Community Planning for Sustainable Livestock-Based Forested Ecosystems in Latin America

Narrative Summary

The primary goal of this project is working with communities in forested mountainous areas of Latin America to improve the quality of life for small landholders through land use and livestock management that is sustainable at the family and community level, and sustainable for the environment at the level of the watershed. The project work is organized around four principal objectives:

1) identify the potentials and limitations for community-sustainable management of natural resources and livestock, and improved quality of life;
2) evaluate current practices of livestock and natural resource management and experiment with alternatives;
3) generate a participatory process for planning, implementing, and monitoring current and alternative practices;
4) establish a long-term, ongoing community planning process for natural resource and livestock management.

An important secondary goal is the study of the process of achieving community-based sustainable development, including monitoring the project activities and developing an integrated, participatory, process-oriented learning approach.

An important tertiary goal is to strengthen the capacity of host-country researchers and professional practitioners and their institutions to effectively promote and assist sustainable rural development within resource-poor agricultural regions of Latin America. This includes conducting project and community workshops and supporting short-term training and degree training for host-country and U.S. students.

Research

Problem Model and Approach. The goal of our project is to determine how livestock, agriculture, and natural resource uses can be incorporated into the environment in a manner that is ecologically sustainable and that will improve the livelihood of local residents, and to achieve this goal through working with and empowering local communities. The area focus of our project is the interface between agricultural and forested ecosystems in critical mountainous ecosystems in Latin America. Livestock, especially cattle, dominate these threatened and degraded landscapes, leading to two questions: 1) the role livestock can and does play in the livelihood of the rural communities of our study sites; and 2) how livestock can be integrated into these forest ecosystems in a manner that is ecologically sustainable. Our increased understanding of these regions and their people has reinforced the need to take a holistic approach at the level of the community and the watershed. To find viable answers to these questions, it is crucial to understand the physical, ecological, social, cultural, and economic context.

The Problem Model defines a process for describing, studying, planning, implementing, and monitoring the integration of livestock, agriculture, and natural resources uses into natural forest ecosystems to achieve sustainable production. This process is organized around four steps: 1) identify the potentials and limitations within the community for sustainable management of natural resources and livestock and improvement of quality of life; 2) evaluate current practices of livestock and natural resource management and experiment with alternatives; 3) generate a participatory process for planning, implementing, and monitoring current and alternative practices; and 4) establish a long-term, ongoing community planning process for natural resource and livestock management. The successes we have achieved strongly reinforce the value and necessity of a participatory, process-oriented learning approach. We have effectively designed an approach support with a "tool box" of strategies, tools, and methods that can be applied effectively and appropriately to rural communities throughout Latin America.

The following initiatives, developed in the past year, were carried out successfully through this year (2002-2003):

1 Intensified farmer/investigator joint experimentation with pasture improvement (see Activity Five).
2. Increased focus on wildlife/ productive system conflicts (see Activity Four).
3. Increased participation of host-country community representatives in our annual planning meetings.
4. Increased focus on community group organizations (women's groups and producer groups) (see Activity Nine).
5. Increased collaboration with governmental institutions and fostering of stronger linkages between local government and community organizations (see Activity Ten).
6. A new initiative to develop a systematic appraisal of the land tenure situation in all three host countries (see Activity Six).
7. Increased focus on policy and its influence on local land use and management (see Activities Eight and Ten, as well as the section that addresses policy).

Greater integration of project research activities was achieved by reassessing our 45 past activities in six categories and reassembling key functional elements from them into a sequence of nine activities following an overarching activity (Activity One), emphasizing our goal to develop a model process for guiding community-based, sustainable agricultural development.

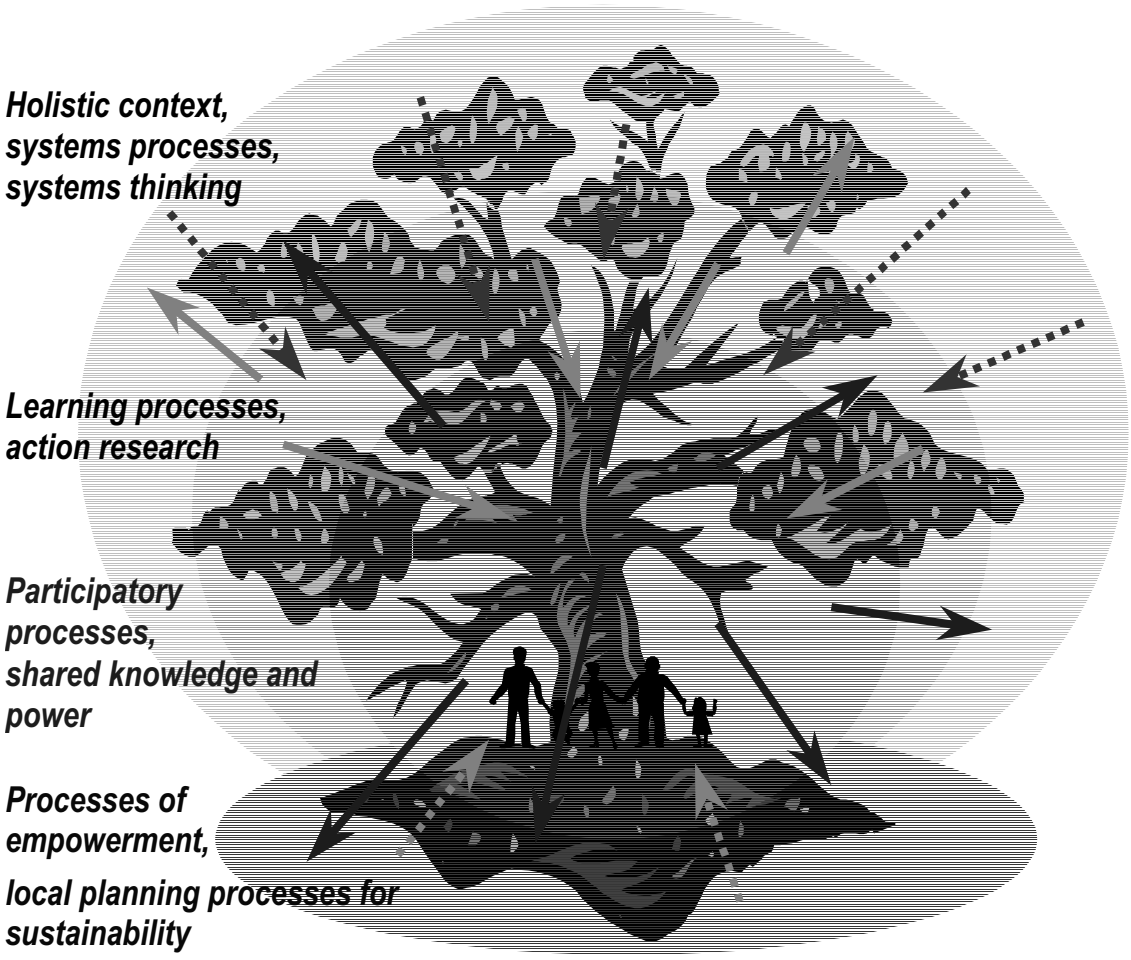
Activity One: Creating a Process of Community-Based Participatory Agricultural Development

The most important expected outcome of Project PLAN is the creation of a process, or model, of community-based participatory agricultural development with a "tool kit" of approaches, methods, and guidelines for use by development agents and/or communities. In our previous workplans, the creation of this process was assumed as an outcome of the other activities. For year six, we developed this Activity One to focus specific work aimed at the development of the process itself. We are using this activity retroactively to allow space to discuss advances related to this key work.

Objective 1.1: Conceptualization of the PLAN model of development and its component processes.

The community-based, sustainable development model approach we have developed defines a process-oriented approach designed for use by communities and development agents to facilitate local capabilities favorable to and feasible for promoting local planning and management for sustainable development. We will present the "process" and the "context" for this goal of sustainable agricultural use. The "process" approach comprises four types of processes that guide and integrate ways of seeing and working: holistic systems process thinking, learning processes, participatory processes, and local planning processes (Figure 1). Below we describe the rationale for the

Figure 1 - Project PLAN model for a local sustainable agricultural development process.



Project PLAN has developed a holistic, process-oriented, community-based approach using systems thinking, learning processes, participatory processes, and local empowerment and planning processes to promote sustainable agricultural development in Latin America.

selection, application, and interaction of these four processes.

Holistic systems process thinking emphasizes the inter-relatedness of everything -- the understanding that any action taken will affect everything else. It requires consideration of the bio-physical context and of the socio-cultural-economic context and the linkages between them.

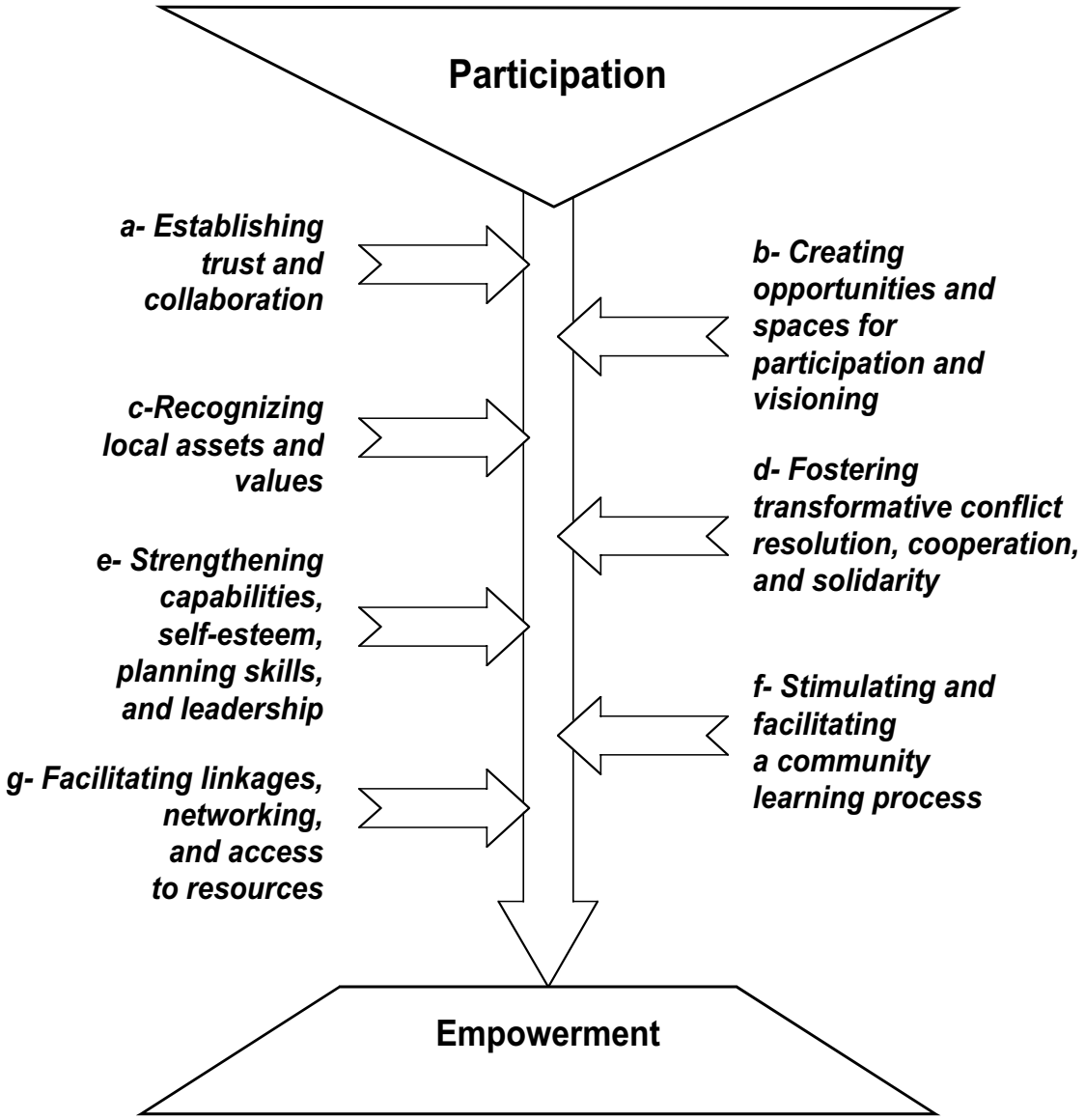
Systems thinking stresses the inter-related, interconnectedness of everything and focuses on linkages and processes -- how things are interconnected, the processes that connect them, and the processes and the dynamics of systems. It means seeing systems as complex networks of causes and effects with feedback loops. This way of thinking increases the understanding of the impacts of change and unpredictability as inherent aspects of complex systems. This way of thinking offers a more effective means to identify leverage points and limiting factors, and offers an important tool to support sustainable planning and adaptive management.

Holistic systems process thinking requires an approach that is interdisciplinary (integration of biophysical and social sciences), collaborative (partnerships with academics, practitioners, local government, and communities), and comparative (working at different scales and across multiple sites). Systems thinking leads directly to an understanding of the interdependence of landscape and community, to the recognition of the importance of outside forces (such as from market and state), and informs the need for communal planning and adaptive management at scales larger than individual farm households. Holistic systems thinking leads to the understanding that ecologically sound agriculture requires decision-making, planning, and management at scales larger than the farm, that the actions of one affect the others, that management and planning at a larger scale, like the watershed, require communities cooperating toward shared interests.

Learning processes emphasize investigative research processes and different ways of thinking. Understanding different ways of learning and seeing is important in enlarging our appreciation of different learning styles, as illustrated with the learning wheel and different types of knowledge illustrated by the following contrasts: scientific vs. indigenous, universal vs. particular, experimental vs. experiential (observation and reflection), field dependence vs. field independence, multi- vs. inter-disciplinary, reductive vs. intuitive, disciplinary vs. systems approach, positive realist vs. constructed, and science vs. wisdom. Understanding these contrasts contributes to the effectiveness of the project and the PLAN Process Approach. Participatory processes are applied to three general goals:

Achieving participation. The first goal (achieving active, involved participation of local community members) is assumed as an essential, desired, and pervasive component of this project, and for community-based rural agricultural development in general. While participatory approaches are almost universally included in development projects, their application is often problematical. The levels of participation intended and achieved differ significantly among projects, from pseudo-participation to real participation in which local people have a controlling role in project decision-making. It is also important to note that the processes through which participation is elicited are quite varied (and often unspecified and undocumented); plus, the same process may vary considerably in its application between projects and, as a consequence, the response/impact achieved may not

Figure 2 - Community participation to community empowerment. Application of seven complementary suites of techniques to foster, facilitate, and strengthen a participatory process leading to local community empowerment.



correspond to that intended. The complexity and subtlety of social dynamics coupled with differences in culture and power relations between the development agent/facilitator and the local people make it exceedingly difficult to achieve appropriate and genuine participation.

In the case of participation, the 'devil is in the details'—its application depends on the processes employed and the training, cultural sensitivity, and skill of the facilitator. The choice of processes to generate participation depends on the goal for the participation. The goal for participation, and hence the processes used, may vary according to the specific activity and the subjects involved, whether the focus is farmer experimentation or capacity building.

For the purpose of strengthening local capacity (which leads to community empowerment), Project PLAN designed a strategy that combines seven different sets of processes and tools (participatory, learning, and planning processes) to foster community development (Figure 2). The application of this participation-empowerment strategy is currently being evaluated; the analysis of the evaluation will be completed over the next several months.

Participatory processes to support cooperation. This involves enabling and strengthening cooperation, inclusion, and equity, and the capacity for collective action within local communities. Conflict within communities has been identified as one of the main factors preventing effective community organization, communal planning, and collective actions. A key means to enable improved cooperation is the fostering and supporting of transformative conflict resolution skills and processes. Transformative conflict resolution differs significantly from negotiation and mediation; the transformative approach emphasizes understanding each others' needs, values, and goals, the sharing of knowledge, and working toward common interests in ways that nurture mutual development. These techniques are not designed or intended to replace local informal customary means for dealing with conflict, such as the social mechanisms used for livestock/crop conflicts in the La Cueva area of Bolivia, as studied in this project (see findings under Activity Six). These transformative processes can be incorporated into any system to help reduce conflict and contribute to more equitable, supportive relationships and increasing social capital.

The change required may be entirely at the higher system level where multiple interdependent stakeholders with different (and often conflicting) interests find that they need to scale up their decision-making to the higher system level and share in problem definitions, accommodate multiple perspectives and 'rich pictures,' and negotiate collective management decisions at this higher level. Area-based planning requires a consensual approach, in that ways forward need to emerge from interaction among the stakeholders—interactive plan formation.

Participatory processes to create and support a learning community. Increased appreciation of the variability and unpredictability of impacts on farming systems from environmental uncertainty has led to increased recognition of the necessity of adaptive management supported by an ongoing learning process. Reviews of successful projects have stressed the importance of having an ongoing learning process as part of the project, as well as in local communities. While many different projects include an ongoing learning process as part of their approach, few appear to include the elements necessary to develop an effective learning organization or learning community. Learning organizations depend on attitude and method. It is the social, organizational nature and intent of this process that makes it primarily a participatory process rather than a learning process. In fact it is both. The two-way flow of the arrows in our process tree are intended to draw attention to the on-going, back-and-forth nature of the interplay of the four processes.

Ecologically sound agriculture (ESA) involves multiple levels of decision-making. Learning communities, farmer field schools, or learning groups are essential, not only because learning ESA is an interactive process, but also because the shift involves the whole network of institutions and agencies in which the farm is embedded.

Local planning processes are important tools to favor and support sustainable land use and ecologically sound agriculture. Effective adaptive planning is informed and guided by related complementary processes including a problem-solving process, a visioning process, and monitoring and evaluation processes. The first phase of our project developed and employed an iterative, problem-solving process with considerable success. However, long-term community planning must be based more on visioning processes and the need to incorporate an effective participatory monitoring and evaluations process. Within PLAN, we are now in the initial stages of adapting and applying a participatory system focused on four capitals: natural, human, social, and financial/built. These four capitals encompass the essential elements of sustainability in a form relevant to people who are struggling to support their livelihoods on their abilities and the health and wealth of their agro-ecosystems. However, directing the focus of managing change toward ecologically sound agriculture makes much greater demands on the understanding of learning than does the promotion of 'more of the same' within the conventional paradigm. It also makes much greater demands on understanding social process than conventional agriculture.

Systems thinking creates new ways of thinking and draws attention to large-scale factors that influence the local system. Seeing and understanding the large system and observing its interconnections gives both balance and inspiration to the efforts as a community. Ecologically sound agriculture requires change, not only at the farm level, but also at higher agro-ecosystem levels, such as watersheds, biotopes, and landscapes. ESA requires multi-level management. Conditions for growing healthy crops and animals and for accessing biomass must be created at system levels higher than the farm (soil and water conservation, habitats for natural predators, bio-diversity conservation, etc.).

Our view of the four processes is one of mutual interaction. Technical spatial tools like geographic information systems (GIS) may be combined with resource mapping by the farmers, using indigenous classification criteria to create resource maps of the catchment in a process designed to help farmers construct a shared perspective on the catchment, and scale up their concerns to the catchment level. This example illustrates a rich interaction of systems thinking, with two-way learning in a participatory manner that enriches the worldview of both outsider and insider.

Objective 1.2: Analysis of case studies of the use of methodological processes in the application of Project PLAN.

The inclusion of Professors Cornelia and Jan Flora in year six was instrumental in the development of the following series of five specific objectives for an analysis and evaluation of the project processes and impact:

1. Codify and measure the processes, for participatory watershed research and development;
2. Develop indicators for impacts related to human capital, social capital, natural capital, and financial capital in the four sites;
3. Link project activity to policy outcomes at the four sites in the three host-countries;
4. Analyze the process of building a cross-site learning community to work for ecosystem health and community empowerment across Latin America in order to help include other researchers and practitioners in the process; and

5. Conduct a comparative analysis of community-based participatory research-development strategies, expanding on the current work to include those theories and practices in Spanish and implemented in Latin America.

The Floras created a matrix to provide a common, systematic framework to guide the compilation and analysis across all the project sites. The host-country assessments are in progress and intended to be completed and analyzed by August 2004.

Objective 1.3: Comparison of the factors and conditions that favor changes in the interaction of ecological, productive, and social systems within the context of local processes in the three countries under the framework of Project PLAN. Determining specific activities and actions to promote sustainable agriculture and overall sustainable development.

For the overall practices of land use and natural resource exploitation, the development must be sustainable ecologically, economically, socially, culturally, and politically. While one can identify problems and actions related to each of these components, the difficulty is how to integrate them all. The PLAN-Ecuador team developed a mechanism to do this by ordering them in a pentagon and then focusing on the links between each of the components (Figure 3). They have successfully used this framework while working with local producers and families in grassroots organizations to identify problem areas specifically involved with two or more sectors. After identifying the problems, the researchers and community members then identified strategies to solve problems or improve the local situation by focusing on actions that involved two or more sectors. The model, while appearing simple, is a major step forward in providing an effective means to promote a relevant and useful integration of the multiple components of sustainable development.

Objective 1.4: Reflection-in-practice on the impact of Project PLAN on the vision and practices of team members and partner institutions.

During the PLAN annual conference/ workshop, we designed a framework to carry out an auto-evaluation of the impact and value of the project's activities including components focused on "reflection-in-practice." All three host-country teams are carrying out this auto-evaluation. Analysis and conclusions are expected to be completed by June 2004.

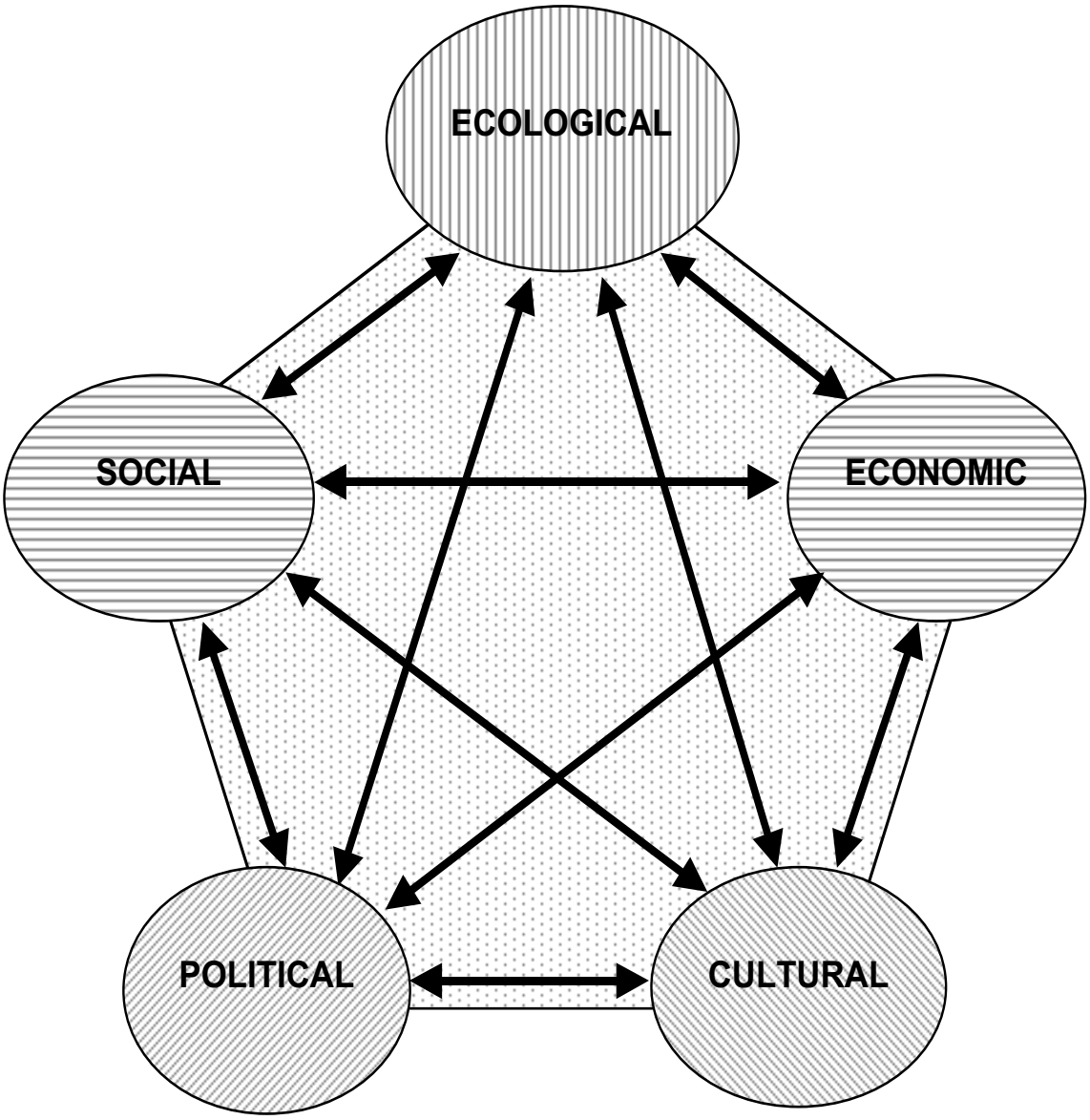
Objective 1.5: Development of a plan for the publication and dissemination (in Spanish and English) of PLAN products: educational materials and scientific results.

An impressive number of student theses (licentiatura and M.S. theses) have been completed in the last two years of the project, and several are expected to be completed within the next year or two. While a large number of scientific publications and several book-length projects are in various stages of progress and completion, the process has been moving more slowly than our original plans. Several manuscripts have been published or are in press, several others have already been submitted for publication, and others are in draft form. Overall, we expect a number of articles to be published over the next two years. In addition to formal scientific publications, the host-country teams have produced a number of reports to be disseminated to government agencies and to communities as part of the impact and future development of the ongoing activities in the target regions of the project.

Objective 1.6: Strengthening and training of host-country collaborators, institutions, future researchers, and practitioners.

Each result under all the activities has been a response to a focus, methodology, proposal, and unique chance that has been constructed jointly with the participation of local organizations throughout the six years of Project PLAN, contributing to the construction of the PLAN development model. This model represents an approach-oriented, process-oriented interdisciplinary perspective in which research and development and theory and practice are inseparably intertwined.

Figure 3 - PLAN pentagon of sustainability.



Activity Two: Changing Land Cover/Land Use at the Scale of the Watershed

Objectives 2.1 and 2.2: Assessment of patterns of land cover/land use change in all three sites; studies of land use potential, soil vulnerability, and environmental impacts within the watershed to inform plans for watershed protection and management.

These studies of land change are valuable for providing a historical perspective on changes in land use within these regions. This information will allow some analyses and assessment of the possible factors, events, and policies that have influenced these changes. These studies, therefore, provide an important background for informing current management, planning, and policy activities. Descriptive studies of land use/ land cover change have already been completed for four sites and documents reporting these results are in varying stages of being finalized: the Tomatirenda and the Rio La Sal watersheds (Bolivia) for 1967 and 1997, the Ayuquila River, the Ejido Zenzontla (Mexico) for 1971, 1993, and 2000, and the Cosanga watershed (Ecuador) for 1997 and 2000.

Impact on livestock production, natural forests, and watershed serves by the expanded cultivation of agave azul. Agave azul (*Agave tequilana* Weber) is the variety of agave used in the fabrication of tequila. Tequila, one of the most important cultural and commercial national drinks of Mexico, is experiencing a boom in popularity and demand in the international market. In response to this increase in demand and future promise, cultivation of agave azul has expanded dramatically in the last few years in Project PLAN's study area in Jalisco, generating major changes in land cover/ land use. This particular cash crop has introduced a unique set of constraints on land use, since it requires seven years to reach maturity, during which time the entire plant is harvested. The long-term, up-front investment required can only be undertaken by large enterprises renting land from local producers. The new crops of agave azul require large blocks of open land resulting in a shift in crops such that large blocks of domestic maize and pasture are taken out of production for seven years and/ or new lands are created by additional clearing of natural vegetation including tropical deciduous forest, which serves as an important source of non-timber forest products and cattle grazing as well as being important sites for biodiversity with high levels of endemism (see Activities Three and Four). What makes this land use conversion even worse is that intercropping with other commercial or domestic crops or even with cover crops is typically prohibited. As a consequence increased use of agro-chemicals are required and heavy rates of soil erosion result with serious consequences for the watershed and future land use options. When the agave was grown on a smaller scale, local producers often employed traditional methods with inter-cropping thus maintaining soil cover and also deriving additional benefits from some of the interplanted crops.

The PLAN-Mexico team has been active in documenting these recent changes in land use/land cover change due to this new expansion of agave azul and evaluation of its environmental and socio-economic impacts with the objective of generating more sustainable alternatives and designing effective strategies and policies to protect the environment and promote a better model for sustainable economic and social development in the region.

Objective 2.3: Promotion of restoration of watershed protection forests.

The Ayuquila River is seen by local farming communities as a critical source of water for irrigation, livestock, and drinking and is also seen as a resource in danger of being lost due to pollution and changes in water flow. Through different regional initiatives of the PLAN-Mexico team, including interaction with several PLAN activities (including environmental education), local communities and stakeholders have become directly involved in activities to improve the situation. One of these activities is the restoration of riverine forests along the river. This past year, 2,100 seedlings of native tree species (1,300 provided by the project community tree-nursery in Zenzontla) have been planted along the Ayuquila River by students and local groups.

Objective 2.4: Analyses/studies documenting the current status and trends in water management issues within the study area watersheds.

The Rio Ayuquila is important to marginal farming communities along the river as a source of protein (fish) and as a supplementary source of income for some families through the sale of fish and chacales (endemic crayfish sold as 'shrimp'). Pollution in the river from untreated sewage, sugar refinery wastes, and agriculture has seriously degraded the quality of water and the abundance and diversity of fish. Efforts over the last few years to reduce sources of pollutions and to recuperate the watershed of the river have resulted in demonstrable improvements. Systematic monitoring of biological indices in the river over the last year (four samples for fish and six for aquatic invertebrates) has shown increases in populations of both groups.

Activity Three: Understanding the Dynamics of Extensive Livestock Production

Objective 3.1: Elaboration of an analytical framework to understand the dynamics of semi-extensive, extensive, and transhumance livestock production systems.

Extensive livestock production systems (ELS) are characterized by the large scale over which the animals are deployed and by the apparent low level of inputs invested in the production. In Latin America, extensive cattle systems have been targeted as a primary cause of deforestation as well as a cause of increased social and economic inequality. Furthermore, cattle as exotic species, partially supported with widespread planting of exotic and invasive grasses, have been implicated in multiple aspects of environmental degradation. If this story is true, then what are the options to achieve sustainable production?

Project PLAN, as both a development and research project, began by examining whether this story is true. An integrated, collaborative, and community participatory study of the nature and dynamics of four different ELSs in Bolivia, Ecuador, and Mexico reveals much greater complexity and multiple coherent stories. Here we present some of the perspectives we have learned from this study in progress.

Two initial points are important to consider: 1) Diversity of ELSs. ELSs have been developed in both traditional form and more recent variants in a wide range of environments in many areas of the world and show a wide range of variation in component and dynamics. In Latin America, ELSs are often associated with shifting (slash & burn) agriculture and may include the practice of interplanting crops with grasses to increase the

production of livestock forage. The forests themselves are often included as a component of the foraging systems, particularly so where the climates show strong seasonality in rainfall.

2) Variations among system components. The extensiveness or intensiveness of livestock production systems is a relative distinction-not only do systems labeled as "extensive" vary in their degree of intensification, but, more significantly, they vary in the degree of intensification among the different components of these systems.

A few of the general components of a livestock production system are compared in Table 1 with respect to possible simple characterizations of intensive vs. extensive expressions. We can offer examples where the degree of intensification of any single factor does not necessarily co-vary with the other factors. As an example, some ELSs in Latin America may be so "extensive" in all components that the animals behave and are treated as feral (e.g., mustangs). Contrast this with "extensive" transhumant systems in southern Bolivia where the high level of attention paid to the cattle may be designated as intensive within the simple comparisons portrayed in the table. Even the unimodal characterization of individual components, such as management, has not been useful for understanding. Extensive production is not synonymous with a lack of management. One may argue that management occurs in all production systems: the differences between systems are related to differences in the type of management.

Animal size and management implications. The type and degree of intensification of a production system can be seen as an outcome of a complex interaction of a series of biophysical and socio-cultural-economic factors. Within a given landscape, the size of an animal, coupled with its needs and risks, is often manifested as an overlapping series of concentric areas in which small animals are kept close to the homestead, medium-sized animals maintained within the daily domain of control from the homestead (typically on the property of the farm), and larger animals arrayed over a much larger area. This series suggests that intensification of production might be expected to be greater for smaller animals.

However, in farm communities dominated by small landholders, the radius of areas used by cattle may frequently be greater than the area owned or controlled by individual farmers. The problem of having access to appropriate land (sufficient in quality and extent) increases in complexity in seasonal environments, such as occurs in our sites in Bolivia and Mexico. Under these conditions, individual farmers with cattle must negotiate arrangements with neighboring landowners to obtain access to the type and extent of land needed to maintain their herds. Successful production for these farmers requires managing complex social interrelations complicated by environmental variability in time and space.

Forage availability in time and space. In west central Mexico and in southern Bolivia, strong seasonality alters the temporal and spatial availability and quality of sources of forage. In west central Mexico and in the Timboy area of Bolivia, cattle are moved into the forest to feed during the wet season while pasture and crops are growing outside the forest; then, at the end of the rainy season after the corn has been harvested, the cattle are moved out of the forest to feed in mature pastures and on stover in harvested corn fields. The changeover periods may often be critical, due to variability in the length and intensity of the rains. Poor quality and availability of

forage at the end the dry season may result in loss of animals that are already weak or stressed. A sample of body condition of herds near Timboy, Bolivia, at the end of an extended dry season showed one fifth of the cows to have a score of 0.75 out a scale of 1 to 5. Farmers can compensate for difficult times by selectively moving particular cattle.

The choice in cycle is not a simple one. Figure 4 (following page) shows two sequences of the seasonal movement of cattle between forest and pasture/cropland. Cycle A shows the movements described for west central Mexico and the Timboy area of Bolivia. Below that, cycle B shows the movements followed in the La Cueva area of Bolivia, which is the REVERSE pattern. At this site, the cattle feed in the pastures through the rainy season as they are growing; then, they move into the forest to browse during the dry season. Why? This site is wetter than the others; the rains come in the winter season when it is cooler. The farmers say that the cattle do not do well in the damp, cold forest, and that cattle in forest then contract higher parasite loads. However, in dry season, the forest still retains substantial forage for the cattle after the pastures are done growing. Both cycles are compromises, but the costs are different.

Getting access to land and forage—alternative social pathways. The reported "multiple coherent stories" arise from the different pathways through which such management is achieved. For example, in Zenzontla, Mexico, producers achieve access to the space needed by renting land; whereas in La Cueva, Bolivia, producers obtain use of the necessary land through reciprocal access agreements among neighbors. This extensive management system permits resource-poor

Table 1 - Variation in components of intensive vs. extensive livestock production systems. Shaded cells indicate typical components in the extensive systems studied.

System	Intensive		Extensive
Area	Small	Medium	Large
Movements	Confined	Fenced	Free
Food	Concentrates	Planted	Natural
Reproduction	Artificial Insemination	Selective	Open
Health Treatment	High		Low
Predation Risk	Low		High
Inputs (labor/resources)	High		Low
Management	High		Low

farmers to maintain more animals possible within the limitations of their individual lands. The lower management requirements allow allocation of limited resources and labor to other activities. The disadvantages that arise from intermingling of herds are:

- Higher parasite loads and more rapid spread of disease.
- Inbreeding and lower rates of reproduction.
- Poor quality forage and, therefore, underweight and poor condition.
- Poor condition decreases resistance to disease and predation.
- Higher risk of predation.

Agricultural options to improve the system. Various options to improve these Extensive Livestock Production Systems are being studied through participatory action research with individual farmers, local

Figure 4 - Typical seasonal migration shift of cattle in Mexico and Bolivia.

A - Typical Seasonal Migration Shift of Cattle:
Wet Season Feeding in Forest
Dry Season Feeding in Pastures and Crop Residues

B - Reverse Pattern Followed by Cattle in La Cueva:
Wet Season Feeding in Pastures
Dry Season Feeding in Forest

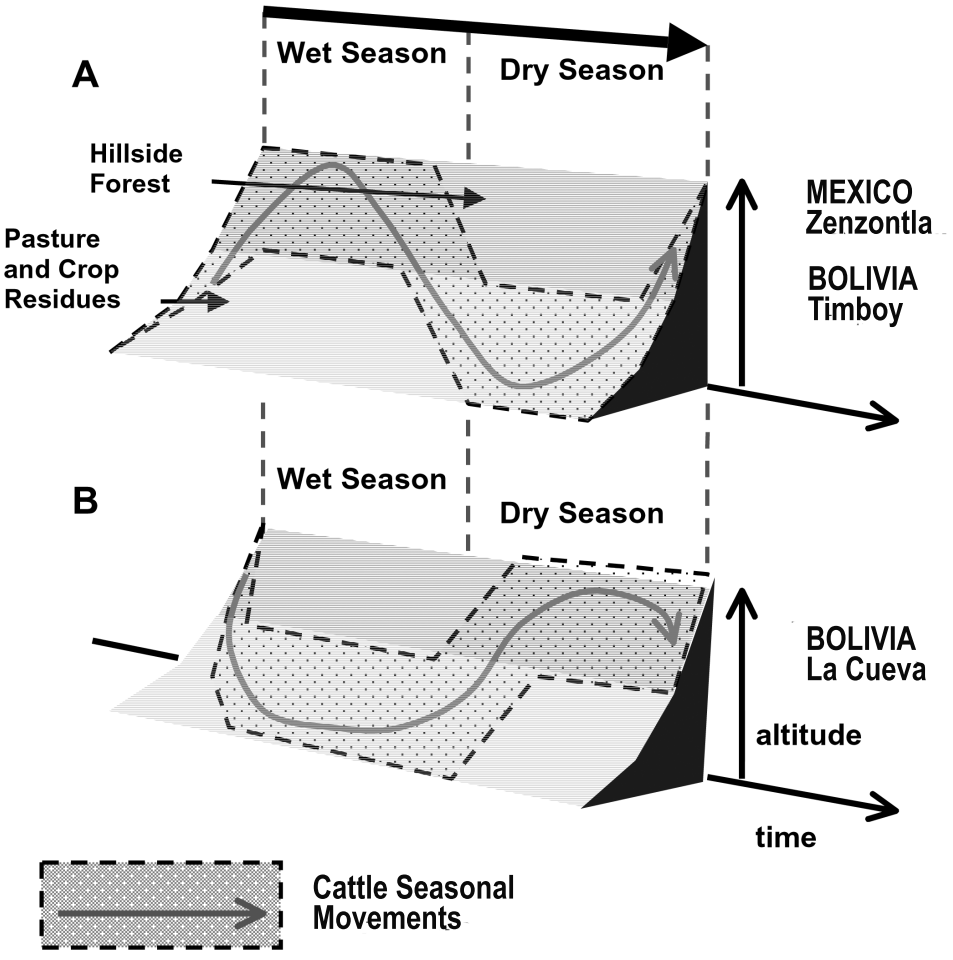
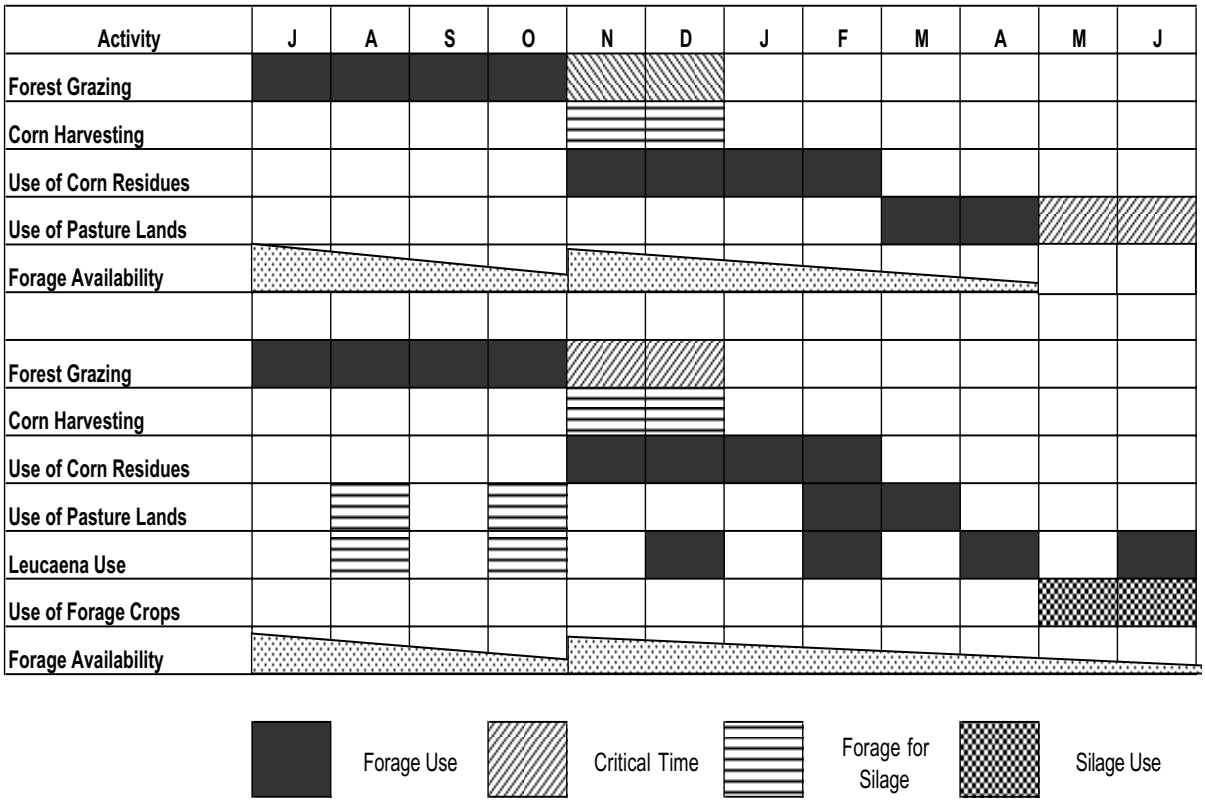


Figure 5 - Current forage management (above) and proposed forage management (below).



producers' associations, and farming communities. Figure 5 provides a comparison between the current ELS being followed in Zenzontla, Mexico, and a proposed system to improve the availability of forage throughout the year. The proposed system includes several integrated components including agro-forestry, new forage crops, and silage. Other options dealing with animal breeding and health are also being considered. These options, however, must be considered within the entire environmental and socio-cultural economic system of the locality.

Interaction of factors revisited. Consider the following series of hypotheses influencing the type of production system, investment in the system, and options for intensification:

- The lower forage productivity/ha, the more space/head needed.
- The larger the type of livestock, the more space/head needed.
- The greater the foraging area/head needed, the lower the growth rate and hence potential value/head.
- The greater the foraging area/head, the less control possible.
- The lower the value/head, lower market prices, and higher costs of inputs lead to lower input/head in resources or labor.
- Lower land tenure security; lower likelihood of investment in land improvements.

In conclusion, cattle production should be examined within a holistic context, including social, economic, cultural and ecological aspects.

Objective 3.2: Analysis of impact of cattle foraging on native vegetation and regeneration.

In Mexico, researchers have cataloged 423 plant species eaten by cattle in the Sierra de Manantlan. Of those species, cattle eat the foliage of 201 species, flowers or fruits of 47 species, the meristem of three species, and the entire plant of 34 species (the parts eaten for the remaining species have not been recorded). The distribution of these forage species according to plant family is interesting: while the greatest number, 105, are of the family *Graminae*, there are also 77 species of *Leguminosae*, 32 of *Malvaceae*, 15 of *Verbenaceae*, 14 of *Compositae*, and 13 of *Moraceae*.

Among tree species preferred as forage by cattle, several are important candidates for agro-forestry uses (for livestock forage as well as other uses): *Brosimum alicastrum* (mojote), *Enterolobium cyclocarpum* (parota), *Guazuma ulmifolia* (guazima), *Sideroxylon capiri* (capiro), *Prosopis laevigata* (mesquite), *Chiocca alba*, *Bernardia gentryana*, *Ziziphus mexicana* (amole), *Pisonia aculeate* (garabato prieto), *Acacia riparia*, and *Leucaena esculenta*.

Within these agro-ecosystems, while some exotic grasses (e.g., *Chloris cayana, Andropogon gayanus,* and *Panicum maximum*) produce more biomass than most native species, some native species (e.g., *Verbesina greenmanii, Leucaena esculenta*, and *Acacia riparia*) provide high levels of crude protein (see publication Carranza, et al. 2002). There are also a number of native species of grasses (*Tripsacum, Ixophorus, Paspalum, Ripidocladum, Chusquea, Lasiacis*, and *Pharus* spp.) and, particularly, legumes (*Giricidia, Crotalaria, Phaseolus, Melilotus, Desmodium, Aeschynomene, Acacia,* and *Canavalia* spp.) that have high potential as important forage species. The tropical dry forests present several advantages over typical monocultures of exotic grasses since the forests provide overall higher levels of biomass and a diversity of forage species spread throughout the year. In addition to livestock forage, these tropical forests also provide many other valuable products for local farming communities, such as foods, medicines, and wood.

Objective 3.3: Evaluation of the options and consequences of the extensive livestock production systems.

Mexico. The Mexico team is developing a book of contributed papers on the "Current State and Perspectives of Extensive Livestock Production in the Sierra de Manantlan (SM)" (Estado Actual y Perspectivas de la Ganaderia Extensiva en la Sierra de Manantlan). The book will be comprised of sections on the current state of livestock production in Mexico, and, within the Sierra de Manantlan region (the focal region of Project PLAN), sections on livestock production and society, the interaction of livestock and biodiversity, the dynamics of livestock in tropical forests, extensive livestock production in the context of a protected area, and perspectives on directions of action.

The model contemplated by livestock producers for livestock development continues to follow that of extensive livestock production with low or no investments and limited interventions from the producer, with no intensification of land use. From the view of the producers, the available resource has not yet reached its limits—they currently see the existing forest as providing sufficient forage during the rainy season. The limiting factor for livestock development has been the lack

of available forage at the end of the dry season. The solution adopted has been to transform forested areas (which have been the source of forage during the rains) into planted pastures to serve as the source of forage as much in the rainy season as in the dry season and with a higher production of forage per hectare than is currently available. Due to the lack of regulations on land use practices, this conversion of forests to pastures will probably accelerate through the region. Such a conversion represents a serious problem for the future since extensive livestock production is not sustainable under current practices with multiple negative impacts, such as the higher rates of soil erosion from pastures and the increase in the spread of destructive forest fires due to burning of pastures. Further conversion of forests to pasture, with the associated degradation of soils and watersheds, will reduce the ability of these agro-ecosystems to maintain this type of exploitation, as well as reducing the possibilities for other options.

From multiple perspectives—social, economic, and ecological—cattle production has great implications in the future for the Sierra de Manantlan as well as other similar regions of Mexico. The problem of development and conservation in this region of Mexico will be closely tied to the production of livestock in the future. Sustainable livestock production appears to be possible only by maintenance of the diverse tropical dry forest and protection of its soils, to be accomplished through sustainable use of the forest for livestock forage and appropriate use of its other beneficial products and services. Successful agro-silvo-pastoral systems using some of the native leguminous, forage species may well play a valuable complementary role with the forests by increasing the sustainable production of crops outside of forests for dry season forage; however, these systems should not be seen as suitable alternatives to the multiple values and high diversity of the dry tropical forests themselves.

Bolivia. *Introduced agro-silvo-pastoral cattle production system.* Livestock production within this region is primarily extensive and is often the cause of severe ecosystem problems: soil erosion, soil compaction, loss of soil fertility, loss of forage species, invasion of undesirable weeds, and degradation of the watershed. In collaboration with PLAN, Centro de Estudios Regionales y Desarrollo de Tarija (CER-DET) has been working with the Guarani to introduce a different, potentially more ecologically sustainable system of cattle production through a complex agro-silvo-pastoral management system appropriate to the biophysical conditions of this zone and adapted to take advantage of local vegetation structure. The strategy of introducing this cattle production initiative in the Guarani communities in the Itika Guasu region was designed to contribute to the local management of indigenous Guarani territory with two principal objectives: a) to improve the quality of life through diversification of livestock and increased commercialization; and b) to use this activity to promote greater local participation of the Guarani people in decision-making for the sustainable use and management of natural resources at communal and regional levels within their indigenous territory.

Analysis of transhumant cattle production systems in Tarija. Cattle transhumance is a practice encountered in various parts of the world. It arises where environmental conditions determined by the presence of mountains and seasonal variation in the production of forage imposes a system of family herd management that permits the translocation of the herds, or parts of them, between different ecological zones to track

favorable environmental conditions as they appear throughout the annual cycle. It is a practice of montane environments, whose ecological basis is the altitudinal migration of mammalian herbivores that follows the phenological wave of forage production along altitudinal gradients. It is also a practice directly associated with small-scale family production units, which typically occur in these landscapes. Their production systems are typically extensive in character, involving a great diversification of activities and the use of the greatest area of land possible. These family systems are characteristically isolated and marginalized.

Raising livestock in these variable and generally nonproductive montane environments of Tarija requires small producers with limited access to fertile land to seek spaces suitable for the livestock but not good for crop cultivation. Livestock production depends on the potential productivity of natural pastures, which in turn varies seasonally and altitudinally. The seasonal movements of family herds among different ecological zones and altitudes provide a means to overcome this environmental contingency in these montane regions. Transhumance is a possible alternative in western Tarija due to the conjunction of three different ecological systems: 1) the alpine grasslands of the high mountains and hills that surround the central valley of Tarija; 2) the pastures in the central valley; and 3) the montane forests covering the foothills of the lower Andean mountain ranges stretching out east of the central valley. Transhumant families move their herds seasonally among these three ecological zones from one space to another, in the form of discontinuous territories, rather like an archipelago of productive islands. The groups of transhumant farmers have developed an effective order in which to use these areas, a cultural institution that controls the collective management of these discontinuous but strategically linked "production territories.

In this manner, a space of interaction and interdependence is constructed between livestock producers and individual places—constituting an institutional arrangement creating a collective management territory for livestock production that includes biophysical and socio-economic dimensions, generating a transhumant territory.

Through this mechanism, inaccessible areas are incorporated into regional economic circuits, as is the case with the winter pasture sites, which would probably be empty were it not for these customary transhumant systems. The occupation of this inaccessible territory by the transhumant producers has likely favored the maintenance of environmental quality that provides efficient environmental services.

This transhumant cattle production system has thus evolved into an institution that fulfills various functions, including the strengthening of cultural identity based on the farmers' production practices. It also favors the incorporation of livestock production under local control of transhumant households and communities. The transhumant cattle production system is, by definition, part of a logic of diversification that permits farm families to reduce their risk in the context of constant change; therefore, it is part of a viable strategy in the fight against poverty.

The re-evaluation of these transhumance cattle production systems is important, along with the reconsideration of the Tolomosa-Lacajes transhumant cattle production system, as a viable alternative for local development. In the interests of the sustainable development of the region, this interesting livestock production practice should not be ignored. Its

cultural, economic, ecological, and political implications are of vital importance for the large part of the rural population of the territory studied here.

Activity Four: Optimizing the Interactions between Biodiversity and Agro-Ecosystems: Conflicts and Uses of Animal and Plant Species

Objective 4.1: Development of an analytical framework of the interactions between production systems and biodiversity.

This objective is scheduled to be completed by a special biodiversity group formed with representatives from each of the Project PLAN teams. The group is planning a book containing the diverse wildlife/ production system interactions, followed by syntheses including an analytical framework.

Objective 4.2: Assessment of the nature and impact of several key conflicts between wildlife and production systems.

Impact of extensive grazing on biodiversity. There are changes in forest dynamics and forest plant communities due to compaction, differential selection of preferred forage species, elimination of rare or preferred plant species, and increased dissemination of seeds of both exotics and open habitat plants into the forest interior in new openings and sites disturbed by livestock activity.

Forest degradation also results in the modification of microhabitats, a general increasing in the levels of light and heat accompanied by a reduction in availability of humid microsites needed by amphibians, as well as by some species of lizards, snakes, shrews, and rodents. Other effects include the deterioration of riparian zones, affecting multiple species of amphibians, turtles, and fish, as well as riparian mammals such as otters.

Forests also experience fragmentation and loss of natural habitats, affecting: a) forest-dependent species, especially those dependent on interior and/or dense, tall forests; b) those species that require larger blocks of forest such as mountain lions and jaguars, deer, several species of bats and rodents, and a number of of endemic bird species. There is an increase in some species that are favored by the changes noted above. These include more widespread open-habitat and forest-edge species, such as cowbirds, which results in a greater negative impact and competition with native forest-dependent species.

Crop depredation by rodents: evaluation of the ecological effects of rock barriers created for soil conservation in Mexico (M). All management actions have multiple effects, several of which were not intended and/or not taken into account in planning. In Mexico, one of the soil conservation practices (introduced prior to Project PLAN) has been to move the many stones in crop fields to create rock barriers along contour lines, impeding soil erosion. While this practice has continued to be encouraged under Project PLAN, we have also instigated an evaluation of the practice in terms of: 1) the values of these barriers for reducing soil erosion, and 2) evaluating their effect on the attraction of fauna into the fields. These rock barriers may attract some fauna, such as rodents, that may be pests of grain crops; however, they may also provide beneficial refuges and foraging sites for native species that are beneficial and/or of concern to conservationists.

Amphibians and reptiles found included frogs (*Eleutherodactylus hobartsmithii*) and lizards of the genera *Sceloporus,*

Cnemidophorus, and *Anolis,* and juveniles of the iguana species, *Ctenosauria pectinata*. These species use the barriers as a refuge during the dry season. The principal mammals found include four rodent species: *Liomys pictus, Sigmodon mascatensis, Reithrodontomys fulvescens,* and *Baiomys musculus*. The rock barriers provide the rodents safe refuges from predators. These rodents are most abundant in the fields during the rains while the crops are growing, and breeding in these species corresponds to this time of peak production. The first two species were most abundant in these cultivated fields and are considered by local farmers to cause serious damage to crop production.

Cattle depredation by Spectacled Bears in Ecuador (E). Severe depredation of cattle occurred in Project PLAN's target communities, with more than 25 cases of cattle attacked by the endangered spectacled bear in the year 2002. No previous cases were known in this area prior to these attacks. A study by PLAN researchers described the situation and presented hypotheses about possible causal factors leading to this unusual and costly case of livestock loss for the local farmers. This case was all the more important due to the high global value placed on the endangered Andean Spectacled Bear—the only bear species in South America. An undetermined number of bears were poisoned by local farmers in response to these episodes of depredation. The attacks appear to have stopped since a local hunter killed the bear thought to be responsible for the majority of the kills. Studies conducted by PLAN researchers working with local farmers produced the following two recommendations to reduce the likelihood of future losses and to decrease the damaging conflict between livestock and this potentially valuable endangered species.

Reducing risk of attacks on cattle in high slope pastures. The unusual switch of behavior that causes bears to begin attacking cattle appears to be engendered when a bear is first able to feed at the carcasses of dead cattle left in high altitude pastures, areas without frequent human presence which are close to forest edges. Therefore, one obvious preventive practice to reduce the likelihood of future bear attacks is for cattle producers/caretakers to check their herds regularly and bury or remove any dead cattle.

Changing the use of high altitude forested areas from pasture to forestry or scientific tourism. The high altitude pastures offer poor short-term benefits. Allowing the restoration/ regeneration of these pastures to forest (with or without enrichment planting of native timber species) would provide future value for timber production and would restore critical habitat to the Andean Spectacled Bear. Due to the high interest of the world conservation community in the Andean Spectacled Bear, organizations of local farmers and landowners have a good opportunity to promote "scientific tourism" through collaboration with Project PLAN conservation NGO partners Fundación Antisana (FUNAN) and Alianza Jatun Sacha/ Centro de Datos para la Conservación (JS/CDC). Income from scientific tourism centered around the bear and high avian biodiversity of the area could augment local farmer household income as well as providing a fund to compensate those local farmers who lose cattle to bears.

Crop depredation by birds in Bolivia (B). A systematic study of depredation by birds on maize was made on six parcels: three located near the river (lowlands with better soil) and three located near the forest (steeper slopes). Depredation on the maize crops was made during the time of seeding and germination and during the time of harvest. The principal birds identified as pests for maize were parrots and parakeets (principally

Pyrrhura molinae and *Pionus maximiliani*), a jay (*Cyanocorax chrysops*), an oropendula (*Psarocolius decumanus*), a thrush (*Turdus rufiventris*), and a cowbird (*Molothrus badius*). During the period of seeding and germination (October to November), the losses were very low, estimated as 1.4% in fields near the river and 1.6% in fields near forest. During the time of the harvest (from the maturation of the maize to the harvest—April to June), losses were estimated as 11.4% in fields near the river and 14.5% in fields near forest. The difference in losses was significant between the seasons but was not significant between fields near the river compared to those near the forest. These losses were not seen as of great importance; however, in years with a poorer yield, the losses may well be more important. The higher losses when the maize is mature could be reduced significantly by harvesting the maize as soon as it is ready. Further study is needed to identify and assess economically feasible alternatives to control depredation by birds near the time of harvest.

Objective 4.3: Analysis of the importance of subsistence fishing activities within the Ayuquila River watershed (M).

The subsistence and artisanal fishery of the Ayuquila River is of major importance for the well-being of rural communities in the Sierra de Manantlán Biosphere Reserve. The fishery is unimportant in a commercial sense because there are multiple economic activities in the region. However, it has tremendous value for nutrition, recreation, social bonding, and as a source of traditional knowledge for river restoration. The fishery has been affected by environmental problems including pollution and overexploitation. Some amelioration of these problems has occurred as a result of the intervention of reserve managers and researchers. However, fishermen in the Ayuquila are under-represented stakeholders in river management strategies and their opinions on environmental quality and management of the river should be included in larger-scale strategies. We presented a description of the fishery of the Ayuquila and the results of surveys regarding the perspective of fishermen towards environmental quality and river management. We suggested some strategies that could improve the condition of the fishery in the Ayuquila. Riparian subsistence fisheries are little studied in the world, but represent a core process in regional management schemes. Our study strategy gives light to studies that should be carried out in other reserve areas where the well being of rural communities is coupled with the conservation of natural resources.

Objective 4.4: Development of environmental education/environmental plan to engage local people in generating alternatives based on the use of biodiversity.

In Mexico, local educational programs aimed at children and families using birds, nature, and conservation themes have been used as a means to raise interest in local people involved in nature and environmental problems. This is part of a strategy to increase the participation of local community members in the process of identifying problems and in the activities of Project PLAN. As part of this strategy, they are preparing pamphlets and bulletins describing the activities and research of Project PLAN investigators in ways that are accessible and relevant to local communities—producers and their families. The participants of Project PLAN are committed to working with the communities in the project's study area for the long-term, so these strategies developed under Project PLAN will be continued.

Activity Five: Experimenting with Forages, Crops, and Agricultural Management Practices to Improve Production and Sustainability of Agro-Ecosystems

Objective 5.1: Experimentation with pasture improvement through improved forage mixes.

A farmer-managed study was conducted in the community of Las Palmas, Ecuador to quantify changes in milk yield that result when the legume lotus (*Lotus uliginosis* Schkuhr) is included in pastures dominated by kikuyu grass (*Pennisetum clandestinum* Hochst). Milk yield data were collected from dairy cows (*Bos taurus*) during three separate grazing rotations. Each rotation consisted of up to 11 paddocks that were divided into three treatment groups according to the percent lotus of total vegetation within each section. Treatments were the following: 1) greater than 15% lotus; 2) 10 to 15% lotus; and 3) 0 to 5% lotus. Following data collection, an enterprise budget analysis was conducted to compare monetary returns on conventional, semi-improved, and improved pasture systems. Results from this research demonstrate that incorporating lotus into kikuyu grass pastures has a positive effect on milk yield. In Rotations 2 and 3, respectively, individual cows grazing pasture with greater than 15% lotus produced 27 and 40% more milk per day than cows grazing grass pastures (0 to 5% lotus) (Table 2). Once established, the semi-improved and improved systems generated revenues that were 128 and 271% respectively of the yearly returns seen with conventional pastures (Table 3). The leadership role that producers assumed in this research has encouraged local and regional participation in pasture improvement activities.

Objective 5.2: Assessment and experimentation with alternative forage systems that strengthen the sustainability of the local traditional livestock production system.

A farmer-managed evaluation of improved cultivars of three forage legume species adapted to temperate climates was conducted in Las Palmas, Ecuador. Two cultivars each of white clover (*Trifolium repens* L.), red clover (*Trifolium pratense* L.) and kura clover (*Trifolium ambiguum* M. Bieb.) were

Table 2 - Comparison of dairy cow milk production on kikuyu grass pastures with three different levels of lotus.

Pasture Treatment	Daily Milk Production		
	Rotation 1 Nov.-Dec.	Rotation 2 Jan.-Feb.	Rotation 3 June-July
	---------- L cow^{-1} day^{-1} ----------		
> 15 % Lotus	6.45 a†	9.52 a	9.95 a
10-15 % Lotus	6.34 a	8.83 a	9.10 b
0-5 % Lotus	6.42 a	7.50 b	7.13 c

† Column averages followed by the same letter are not different at P = 0.05 according to Fishers protected LSD.

Table 3 - Returns (US $ ha^{-1} yr^{-1}) prorated over a five-year period for conventional, semi-improved, and improved pasture management systems.

Prorated Returns (USD $ ha^{-1} yr^{-1})	Conventional	Semi-Improved	Improved
Prorated Gross Income	240	527	746
Prorated Return I †	192	440	647
Prorated Return II	191	392	588
Total 5-year Return (USD $ ha^{-1} yr^{-1})	**955**	**1961**	**2938**

† Return I = return over variable costs; Return II = return over variable and fixed costs.

sown into pastures on three farms. Establishment and performance of these legumes was poor, likely because of low soil P and pH, and they are not practical alternatives to the very well adapted *Lotus uliginosis* previously introduced to the region.

During this past year, the community tree nursery in Las Vantanas has produced 4,500 tree seedlings for forage, timber, and fruits. The great majority were used for agro-forestry to create living fences to improve pasture separation, increase soil fertility (with leguminous species), and provide cattle forage. The principal research in this area has been in Mexico, with the goal of improving soil fertility and forage availability in cultivated maize fields (M) through agro-forestry experiments with the introduction of leguminous trees (*Leucaena leucocephala* and *L. esculenta*) along contour erosion barriers within fields. Five different parcels are being studied as part of a collaborative research initiative with local farmers. After serious setbacks in earlier trials with 100% die-offs in drought years, they have achieved a 92% survival rate of planted trees in the fields. The results from experiments are now being analyzed.

Objective 5.4: Experimentation with improved crop production systems. Activities to increase the production of cultivated crops through practices to rehabilitate degraded systems.

Design and implementation for the introduction of non-native, herbaceous legumes to enable maize production on degraded soils in abandoned fields (E).

In the wet highlands of Ecuador, the conventional system of maize (*Zea mays* L.) production is an erosive and extractive process that could be made more sustainable through alternative management practices. A farmer-assisted study was conducted in the agrarian community of Las Palmas, Ecuador to test the use of lotus (*Lotus uliginosis* Schkuhr) living mulch for maize production. Treatments were no-till maize with: 1) 0 kg N ha^{-1}; 2) 100 kg N ha^{-1}; 3) 200 kg N ha^{-1}; and 4) lotus living mulch. Maize grain yields of the 200 kg N and lotus living mulch treatments were double those of the 0 and 100 kg N treatments (Table 4). But these differences were not statistically significant ($p = 0.10$) at either location and population density was not different among treatments at Location 1, but was different at Location 2. The lack of treatment differences for grain and population density may be attributed to a high degree of random experimental error. Results demonstrate that grain yields from maize produced in lotus living mulch are similar to those of no-till maize with 0 kg N ha^{-1}, the closest approximation of conventional maize cultivation. Consequently, farmers who produce maize in lotus living mulch can expect

Table 4 - Maize yield and population density under four treatments at two locations in Las Palmas, Ecuador.

Treatment	Grain		Population Density	
	Location 1	Location 2	Location 1	Location 2
	---------- Mg ha^{-1} ----------		---------- plants ha^{-1} ----------	
0 kg N ha^{-1}	1.78 a†	0.71 a	25 000 a	14 375 b
100 kg N ha^{-1}	1.74 a	0.88 a	17 500 a	16 875 ab
200 kg N ha^{-1}	3.34 a	1.65 a	29 375 a	30 625 a
Lotus Living Mulch	3.70 a	1.57 a	25 625 a	30 000 ab
CV%	84	47	39	22

† Within columns, means followed by the same letter are not significantly different according to LSD (P = 0.10).

to reap the soil remediation benefits of legume associations, with no yield loss. Maize cultivation in legume living mulch could be a sustainable, low cost, and profitable alternative to the region's conventional system of maize production, yet further study would be required before the use of legume living mulch could be recommended to farmers.

Activity Six: Improving Systems of Use and Conflict Resolution over Natural Resources

Objective 6.1: Develop a useful framework of information in each site regarding the relationship between tenure systems and natural resource management. Investigate contextual factors (economic, cultural, political) that influence the relationship between tenure systems and natural resource management. Synthesis of information on natural resource tenure systems and use of natural resources, at site level and overall project level:

- *Analysis of tenure norms and practices: formal, customary, and informal.*
- *Analysis of current legal property rights in each area.*
- *Types of access to natural resources (buy-sell, inheritance, 'arriendo', etc.) in the current system of land tenure in the zone.*

Objective 6.2: Explore the nature of conflict situations over natural resources and the use of local conflict resolution mechanisms.

An important aspect of community organization that has significant impact on livestock production systems and on natural resource sustainability is access to resources- the rules and practices that determine a family's ability to access and control land and other natural resources. Land and natural resource tenure systems vary across the three Project PLAN countries, with different property systems and different specific property rights in each site. These different property systems and rights sometimes overlap spatially, requiring careful management to avoid potentially conflictive situations. In addition, land and other natural resources are not equitably distributed among households in the communities. Although the communities are composed mostly of smallholder families, some families do not

have sufficient land to support themselves, while other families have been able to accumulate large extensions of land. Conflict over land and other natural resources is of special interest to Project PLAN because conflict often results in deficient natural resource management.

One of the primary prerequisites promoting sustainable land use is secure land tenure and secure resource use rights. In our target communities, there are residents with secure title, others with customary titles without legal papers, squatters with or without rights, residents with conflicting titles, absentee landlords, and others without access to land. Social sustainability is not feasible without some regularization of these situations. This activity is designed to clarify the legal and common law context within which these communities fall.

A full and well-developed picture of land rights in the three countries will afford us an understanding of the complexities involved in the situation. This understanding will enable us to affect policy and conditions of land tenure – if not directly, then through our work with local government, as part of the integrated nature of our project activities.

During the past year, the three countries have continued to collect information on the natural resource tenure rules and practices for their sites in order to better prevent and manage land conflicts and improve livestock and natural resource management.

In the Ecuador site (a watershed area settled over the last century, but more intensely since the 1950s by farmers from other regions), the majority of the households have legal documentation for their land. Land problems persist, however. State policy in Ecuador, particularly conflicting environmental and agrarian legislation, has been detrimental for the environment and for tenure security. Agrarian legislation that promoted settlement of Amazon frontier regions in the 1960s required clearing and cultivation of at least 50% of the land claimed by the settler household in order to claim title; that requirement was reduced to 25% in 1972. Environmental legislation, on the other hand, established national reserves in the Quijos and Cosanga watershed areas, forbidding the cutting down of forests. Often, the boundaries of these reserves included land claimed by settlers, creating land tenure insecurity among those families. Aggravating this problem is the fact that often state officials in charge of the reserves and the land titling offices are not familiar with legislative conflicts and gaps, and sometimes not even that knowledgeable about the rules and regulations of their own agency. This creates confusion and uncertainty with regard to land rights and land use regulations among the families in the Quijos and Cosanga valleys, particularly those in the buffer zones and along the reserve boundaries.

A study initiated in 2001 showed that land distribution is highly skewed and that land conflicts among households have highly negative impacts on the community. Further interviews and data analysis carried out this past year show that a significant percentage (11%) of the households in the Quijos and Cosanga valleys do not own land and must either enter into sharecropping agreements or work as day laborers. Those families who do not have legal title to the land they occupy make up 25% of landholders in the area—these families are vulnerable in that other families or the state could make a claim for the land they are working. The percentage is extremely high in some communities such as Cosanga, where 54% of the families have no legal documentation to their land. This insecurity with regard to land rights is a great obstacle to social cohesion and community organization,

particularly in those communities where tenure insecurity is highly prevalent. The impact of tenure insecurity for natural resource management is also evident in the extractive practices used by households that use short-term livelihood strategies such as lumbering. This study also found gender bias with regard to land rights. In spite of constitutional guarantees to equal property rights for men and women, it was found that in 69% of the properties with legal title, only the male head of household is listed on the title. Women held 12% of the titles and couples only 10%. Interviews revealed that even where joint title is held by the couple, in most cases the male head of household makes the major land management and farming decisions, reflecting cultural values and norms prevalent in Ecuadorian society. This control over these household's major asset—land—by male heads of household contributes to the vulnerability of women and children.

The Ayuquila River watershed in Mexico contains numerous ejido communities, a particular type of customary tenure regime formalized in the Mexican constitution. In order to have a broader picture of formal land tenure relations in the lower Ayuquila watershed, the Universidad de Guadalajara, Centro Universitario de la Costa Sur (UdG CUCSUR) collected data over the past year for eight municipal areas and established an Excel database. A preliminary analysis of the database reveals that while private property is the dominant property form (66%), ejidal land represents a strong 34% of the production land. Ejidos in Mexico have been undergoing change since the early 1990s when legislation was passed that liberalized property rules with regard to ejido land rights, approximating them to individualized private property. It appears that in the Manantlan area, ejidos have been cautious to adopt full private property rules. A possible reason for this caution is to avoid conflicts that may arise from parcelizing ejido land and granting full property rights to current occupiers.

Earlier PLAN research in one ejido (Zenzontla) showed that in spite of egalitarian rhetoric with regard to ejido land access, distribution of land rights was not only somewhat concentrated, a substantial number of community families (51%) had no access to land or only indirect access. During this past year, a study in another community (Ahuacapan) revealed that 47% were landless and that the Gini coefficient (for land concentration) was high: 0.86.

Future land tenure work on the Ayuquila watershed will break down the municipal-level data by locality in order to have a more detailed picture of land tenure relations. UdG CUCSUR also plans to study land conflicts in the Zenzontla ejido in order to establish with the community a conflict management process for the resolution of these disputes.

The team working on land tenure and conflicts in Bolivia has studied two very different situations. La Cueva is a community of smallholder farmers and livestock producers. Pasture requirements over the summer and winter seasons oblige livestock owners to move their herds, at times causing conflicts over access to land for either grazing or simply passage. Formal legislation does not adequately deal with these types of land conflict situations. While the potential for these conflicts is high, research has found that informal rules and practices among smallholder groups, driven by the need to keep disruptive conflicts at a minimum and the need to assure future access to land, avoid the escalation of disputes into legal and/or violent conflicts.

The other Bolivian site is a Guarani indigenous community in Tomatirenda that has experienced the loss of most of their land

through the invasion of large livestock producers. In its 1995 constitution, the Bolivian state recognized indigenous territorial rights and the Guarani communities in southern Bolivia have attempted to reclaim their land. The regulations of the 1995 legislation, however, permit "third parties" (in this case, the livestock owners) to make their claim for land first; the amount these "terceros" are able to claim is based on the amount of livestock they own—5 hectares per head of cattle plus 30-50% more land for future herd growth. The Guarani communities are then allocated land in unclaimed areas. Project PLAN has provided some support to this process, particularly in paralegal support.

A monitoring of the ranchers' claims has found that the sizes of their livestock herds are inflated in order to obtain more land. The result is that more land is allocated for the cattle of ranch owners than for the human beings living in the Guarani communities. A study by CER-DET found that Guarani communities were allocated an average of 1 hectare per family while ranch owners were allocated 7.5 hectares per head of cattle—medium-sized ranches range from 500 to 2,500 hectares and there are large ranches over 2,500 hectares. CER-DET has worked with the Guarani communities in assisting them with legal and technical assistance to monitor the allocation process by verifying the actual existence and sizes of livestock herds. This assistance has included the training of local leaders and paralegals in the communities. As a result of the training and monitoring of the allocation process, the Guarani communities have identified 67,000 hectares of unclaimed land for Guarani communities and have detected false herd size claims, making available another 40,000 hectares.

Smallholder families in the project communities of all three countries face land tenure problems. The most prevalent are: (1) concentrated land ownership structures leaving many households with little or no access to land, and (2) conflicting rules and regulations among state agencies regarding land rights and land use. Both of these problems contribute to land tenure insecurity and poor management of natural resources. These situations may then result in conflicts over land access, land rights, and land use among smallholders and between smallholders and state agencies. An understanding of these conflict situations permits communities and households to more effectively resolve conflicts or transform them into positive socio-economic change.

Activity Seven: Improving Food Security and Health at the Level of the Family and Community

Food-based approaches are often illustrated as a sustainable approach because the process empowers individuals and households to take ultimate responsibility for the quality of their diet by growing their own nutrient-rich foods and making informed consumption choices.

Objective 7.1: Validation of a food security instrument.

In the past, focus groups were used prior to the survey and the following issues were examined: local perception of food insecurity, concepts, causes, consequences, and strategies to confront the event. The focus groups were combined with transects and in-depth interviews. Cognitive testing was conducted on each of the items included in the food security scale. Wording on the items for the survey was changed based on the results of this testing. These activities were focused on the goal of the assessing the validity of an easy-to-apply

food security tool in the communities where Project PLAN works, and to examine the correlation of the food security scale with household food supply and socio-economic variables.

Factorial analysis confirmed existence of different levels of food insecurity. The results showed that internal consistency of the scale was good in all three countries. The following data were produced. Mean food security score (number of questions responded affirmatively): Bolivia: 10.6 (± 5); Ecuador: 6.6 (± 3.9); Mexico: 8.8 (± 4.1). Although the frequency of affirmative responses differs from one country to the other, with a lower frequency of affirmative response in Ecuador, the pattern of response among the three countries is very similar. Final conclusions are summarized below:

- The more severe the level of food insecurity, the lower the number of food items in the household at the time of the survey.
- The results confirm the findings of a previously conducted qualitative food security assessment: diet of the majority of families living in the PLAN work areas is high in carbohydrates and low in micronutrient rich foods, especially in Bolivia and in Mexico.
- Social-demographical variables showed low correlation with food insecurity, although the trend was expected.
- Bolivian communities showed the highest level of food insecurity, followed by the Mexican communities.
- The small sample size and the low variability within the sample (especially in Bolivia and Mexico) imposed limitations on the analysis and could have affected the results.
- Despite the small sample size, the Ecuadorian sample had a higher variability, which explains the differences in the results between Ecuador and those of Bolivia and Mexico.
- The food security questionnaire is a useful tool to monitor and evaluate interventions to improve the food supply, both quantitatively and qualitatively.
- Other indicators need to be explored and included in the food security questionnaire.
- More research is needed to evaluate the correlation of the food security scale and dietary intake.
- Future validation studies should include a larger sample size and more variability within the sample for validation.

Objective 7.2: Farmer experimentation projects.

The preliminary results of the farmers' experimentation for food security can be summed up in several conclusions made by the community workers in Bolivia, where the experimentation has begun full scale:

- The government of Bolivia has failed to recognize the poverty that causes food insecurity in the rural areas of the country. Food security for all the nation's people should be made a priority on which to focus.
- The government of Bolivia should be obligated to guarantee access to resources such as credit, technology, infrastructure, basic services, health, roads, and employment for all in order to fight poverty.
- Indigenous knowledge must be heeded and promoted by institutions immersed

in rural development as a way to generate new forms of participatory investigation.
- The Bolivian government should create a new mechanism, separate from the Agrarian Reform of 1952, which allows more equitable land access to the rural population.
- Macroeconomic policies should be revised in order to better accommodate the rural areas.
- On the institutional level of the NGO, an issue that must be addressed is the fact that problems arise when development institutions conduct research over the long term, and the local people feel that the only benefit of that research in economic terms is for the researcher himself.

Objective 7.3: Home gardens and irrigation in Mexico.

A program for the establishment of backyard vegetable gardens was begun this year in the community of Ventanas. This program provided six families with irrigation pumps and seeds for starting the gardens. The only requirement of the program on the part of the farmers is the preparation of the soil and maintaining fencing to protect the area from damage caused by animals. Vegetables planted (chosen by the members of the community) were lettuce, cucumbers, cabbage, squash, tomatoes, cilantro, and onions.

Objective 7.4: Initial analyses and evaluation of local perception of impact of household or community plant preparation on household food security in Mexico.

Barbara Whitelaw, from the International Agricultural Development program at UC Davis, did her Master's thesis on this part of the project. Her P.A. was Dr. Lucia L. Kaiser in the Department of Nutrition at UC Davis. Following is a synopsis of her study, entitled "Nutritional Implications of Living in a Biosphere Reserve in Sierra de Manantlán, Jalisco, Mexico." This study explored the use of wild plants and perceptions of food insecurity in the reserve, by pursuing the following objectives:

1. Identify edible wild plants used in the reserve and explore reasons for their increase, maintenance, decline, or disappearance based on in-depth key informant interviews and information from the management agency of the reserve.
2. Explore, via key informants, cultural aspects of gathering edible wild plants by season, locality, food preparation techniques, and dietary uses, including the incorporation of wild plants into home gardens.
3. Determine the relationship between wild plant use and food insecurity using household survey data.

Results. At the start of the wet season (July and August), a limited number of edible wild plants were available for gathering. With key informants, the author gathered voucher specimens and information on 18 different species. Five species of fungi and wild plants were noted, but not collected due to scarcity and/or difficulty of identification by botanists at the University of Guadalajara, Autlán. One 44-year-old woman who lived on the riverside of the reserve noted a definite decrease in the use of edible wild plants and foraging activity in general. Subjects recognized the relationship between decreased availability of wild plants and agricultural practices, with increased chemical use thought a cause of decreased wild plant availability.

With the exception of cactus (*Opuntia*) species, wild plants were rarely transplanted into home gardens. Feelings of shame and

Table 5 - Food insecurity scores and percentages of households that collect wild plants.

Food Insecurity Score	Total Households in Reserve that Collect Wild Plants n (% of Total Pop.)		# Households Located in River Side n (%)		# Households Located in Forest Side n (%)	
	Yes	No	Yes	No	Yes	No
Food Secure (0-2 [1])	3 (2)	0	3 (7)	0	N/A	N/A
Food Insecure without Hunger (3-7 [1])	19 (18)	26	12 (26)	7	7 (12)	19
Food Insecure with Moderate Hunger (8-12 [1])	19 (18)	13	12 (26)	4	7 (12)	9
Food Insecure with Severe Hunger (13-18 [1])	12 (12)	11	6 (13)	2	6 (11)	9
Kid's Food Insecurity Score [2]	3.8	4.1	3.6	3.4	4.6	4.3
Food Security Score [1]	8.8	8.9	8.1	8.2	10	9.2

[1] *Points in a food security scale (0-18).*

[2] *Based on 8 children's items. Maximum score: 8 points.*

isolation were reported by key informants regarding the use of wild plants. Perhaps more pertinent, informants expressed a loss of knowledge of the uses and available species of wild plants. The younger generation relies heavily on purchased foods and agricultural commodities rather than gathering, and information regarding the use of wild plants is not passed on to youth. Some plants were popularly gathered, such as wild raspberries and nopales (cactus), but these were not viewed as a wild plant to be eaten in times of food scarcity. Some women reported feelings of shame associated with wild plant use; wild plants are regarded as food only when there are no other options for eating. Many women thought the people in the reserve were the only ones using wild plants in Mexico. Knowledge of wild plant use outside of the reserve was practically nonexistent.

Informant responses between the forest and river sides of the reserve showed differences in wild plant use, which could be due to historical and socio-economic reasons. Informants on the river side of the reserve reported wild plant gathering in response to food insecurity, while the forest side reported collecting wild plants as a way of life. Informants on the river side of the reserve demonstrated knowledge of fewer species of plants and fewer methods of preparation. Forest side informants, who used more species of wild plants, reported that elder members of the community, grandparents and parents, taught them to recognize and eat wild mushrooms.

Frequency of wild plant gathering was not correlated with food insecurity; however, a trend was seen in the forest side where hungrier people collected more wild plants. Table 5 illustrates food insecurity scores and percentages

of households that collect wild plants. On both sides, with a food insecurity score of 14-18 (indicating hunger is reaching the children), families collected more wild plants. There was also a trend seen in the children's food security scale. When the children experienced hunger on either side of the reserve, families tended to collect more wild plants.

Food security correlated differently with wild plant collection on either side of the reserve. On the river side, food insecurity was greater in households that collected wild plants. In the forest side of the reserve, the opposite effect was seen; those who collected wild plants had a lower score. A trend of higher household inventory scores was observed when wild plants were collected, indicating greater food variety found in the home.

Activity Eight: Improving Household and Community Livelihood Strategies Through Diversification, Value-Added Options, and New Alternatives

Objective 8.1: Evaluate local strategies and options for livelihood diversification.

We standardized methods across three countries in comparison with extensive livestock production. The main focus will be to examine the likely advantages and disadvantages of the diversification of production systems in order to reduce the dependency on one system, which in turn supports conservation of natural resources, increases household security, and minimizes risk.

Objective 8.2: Gender analysis of agriculture, livestock, and natural resource use.

The goals of this activity are to generate information regarding agricultural, livestock, and natural resource activities in which women participate, as well as to identify opportunities for development and propose alternatives. We will analyze the differences in the form livelihood diversification takes for men and women of households.

Objective 8.3: Experimentation with the production and commercialization of alternative products and micro-enterprises.

The micro-enterprises we analyze include micro-livestock, fish culture, vegetables, fruit trees, handicrafts, medicinal plants/herbal remedies, handicrafts, and eco-tourism. We will identify mechanisms to support micro-enterprises, including micro-credit.

Objective 8.4: Analysis of the impact of globalization on livestock production within the context of all three countries.

The major objective of this study is to analyze the interacting effects of biosphere reserve policies, migration, and a changing economic environment (potentially associated with a livestock revolution) on household decision-making regarding the allocation of land and resources to livestock and grazing. Results from the study will help to determine policies that address rural poverty by facilitating the participation of smallholders in Mexico's livestock markets, while also contributing to efforts to conserve biodiversity by facilitating the development of ecologically and economically sustainable livestock management systems.

This activity focused on evaluating the potential of additional and/or non-traditional types of micro-enterprises. It is important to evaluate the feasibility of such alternatives, since the resources of the project can open doors to a wider range of alternative productive

activities that might not have otherwise been available to households. Including new activities in household economic portfolios may improve household well-being while buffering environmental stress caused by strict dependence upon traditional productive systems. Disseminating basic skills associated with conducting cost-benefit analyses will enable community members to continue to evaluate their productive possibilities in the future, improving the sustainability of this activity.

A microcredit fund was established at the Ecuador site to promote resource use change among smallholder families. FUNAN is providing the administrative support for the fund. Eleven milk-producing families participate in this microcredit fund. The specific purpose is to improve milk production and introduce alternative production activities. To date, the microcredit fund has financed 30 production initiatives with technical assistance from FUNAN. Among these experimental production activities are pig stables to improve pig production and raising poultry, such as quail.

Activity Nine: Strengthening Community Organizations and Local Planning Processes

In each of the three countries, we have focused on the activities of local groups as a means of supporting community-based conservation and management activities. Women's groups in particular have been a focus, since women are easily and quite commonly overlooked and passed by when it comes to resource management decisions and institutional support. Our approach is to continue working with established women's groups and foment the development of new ones. The development of producers' groups goes hand-in-hand with the exploration of production alternatives outlined in Activity Eight.

Objective 9.1: Support the development of local social groups such as women's groups and producer's groups.

In Ecuador, the project team facilitated a workshop that included the completion of a strategic work plan for the group ALPHA, an association of artisans from local communities in the area. Five women and seventeen men participated in this workshop, where they identified existing problems within the organization in order to address and solve them. The group will be meeting continuously in the future, and with the assistance of the Ecuadorian team members, hopes to continue strengthening the organization and working toward marketing products produced by the artisans.

Also in Ecuador, the project team worked with the Women's Association of Cosanga to conduct a series of seven workshops designed to identify strengths and weaknesses of the group. Ten women participated in these workshops. The participatory and democratic nature of the workshops allowed the women to develop important insights into the function and future of the group.

In Mexico, the collaboration between women's groups and the Mexican team has continued over the year. The mojote project gained much momentum, and women as well as men and children participate in the collection and sale of the seeds in El Grullo. These activities provide families with the opportunity to supplement their incomes, as well as to advocate for their interests in the form of an organized group that involves itself in the production of the mojote products. The group and the Mexican team continue to

explore means to increase the quality of the mojote products, and are currently focused on discovering markets for the sale of the improved products outside of the immediate area.

Groups of both men and women are involved in the production of vegetables using organic fertilizers and intercropping systems of squash, corn, and beans. The group is attempting to return to traditional forms of agriculture that focus on natural means of maintaining the integrity of the soil and the local biophysical systems.

Objective 9.2: Evaluate and document the processes of strengthening local organizations to improve their abilities with respect to their goals: 1) production systems, 2) basic services, and 3) household security.

This year, PLAN team member April Sansom completed a comprehensive study of the role of women in La Cueva, Bolivia in natural resources management, using women's groups as the focal point for the study of the community dynamic. During this process, she explored the dynamic of the organization and with the women, investigated possibilities for strengthening the function and role of the group. The principal activities of the group in Fuerte Santiago were the production of embroideries as a way to provide additional income to the farming families of the women.

Challenges that face the continuation of this type of activity include allocating the funds earned by the sale of the embroideries. For example, the question of how to divide the funds between the women themselves and the group account caused distress within the organization and provided an opportunity for the women to rethink their goals and the interaction among the women in the group. Colleagues at Communidad de Estudios JAINA (JAINA) continue to work with the group to discuss and explore solutions to these types of conflicts, and discover the best ways to foster progressive activity within the group.

Objective 9.3: Design and establish management plans at the level of individual farms (Ecuador), communities (Bolivia, Mexico), and communal lands (Bolivia).

Three farms are now serving as sites for joint farmer researcher experiments and as models within the community for the slower process of fostering community-wide plans in Mexico, at the La Cueva site in Bolivia, and with the Guarani in the Tomitarenda watershed in Bolivia. The efforts to foster these plans will continue into the future. Furthermore, the development of a system to monitor the success of the management plans will be initiated as a participatory process, with local farmers themselves identifying indicators that determine the utility of the plans.

Farmers at the Ecuadorian site have been developing their management plans based on sound livestock management techniques and research completed by students and colleagues of the project. Studies by the Ecuadorian team on the social, political, and economic effects of livestock activities of local farmers will allow the teams to elaborate the plans at the family level. Structures for the monitoring and continuous evaluation of the management plans are still in the developmental stage, and a variety of team members are involved in the development of these structures.

Substantial increases in milk yields over the past year have been an extremely encouraging result of PLAN research. The basis for this increase in production was the incorporation of a mixture of pasture forages designed to add protein to the animals' diets while adding nitrogen to the soil. Furthermore,

implemented management plan activities included decreasing the stocking rate in individual fields and the construction of drainage canals that allowed previously unusable portions of the fields to be brought into use by the farming families. The successes associated with the activities of the pilot management plans already implemented have encouraged fifteen other farm families to engage themselves in developing and applying plans. Moreover, the local government in the area has approached PLAN personnel, hoping to collaborate on a large-scale basis to promote and advance the development of similar adaptive farm management plans across the region. This is an extremely exciting opportunity for the Ecuadorian team, and a way to focus on scaling up the project activities from the family level to the regional scale.

Activity Ten: Linking Local Communities to Local and Regional Institutions to Support Planning and Policy for Sustainable Development.

Objective 10.1: Examine the effects of public policy on the use and management of natural resources.

Preliminary analyses of the influence of external factors on patterns of change in local land use, livestock production, and use of natural resources point to the economic power and control of the market. With differing degrees of intensity across Latin American countries, a series of political and economic structural adjustments are being imposed in an effort to liberalize Latin American economies, open them to foreign investment, and create conditions for the advent of the Free Trade of the Americas Area (FTAA) in 2005. Many of the impacts of these transformations have yet to be quantified on the local level of smallholder cattle production systems in Ecuador and Mexico. The agriculture crises and the increase in the cost of land make it more difficult to gain access to enough land or pasture to maintain a herd of cattle. Those who have pastureland but no cattle find it more profitable to sell forage than to raise livestock. An increasing number of landowners are finding it more favorable to rent their land while they seek salaried, off-farm employment.

Michelle Young and Fabián Calispa have completed a case study investigation of smallholder dairy producers in the Cosanga region of Ecuador and in the ejido of Ahuacapan, in the Sierra de Manantlan Biosphere Reserve (SMBR) in Jalisco, Mexico. This study has verified that in Ecuador the cost of production of 1 liter of milk at the farm level ranges from USD $0.18 to $0.31, while the milk processors purchase the milk at an average price of USD $0.22. On the other hand, the international price of milk is as low as USD $0.08, which even with a 72% tariff would enter domestic markets at the cost of USD $0.13. It is therefore evident that milk producers, especially small-scale producers, are in a precarious situation, faced with the imminent socioeconomic collapse of their production systems and livelihoods. In relation to the domestic price for milk, those producers with the lowest production costs (USD $0.18/ liter) are currently still able to compete with imported milk. It is the smallholders in regions like Cosanga, with production costs as high as US $0.31/ liter that are facing the greatest difficulties, as illustrated in the Table 6.

Similar to the situation in Ecuador, the substantial asymmetry between Mexico and its North American neighbors in terms of physical, agroecological, infrastructural,

Table 6 - Production costs and net income from smallholder dairies in Cosanga, Ecuador (May 2003).

Indicators	Value
Production: 45 liters per day for 30 days	1350 liters
Total Value of Production	297 USD
Monthly Production Costs (including the opportunity costs of family labor)	429 USD
Net Income	- 132 USD
Sales Price per Liter	0.22 USD
Cost of Production per Liter	0.31 USD

technological, and financial resources has put Mexico's agricultural and livestock sectors at risk. Also at risk are the livelihoods of that 27.5% of the population who, as of 1994, depended on agriculture and livestock for their livelihoods.

This is the context in which Mexican small-scale farmers and livestock producers make production and resource-management decisions. In an effort to understand the impacts of economic liberalization policies in Mexico on household land-use decisions among small-scale farmers, 62 households were surveyed in the ejido of Ahuacapan, in the SMBR in Jalisco, Mexico. In Ahuacapan, Mexico, those farmers still operating small plots of land are re-specializing in maize production. The minority of landholders who have access to large areas of land (generally >10ha) tend to specialize in yearling calf production. Their demands for supplemental forage resources are creating a market for maize residue and other forage grasses. The minimal (but nonetheless relative) price support for maize combined with a demand for maize residues have made pasture (maize residue with or without forage grass) the "best business in Ahuacapan." However, the outcome for smallholders in Ahuacapan is uncertain. As maize prices in Mexico are eventually liberalized, small farmers may or may not find it worthwhile to produce maize merely for subsistence and pasture rentals.

The study in Ahuacapan revealed that it is a rare household that does not have at least one member residing in the U.S. The current trend in Ahuacapan for most households is to look for off-farm sources of income, either in nearby urban centers or in the U.S. Such a trend could affect cattle producing households in a number of ways. Perhaps they will gain permanent access to larger areas of land as smallholders emigrate, thereby increasing their production capacity. Alternatively, smallholders could emigrate and maintain ownership of their plots while earning a fixed annual income by leasing their land to corporate agave producers (tequila companies), thereby reducing access to land for both the landless and those looking to supplement their landholdings for cattle production purposes. As is the case in Ecuador, the result of economic liberalization for most smallholders is that they can no longer support themselves through agriculture.

Objective 10.2: Design a plan to strengthen local natural resource management capacity at the scale of the watershed and region. Establish coordination mechanisms among natural resource management organizations and institutions, both internal and external to the community, in order to identify community sustainable management policies for the watershed.

In Ecuador, the project has developed strong links with government officials at the municipal level (a county-level regional government that is very important for local policy, support of local community initiatives, and for coordination of activities in the region). This collaboration has continued with the Municipal of Quijos. Currently, Project PLAN is contributing to the planning process through the facilitation of biophysical and socioeconomic information (Heifer Project International, FUNAN, Terra Nuova, and JS/CDC), as well as assisting with themes of resources management and environmental impacts (FUNAN).

Parallel to this process of planning, the Cantonal Civic Committee was created with the purpose of contributing to the development of the region and supporting the process of participatory planning. Project PLAN participates actively in this committee through FUNAN, which is the representative of the NGOs that work in the region. The civic committee is a participation space that represents the different sectors from civil society, facilitating access to decision-making and institutionalizing the process of planning and participatory management.

In Mexico, Project PLAN team members are also collaborators on the large project for the improvement of the Rio Ayuquila watershed. This project has opened important levels of dialogue between local regional governments and local residents about mutual interests in the sustainable development of natural resources and watershed protection. An Intermunicipal Commission of the low river basin of the Ayuquila River has been formed with assistance from Luis Manuel, the Mexican coordinator of Project PLAN. The intermunicipal commission includes the participation of the municipalities of Autlán, Grullo, Union of Tula, Lemon, Tonaya, Zapotitlán de Vadillo, Tolimán, and Tuxcacuesco. Project PLAN actively participates in the semimonthly meetings of this commission, where aspects of the handling of the water of the river basin are discussed. A monitoring program has been initiated that will assist with the management of the watershed.

In Bolivia, collaboration with municipal officials of Entre Rios has continued; in addition, community members have been involved in meetings with Municipal officials; thus, the project plays an informal but increasingly effective role as a facilitator for improved communication and support between local government and these communities. Also, JAINA has been developing a proposal for collaboration with the municipal planning officials in the design of community planning models. Community and regional planning is the responsibility of the Municipal; however, they do not have the staff or training sufficient for the challenge. These officials have expressed interest in working with PLAN researchers as a resource to inform their planning. In April, with the backing and interest of the Municipal, JAINA presented a public demonstration about Project PLAN to inform the public and government officials about the nature of project activities.

Gender

Since its inception, Project PLAN has maintained a specific focus on gender issues and the needs of women in the project sites. More women are involved in the project every year: they are students, collaborators, community workers, and co-directors of partner organizations. Women play an ever-increasing role in the management of the project itself. In Ecuador and Bolivia, women serve as directors or assistant coordinators of the project teams in their respective countries.

We believe that encouraging women's involvement in the overall management of the project is one of the best ways to assure that the opinions and needs of women will be included and addressed within the scope of activities on which we focus.

We have been working with women's groups at each site, and have identified specific objectives for the coming year to further develop the organization and activities of women's groups in all sites. Several of our activities deal primarily with women's interests, such as Activity Seven, improving food security and health, and Activity Eight, improving household and community livelihood strategies through diversification, value-added options, and new alternatives. Family food security issues directly concern women, as they are often principal decision-makers in terms of food purchase and preparation.

In Bolivia, the strengthening of women's organizations is an identified priority for next year. The participatory research conducted in the communities of Fuerte Santiago and Rio la Sal last year provided the foundation for these types of continuing activities with the women's groups there.

In Ecuador, a women's group in Cosanga has successfully ventured into collective small animal production for market. During this past year, 11 community women volunteered to receive training from the project as local researchers to enhance and build on their past experience with production experiments. Some women have also received gender training in an effort to improve gender equity in the local communities and reduce patriarchal hierarchy. In this same vein, Project PLAN facilitated the participation of several Cosanga Valley women in the "Encuentro Andino de Mujeres Líderes" in Quito (June 30–July 4, 2003) organized by Fundación Heifer Ecuador. Peasant and indigenous women from Bolivia, Peru, and Ecuador participated in this event for rural women leaders. One of the results of this workshop was the establishment of a Regional Network of Andean Women in order to continue the process of forming women leaders and arrive at a common action plan. As a result of this year's and past years' activities by local community women (such as organizing, training, and experimentation with alternative income-producing activities), a significant change has been observed in the participation of women in decision-making at the local community and municipal levels. One of the women who has participated in Project PLAN and received training has been elected a municipal council member.

In Mexico, a new member of the Project PLAN team is Rosa Ramirez, who as a native of the community of Cuzalapa and current resident in Zenzontla, serves as a liaison and community organizer on the Mexican team. Her collaboration with the project enhances opportunities for exchange of ideas and increased understanding between the communities and the project team. The ten women who have organized themselves into a working group to generate income-production activities tend to come from the poorest households. They are also aware of what resources are available for potential production activities. Thus, for example, women and children from the poorest households have been gathering and processing mojote as a low-cost alternative to coffee. Based on this experience, the women's group has organized a mojote production enterprise. They have purchased an industrial mill, requested a plot of land on which to build a locale for the mill and processing, and secured funds from local government for the building. They collect or purchase (at 10

pesos/kilo) the mojote beans, dry, toast, grind, package, and label the processed mojote to sell as mojote coffee at 100 pesos per kilo. This activity has increased the amount of income women have control over. These women, working together as a cohesive group, have improved community household interactions, reducing disputes and strains that generally have existed within the community.

Gathering the communities' perceptions of development is one of the most important and fascinating aspects of this relationship. Our increased documentation of processes occurring in the communities has provided valuable insight into the processes that inhibit or encourage development of women's organizations. This information will in turn allow us to design focused strategies for supporting women's activities in the years to come.

Policy

Collaborating with governmental bodies within the three countries is one of the ways that we can most positively influence sustainable management in the long term. For this reason, in Year Six we focused Activity Ten on strengthening linkages between local government, regional institutions, and local groups for the purpose of affecting planning and policy issues in the areas where we work. The linkages that we have fostered in the past years provide us with the strong background on which to build the deeper relationships between project team members and government officials necessary to succeed. During the past years, key local counterparts (Instituto Manantlán de Ecologia y Conservación de la Biodiversidad in Mexico - IMECBIO, FUNAN in Ecuador, CER-DET, Servicios Agroinformaticos de Apoyo a la Planificación para la Uso y Manejo de los Recursos Naturales - AGROSIG, and JAINA in Bolivia) have developed the authority to work in the region and thus have working agreements with local authorities and communities.

In Mexico, the team has a collaborative working agreement with SEMARNAP (the government agency that administers the biosphere reserve) that includes the primary target communities and other related communities where studies and activities have been extended. The regional-scale work on the Ayuquila River watershed opened great potential for regional interaction with several regional government agencies at state (Jalisco) and national levels. Some of the policy results of this collaboration include an Intermunicipal Commission for the lower Ayuquila River watershed composed of eight municipalities. This Intermunicipal Commission has now set up a trust fund with monies from the municipalities, SEMARNAP, and the State of Jalisco to collect funds for financing environmental management activities and programs by municipalities.

Project PLAN team members in Mexico are also active on the Ayuquila Watershed Commission and the Board of Directors of the Biosfera Sierra de Manantlán. Both of these governing bodies deal with management of natural resources in the area, principally the River Ayuquila and the Biosphere, and develop policies concerning contamination and bio-diversity threats. One concrete result of this cooperation was a series of recommendations developed by CUCSUR for the alternative management of waste contamination going into the River Ayuquila. This work was done in collaboration with the Melchor Ocampo mill and the Ejido Las Paredes.

In Ecuador, FUNAN continues to work directly with the new Ministry of the Environment, the government ministry in

charge of natural resources and the administration of the Reserva Ecologica Antisana. All four institutions of PLAN-Ecuador work with the Municipio in Baeza, the regional government authority that includes the area of our project. One of the NGOs, FUNAN, has been brought into the Cantonal Civic Committee to oversee Municipal management. This invitation to participate in local governance is a direct result of PLAN project activities in the area. This participation in local governance offers an excellent opportunity to influence the discussion and definition of local policies in those areas of concern to Project PLAN. Information gathered from this project that could inform Municipal-level planning and regulations with regard to natural resource management, local production, and local organization has been shared with the Quijos Municipality. In this way, the project and community researchers are now in a position to influence local government policy.

Outreach

We have been developing and assisting local and regional efforts to increase the welfare of small landholders and rural communities, increasing a sense of empowerment. This contributes to overall economic stability and development for the host country. This is being done in part by increasing the capacity of local institutions and researchers, as well as local communities, to approach land use problems through an integrated interdisciplinary approach and a variety of shared participatory methods and perspectives.

In all three countries, the conceptual model and methodology has been to search for sustainable use and management of natural resources by rural communities as they strive to improve their levels of production and their standard of living. The outreach aspect of this project has varied across the sites according to the particular history and conditions of each site. For example, in Ecuador, the accumulated experience of the team members (from four different NGOs) has resulted in a cohesive and holistic approach in their working relationship with the site communities. The experience, trust, and knowledge derived from this project culminated in a much-improved working relationship with the communities to the extent that team members have been invited to participate in local governance. At the individual level of households, the studies and local experiments on different aspects of smallholder agriculture and rural life is permitting rural families to access information on which to make their household, production, and natural resource management decisions. At the community level, this information is also available to local and regional government institutions as well as other communities in the area. The presence and activities of the project have motivated local organizations to coordinate their objectives and activities. The project has also motivated and encouraged an important sector of local communities in all three countries, the women, to organize themselves so as to initiate and coordinate production and income-producing activities.

Developmental Impact

Environmental Impact. One of the major goals of this project is the sustainable management of natural resources. Attaining this goal will have a significant impact on the environment, decreasing natural resource degradation and depletion and improving biodiversity. Project activities in all three countries have contributed significantly to knowledge and information, through farmer

experimentation and survey research, on the impact of human activities on the land and its natural resources in each site. The strategy has been to generate this information together with the communities, and then analyze and discuss with them how to reduce the negative impacts (such as deforestation, water quality, and soil erosion) of their use of natural resources. Local researchers have made an important contribution not only to the generation of local knowledge, but also to raising awareness within the community on the issue of sustainable management of natural resources and generating alternative and sustainable production practices.

Agricultural Sustainability. Agricultural sustainability, together with sustainable management of natural resources, forms the basis of this project. Livestock and crop production practices are examined with the goal of conserving natural resources for future agricultural production (such as soils and water sources) and achieving economic sustainability of the household. Some of the specific objectives worked on during the past year include:

- Evaluation of native plants for livestock feed, thus reducing the need to cut down more forest for pastures.
- Rotating and intercropping lotus and local kikuyu grass in established pastures in order to conserve soil cover, reduce erosion, and increase livestock feed sources.
- Experimenting with corn varieties and cropping practices that increase production, use less commercial inputs, and reduces the need to open more fields by clearing into the forest.
- Improve local understanding of national and international trade patterns in order assess risks and to avoid over-dependence on uncertain product markets; this understanding is being accompanied by strengthening local organizations that rally around product prices and markets.

Contributions to Host Country. The results and experience of this project contribute to local policy processes, as well as regional and national policy agencies along two lines. One line seeks to improve smallholder livestock and agricultural production in order to attain sustainable rural households and improve rural standards of living. The other line focuses on sustainable management of natural resources in order to decrease both deforestation and soil degradation and loss of biodiversity in fragile mountainous tropical zones. In Ecuador, for example, the research results from Project PLAN were utilized as input for the policy discussions sponsored by the Ministry of Agriculture during this past year's Movimiento Nacional Pachacutec.

Linkages and Networking. The methodology of this project is based on linkages and networking. This occurs at various levels: between communities and country team agencies (universities and NGOs), among the country team agencies themselves, and between U.S. universities and host country institutions. These ties have continued to be strengthened during this past year. The institutions working at each country site, through this project, have significantly improved the coordination of objectives and activities, improving their impact in the project site and their relationships with communities. In addition, one of the principal objectives of the project has been to establish and strengthen linkages and working relationships between the communities and governmental agencies. During the past year in Ecuador, for example, several local community producer and women's groups have become active in local government and some of their members have joined the local Municipal Council.

Collaboration with International Agricultural Research Centers & Other CRSPs. CIAT (International Center for Tropical Agriculture) carried out a training program in the Ecuador site. This training program worked initially with a group from the project team and community members to establish a core of local researchers in agricultural production experimentation, the Local Agricultural Research Committee (CIAL). This CIAL group has been working with local communities during the past year, training additional local researchers in more communities along the watershed.

Other Contributions

Support for Free Markets and Broad-Based Economic Growth. All three in-country sites are experiencing daily the conflict between free markets at the international scale and broad-based economic growth. Smallholder producers are unable to compete with multi-national corporations who pressure national governments and international agencies for the reduction of import quotas and tariffs. In the Ecuador site, for example, the principal commercial agricultural activity is milk production and the major buyer in the valley is a Nestle milk plant. The import of milk products into Ecuador has resulted in reduced Nestle prices to milk producers, prices that are below smallholders' production costs. In Mexico, a similar process has occurred as sorghum, soybean, rice, barley, and wheat imports have depressed agricultural prices below local producers' costs.

Concern for Individuals. Both the objectives and the methodology of Project PLAN demonstrate its concern for individuals. Improving the quality of life and living standards of rural communities and smallholder families, including women and children, is one of the principal objectives of the project. In addition, the approach utilized in project implementation is one of participatory planning and research, striving to include as many community members, across all population groups, into the project.

Support for Democracy. Project PLAN's objective of improving rural communities' living standards is a basis for the growth and fortification of democracy. In addition, Project PLAN's approach (using participatory methods and working with civil society) provides the opportunity for local communities to learn democratic norms and practices. Improving local governance through training and participatory planning also contributes to building democracy.

Humanitarian Assistance. A volcano in the area of the Ecuador site erupted late last year, covering the Cosanga valley with ash, putting at risk not only people's health, but also threatening many of their crops and animals. Project PLAN, through its local institutions and members, was able to provide humanitarian assistance to the affected communities.

Leveraged Funds and Linked Projects

Substantial leveraged funds have been obtained by our partner institutions in each country for projects related directly or in part to PLAN goals and activities. The total leveraged funds for our non-Wisconsin partners were $91,450. For each partner, the individual grants are listed. For each grant we list: 1) title or purpose of the proposal; 2) principal investigator(s) from Project PLAN; 3) the source of funds (donor); 4) funds used for PLAN activities; and 5) duration of the grant.

United States of America

"Development of a measurement tool to assess food insecurity in communities located in the Sierra de Manantlán biosphere reserve." Hugo Melgar-Quiñonez & Ana Claudia Zubieta, P.I.s, from the University of California Institute for Mexico and the United States (UC MEXUS) Grants for Collaborative Projects, $25,000, June 2001 - Dec. 2002.

"Testing of a Household Food Security Tool in Rural Communities of La Cueva, Bolivia." Hugo Melgar-Quiñonez & Ana Claudia Zubieta, P.I.s, from the Gifford Center for Population Issues - Small Grants for Research on Population, Food and the Environment, $3,000, June 2002 - May 2003.

Bolivia

"Study of three species of grass to improve forage available for cattle." Milton Borda with Angelo Lozano and Grover Maella, P.I.s, from INTERMON, $5,000, Dec. 2001 - Dec. 2002.

"Community commercialization of maize." Grover Maella and Henry Valdez, P.I.s, from INTERMON, $10,000, Aug. 2000 – Aug. 2003.

"Sustainable livestock management." Angelo Lozano, P.I., from INTERMON, $15,000, Aug. 2000 – Aug. 2003.

Ecuador

"Development of initiatives with local residents for sustainable use of soils and forests." Fundación Antisana, from PROBONA, $15,000, Jan. 2000 – Jan. 2002.

Mexico

"Impacto de la ganadería sobre las aves del ejido Zenzontla." Sarahy Contreras Martínez, P.I., from the National Fish and Wildlife Foundation, $5,560, 2000-2002.

"Socio-environmental analysis of Agave Azul (*Agave tequilana* Weber) in the municipalities of Autlán de Navarro and Tuxcacuesco, Jalisco." Oscar Cardenas, P.I., from the Universidad de Guadalajara, $1,450.

"Water management of Ayuquila River watershed." Luis Manuel Martínez Rivera, P.I., from the Programa ACUDE of the University of Guadalajara, $2,500.

"Environmental and socio-economic evaluation of agave azul in the municipality of Tonaya." Luis Manuel Martínez R., P.I., from the Programa ACUDE of the University of Guadalajara, $2,700.

"Management and conservation of the Ayuquila River watershed." Luis Manuel Martínez R., P.I., from the Programa ACUDE of the University of Guadalajara, $2,700.

"Participatory restoration of the riverine forests in the watershed of the Ayuquila River." Claudia Ortiz Arrona and Luis Manuel Martínez R., from the University of Guadalajara, $2,400.

"Evaluation of populations of the 'cotorra' (*Aratinga canicularis*) as an exploited resource the Ejido Platanarillo, Colima." Carlos Palomera García, P.I., from the University of Guadalajara, $1,140.

Training

In Progress

Blanco, Carla, B.S., 2004, Biology, Universidad de Guadalajara (CUCSUR).

Borda, Milton, B.S., 2004, Agronomy, Universidad Autonoma Juan Misael Saracho.

Caranza Montaño, Eloy Fernando, B.S., 2003, Natural Resources Management, Universidad de Guadalajara (CUCSUR).

Cardenas, Oscar, Ph.D., 2004, Land Resources, University of Wisconsin – Madison.

Corso, Orlando, B.S., 2003, Veterinary Science, Universidad Autonoma Juan Miseael Saracho.

Del Carpio Borda, Ricardo, M.S., 2004, Agronomy, Universidad Autonoma Juan Misael Saracho.

Espinoza, Linder, Ph.D., 2005, Forestry, Universidad de Sevilla.

Flores, Marbella, B.S., 2003, Natural Resources Management, Universidad de Guadalajara (CUCSUR).

Flores Beltrán, Laura Elena, B.S., 2003, Natural Resources Management, Universidad de Guadalajara (CUCSUR).

Gutierrez, Octavio, B.S., 2003, Natural and Agricultural Resources, Universidad de Guadalajara (CUCSUR).

Melendez, Gabriela, B.S., 2004, Natural Resource Management, Universidad de Guadalajara (CUCSUR).

Perez Rangel, Rafael, B.S., 2004, Engineer, Universidad de Guadalajara (CUCSUR).

Pratsch, Samuel, M.S., 2004, Conservation Biology and Sustainable Development, University of Wisconsin – Madison.

Ramirez Zavalza, José Felix, B.S., 2004, Natural Resources Management, Universidad de Guadalajara (CUCSUR).

Reyes Castelan, Evelia, B.S., 2004, Agricultural Economics, Universidad Autónoma Chapingo.

Rodríguez Durán, Juan Antonio, B.S., 2004, Natural Resources Engineering, Universidad de Guadalajara (CUCSUR).

Ronquillo, Juan Carlos, B.S., 2004, Botany, Universidad Central.

Sansom, April, Ph.D., 2006, Land Resources, University of Wisconsin – Madison.

Tapia, Carlos, B.S., 2004, Agronomy, Universidad Autonoma Juan Misael Saracho.

Valdez Esnor, Henry, M.S., 2004, Ing. Agronomica, Universidad Autonoma Juan Misael Saracho.

Villena, Aldo, B.S., 2004, Forestry, Universidad Autonoma Juan Misael Saracho.

Whitelaw, Barbara, M.S., 2004, International Agricultural Development, University of California – Davis.

Completed

Adautt, Samuel, B.S., 2003, Agronomy, Universidad Autonoma Juan Misael Saracho.

Camacho, Arturo, B.S., 2003, Natural Resources Engineering, Universidad de Guadalajara (CUCSUR).

Esparza Carlos, Juan Pablo, B.S., 2002, Biology, Universidad de Guadalajara (CUCSUR).

Gallardo Vazquez, Eduardo, B.S., 2003, Agricultural Economics, Universidad Autónoma Chapingo.

Guzmán de Jesús, Felipe, B.S., 2003, Agricultural Economics, Universidad Autónoma Chapingo.

Jurado, Monica, B.S., 2003, Biology, Universidad Autonoma Juan Misael Saracho.

Llanes Espinoza, José Bernardino, B.S., 2003, Agricultural Economics, Universidad Autónoma Chapingo.

Martinez Rivera, Luis Manuel, Ph.D., 2002, Watershed Management, Universidad de Guadalajara (CUCSUR).

Milofsky, Tessa, M.S., 2003, Agronomy, University of Wisconsin– Madison.

Montero Solis, Flor Maria, B.S., 2003, Biology, Universidad Veracruzana.

Olguín López, José Luis, B.S., 2003, Agronomy, Universidad de Guadalajara (CUCSUR).

Sansom, April, M.S., 2003, Conservation Biology and Sustainable Development, University of Wisconsin – Madison.

Velez Izquierdo, Alejandra, B.S., 2003, Agricultural Economics, Universidad Autónoma Chapingo.

Non-degree Training

Planning meeting, October 14 – 16, Madison, WI. Eleven Project PLAN team members participated.

Sixth Annual Conference of Project PLAN, July 21 – 26, 2003, Tarija, Bolivia. 35 Project PLAN team members participated.

Association of Cosanga, February 8 and 22, 2003, Cosanga, Ecuador. Facilitator: Kattya Hernández. Eleven female community members participated.

ALFA organization, June 2002 – January 2003, Ecuador. Facilitators: Kattya Hernández, María Isolda. Eleven female community members participated.

Collaborating Personnel

United States of America

Albrecht, Ken, Professor, Agronomy, UW - Madison.

Laca, Emilio, Professor, Range Science, University of California, Davis.

Lastarria, Susana, Researcher, Sociologist, UW - Madison.

Melgar-Quiñonez, Hugo, Researcher, Nutrition and Public Health, University of California, Davis.

Mercado-Silva, Norman, Graduate Student, UW - Madison.

Milofsky, Tessa, Graduate Student, UW - Madison.

Moermond, Timothy, Professor, Zoology and CBSD, UW - Madison.

Nordheim, Erik, Professor, Statistics and Forestry, UW - Madison.

Rosemeyer, Martha, Professor, Agroecology, Evergreen State College.

Sansom, April, Graduate Student, UW - Madison.

Wattiaux, Michel, Researcher, Animal Science, UW - Madison.

Young, Michelle, Graduate Student, University of California, Davis.

Yuill, Thomas, Director, Professor, Veterinary Science, UW - Madison.

Zubieta, Ana Claudia, Researcher, Nutrition and Public Health, University of California, Davis.

Bolivia

Baldivieso, Herlan, Student, Climate and Botany, AGROSIG.

Calla, Rhinda, Sociology, JAINA.

Cari, Christina, Agronomy, CER-DET.

Carranza, Freddy, Agronomy, JAINA.

Del Carpio, Ricardo, Agronomy and Business, JAINA.

Castro, Miguel, Director, Lawyer, CER-DET.

Corzo, Orlando, Student, Animal Science, CER-DET.

Cuba, Ruben, Agronomy, Botany, CER-DET.

Espinoza, Linder, Researcher, Forestry, AGROSIG.

Flores, Magaly, Agronomy, Biology, JAINA.

Flores, Nelson, Student, Climate and Botany, AGROSIG.

Gallardo, Norberto, Lawyer, CER-DET.

Juardo, Monica, Student, AGROSIG.

Lizárraga, Pilar, Researcher, Sociology, JAINA.

Lozano, Angelo, Agronomy, CER-DET.

Mealla, Grover, Agronomy, CER-DET.

Milton, Borda, Student, Agronomy, CER-DET.

Molina, Jesus, Agronomy, JAINA.

Montaño, Blanca, Sociology, CER-DET.

Mujica, Roberto, Agronomy, Ecology, AGROSIG.

Paita, Ricardo, Agronomy, Ecology, CER-DET.

Ruiz, Jorge, Director, GIS and Agronomy, AGROSIG.

Tapia, Carlos, Student, Business, CER-DET.

Vacaflores, Carlos, Agronomy, JAINA.
Villena, Aldo, Student, JAINA.

Ecuador

Calispa, Fabian, Researcher, Agronomy, TE.
Castellanos, Armando, Researcher, Biology, Alianza Jatun-Sacha/CDC.
Hernández, Kattya, Researcher, Anthropology, HPI.
Larrea, Fernando, Director, Anthropology, HPI.
Leguísamo, Alex, Researcher, Agronomy, FUNAN.
Molina, Estalin, Extension Worker, Farmer, FUNAN.
Mosquera, Gustavo, Researcher, Biology, FUNAN.
Muñoz, Juan Pablo, Anthropologist, TE.
Murillo, Isabel, Researcher, Sociology, FUNAN.
Peñafiel, Marcia, Researcher, Biology, Alianza Jatun-Sacha/CDC.
Pinos, Gonzalo, Cartographer, Alianza Jatun-Sacha/CDC.
Ruiz, Armando, Ecologist, FUNAN.
Torres, Alandi, Assistant Researcher, Farmer, FUNAN.

Mexico

Aguirre, Angel, Professor, Ecology and Natural Resources, IMECBIO.
Beltrán, Laura, Student, Agroforestry, IMECBIO.
Carranza, Eloy, Student, Agroforestry, IMECBIO.
Cárdenas, Oscar, Professor, Land Resources, IMECBIO/UW - Madison.
Castellanos, Blanca, Student, Zoology, IMECBIO.
Contreras, Sarahy, Professor, Ornithology, IMECBIO.
Cuevas, Ramón, Professor, Botany, IMECBIO.
Esparza, Juan Pablo, Student, IMECBIO.
Figueroa, Pedro, Professor, Community Development, IMECBIO.
Flores, Marbella, Student, Natural Resources, IMECBIO.
Gallardo, Eduardo, Student, Agricultural Economics, IMECBIO.
Gerritsen, Peter, Professor, Sociology, IMECBIO.
Guzmán de Jesús, Felipe, Student, Agricultural Economics, IMECBIO.
Guzmán, Luis, Professor, Botany, IMECBIO.
Iñiguez, Luis Ignacio, Professor, Zoology, IMECBIO.
Llanes, José Bernardino, Student, Agricultural Economics, IMECBIO.
Martínez, Luis Manuel, Professor, Limnology and Watersheds, IMECBIO.
Moreno, Arturo, Professor, Economics, IMECBIO.
Olguín, José Luis, Student, Agronomy, IMECBIO.
Palomera, Carlos, Professor, Conservation, IMECBIO.
Pérez, Rafael, Student, Natural Resources, IMECBIO.
Pineda, Maria del Rosario, Professor, Botany and Ecology, University of Vera Cruz.
Ramírez, Manuel, GIS Engineer, IMECBIO.
Ramírez, Rosa Elena, Community Outreach, Community of Cuzalapa.
Rosales, Jesús Juan, Professor, Agroforestry, IMECBIO.
Sánchez, Lázaro, Professor, Botany and Ecology, University of Vera Cruz.
Sandoval, Jose de Jesús, Professor, Limnology and Watersheds, IMECBIO.
Vélez, Alejandra, Student, Agricultural Economics, IMECBIO.
Zamora, Julián, Student, Natural Resources, IMECBIO.
Zavala, Félix, Student, Natural Resources, IMECBIO.

Collaborating Institutions

United States of America

CIAD (Center for International Agriculture and Development)
University of California - Davis
One Shields Avenue
Davis, CA 95616
Phone: 530-756-8183
Fax: 530-752-8966

University of Wisconsin - Madison
International Agricultural Programs
1450 Linden Drive
Madison, WI 53706-1562
Phone: 608-262-8633
Fax: 608-262-8852

Iowa State University
North Central Regional Center for Rural Development
107 Curtiss Hall
Ames, IA 50011-1050
Phone: 515-294-8321
Fax: 515-294-3180

Bolivia

AGROSIG (Servicios Agroinformaticos de Apoyo a la Planificación para la Uso y Manejo de los Recursos Naturales)
Casilla Postal 502
Tarija, Bolivia
Phone: 591-4-66-44644
Fax: 591-4-66-12302

CER-DET (Centro de Estudios Regionales y Desarrollo de Tarija)
Virginio Lema 173
Tarija, Bolivia
Phone: 591-4-66-35471
Fax: 591-4-66-33454

CIEC (Centro Interdisciplinario para Estudios Comunitarios)
Calle Fernando Guachalla
Pasaje Fernando de Vargas No. 751
La Paz, Bolivia
Phone: 591-2-24-16597/16585
Fax: 591-2-24-16585

JAINA (Comunidad de Estudios JAINA)
Casilla 88, Calle Sucre 1380
Tarija, Bolivia
Phone: 591-4-66-46879

Ecuador

Alianza Jatun-Sacha/CDC (Centro de Datos para la Conservación)
Pasaje Eugenio de Santillán N34-248 y Maurián
Cdla. Rumipamba
Quito, Ecuador
Phone: 593-2-24-32240/32246
Fax: 593-2-24-53583

TE (Terra Nuova)
Mallorca 440 y la Coruna
Quito, Ecuador
Phone: 593-2-25-07865
Fax: 593-2-22-26291

HPI (Heifer Project International-Ecuador)
Calle Tamayo #1313 y Colon
Quito, Ecuador
Phone: 593-2-25-56241/29-08985
Phone and fax: 593-2-25-01427

FUNAN (Fundación Antisana)
Gonzalo Serrano E 10-27 y Seis de Deciembre
Quito, Ecuador
Phone: 593-2-24-30861
Fax: 593-2-24-42302

Mexico

UdG, CUCSUR (Universidad de Guadalajara, Centro Universitario de la Costa Sur)
IMECBIO (Instituto Manantlán de Ecologia y Conservación de la Biodiversidad) and
Departamento de Producción Agricola
Apartado Postal 64
Autlán, Jalisco
C.P. 48900, Mexico
(Avenida Independencia Nacional 151)
Phone: 52-3-17-381-1165/0353
Fax: 52-3-17-381-1425

Publications

Articles and Books

Cardenas G., Oscar. 2003. "El otro efecto tequila." Periódico El Regional. Marzo 26. Page 12.

Cárdenas H., O. G., S. Contreras-Martínez y R. Esparza-Salas. 2002. "Efectos potenciales de la deforestación y el cambio en la cobertura vegetal sobre las especies de aves endémicas y parásitas de nidos del ejido Zenzontla, Reserva de la Biosfera Sierra de Manantlán, México. Memoria en extenso. En: Memorias del V Congreso Nacional de Áreas Naturales Protegidas de México. UdeG-CUCSUR, Autlán, Jalisco, Mexico, 17-20 de Octubre del 2002.

Carranza, M. M. A., L. R. Sánchez-Velásquez, Ma. del R. Pineda-López y R. Cuevas G. 2003. Calidad y potencial forrajero de especies del bosque tropical caducifolio de la Sierra de Manantlán. Agrociencia 37:203-210.

Gerritson, P. R. W., M. Montero C., y P. Figueroa B. 2003. "El mundo en el espejo: Percepciones campesinas de los cambios ambientales en el occidente de México, " Economia Territorio y Sociedad.

Lizarraga, P. 2002. Un camino a la participación: Caso del Pueblo Guaraní del Itika Guasu. Educación, Territorialidad, y Ciudadanía Indígena. pp. 25-62 in: R. Leon, P. Lizarraga and C. R. Rea (Eds.), El Centro de Estudios de la Realidad Económica y Social (CERES), Cochabamba, Bolivia.

Lizarraga, P. 2003. "Una comunidad de aprendizaje para empoder a actores locales – Proyecto PLAN – Jaina." Participa, Febrero, 2003, No. 3:12-13 (Official publication of the "Grupo Nacional de Trabajo para la Participación" of Bolivia).

Martínez R., L.M., Arturo Carranza M., Ángel Aguirre G., José J. Sandoval L., José L. Olguín L. y Eva Judith Hueso G. 2002. Manejo y conservación de la cuenca del Río Ayuquila. 2002. Revista Reportes del IPICYT. Vol 1(1):118-125.

Martínez R., L.M., A. Moreno, R. Cuevas, Jesús J. Rosales Adame. 2003. Manejo Sustentable de sistemas naturales y agropastoriales del Ejido Zenzontla, Reserva de la Biosfera Sierra de Manantlán. Vinculación y Ciencia. Año 4 No.12: 14 – 26.

Sánchez-Velásquez, L. R., G. Hernández, M. Carranza, Ma. del R. Pineda López, R Cuevas y Fernando Aragón. 2002. Estructura arbórea del bosque tropical caducifolio usado para la ganadería extensiva en el norte de la Sierra de Manantlán, México: Antagonismo de usos. Polibotánica 13: 25-46.

Vacaflores R., C., R. del Carpio B., R. Calla G., and J. Molina A. 2003. Entre Territorios Poblados y Desplobados: Transhumancia Ganadera en Tarija. Investigaciones Regionales, Programa de Investigación Estatógica en Bolivia (PIEB), La Paz, Bolivia. 172 pp.

Theses

Adautt F., Samuel. 2002. Evaluación de Tierra con Fines Ganaderos en la Subcuenca del Río La Sal. Licenciatura, Ingeneria Agronomica, Universidad Autonoma "Juan

Misael Saracho," Tarija, Bolivia (Advisor: Jorge Ruiz).

Baltazar C., Arturo. 2003. Evaluación De Zonas De Uso Agropecuario Como Hábitat Para La Rodentofauna, En La Comunidad De Ventanas, Zenzontla. Ingeniero, Recursos Naturales y Agropecuarios, Universidad De Guadalajara, CUCSUR (Advisor: Arturo Moreno).

Gallardo V., Eduardo. 2003. Evaluación De La Economía Sustentable De La Ganadería Extensiva En La Región Costa Sur: Estudio De Caso Del Ejido Barranca De La Naranjera. Ingeniero, Recursos Naturales y Agropecuarios, Universidad De Guadalajara, CUCSUR (Advisor: Arturo Moreno).

Guzmán de J., Felipe. 2003. Evaluación De La Economía Sustentable De La Ganadería Extensiva En La Región Costa Sur: Estudio De Caso Del Ejido Zenzontla. Ingeniero, Recursos Naturales y Agropecuarios, Universidad De Guadalajara, CUCSUR (Advisor: Arturo Moreno).

Jurado, Monica. 2003. Incidencia de Las Aves en El Cultivo del Maiz. Licenciatura, Ingerieria Agronomica, Universidad Autonoma "Juan Misael Saracho," Tarija, Bolivia (Advisor: Jorge Ruiz).

Martínez R., Luis Manuel. 2002. Watershed management for pollution control in the Ayuquila Watershed. Ph.D., Watershed Science. Utah State University (Advisor: James Dobrowolski).

Milofsky, Tessa. 2003. Corn-lotus living mulch system to improve crop and forage production in Las Palmas, Ecuador. M.S., Agronomy, University of Wisconsin - Madison, Madison, WI (Advisor: Ken Albrecht.).

Montero S., Flor María. 2003. El Impacto De La Ganadería Sobre La Regeneración Del Bosque Tropical Caducifolio En La Sierra De Manantlán, Jalisco. Licenciatura, Biología. Universidad Veracruzana (Advisor: Lazaro Sánchez).

Olguín-López, José Luis. 2003. Descripción Física e Hidrográfica de la Cuenca del Río Ayuquila Jalisco, México. Ingeniero, Agrónomo Fitotecnista. Universidad De Guadalajara, CUCSUR (Advisor: Luis Manuel Martínez).

Sansom, April. 2003. Action Research in Bolivia: Women, Community Dynamics, and Natural Resource Management in La Cueva, Tarija. M.S., Conservation Biology and Sustainable Development, University of Wisconsin - Madison, Madison, WI (Advisor: Timothy Moermond).

Zamora D., José Julián, and Elisa Marbella Flores P. 2003. Análisis Preliminar de la Expansión Del Cultivo De Agave Azul (*Agave Tequilana* Weber) En Los Municipios De Autlán De Navarro Y Tuxcacuesco, Jalisco. Ingeniero, Recursos Naturales y Agropecuarios, Universidad De Guadalajara, CUCSUR (Advisor: Oscar Cardenas-Hernandez).

Abstracts and Presentations

Cardenas H., O. G., S. Contreras Martínez y R. Esparza Salas. "Potential effects of deforestation change in vegetation cover and nest parasites on endemic bird species in the community of Zenzontla, Sierra de Manantlán Biosphere." V Congreso Nacional de Áreas Naturales Protegidas de México. Guadalajara, Jalisco, October 17th-20th, 2002.

Eakright (Murphy), Alexis. "Livelihood strategies in the Zenzontla Ejido, Mexico: Cattle-based strategies, barriers to entry, and next-best alternatives." GL-CRSP Program Conference, Washington, D. C., USA, October 8-12, 2002.

Esparza C., Juan Pablo, Luis I. Iñiguez, Timothy Moermond, and Lucina Hernández.

"Cattle foraging in tropical deciduous dry forest, Sierra de Manantlán, México." GL-CRSP Program Conference, Washington, D. C., USA, October 8-12, 2002.

Iñiguez D., Luis Ignacio, and Juan Pablo Esparza. "Evaluation of the incidence of vampire bat attacks on cattle in the Sierra de Manantlán, México." VI Congreso Nacional de Mastozoología. CIIDIR-Oaxaca (IPN) y Asociación Mexicana de Mastozoología, A. C. Oaxaca, Oaxaca, October 21th-25th, 2002.

Iñiguez, Luis I., and Juan Pablo Esparza C. "Evaluation of the incidence of vampire bat attacks on cattle in the Sierra de Manantlán, México." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Kaiser, Lucia L., H.R. Melgar-Quiñonez, and Ana C. Zubieta. "Food insecurity in Latin American rural communities and in Latinos of California: Focus group observations." In: Symposium on Food Security from a Focus Group Perspective at the 9th International Conference of Qualitative Health Research, Guadalajara, Mexico, February 2003.

Kaiser, Lucia L., E. Valdez Curiel, H. Melgar-Quiñonez, and A.C. Zubieta. "Development of a tool to monitor food insecurity in the Sierra de Manantlán, Mexico." American Public Health Association 131st Annual Meeting. San Francisco, California, November 2003.

Lizárraga, P., Katty Hernandez, Carlos Vacaflores, and Fernando Dick. 2002. "Pathways to participation: looking for development through research." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Martínez R., Luis Manuel. "Management of water in the Rio Ayuquila watershed." Semana Nacional de la Conservación. November 25th-29th, 2002.

Martínez R., L.M., Paul Zedler y Eduardo Santana. 2003. "Local initiatives for watershed management." ALO-Partnership – USAID. Washington, D.C., August 7th-9th, 2003.

Melgar-Quiñonez, H. and Ana Claudia Zubieta. 2002. "Food insecurity in Latin-American rural villages: A qualitative assessment." GL-CRSP Program Conference, Washington, D.C., USA, October 8th- 12th, 2002.

Melgar-Quiñonez, H.R., A.C. Zubieta, and T.C. Moermond. "Seguridad alimentaria en comunidades rurales de América Latina: diagnóstico cualitativo." XIII Conference of the Sociedad Latinoamericana de Nutrición. Acapulco, Mexico, November 2003.

Melgar-Quiñonez H.R., A.C. Zubieta, L. L. Kaiser, E. Valdez, and T.C. Moermond, "Seguridad alimentaria y disponibilidad de alimentos en hogares del área rural." XIII Conference of the Sociedad Latinoamericana de Nutrición. Acapulco, Mexico, November 2003.

Moermond, Timothy, Luis I. Iñiguez, and Carlos Vacaflores. 2002. "Community planning for sustainable livestock-based forested ecosystems in Latin America." GL-CRSP Program Conference, Washington, D.C., USA, Oc tober 8-12, 2002.

Moermond, Timothy, Carlos Vacaflores, Luis Manuel Martínez, Gustavo Mosquera, Fabian Calispa, Freddy Caranza, Estalin Molina, Ricardo Paita, Michelle Young, and Alexis (Eakright) Murphy. 2002. "Extensive livestock production in Latin America: A syndrome of consequences and options." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Peñafiel, M.C. and Toasa G. 2002. "The results of multitemporal analysis of changes in vegetation cover in the Rio Cosanga watershed." VIII Congreso Latinoamericano de Botánica, Cartagena de Indias, Colombia. October 12-18, 2002.

Rosales Adame, Jésus Juan, Laura Elena Flores Beltrán y Eloy Fernando Carranza Montaño. 2002. "Cultivo en callejones con 'guaje': Alternativa agroecológica en el manejo de ganado en la Reserva de la Biosfera Sierra de Manantlán." Congreso Nacional de Áreas Naturales Protegidas, Guadalajara, Jalisco, Octuber 17th - 20th 2002.

Sansom, A. 2002. "Empowering farm women for decision-making in natural resource management, La Cueva, Bolivia." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Vacaflores, Carlos, Timothy Moermond, Luis I. Iñiguez, and Kattya Hernández. 2002. "Role of rural development NGOs: Fostering research skills, enhancing capabilities." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Whitelaw, B.L. 2002. "Relationship of wild plant use and food security within the Sierra de Manantlán Biosphere Reserve." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Young, M. 2002. "Heterogeneous land endowments: Implications for land use and income-generating strategies in the Mexican Ejido of Ahuacapán." GL-CRSP Program Conference, Washington, D.C., USA, October 8-12, 2002.

Principal Investigator

Lead Principal Investigator. Timothy Moermond, University of Wisconsin – Madison, Environmental Studies/Zoology, 430 Lincoln Drive, 451 Birge Hall, Madison, WI 53706. Tel: 608-262-5868; Fax: 608-265-6320; Email: tcmoermo@facstaff.wisc.edu.