically contaminated food.

The rapid rate of environmental degradation in hillsides is driven by the unfavorable structure of incentives for hillside farmers to invest in conservation. These incentives are shaped by specific agroecological conditions, available technologies, prices of inputs used and outputs produced, opportunities for off-farm employment and migration, as well as cultural and organisational norms of natural resource management. Income-generating activities that permit capital accumulation and agricultural intensification, and that involve the use of profitable conservation technologies are key to changing farmers' environmentally destructive management practices. This is the rationale for the objectives of the CIAT Hillsides AgroEcosystem Program, which are:

1. To characterize mechanisms leading to resource degradation and to assess technological options.

2. To generate agroecologically and economically viable components that are acceptable to farmers, for soil and water conservation and management practices.

3. To strengthen the capacity of national systems to generate and transfer resource-enhancing technology.

Each objective is discussed in CIAT's Strategic Plan (CIAT, 1991) and Midterm plan 1993-98 (CIAT, 1992).

Program Structure and Development

The Program's logical framework structure is shown in Table 1. Program research activities are organized under four highlighted outputs which reflect tight structural integration across projects. For example, participatory research methods appear as a separate output, when in fact, participatory methodologies are integrated, to a greater or lesser degree, into all program projects.

Figures 1, 2, 3, and 4 on pages 6, 7, 8 and 9 outline the work breakdown structure, which follows from the Program's logical framework.

Program staffing has varied significantly since 1992. Currently, principle research staff, as measured by full time equivalents (FTE), stands at 2.75 headquartered at Tegucigalpa, Honduras and 2.70 headquartered at Palmira, Colombia. An additional 0.6 FTEs are allocated from the Tropical Lowlands Program and are associated with the Interprogram Project (HA-3). Special restricted funding supports all but 2.45 FTEs.

The CIAT Hillsides Program enjoys a special working relationship with CIMMYT through the mechanism of a jointly funded research position for a soil fertility specialist working on mulch conservation systems. The specialist also acts as regional project coordinator for Central America.

Site Selection for Hillside Eco-regional Research.

A major challenge for researchers addressing issues in natural resource management (NRM) and agricultural sustainability is to fill knowledge gaps through innovative experimental methods that do not rely on large numbers of expensive, replicated observations across numerous sites. The most promising approach is to adopt a logical experimental framework that requires a minimum of sites to elucidate key principles and processes. This is preferable to relying on huge quantities of data and statistical relationships, as is common in traditional commodity research. In such research the typical experimental site is a single farmer's field. By making observations over numerous fields, researchers identify productivity constraints through conventional experimental design and statistical analysis. In Figure 5 this traditional commodity approach is shown as a series of comparisons across research sites at the field scale.

Table 1. Logical Framework Structure for the CIAT Hillsides Program

	INDICATORS	*VERIFICATION*	*ASSUMPTIONS*
GOAL To improve the welfare of the Hillside farming community through development of sustainable and commercially viable production systems.	Project farming communities experience increased individual and social benefit.	Locally relevant indicators show family well-being and sustainability of production systems improving.	Well-being indicators and sustainability indicators are available.
PURPOSE To develop and validate a strategy, including a methodological "toolkit" and delivery system, for generating and executing projects consistent with the program goal.	Projects are generated and executed by stakeholders.	Projects are funded and satisfactorily completed.	Development funds are available.
OUTPUTS ■ Soil quality assessment methods. ■ Prototype production systems development. ■ Participatory research methods and organizational models. ■ Community-based, watershed decision-support systems. ■ NARs capacity improved to use the models and methods.	■ Methods in use by NARs, and Consortia. ■ Publications. ■ Functioning stakeholder action groups. ■ Stakeholder adaptation of prototypes. ■ Stakeholders use decision-support systems to plan land use. ■ Training carried out.	■ Publications available. ■ Annual reports. ■ Planning workshops using systems applications. ■ Annual reports. ■ Consortia workplans.	■ Interprogram and interinstitutional cooperation. ■ Technologies and methods available. ■ Completion of Outputs 1,2,3 and interinstitutional cooperation. ■ Adequate funding.
INPUTS A) Staff B) Budget	FTE years of senior scientist and support staff. Operational budget.	Annual report of the Hillsides Program. Annual budget.	There is a Hillsides Program, and inter-program projects share staff. Ditto.

HILLSIDES PROGRAM WORK BREAKDOWN STRUCTURE

PROJECT 1. EFFECTS OF SOIL DEGRADATION

Program Goal

To improve the welfare of the hillside farming community through development of sustainable, commercially viable agricultural production systems

Project Purpose

To define and quantify causes and effects of accelerated soil quality degradation and its true costs, both individual and social

Project outputs

Activities

1 Criteria to stratify and map experimental sites

- Statistical characterization of historical soils analysis
- Georeference and resample soils in fields with historical soil analysis
- Analyse changes in soil properties due to changes in land use
- Quantify soil change as function of land use history
- Publish journal article on soil quality assessment and land use change

2 Estimates of loss of yield potential

- Select field locations for cronosequence studies
- Conduct maximum yield trials (MYT)
- Define healthy and degraded soil systems through estimated crop response curves
- Publish journal article on loss of yield potential

3 Criteria to evaluate soil improvement practices

- Determine the relevant environmental variables
- Establish on farm practices trials (PT) with indicator crops in different *land use types*
- Prioritize soil P response mechanisms
- Monitor soil properties vis-a-vis different types of practices
- Evaluate types of practices with respect to effects on productivity
- *Derive implications for* new soil improvement techniques
- Publish guidelines for determining practices to use in a given type of environment

4 Prioritized soil properties correlated with soil degradation and regeneration, and changes in productivity

- Parameterize process-level P component of IBSNAT crop models
- Prioritize organic matter effects in trials and identify indicators of effects of practices on soil properties
- Prioritize N-flux effects in trials; identify indicators related to changes in productivity and the effects of practices on soil properties
- Describe soil fauna communities
- Determine relationships between landuse, soil fauna and productivity
- Explore interrelationships between P, N-flux and soil biology and organic matter properties
- Identify relative importance among them for soil improvement
- Derive implications for design of new soil improvement techniques
- Publish joint articles on soil system properties

5 Acceptability and management requirements

- Identify farmers with known soil improvement practices
- Establish management costs with farmers
- *Identify economic* interactions between soil improvement practices and other activities
- Study labor demand and supply and implications for practice adoption
- Publish results

6 Estimates of private costs

- Collect data on inputs and outputs in practices
- Cost-benefit analysis
- Develop methods to value changes in soil properties
- *Quantify economic value* of loss of yield potential

HILLSIDES PROGRAM WORK BREAKDOWN STRUCTURE

PROJECT 2. DECISION SUPPORT SYSTEMS

Program Goal

To improve the welfare of the hillside farming community through development of sustainable, commercially viable agricultural production systems.

Project Purpose

To process information from strategic research in the form of decision-support systems

Project outputs

Activities

1 Priority areas in the Andean and Central American hillsides identified

- Multiple - scale analysis of land use change
- Characterize hillside watersheds by hierarchal organizational structure
- Value effects of sedimentation and agrochemical pollution from different land uses in selected watersheds
- Develop ex-ante economic impact assessment model for hillsides agroecoregion
- Workshops on impact assesment

2 Guidelines for defining minimum data needs

- Develop prototype user-friendly biophysical and socio-economic databases with NARI'S
- Test minimum data needs for modeling options
- Develop a step-wise procedure for refining precision and resolution of spatial data
- Conduct cost/benefit analysis of decision support models
- Publish a manual on the procedures

3 Methodology for incorporating stakeholders values into optional changes

- Conduct participatory resource mapping and correlate results with remote sensing and GIS micro zoning
- Identify indigenous environmental indicators and calibrate with scientific measurements
- Translate local stakeholder taxonomy into relevant categories to assist interactive modeling
- Develop field tools for local monitoring of indicators for different interest groups; assess KB decision support model
- Validate models interactively with stakeholders
- Compare results from process models built with "hard" data and from models built with subjective weights or decision rules
- Audit indicators with local monitoring and calibrate with GIS analysis
- Conduct AEAM workshops
- Publish manuals on concensus - building procedures

4 Prototype interactive, computer-based decision-support applications for hillsides stakeholders

- Analyse evolution of land use in case study sites
- Construct multi-objective analytical models with input from projects (1), (3), and (4)
- Develop knowledge-based (KB) models
- Evaluate and adapt software for presentation of scenarios in interaction with stakeholders
- Simulate environmental x production tradeoffs
- Estimate true value of production at plot, farm & landscape units of analysis including environmental costs
- Assess economic environmental x production tradeoffs in farm and landscape models
- Test the decision-support system with stakeholders
- Feedback needs for data to improve modeling

HILLSIDES PROGRAM (INTERPROGRAM PROJECT) WORK BREAKDOWN STRUCTURE

PROJECT 3. PROTOTYPE SYSTEMS FOR ECOLOGICALLY-SOUND INTENSIFICATION OF PRODUCTION IN THE HILLSIDES

Program Goal

To improve the welfare of the hillside farming community through development of sustainable, commercially viable agricultural production systems

Project Purpose

To contribute to sustained and improved total productivity and to enhance natural resource conservation in the hillsides, by developing a strategic understanding of how to incorporate new and different combinations of species into existing types of production systems

Project outputs

Activities

1 Potential system components identified and characterized

- Hypothesize "benchmark" cropping patterns and rotations from existing data, site appraisals
- Review available information on effect of potential components on environmental variables
- Review available information and survey livestock population, feed supply, animal productivity
- Establish "satellite trials" to identify germplasm for poor, acid soils
  - evaluate elite cassava germplam to expand cassava harvesting window from 12 to 18 months, increase starch yield 15% ha
  - evaluate bean germplasm with low P tolerance and higher N fixation
  - evaluate materials for live barriers
  - evaluate promising grasses and legumes to identify promising rotation and improved fallow components
- IPM subproject for pest/disease complexes in different crop regimes

2 Strategic principles for prototype multispecies combinations identified

- Review information on hillside systems to identify strategic entry points for sustainable intensification
- Determine theoretical principles for design of prototype combinations of species, and
- Hypothesize promising "blends" of introduced and traditional technology
- Select and characterize experimental sites (see Output 1 of HSProject #1)
- Design prototype species combinations with center-wide team to test crop, grass, tree, legume species within benchmark prototype systems and rotations
- *Establish these treatments* in long-term system trials in at least 2 different environments
- Determine mechanisms of sustainable grass/legume establishment
- Evaluate crop/tree associations

  Evaluate acceptability with farmers (Link to HSP #4)
- Model in qualitative and quantitative form (Link to HSP #2)

3 Strategic principles for interaction among plant and livestock species identified

- Review information on hillside crop-livestock systems to identify strategic entry points
- Determine theoretical principles of *competition and synergy* among species
- Introduce animal components to long-term system trials in at least 2 different environments
- Evaluate animal production in systems trials
- Determine forage quality and LWG in systems with trees
- Stabilize DM yield and botanical composition
- Determine optional niches for trees
- Evaluate acceptability with farmers (Link to HSP #4)
- Model in qualitative and quantitative form (Link to HSP #2)

4 Effect of prototype combinations of plant and animal species on system productivity and soil health evaluated

- Evaluate prototype combinations for biomass, yield, soil quality (Link to HSProject #1)
- Study dynamics of organic matter pools
- Construct nutrient budgets

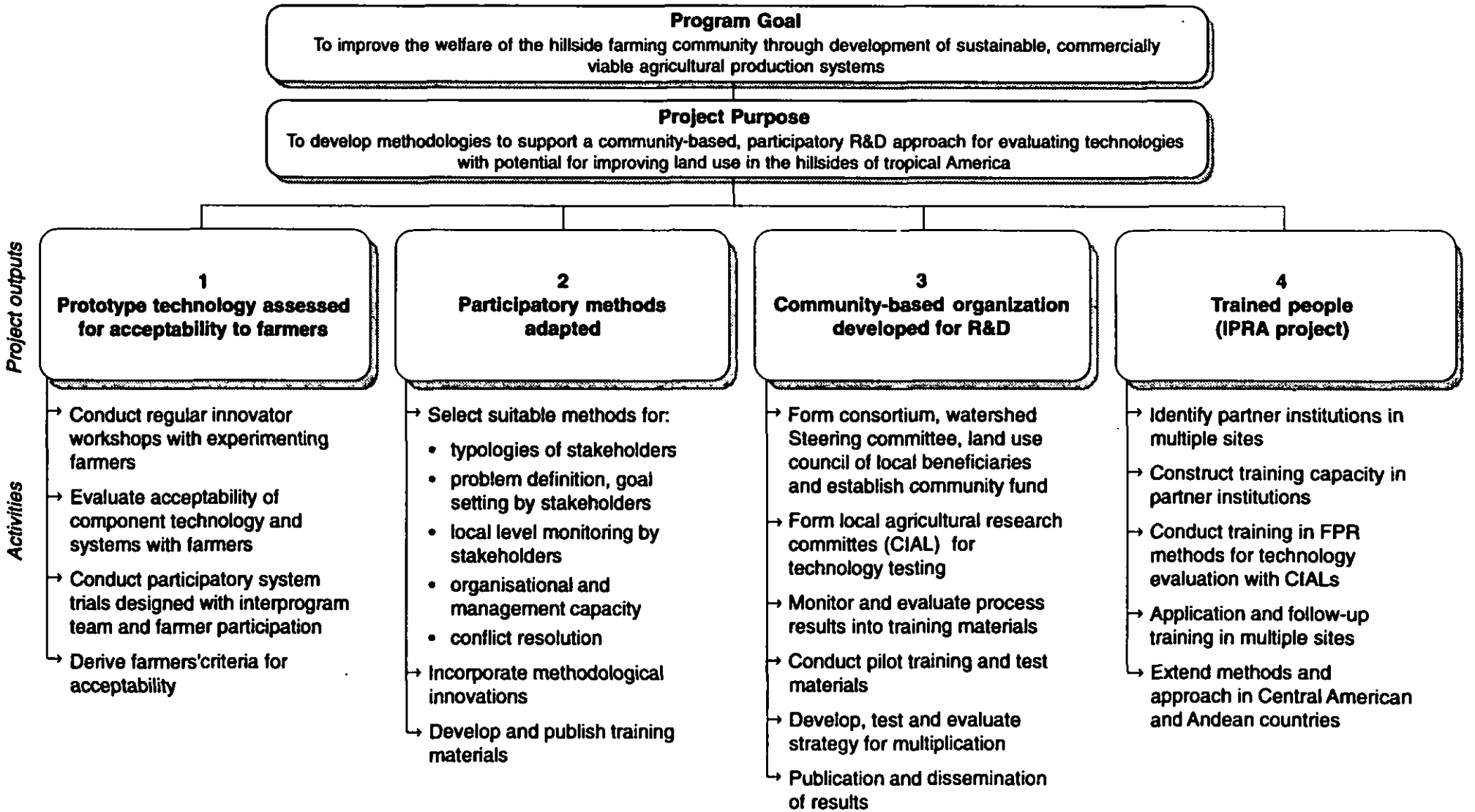
  Study soil biology, conduct soil fauna surveys
- Conduct soil physics studies on soil quality indicators, erosion dynamics
- Develop indicators to monitor environmental impact to compare alternatives in the system trials
- Input to models (Link to HSProject #2)
- *Publish results*
- Construct database with published and indigenous knowledge about species and combinations in different environments

5 Economic value estimated of prototype combinations of plant and animal species for system productivity and environmental effects

- Review literature to identify scarce factors of production important for design of hillsides systems
- Characterise labor use in systems with high, low and medium management intensity; derive implications for prototype system design
- Study markets to identify product opportunity; prioritize high potential products for inclusion in system trials
- Model potential impact of markets on adoption of prototype systems
- Estimate management requirements of prototype combinations
- Model bioeconomic interactions
- Value environmental impact of incorporating prototype combinations into different types of hillside production systems
- Introduce economic values to models (Link to HS Project #2)
- Publish results

HILLSIDES PROGRAM WORK BREAKDOWN STRUCTURE

PROJECT 4. PARTICIPATORY RESEARCH



NRM research requires that the traditional definition of research sites be adjusted to include different spatial scales. This is essential for addressing sustainability issues. But so far "across-scale analysis" at NRM research sites has resulted in little more than independent characterization of ever larger geographical areas (from the plot to the landscape, as indicated in Figure 5) in less detail.

To characterize, categorize, and compare research sites at multiple scales is expensive and time-consuming. As a result, NRM researchers have little choice but to use fewer experimental sites than in commodity research. Documents on NRM research methods refer to "benchmark," "heritage," and "sentinel," sites, suggesting that these have unique properties, which permit tradeoffs between data quality and quantity.

CIAT's Hillsides Program has adopted an alternative strategy that radically redefines the purpose and function of research sites. One of our main activities is to analyze the *organizing principles or relationships which structure* multiple-scale systems. The outputs of this research are process-level analytical models that can define and categorize the biophysical and socioeconomic resources upon which agricultural systems depend. This information helps identify points of policy and management intervention, and provides ex-ante analysis of the trade-offs involved in choosing different interventions.

As suggested in Figure 5, the research of the Hillsides Program emphasizes the *linkages* that act as feedback and feed-forward control mechanisms across scales. A key advantage of this strategy, based on hierarchical systems theory, is that it does not depend on large numbers of sites, nor does it require that we identify representative sites exhibiting certain uniform characteristics.

In fact, with a research strategy that focuses on system processes, detailed descriptions of representative sites (whether fields, farms, watersheds, communities, regions, or countries) is of secondary importance. More important are examples of sites that illustrate the range of variation in hillside systems at different scales of analysis, whether biophysical, geographical, or social (e.g., noncontiguous farm fields, watersheds, and institutions), and that allow contrasting types of interventions and their likely impact to be tested.

Watersheds as an organizing unit of study

The CIAT Hillsides Program has adopted the "watershed" as a useful unit for organizing some, but by no means all, of its research activities. Reasons for this are that overland and through-flow of water draining through catchments integrates and concentrates the effects of many crop and land management activities; off-farm effects can be made explicit; catchment boundaries are specifically definable and reproducible permitting application of systems analysis; catchments are naturally organized into biophysical, and in some cases, socio-economic hierarchal systems. Although watersheds are a useful unit for organizing research, this does not imply that an objective of the Program is to identify a management plan that would optimize resource use at the watershed scale. Rather, the objective is to include analysis of water as well as soil and vegetation in the indicators which provide a "feedback mechanism" for stabilizing and sustaining hillside production systems (TAC, 1995 "Priorities and Strategies for Soil and Water Aspects of Natural Resources Management Research in the CGIAR).

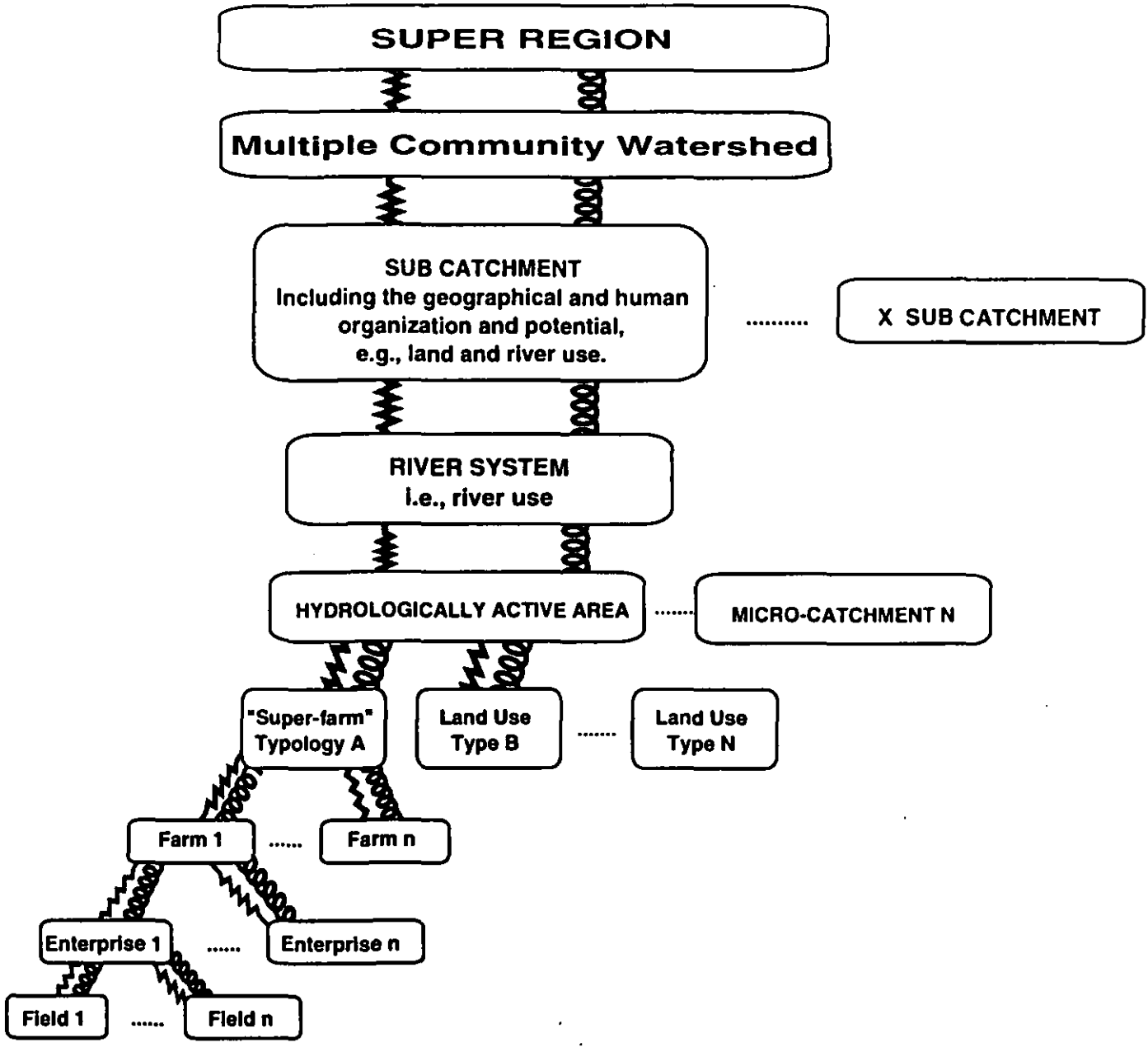


Figure 5. Schematic diagram illustrating a common physical and social organizational structure found throughout the Hillside agro-ecosystem. Program research emphasizes the role of the multi-scale linkages that act as control mechanisms for introducing change.

Current research sites

Using the strategy of selecting contrasting sites across a range of variation, the CIAT Hillsides Program is currently focusing its research efforts in two sites. The Andean region site is a 100,000 ha watershed in the Department of Cauca in southwestern Colombia (Fig. 6). In-depth descriptions of the Cauca study area can be found in many of the research papers presented in the annual report, particularly beginning on page 25.

In Central America, the Program works in five watersheds in Honduras and Nicaragua. Detailed site studies, consistent with the strategy detailed above, are beginning in the regions of La Ceiba, Yorito, and Danlí in Honduras and Matagalpa and Esteli in Nicaragua (Fig. 6). These sites were selected after consultations with partners in the Central American Hillsides Consortium.

Program Evaluation and Donor Relations

During 1995, the Hillsides Program took part in three formal reviews; an External Program and Management Review (EPMR), an Internally Commissioned External Review (ICER), and a review by the International Development Research Centre (IDRC-Canada). In addition, the Program hosted a week-long visit by the new Swiss Development Corporation (SDC) representative from Bern.

The two visits by Program donor representatives were particularly satisfying. In both cases, donor representatives strongly endorsed current efforts of the program and made significant suggestions on future areas of program-donor collaboration. Specific results of consultations with SDC representatives from Bern, together with local Central American representatives, was the submission of a request for an interim program phase in the Central America program to take full advantage of available resources and program momentum. Similarly, the visit by the IDRC representative was followed by strong endorsement and a suggestion to submit a request for continuing work in the Colombian study site.

In addition to formal visits by donor representatives, the Program is very grateful for significant continuing support from the W.K.Kellogg Foundation and the Royal Danish Ministry of Foreign Affairs (DANIDA). Over time, the W.K. Kellogg Foundation has consistently supported research and development of methods for improving and increasing the participation of rural stakeholders in promoting technology change for improving the livelihood of rural poor. During 1995, DANIDA supported Hillsides Program efforts with salary and operational funds for a post-doctoral rural sociologist, as well as for restricted core activities.

Additional support for the Hillsides Program came in the form of support for student research assistants from DANIDA, ETH-Switzerland, and Norway. The Hillsides Program gratefully acknowledges both donor financial support and the indispensable efforts of the visiting student researchers. Figure 7 outlines the financial structure of the CIAT Hillsides Program for 1995.

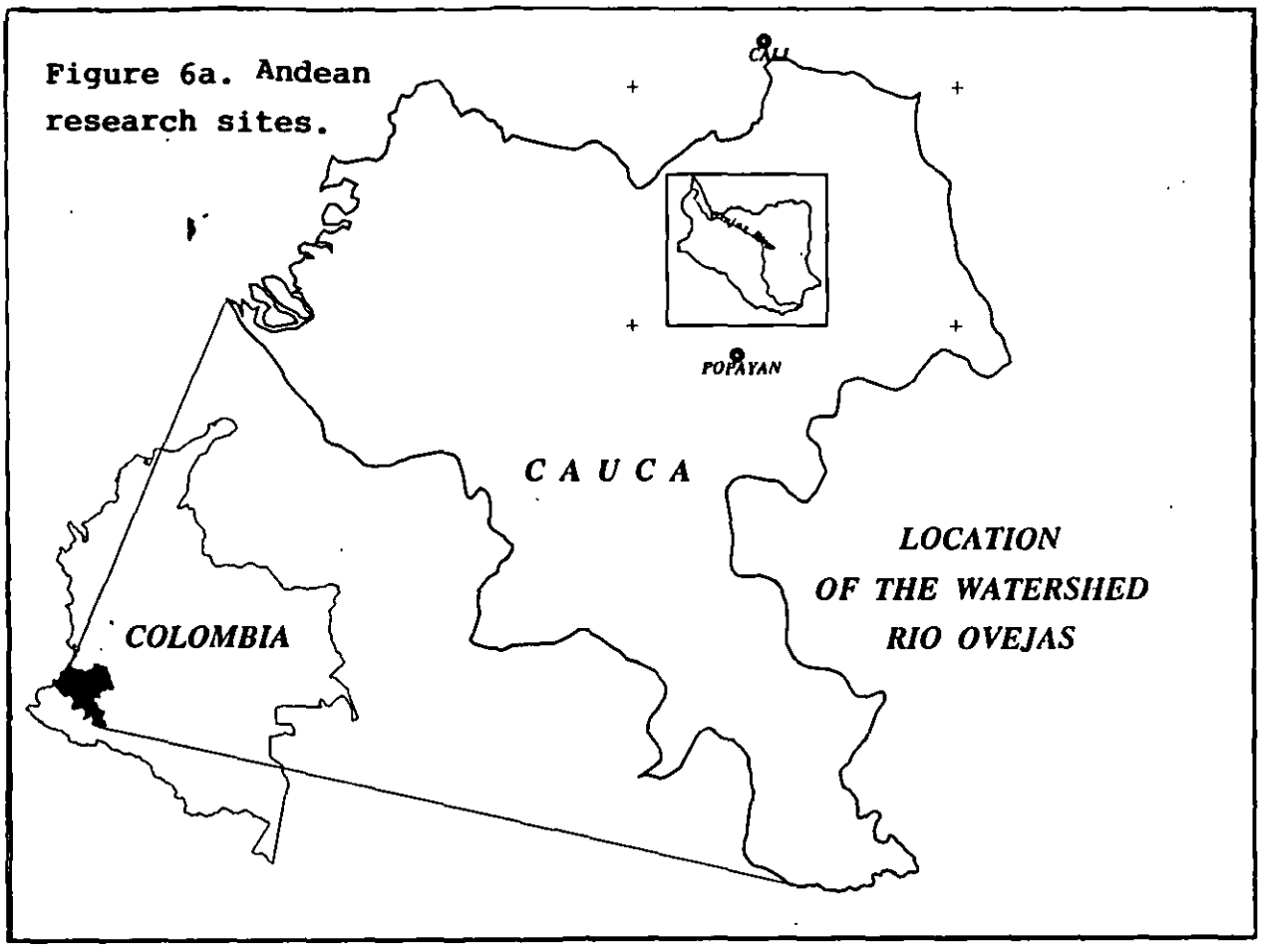
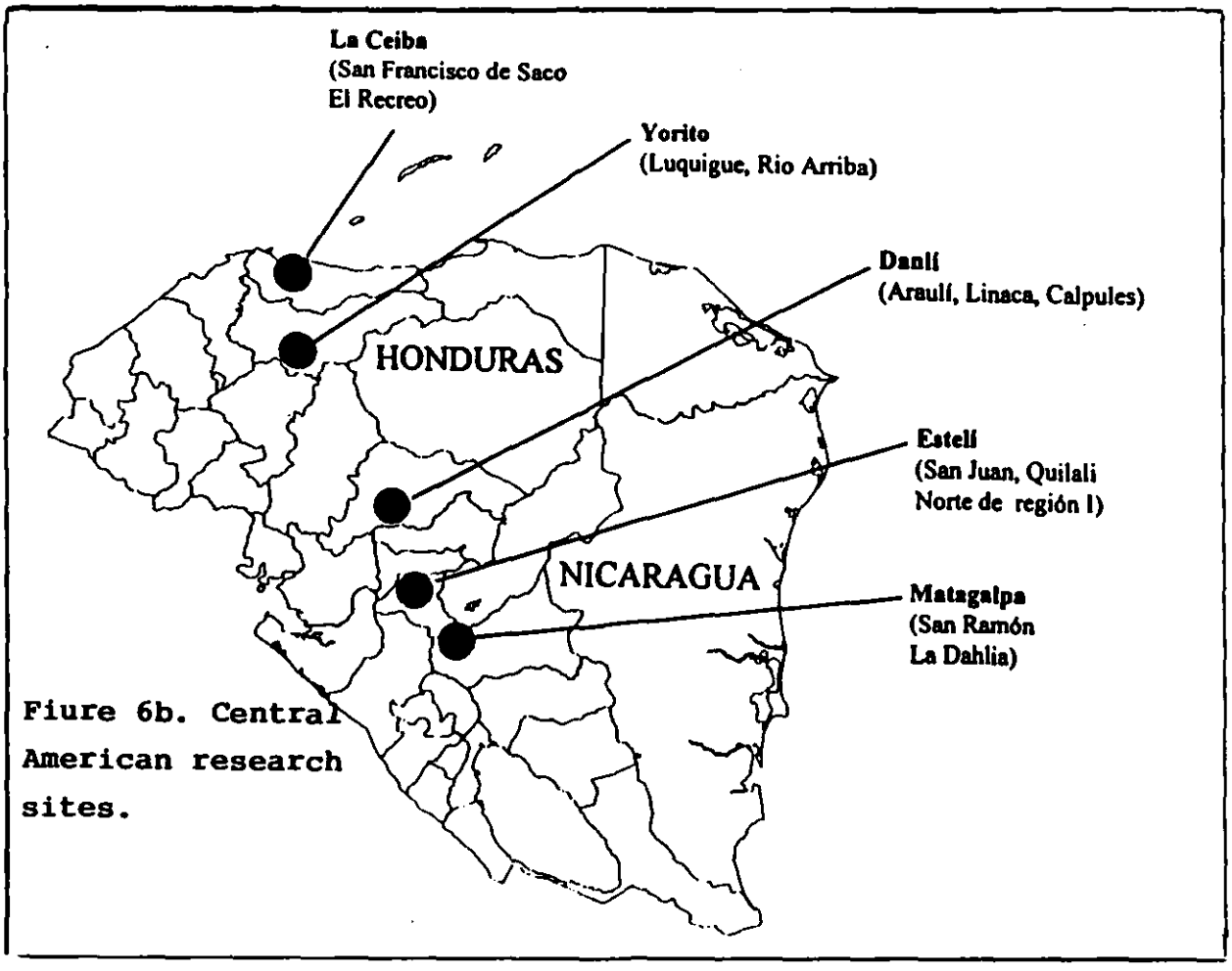


Figure 6a. Andean research sites.



Fiure 6b. Central American research sites.

Figure 7. Financial Structure of the CIAT Hillsides Research Program

	AREA	
PROJECT	**ANDEAN HILLSIDES**	**CENTRAL AMERICAN HILLSIDES**
Project 1. Effects of soil degradation	Core	SDC
Project 2. Decision support systems	Core IDRC	Core SDC
Project 3. Prototype agrosilvopastoral systems	Core IDRC	SDC
Project 4. Participatory research	IDRC DANIDA W.K.Kellogg	SDC W.K.Kellogg IDRC

Research Highlights for 1995

Project 1 (HA-1): Effects of Soil Degradation.

In Cauca, useful criteria for detailed characterization and stratification of contrasting site soil mapping units are being investigated. The treatments are historical land use types (LUT) ranging from undisturbed 40 year-old secondary regrowth forest to traditional cassava cultivation. Results show a range of 9 LUT can be categorized into 2 classes, which accounts for 67% of the total variance in four soil chemical indicators of nutrient retention. The two classes correspond to non-cultivated and cultivated LUT. Detailed spatial analysis of undisturbed forest and traditional cassava sites showed most, but not all, soil nutrient retention indicators were spatially autocorrelated with sample independence occurring at intervals of from 2.4 to 8.0 meters. (Beginning Part 2).

For the Cauca study site, a digital database was created from several hundreds of historical soil analysis records supplied by the Secretaria de Agricultura y Ganaderia (SAG). Descriptive statistical pattern analyses are being carried out with the intention of developing time series information for soil quality change analysis.

Also, a study appraising soil quality, using estimates of irreversible loss of attainable soil productivity, has completed four crop cycles. Bean, cassava and maize yields attained on farmers fields are quite variable but reach 2 to 10 times farmer yields. This amounts to 3 t/ha bean, 7 t/ha maize and 60 t/ha cassava root. There is not yet any indication that a soil productivity degradation threshold has been passed. Causal (path) analysis for bean and maize indicates the major source of yield variability is attributable to "cropping cycle", i.e., semester B versus semester A, followed distantly by previous historical land use. (Beginning Part 2)

A survey of soil macrofauna properties across diverse LUT is following the protocol supported by the CIAT Tropical Lowlands Program and the Tropical Soil Biology and Fertility (TSBF) Consortium. Quantification of macrofauna density, biomass and species diversity of earthworms vary considerably across LUT, both with respect to sampling depth and date. Initial factor analysis (principle components) resulted in 3 factors accounting for 88% of total variance in macrofauna density. Factor 1 accounts for 48% of the variance and can be interpreted as a termite/myriapod/aracnido factor, which is associated exclusively with the undisturbed secondary regrowth forest. Factor 2 accounts for an additional 25% of total variance and can be interpreted as an ant/beetle (coleoptera spp.) factor. The third factor accounts for an additional 15% of total variance and can be interpreted as an earthworm factor. (Beginning Part 2).

Project 2 (HA-2): Decision Support Systems.

A simulation modeling exercise was carried out in Cauca, to test the appropriateness of experimental crop modeling/GIS software developed at the University of Florida at Gainesville. The study explored *ex-ante* analysis of change in water balance in small watersheds as a result of development of small irrigation projects. The modeling tool proved appropriate for rapid *ex-ante* analysis using data generally accessible in lesser developed countries. (Beginning Part 2. (This work is in press as a co-authored book chapter, and was presented at three conferences).

Collaborative research with the Land Use SRG has made significant progress overcoming technical problems of precision in remote sensing interpretation and spatial mapping and analysis of very small, sloping, heterogeneous land use/land cover units. An initial study used traditional airphoto interpretation and GIS to quantify changes in land use/land cover for a sub-watershed in Cauca for three key dates beginning with 1946. Results show that aggregate estimates of land cover change need to be interpreted with caution, as specific land mapping units show much greater dynamic shifts into and out of land cover classes. (Beginning Part 2. This work has been presented at two international conferences.)

Another Cauca study is exploring minimizing aggregation bias and maximizing stakeholder acceptance in regional scale systems analysis. Research is progressing on the development of a farmer-derived, locally-relevant social index of family "well-being". The index was synthesized from responses to a survey of local residents. It has five parameters related to land and cattle ownership, labor sources and housing characteristics. The utility of the indigenous index is being tested for aggregating households for possible analyses of regional systems. This was done by assessing the within-and across-class variability of index-derived classes. Predictions of household wealth, financial risk and farm viability were simulated by a process-level, whole-farm economic model driven by stochastic economic and weather variables. The farm model is based on the DSSAT suite of models. The goal of this research is to improve precision of regional scale analyses and to make the analyses more participatory and relevant to stakeholders. (This work is being presented as a co-authored poster at an international conference, Los Baños, Philippines.)

In Central America, significant time and resources have been spent gathering and evaluating digitized biophysical and socio-economic data from a variety of sources with two main objectives in mind. First, the data will be processed and analyzed as part of the Program's strategic research addressing the issue of improved targeting of research and development activities. Second, in

exchange for much of the data, the Hillsides and Land Use Programs will create user-friendly accessible GIS databases for collaborators in the region. During 1995, satellite imagery for multiple dates covering most of Honduras and Nicaragua has been obtained. A supervised classification of land cover has begun for Honduras. In addition, for local study sites, detailed digital orthographic mapping has begun. This is required for resource modeling analysis, using spatially distributed landscape parameters. Significant progress has also been made in linking population and agricultural census data to spatial coordinates. A digital database of the IV National Agricultural Census for Honduras at the municipio level has been developed by the Tegucigalpa office. Work by the CIAT Land Use SRG is well advanced disaggregating census data to the village level. Results of this work will permit direct analysis of the relationships between poverty, land management and resource degradation. Finally, in collaboration with the Land Use SRG, a detailed climate grid database which surpasses any previous attempts has been created. (see CIAT Land Use Program's annual report for more information.)

Project 3 (HA-3): Prototype Systems for Ecologically Sound Intensification in the Hillsides.

The Interprogram Project in Cauca is a long-term project that is less than two years old, and therefore data interpretation would be premature. Nevertheless, early indications are that, contrary to common belief, land fallowed for several years is not necessarily more productive than continuously cropped land. Soil productivity depends on past managementm and continuously cropped land that has received applications of organic manure over time is highly productive. (These results are consistent with results observed in Project 1 above.) An additional aspect of organic manuring uncovered in this study is that common application rates of 6 t/ha manure far exceed the total nutrient uptake and exports from the harvest. This raises the issue of potential accelerated soil acidification due to leaching. (Beginning Part 2)

In Cauca, research on a methodology for quantifying relationships between resource sustainability and current and potential product marketing systems is well advanced. As a step in the methodology, a market survey, centering on Cali and its area of influence, was completed in 1995. Information was obtained for a portfolio of products from supermarket chains, milk and food processing companies and flower shops. Eight reports were prepared and presented to groups of stakeholders. (Beginning Part 2).

Project 4 : Participatory Research

Research is progressing on developing a methodology for producing rural poverty (or well-being) profiles to improve the targeting of research to different types of beneficiary groups. (Beginning Part 2). Based on enquiries among local informants into what constitutes well-being, a well-being index was developed. In Cauca, this index has seven parameters related to dependency/independency on day-laboring as a source of income, ability to employ day laborers, access to non-agricultural sources of income, land and cattle ownership, crop diversity, and housing quality. The well-being index will improve targeting of research and development activities and will provide indicators against which to assess the impact of such activities.

In Cauca, research is underway to identify critical issues, including organizational principles, for local-level watershed management. (Beginning Part 2). The research follows a participatory action research approach and uses FEBESURCA, the río Cabuyal watershed beneficiary federation which forms part of CIPASLA, as a case. A description of the work to date has been submitted to an international journal for publication.

During this research, burning as a common means of land preparation was identified as a critical - and controversial - issue, as it has detrimental effects on local watershed management. Burning was therefore used as a case study to test with methodology based on a stakeholder approach to the identification, analysis and negotiation of conflicting interests involved in watershed management. (Beginning Part 2).

A strategy is now in place for developing in-country capacity for training professionals and farmer-paraprofessionals in the CIAL methodology. The concept of focus sites as permanent training ground is essential. In order to establish such sites, it was found necessary to (1) establish relationships with potential partner institutions and inform them of the project's objectives, and (2) develop the terms of the interinstitutional agreement. The search for partners is organized around two vital institutional functions: research capacity (e.g., national or regional agricultural research institutes and agriculturally oriented universities) and development work with small farmers.

Opportunities for 1996

The CIAT Hillsides Program looks forward to 1996 with great anticipation. In addition to finishing certain research activities and continuing others, new opportunities have presented themselves. The Program is continuously being approached by potential research partners including PROCIANDINO, CORPOICA, the Wageningen Agricultural University, CIP, IFPRI and IIMI to mention a few. During 1996, collaborative research with CIMMYT, CIP and IFPRI are likely to be formalized through funding of the Latin American Agroecoregional Initiative. There also appears to be opportunities for a jointly funded CIAT-CIP economic systems staff position similar to the CIAT-CIMMYT position in Central America. Another highly probable collaborative effort will likely be catalyzed by the Inter-Center Initiative on Water Management. This will result in the CIAT-hosted IIMI representative working in the Cauca, Colombia, research site.

Other opportunities for 1996 include continuing linkages with other CIAT Programs, as well as non-CIAT institutions, through the organizing, managing and delivering training courses by Hillsides Program staff in Farmer Participatory Research.

PROGRAM PUBLICATIONS AND COMMUNICATIONS

1993

Ashby, Jacqueline A. "Agriculture, Food, Environment and Rural Development: Perspectives and Principles From the Experience of an International Research Center". Lecture presented at the Salzburg Seminar Session: "Agriculture, Food, Environment and Rural Development", Salzburg, Austria, October 30-November 5, 1993.

E.B. Knapp. 1993. Concensus building and conflict resolution, a case study of North Cauca, Colombia. Presented at IDRC, Uruguay.

E.B. Knapp, 1993. Organizing principles for soils related research for the CIAT Hillsides Program, presented at organizing meeting of M.A.S. (Consortium for managing acid soils), CIAT.

Humphries, S. A. 1993. "The Intensification of Traditional Agriculture among Yucatec Maya Farmers: Facing up to the Dilemma of Livelihood Sustainability". Human Ecology, Vol. 21, No. 1.

Jones, P.G., P.K. Thornton, E.B. Knapp, and J.N. Fairburn, 1993. Making soil research and development relevant and sensitive to socio-economics in Latin America. (Invited paper ISSS meeting, Mexico.)

Laing, Douglas and Jacqueline A. Ashby, "Adoption of Improved Land Management Practices by Resource-Poor Farmers" in Michael A. Zobisch (ed.) Acceptance of Soil and Water Conservation Strategies and Technologies. Witzenhausen, Germany: DITSL (in press).

Moreno, R. and Sánchez, J. Parcelas de Pre-producción como nexo entre investigación y extensión. Presented at the International Symposium on Agricultural Systems. Quito, Ecuador, February 1993.

Moreno, R. Investigación Agrícola en las laderas de América Central. Presented at the Semana Universitaria Curla, La Ceiba, Honduras, September 1993.

1994

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

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

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

Ravnborg, H.M. and J.A. Ashby. "Organising for local-level watershed management-lessons from Río Cabuyal watershed, Colombia." Submitted to Technology and Society.

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

1995 - Andean Region:

Ashby, J.A., J.A. Beltrán, M.P. Guerrero and H.F. Ramos, "Improving the Acceptability to Farmers of Soil Conservation Practices", Soil and Water Conservtion Society. (forthcoming)

Ashby, J.A., T. Gracia, M.P. Guerrero, C.A. Quirós, J.I. Roa, and J.A. Beltrán. "Organizing Experimenting Farmers for Participation in Agricultural Research and Technology Development". Paper presented at the Workshop on Traditional and Modern Approaches to Natural Resource Management in Latin America, World Bank, Washington, DC, April 1, 1995.

Ashby, J.A., T. Gracia, M.P. Guerrero, C.A. Quirós, J.I. Roa, and J.A. Beltrán. July 1995. Institutionalizing Farmer Participation in Adaptive Technology Testing with the CIAL. ODI Network Paper 57 (45 pages).

Ashby, J. A. and L. Sperling. 1995. "Institutionalizing participatory client, driven research and technology development in agriculture." Development and Change. Vol. 26 No. 4, October 1995; 753-770.

Beinroth, F.H., J.W. Jones, E.B. Knapp, P. Papajorji, and J.C. Luijten. 1995. Applications of DSSAT to the Evaluation of Land Resources. In: IBSNAT Monograph. (in press)

Kronik, Jakob. 1995. Studying Local Knowledge on Biodiversity. A Video. (19 minutes) (English and Spanish)

Ravnborg, H.M., and J.A. Ashby. 1995. Organizing for local-level watershed management -Lessons from río Cabuyal watershed, Colombia. CIAT (mimeo), 22 pages.

Ravnborg, H.M., and M.P. Guerrero. 1995. Poverty profiles for designing and evaluating rural research and development activities - A methodology. CIAT (mimeo), 41 pages.

Urbano, P., J.E. Rubiano, W.B. Bell, and E.B. Knapp, 1995. Cambios en el Uso de la Tierra como Posible Indicador de un Desarrollo Sostenible en una Zona de Laderas - Subcuenca del río Cabuyal, Cauca, Colombia. In. Memorias del IV Congreso AESIG Barcelona, España, en septiembre 7, 8 y 9 de 1995.

Central America:

Barreto H. y K. Dvorak. Mayo 1995. Plan Operativo. Reporte Interno. Tegucigalpa, Honduras: CIAT (mimeo).

Barreto H. y K. Dvorak. Junio 1995. Los comités locales del Programa de Laderas-CIAT en Honduras y Nicaragua: Fase de Organizacion. Reporte Interno. Tegucigalpa, Honduras: CIAT (mimeo).

Barreto, H. August 1995. Digital Database of the IV National Agricultural Census for Honduras at Municipio Level. Internal Report, not for distribution. Tegucigalpa, Yonduras: CIAT (mimeo).

Dvorak, K., y P. Jiménez, septiembre 1995. Guía para el Sondeo sobre Recursos Agrícolas en América Central, Tegucigalpa, Honduras: CIAT (mimeo).

Moreno, R. Agosto 1995. Resumen de la Primera Reunión del Grupo Consultivo del Proyecto de Laderas de América Central, La Loma, Cortes, Honduras, 18-20 de mayo de 1994 y Objetivos y Conclusiones el Taller de Consulta en Managua, Nicaragua, 27-28 agosto 1993. Reporte interno. Tegucigalpa, Honduras: CIAT (mimeo).