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Executive summary

The Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP) promotes stakeholder empowerment and improved livelihoods through the discovery, organization, and dissemination of sustainable agriculture (SA) and natural resource management (NRM) knowledge. The approach is participatory, engaging stakeholders at all levels in research problem formulation within priority areas of inquiry, focusing on multiple countries and/or regions to facilitate scaling research findings up and out. Program efforts are competitively driven and organized through a nested landscape systems approach. Gender sensitivity is integral to the SANREM approach and reinforced by gender-sensitive participant training programs that include degree and non-degree plans. All activities link sustainable NRM with the economic concerns of local populations and the promotion of good governance.

The objectives of the SANREM CRSP program are to:

- increase scientific knowledge and technical innovations in SA and NRM
- improve knowledge management, education, and communication leading to behavioral changes in adaptation and adoption of new SA and NRM technologies and practices
- reform and strengthen SA and NRM governance, policies, and local institutions, and
- promote the functioning of sustainable resource-based local enterprises in national, regional, and global markets.

Long-term Research Award activities

The five Long-term Research Award (LTRA) activities were awarded between January and March 2006. In Fiscal Year 2008, these activities engaged U.S. and host country researchers, development agents, local officials, and community members in their respective sites. Following are highlights from each project.

LTRA-1: Decentralization Reforms and Property Rights: Potentials and Puzzles for Forest Sustainability and Livelihoods

This project addresses the complexities involved in local land use for sustainable forestry and improving livelihoods resulting from decentralized governance and property rights reform formulated at the national level. The researchers collected and are analyzing data from Uganda, Kenya, Mexico, and Bolivia to identify the institutional conditions, interactions, and strategies that will deliver benefits equitably to local people while sustaining natural resources. Regional and global comparative research creates a learning environment among critical actors leading to more effective policy formation, implementation, monitoring, and enforcement.

After dealing with numerous data entry delays, we have started to focus on data analysis. A meeting of the steering committee in December identified analytical products and assigned members to begin tackling them. Early findings show that both rulemaking activities and investments in natural resources increased significantly after decentralization in three of the four countries. Perceptions of inequality increased in Uganda following decentralization, a finding echoed by the Poverty and Environment Network (PEN) study, which showed that forest income increased significantly in wealthier households, while forest income in lower-income households declined moderately.

Kenya spent the first half of the year rectifying data problems and, after revising its work plan, collecting International Forestry Resources and Institutions (IFRI) data in its final site. Data collection and entry are now complete, and the team can focus on analysis, training, and dissemination.

Uganda also encountered data problems when an error in the database corrupted several IFRI forms. These problems have now been corrected. In the meantime, the team focused on training efforts in sites 1 and 2. This training targets both community residents and higher-level local officials, and focuses on conservation techniques, monitoring, and other community forest management concepts.

Mexico likewise encountered problems with the IFRI database that have now been remedied. The Mexico team led a workshop involving representatives of 42 communities in Oaxaca that focused on the findings of the national survey of forest communities conducted last year.

Bolivia continued work on reports for four of its sites and started numerous publications. A student thesis comparing 1996 (pre-decentralization) and 2008 (post-decentralization) IFRI data found that decentralization disrupted traditional governance structures in Chiquiaca (a site where University of Michigan funded research to complement the studies done through SANREM), introducing rules and requirements that are foreign to the indigenous population.

LTRA-2: Developing a Participatory Socioeconomic Model for Food Security, Improved Rural Livelihoods, Watershed Management, and Biodiversity Conservation in Southern Africa

The goal of this project is to test and optimize a “third generation” biodiversity conservation model that seeks to use markets to link improvements in rural livelihoods and food security with biodiversity conservation objectives. The Community Markets for Conservation (COMACO) model endeavors to operate on a triple bottom line of being economically, socially, and environmentally sustainable. SANREM research is involved in testing this ecosystem scale activity to identify strengths and weaknesses, and to define the sets of conditions under which it can operate so that the model could be replicated elsewhere. Researchers also are involved in host-country capacity building so that their work can be translated into on-the-ground impacts that improve the operations of the model.

Key accomplishments in the past half year include the collection of sales, transportation, and cost data for all products at all regional trading centers and the headquarters in Lusaka. These data are essential for the economic modeling that will verify COMACO’s ability to be financially self-supporting and will be essential for COMACO to understand its own business costs and benefits. In food sciences, SANREM research in years 1-3 identified key changes that needed to be made to ensure food production safety. This culminated in more varied food products, exports of such products to wider markets, and the development of new products. COMACO embraced changes suggested by SANREM researchers and hired its own food technologist. These advances have led to a partnership with U.S. food products company General Mills. In this half year, the COMACO food technologist and a Cornell master’s degree student completed an externship training program at General Mills and are now going to Zambia to implement their training and further improve COMACO’s operations and host country capacity. Data from the past three years of soil experiments have undergone initial analysis establishing the effects of climate (rainfall, temperature), soil properties (texture, carbon, pH, nutrients), and landscape position on crop yields through conservation farming (CF). CF is especially suited to improve productivity in higher rainfall areas. Social science surveys continued through the first quarter of SANREM Year 4, and data analysis is almost complete for many critical comparisons on the impacts of COMACO activities on food security, nutrition, and household economics. Research on poultry vaccination for Newcastle Disease virus continues, as does analysis of wildlife counts from aerial surveys.

LTRA-3: Watershed-based Natural Resource Management in Small-scale Agriculture: Sloped Areas of the Andean Region

This project is conducting research at sites in Guaranda, Bolivar Province, Ecuador; and Tiraque, Cochabamba Province, Bolivia. Work is being done in farmer fields and at experiment stations in both countries by a network of researchers at U.S. and other universities, and several partner organizations. Coordinators at both sites are engaging local governments, farmer and community groups, and individual decision makers in research planning and implementation. The program is fully participatory, and research findings are influencing decisions at the field, farm, and watershed levels.

Progress is meeting expectations. All objectives are being met. We had a major training event on watershed management and modeling in Cochabamba, Bolivia, in September 2008 for a number of academic and other local stakeholders. Training was led by the Virginia Tech Biological Systems Engineering program. Other workshops were held at sites in Bolivia and Ecuador at the national and local (watershed) level. Equipment for monitoring stream flows and weather is functioning in Bolivia and Ecuador sites, and participatory monitoring is being undertaken. Three U.S. graduate students (two at Penn State, one at Virginia Tech all three women) have visited Bolivia in the past two months to continue research activities, collect data, and verify/validate existing data.

Our scientific work continues to focus on livelihoods and their impacts on water quality, soil productivity, and household wellbeing. In tests on farmer fields, we are evaluating a number of conservation agriculture practices including live barriers, contour and limited plowing, use of cover crops, and use of new crops. We examine these practices from a point of view of cost effectiveness (in reducing erosion and runoff), impacts on existing livelihoods, and impacts on overall household wellbeing. We also recognize that the solution to environmental degradation and the ultimate sustainability of the farming/agricultural system cannot be found entirely on the farm. We place high priority on identifying off-farm activities (including value chain participation) to incorporate into existing systems. We find that in the isolated areas, only limited off-farm opportunities are possible, including agri-tourism, value-added marketing, and cultivation of medicinal herbs.

Another important thrust of our research is to examine biological controls of important plant diseases. These bio-control methods (including the use of endophyte bacteria) have the potential for reducing production costs, hence improving the financial sustainability of farm systems; and reducing the use of pesticides. They also offer the potential for non-agricultural industries in the production, dissemination, and sales of bio-control products. Bio-control was a major theme of a recent seminar held by SANREM scientists in Bolivia. At a session attended by 22 people – 9 women and 13 men – Ph.D. candidate Rachel Melnick spoke on biological control of cacao diseases in Ecuador. Ph.D. candidate Anissa Poleatewich gave a talk about biological control and endophytes, addressing 12 people – 5 women and 7 men.

A second SANREM undergraduate research experience is being prepared for May-June 2009 in Quito and Guaranda, Ecuador. Five undergraduates from Virginia Tech, together with Professors Jeffrey Alwang, Darrell Bosch, and George Norton, will participate. Students are currently taking an evening class to design the research and prepare themselves. While in Guaranda, they will evaluate the determinants of adoption of soil conservation techniques and try to analyze the effectiveness of different dissemination strategies in effecting local action.

LTRA-4: Adapting to Change in the Andean Highlands: Practices and Strategies to Address Climate and Market Risks in Vulnerable Agro-ecosystems

The goal of LTRA-4 is to improve the capabilities of rural communities in Andean highland (Altiplano) to adapt to climate, market, and social changes. These changes challenge agricultural production, natural-resource sustainability, and livelihood wellbeing due to alterations in the dynamics of the ecosystem that translate into production system risks and income uncertainties. Developing an understanding of how these changes have affected these ecosystems from a scientific and producer perspective is the first step toward developing adaptive strategies. Based on this understanding of the systems, the project completed its participatory research and training efforts to address these challenges in the areas of plant varieties, soil amendments, pest management, production strategies, and marketing. These efforts should ultimately change knowledge, attitudes, skills, aspirations, and finally, practice.

Activities were conducted as planned. Third-year soil amendment research, monitoring of dynamic of pests, and crop experiments were established. A protocol that integrates local and new knowledge was developed and implemented. Knowledge is being shared with community research groups in the three regions of Peru and Bolivia. Twenty-one workshops were held with community groups. Three types of products were designed and distributed – posters, leaflets, and detailed reports – aimed at the community center, families, and community officials, respectively. Some have been uploaded in the SANREM Knowledgebase. Uploading will continue during the second half of the fiscal year. These products integrate information on climate, markets, soils, pests, biodiversity, and landscape perception maps. The advocacy coalition approach to building social and human capitals in each community research group is currently being implemented. This process is further along in Peru. A problem we are facing with the amount of information shared with farmers is the farmers' own time constraints. Close coordination with the communities is taking place to address this. Research findings have been presented at several forums, from farmer meetings to government agencies in Bolivia and Peru, USAID Missions, academic events, and international meetings like the International Scientific Conference on Climate Change in Copenhagen March 10-12. Two of our doctoral students passed qualifying examinations, three passed their comprehensive examinations, and two master's students successfully defended their theses. Most of our students will complete their programs after Sept. 30. We have students pursuing seven Ph.D.s, 26 master's and 33 *licenciatura*/engineer degrees. We also organized seminars, workshops, and training courses involving 820 people – 451 men and 369 women – and held 25 farmer group events in which 304 men and 213 women participated. We reached 116 women and 131 men in several stakeholder events with USAID Missions, their collaborators, and government officials in Peru and Bolivia.

LTRA-5: Agroforestry and Sustainable Vegetable Production in Southeast Asian Watersheds

Communities in many forest and vegetable-producing watersheds in Southeast Asia are suffering from poverty and degradation of forest, soil, and water resources. The overall hypothesis of this research is: "Integrating vegetable production in tree systems and trees in vegetable production systems will alleviate poverty and will enhance environmental protection, ecosystem diversity, and sustainability on small farms in Southeast Asia." This research is being conducted by the TMPEGS team, which derives its name from its six objectives.

Farmers both women and men were provided with planting material to test viability of vegetable agroforestry (VAF) systems. Tree vegetables (bago, katuray, alikway, and malunggay) were provided in the Philippines; katuk, chili, and eggplant in Indonesia; and Cu nang in Vietnam. Initial results showed that katuk and Cu nang have prospects based on yield and farmers' positive reaction. Ongoing experiments on tree-vegetable interactions at the World Vegetable Center showed that in Year 1, young trees did not influence vegetable yield; in Year 2, vegetable yield with trees was higher than in open

systems; and in Year 3, as trees matured, most vegetables tested had significant decreases in yield except for cucumber and eggplant. Drip kits and seeds were also provided to farmers, and their yields of cabbage, Chinese cabbage, tomato, and bell pepper were higher in drip irrigation than in rainfed systems despite frequent rainfall. The results of irrigation uniformity coefficients of low-cost drip irrigation systems in sloping land were published showing that pressure regulators are needed for this drip kit to be applicable in steep slopes. Kit developers are now experimenting with low-cost pressure regulators.

Tests on perennial peanut (*Arachis pintoii*) as a cover crop had mixed results. It has prospects as a cover crop for taller fruit vegetables like tomato and bell pepper but significantly outcompeted low-statured vegetables like carrot and cabbage. Yard-long bean yield was also lower when planted with *A. pintoii*. There was no evidence that *A. pintoii* reduced pest numbers, but it reduced weeding and irrigation time. In a study on cashew trees with different soil covers, soil quality was highest for cashew trees with cacao trees and weeds, followed by cashew trees with no weeding. Cashew plantation with clear weeding had the poorest soil quality. Furthermore, cashew yield with clear weeding was lower than in those without clear weeding. The Soil and Water Assessment Tool (SWAT) model was validated using measured data in the Philippines and has good prospects as a tool to predict environmental impacts of changes in land use and management practices such as predicting the watershed-scale impacts of cover crops.

Drag force tests on a reduced tillage implement prototype focused on the coulter and opener. It was found that a 12-tooth round coulter and an opener with a larger rake angle with plastic siding and spiked sides had the least drag forces.

It was found that there are weak linkages and coordination among research institutions and universities in the research and development (R&D) system in Vietnam and the Philippines. R&D activities, technology transfer, and training have not been closely linked. Sharing of scientific information is weak. Research outputs have not been transferred to decision makers and end users in a timely and adequate way, and a knowledge-to-action approach will help improve the efficiency of the R&D system. There is some evidence of success that knowledge to action works. Through a closely coordinated partnership in Lantapan of SANREM researchers, local government politicians, and farmers both women and men, a municipal ordinance was enacted supporting the implementation of an incentive-based program to promote the adoption of a sustainable farming system (SFS) in a municipality. The SFS Investment Plan was finalized and is now ready for implementation. The local government has allocated a budget for the program, particularly the institutional arrangements required to implement the development plan.

It was observed that women benefit more from informal networks than from scheduled formal networks like workshops and training, for women have little time to attend training due to their household responsibilities; and women actively participate in ensuring the family wellbeing by mobilizing human and non-human allies. (Non-human allies include land, water, capital, crops, cell phones, knowledge and technologies from past and current SANREM projects.) Through a combination of informal and formal networks, SANREM women partners are developing their own katuk marketing system and slowly moving away from middle person marketers. Seedlings of tree vegetables were provided because women were keen on planting them. Their motivation appears to be that tree vegetables produce year round, and ensuring food security for the household is a main concern for women. Women were also provided vermicomposting technology out of their concern for cheaper farm inputs and their desire to try an alternative win-win solution that both improves production and benefits the environment. Socioeconomic impacts together with adoption by farmers both women and men are currently being studied.

A seminar-workshop was undertaken with 58 participants from a farmer group, non-governmental organizations, government institutions, and academia to discuss technology, marketing, organization, prospects for adoption, and gender issues in VAF systems. A SANREM case study on pesticide use and farmers' health cost was attended by about 140 staff members from various government agencies and

local leaders from village to provincial levels. The session showed the detrimental health, environmental, and economic impacts of improper pesticide use. SWAT workshops in Vietnam and Thailand were attended by 70 scientists and staff members from several countries in Southeast Asia. The first International SWAT-Southeast Asia conference was held, with more than 80 scientists from 16 countries participating. A book titled *SWAT: Global Applications*, sponsored by SANREM, was introduced at the conference.

Cross-cutting initiatives

When the SANREM CRSP selected the five LTRAs for funding, those reviewing the proposals noted common themes in many of the projects and recommended developing these as cross-cutting activities that would tie together synergies across SANREM's global work. These cross-cutting initiatives contribute to the overall SANREM CRSP program objectives of implementing multidisciplinary, multi-institutional research that mobilizes science and technology, foster innovation and improvement in the social, economic, and environmental sustainability of agriculture and natural resource management, and lead to improved livelihoods and expanded trade opportunities and capacities for stakeholders. They also promote cooperation among individual LTRAs.

Gendered Access to Markets: Gendered Networks and Livelihood Alternatives

The goal of the SANREM gender initiative is to determine how the gendered nature of market networks affects the quality of information women receive and their bargaining power in the household and the market. As markets emerge and change, producers join together to improve their exchange capabilities. This project compares how gendered networks and collations affect the ability of groups to access and control natural resources and markets to capture value for their agricultural and forest products. The specific proposition is whether women producers' participation in networks consisting primarily of women increases their access to markets.

Over the past six months, progress was made by all Long-term Research Award (LTRA) projects collecting and organizing data, yet much remains to be done within individual case studies before we can move to comparison and dissemination of research. A new case looking at gender relations and decision making in the dairy sector in Ecuador, led by Elena Cruz, was added to the gender cross-cutting initiative. There are now of nine gender projects and case studies; one of these (Hamilton) is in a different category and is aimed at producing a methodological chapter based on the experience of the two case studies (Amaya and Cruz) within LTRA-3. Another three case studies submitted preliminary reports that show promise of future results. Despite promising data collection, there is a long way to go before research is completed and presentable, much less comparable. The period ended with the posting (and distribution) of a partial collection of abstracts, literature reviews, and collective bibliography. A brief introductory literature review on networks was drafted to be expanded on after all the literature reviews are complete. Support and guidance were provided through ongoing electronic correspondence, assistance in the revision of case study profiles, and continued posting of information and literature on the SANREM CRSP Team Room and Knowledgebase (SKB) pages.

Assessing and Managing Soil Quality for Sustainable Agricultural Systems

The overall intent of this project is to identify effective, low-cost methods that can be used to evaluate soil quality across the wide range of climates, cropping systems, and socioeconomic conditions represented in ongoing SANREM-CRSP projects. Soil quality assessment is a process by which resources are evaluated on the basis of function. The need for an effective, low-cost method to evaluate soil quality is important in developing countries because soil degradation is a major impediment to sustainable crop growth.

Significant progress was achieved in the past six months of the soil quality project through surveys of community members and agricultural professionals, and laboratory testing and field procedures for soil quality. Initial testing of analytical methods for determining changes in soil quality due to degradation have been conducted with soils from a long-term experiment in the United States with different tillage and fertility treatments, and from soils collected in the Altiplano Region of Bolivia that had different cropping histories and periods of fallow. In the past six months, collaborators in Indonesia and the Philippines were identified and trained in soil quality measurements with the potassium permanganate (KMnO_4) portable kit test for labile carbon (C). A difficulty identified in Bolivia (Cochabamba and Umala), Indonesia, and the Philippines was difficulty obtaining the KMnO_4 reagent for researchers' use. The near infrared (NIR) procedure works successfully for prediction of several soil C fractions including water-soluble C, KMnO_4 C, and particulate organic matter (POM) C. Different methods to prepare samples for diffuse reflectance infrared Fourier-transformed spectroscopy (DRIFT) analysis, including separation of humic acid fractions and treatment with hydrofluoric acid (HF), have been compared to evaluate their effectiveness for removal of interference from the soil mineral fraction. The ratio of peaks from the DRIFT analysis for degraded and non-degraded soils will be used as an index of soil quality. These different procedures are being compared to determine which has the best relationship with labile C fractions predicted by the water-soluble, KMnO_4 , and POM C tests.

People in the highlands of Bolivia are curious about the nature and properties of their soils. Results of our surveys indicate that these indigenous farmers have an in-depth classification system based on experience that ranks different soils based on their agricultural use. However, lack of available soil- and plant-testing facilities hampers effective decision making regarding soil fertility management and long-term sustainability. In a recent test of a portable kit for evaluating soil quality based on the amount of biologically available forms of soil organic matter, a local farmer accompanied agronomists from Fundación PROINPA, a non-governmental organization based in the region, to evaluate use of the kit. The kit was effective in detecting degraded areas, but several factors hamper its use in this region, including the cost of the kit and the difficulty of obtaining the primary chemical reagent. The SANREM team is looking at ways to reduce costs and is evaluating other rapid methods of soil quality testing under a wide range of environmental conditions in Asia and Latin America. These tools will then allow community members and organizations working closely with them obtain information to make informed decisions to conserve their soil resources.

Soil Metagenomics to Construct Indicators of Soil Degradation

This project is collaborating with researchers in Bolivia (two groups) and Zambia to gain experience with one of the most exciting new techniques for studying soil traits and quality. Pyrosequencing allows a whole new level of understanding of soil microbes and their responses to management decisions. We are applying these techniques in the context of important problems for soil management in SANREM Long-term Research Award projects. In Bolivia (LTRA-4) we are evaluating how the trend toward shorter fallow periods because of economic pressures will influence soil. This will contribute to tradeoff analyses for management decisions. We are also studying (LTRA-3) mycorrhizal populations in soils and how they respond to soil conditions. This will contribute to strategies to optimize the use of mycorrhiza for crop fertility management. In Zambia (LTRA-2) we are studying soil community responses to farmer and conservation farming approaches. This will contribute to evaluation of strategies for conservation farming. Because of the many links between researchers and communities in SANREM, this cross-cutting biotechnology project will have impact to improve both training and infrastructure for scientists and insights for management in communities. We are excited to have new data available soon to contribute to these goals.

The project is progressing well, with graduate students in place and soil samples for the analyses in hand in collaboration with the three LTRA projects. The first sample was submitted for sequencing, and we

should have the results in about one month. Several synthesis papers related to microbes are in various stages of publication.

Linking Knowledge and Action: Meeting NRM Challenges

The goal of this cross-cutting activity is to identify the conditions under which research knowledge can influence the practice and behavior of policymakers, practitioners, and resource users. More specifically, the activity will systematize the recording and analysis of different strategies and processes used by SANREM Long-term Research Award activities 1, 3, 4, and 5 to influence policy and practice, and to gain an understanding of what strategies worked (or not) and how research and policy linkages can be enhanced to improve decision making at multiple levels of governance.

The case studies suggest that where farmers and resource users participate in the research process, they are more likely to accept the research findings and to use them. The method for incorporating farmers and resource users into the research process varies, from direct involvement in data gathering to the design and execution of field trials and experimentation. Regardless of method, farmers appreciate the additional knowledge gained in participatory research processes, just as they appreciate their knowledge being valued and recognized by external actors. In addition, different strategies must be used to engage actors at different levels of governance. Round tables that include policymakers, non-governmental organizations, and national research institutes have been effective in spotlighting local-level priorities and in defining and adopting resource management practices that enhance local, resource-user benefits. In situations with significant political barriers to participation, for example ethnic mistrust or skepticism by politicians, the sequencing of activities assumes importance.

Watershed Modeling and Assessment

The primary focus for this project period was field data collection to coincide with the November-April rainy season in Bolivia, Ecuador, and Zambia. Site visits in December (Zambia) and January (Bolivia and Ecuador) were used to check and calibrate field instruments and expand the sample collection with both automated and manual measurements.

A significant expansion of the watershed assessment for this rainy season was the addition of water quality analysis to the basic hydrology data. Stream samples were collected and analyzed for selected water quality parameters. The basic parameter at all locations is total suspended solids (TSS), but at the watersheds in Ecuador and in Jatun Mayu watershed (Tiraque, Bolivia) nutrient analyses have also been added.

Field (plot) studies in Jatun Mayu watershed were designed and implemented this season, supporting two specific study objectives: to evaluate the effects of cropping on runoff, erosion, and nutrient losses in the high altitude “upper zone” of the watershed’ and to characterize nutrient dynamics in fields to be able to develop and evaluate models that can then be used to analyze cropping systems and nutrient management practices and their impact on productivity and nutrient loss.

Watershed-scale analysis and integration studies through imagery analysis and modeling studies are ongoing by several partners and will become more prominent in focus following the end of the rainy season and the field data collection efforts.

Management Entity activities

The SANREM CRSP Management Entity was busy during the first half of Fiscal Year 2009 assisting the Long-term Research Awards (LTRAs) and cross-cutting initiatives culminate their activities and disseminate their findings. Sustainable agricultural and natural resource management innovations, policies, and practices were tested and the results disseminated through professional publications, extension documents, and various reports to partner organizations. Highlights of these supportive activities include the following.

- The *SANREM CRSP 2008 Annual Report* was submitted to USAID.
- The SANREM CRSP website is routinely updated with newly released reports and information.
- Three hundred fifty-six new information resources were entered into the SANREM Knowledgebase (SKB) and their metadata verified.
- The gender equity coordinator organized a gender and participative methodologies workshop in October for SANREM researchers from Ecuador, Peru, and Bolivia.
- One hundred twenty researchers participated in the SANREM CRSP co-sponsored Soil and Water Assessment Tool (SWAT) conference and workshop in Chiang Mai, Thailand and SWAT modeling workshop in Ho Chi Minh City, Vietnam.
- An online survey of SANREM partners identified conservation farming systems, water management, and food security as the top research priorities for SANREM Phase IV. A separate survey of USAID personnel found biofuels, ecosystem services, and food security to be additional priorities.
- A draft concept paper outlining the vision for competitive research programs focusing on conservation agriculture farming systems (CAFS) for the next phase of the SANREM CRSP was developed, disseminated for public comment, and revised.
- An Associate Award with the Sudan Mission was initiated to evaluate higher education needs in agriculture and natural resource management in Southern Sudan. Two symposiums with government, private sector, and university partners provided findings for the design and planning of a new agricultural curriculum for the Catholic University of Sudan and University of Juba.
- Version 4 of the SANREM Knowledgebase Metadata Guide updating the guidelines for entering information resources was published.
- Two SANREM newsletters were published (December 2008 and March 2009).
- Nine working papers based on LTRA research were published.
- The SANREM systems book, *The Sciences and Art of Adaptive Management*, was edited and prepared for submission to the Soil and Water Conservation Society for publication.
- The SANREM CRSP hosted two seminars at Virginia Tech. “Linking Knowledge with Action: Meeting NRM Challenges through SANREM” was led by the LTRA-5 co-principal investigator studying in the Sustainability Science Program at Harvard University this year. The other, titled “Market access and gender roles in the Jatun Mayu watershed communities (Tiraque, Bolivia)” was led by an LTRA-3 master’s student at Virginia Tech.
- The SANREM Technical Committee held a telephone conference to discuss the semiannual and final annual report and the SANREM CRSP annual meeting to be held in the Washington, D.C., area Aug. 31-Sept. 1.

Long-term Research Award activities

LTRA-1: Decentralization Reforms and Property Rights: Potentials and Puzzles for Forest Sustainability and Livelihoods

Lead PI: Elinor Ostrom, Indiana University

Research progress by objective

Much of the activity this year supports all three objectives so is covered here together.

Progress toward completing critical Annual Work Plan tasks

The steering committee met in December to further discuss analytical products from the research. The meeting was attended by Krister Andersson, Jacqui Bauer, Eric Coleman, Forrest Fleischman, Pam Jagger, Marty Luckert, Esther Mwangi, and Elinor Ostrom. The group discussed progress on the decentralization concept paper, and Marty agreed to further develop the proposed framework. Jacqui, Eric, and Forrest agreed to undertake preliminary analysis of conditions and behaviors before and after decentralization. Results from that analysis are summarized below.

Changes in research design or methods, obstacles encountered, and actions taken

Fiscal Year 2009 experienced a number of data entry delays. Errors in the IFRI database corrupted Uganda's data and caused data entered by Mexico to be erased. In addition, as indicated in previous conversations, when Kenya submitted its data at the end of FY 2008, it became clear that there were some problems –due to budget constraints that Kenya had not clearly articulated to us, they had completed household surveys in only three of their seven sites (rather than both IFRI and household surveys as expected). After discussion, the steering committee retooled the work plan, asking the Kenya Forestry Research Institute (KEFRI) to complete the IFRI study in the final site (Kedowa-Mau) and leaving Upper Imenti, Ramogi Hills, and Arabuko Sokoke with only partial IFRI data. Field work in Kedowa-Mau is now complete.

These obstacles in turn delayed data analysis. We hope that having a dedicated research assistant this summer will allow us to perform analyses that will further enhance and explain the findings listed below.

Significant research findings

- In an analysis of forest user group behavior before and after decentralization reforms for their respective countries, we found the following:
 - A greater number of user groups engaged in rulemaking after decentralization in Bolivia and Uganda (significant at the 0.01 probability (p) level) and in Kenya ($p < 0.05$).
 - There was no significant difference in user group rulemaking in Mexico, possibly because decentralization in Mexico took place over many years and the available data covered only the most recent decentralization reform, in 2003.
 - A greater number of user groups invested in natural improvements (planting seeds, trees, and bushes) after decentralization in Bolivia, Mexico, and Uganda ($p < 0.01$). There was no significant change in Kenya, but this could be due to insufficient data (post-decentralization data were

submitted for only 10 user groups, compared with 57 user groups with data from before decentralization).

- o The perception of the difference in wealth among members of user groups showed that the perception of inequality increased after decentralization in Uganda ($p < 0.05$). This is consistent with the previously reported findings of the Uganda PEN study, which showed that wealthier households experienced large gains in income from forests following decentralization, whereas the lowest income households experienced moderate losses.
- Analysis also showed that scarcity (as shown by the number of households per hectare of forest) has a strong negative relationship with investments in the resource, that is, higher numbers of households per hectare are associated with lower levels of investment in the forest resource.
- In Bolivia, a student thesis showed that decentralization disrupts traditional governance structures in Chiquiaca (a site where University of Michigan funded research to complement the studies done through SANREM), introducing rules and requirements that are foreign to the indigenous population.

TOP Objective 1. Develop capacity within resource user groups at the selected forest sites to enable differentiated actors (particularly women, the poor, and other marginalized groups) to identify, understand, and participate in forest governance, benefits, and policy processes

Progress toward completing critical Annual Work Plan tasks

- The Kenya team completed data collection and submitted data for analysis. The team's initial impressions are that the forest condition at Site #7 worsened considerably since the last IFRI visit in 2003, with tree density visibly reduced and most rivers now dry. Population increased, and poverty levels are high, making the demand for illegal forest products high as well. Ethnic rivalry between the Kikuyus and the Kalenjins increases competition to harvest. They also created a video on Participatory Forest Management activities in Upper Imenti (Site #3). It is being translated into Kiswahili and one other local language to allow the team to disseminate information across a number of sites.
- In Bolivia, the team focused on writing reports from four of its sites. The team reports that, although the forest around Simay (Site #5) was disturbed by human interventions throughout the 1980s and 1990s, it has almost fully recovered and is in good condition, populated by numerous large mammals. The community uses the forest for palm fruit and cacao; timber also is harvested occasionally, even though there is a forest management plan. Both the municipal government and the forest superintendence are largely absent from the local forest sector. In San Isidro (Site #6), the population is mostly colonists who have expanded agricultural land and degraded the forest. The management plan created five years ago is no longer operative, with many sites included in the plan also included in conflicting plans for forest clearing.
- Uganda continued working with the Kirugu and Nakalanga user groups in Mabira (Site #1) to strengthen the forest management committees formed to participate in collaborative forest management (CFM). The committee grappled with the challenge of persuading unemployed youth to stop illegal forest harvesting activities. The National Forest Authority insists that all illegal activities cease before a CFM agreement can be implemented. Also in Site #1, Uganda Forestry Resources and Institutions Center (UFRIC) facilitated linkages between these user groups and other CFM committees on the western side of the reserve who have effectively protected their areas of the forest; and started several income-generating activities for local youth, such as ecotourism (developing lodging and trails, and planting trees). These groups will participate next month in another CFM exchange among Mabira, Kyarukooka (Site #2), and Sango Bay (Site #4). This workshop, arranged

by UFRIC, is intended to build the group's capacity to play a more effective role in governance of its own forests. UFRIC also conducted a two-day training and networking workshop, outlined below.

TOP Objective 2. Develop capacity within key organizations, especially government agencies and non-governmental organizations (NGOs), in the forestry sector to understand the impacts of policies on differentiated local actors and to adopt strategies for inclusion of such actors within broader policy processes

Progress toward completing critical Annual Work Plan tasks

- Uganda held discussions with officials Kibaale District (Site #2), where there are extensive forested areas that are not legally protected, on both private and public land, and where deforestation is rampant. Researchers used satellite images to convince both technical and political leadership of the rapid rate of deforestation, and have scheduled a one-day workshop to take place in the next quarter.
- As part of this objective, partners are disseminating a number of findings to scholars, policy makers, and other key stakeholders in the development of forest and decentralization policies. Graduate students Amy Duchelle, Pam Jagger, and Patricia Uberhuaga have been involved in a number of publications and presentations. Those that have been completed appear in the publications form and/or the SKB.

TOP Objective 3. Develop effective monitoring techniques for use by resource user groups and their partners (including NGOs and local agencies) at the community level to assess the impacts of decentralization and other property rights reforms on natural resources (including biodiversity) and livelihoods

Progress toward completing critical Annual Work Plan tasks

- Uganda focused on building monitoring skills at both the community level with the training of Community Based Organizations (CBOs) in Site #1 and at higher scales through discussions with forest district officials in Site #2). Increasing awareness of the need for monitoring at both of these scales is critical in making decentralization efforts meaningful, for it helps to ensure that consequences will result from illegal activities.

Significant training, capacity building, and networking activities

- Uganda held a two-day training and networking event with organizations involved in community forest management at Site #1 (Mabira). Participating groups include the Mabira Forest Integrated Community Organization, Conservation for Future Sustainable Development Association, and Naggoje Community Based Association. Groups were trained in conservation and monitoring techniques, including managing boundary trees, patrolling forest boundaries, and establishing alternative income-generation activities.
- Mexico conducted a workshop to present and discuss the results of the national survey completed last year. Representatives from 42 communities in the Sierra de Juárez region of Oaxaca attended.

Vignettes

Kenya. The user groups of Kenya's Ramogi Forest have really taken to heart SANREM's message of linking sustainable natural resource management with livelihoods. Because of the research and training team's efforts, the groups not only decided to organize the community into a formal, registered association; they have also been exploring both conservation and income diversification. The team's work

to sensitize the group on the importance of conserving the forest resulted in some members creating some of the biggest tree nurseries in the district. The KEFRI team also introduced the idea of planting aloe as a business enterprise, and local farmers formed a cooperative to raise and sell aloe. The SANREM team linked them with relevant marketing channels through one of KEFRI's lead aloe experts. Finally, after the SANREM team highlighted the plight of the community and the potential of the area for ecotourism due to its historical and cultural importance as the home of the founding father of the Luo Community, the Ramogi Conservation Group is now proudly involved in an ecotourism initiative that is being coordinated by a former director of KEFRI.

Uganda. Policymakers and officials reported historical antagonism and conflict between the communities and the forest officers. The SANREM approach to research involved all stakeholders to be part of the team, which stimulated dialogue between members of the communities and the forest officers. After these interactions, a friendlier atmosphere developed so that community members could discuss issues amiably instead of solving problems through violent means. National Forest Authority officers who before could hardly park their motorbikes in the communities without them being vandalized say they can do so safely now. In Sango Bay, the forest officers who before the SANREM /UFRIC research were referred to as "those animals" are now viewed as allies by community members, who even patrol with them. This made the forest officers' work easier.

Uganda. For two weeks, UFRIC researchers camped with the communities at each site, eating and working with them and building a good relationship. As a result, monitoring by community members and forest officials improved in the Nakalanga and Kirugu settlements in Mabira forest. This meant that harvesting forest products illegally was more difficult because the likelihood of being caught was very high. Forced to seek alternatives, some local residents previously engaged in illegal harvesting found employment in brick making, stone quarrying, sugar growing, and casual employment in nearby towns.

LTRA-2: Developing a Participatory Socioeconomic Model for Food Security, Improved Rural Livelihoods, Watershed Management, and Biodiversity Conservation in Southern Africa

Lead PI: Alex Travis, Cornell University

Research progress by objective

Objective 1. Determine the extent to which the COMACO model can be economically self-sustaining and the effectiveness of the different COMACO model components.

Progress is very strong on this objective as it moves to completion.

- Data were gathered for the economic assessment and self-sufficiency analysis.
- Templates for business analyses have been formulated

Objective 2. Identify and integrate new technologies into the COMACO model to improve its profitability, food security, and rural incomes.

This objective includes three main components: soil/crop sciences, food sciences, and veterinary sciences. Progress is continuing on all three fronts.

Soils

- Multivariate analyses have been performed to discern the benefits of various soil amendments and farming practices in light of different rainfall, slope, and soil type.
- Soil samples are being analyzed for mineral and nutrient composition as a result of different farming practices.
- Soil samples are being analyzed as part of cross-cutting research for metagenomic analysis.
- False chronosequence data continue to be collected in this current harvest season.

Food sciences

Note: The first three bulleted items took place before this half year, but the results of the research are being utilized currently.

- The project significantly improved COMACO's capacity for safe food commodity processing by:
 - providing theoretical and hands-on training on basic food hygiene and good manufacturing practices for the COMACO production staff from the community trading centers (CTC), and
 - providing COMACO with electronic and printed materials for future in-house training on food safety and personal hygiene in food processing facilities.
- The project helped to enhance COMACO's capacity for efficient value-added processing of local commodities through:
 - assistance in identifying and correcting some of the problems encountered in their food processing facility. Examples were suggested technical solutions for reducing the oil separation in peanut butter, reducing breakages in rice, and utilization of broken rice
 - assistance in developing new products, including soy milk and tofu, and providing COMACO personnel with suggestions for the utilization and commercialization of such products, and

- providing the CTC with necessary instrumentation for quality control, which will help them monitor and ensure the quality of their products.
- SANREM helped to boost COMACO's sales of value-added products. As a result of the training and the enforcement of food safety and good manufacturing practices measures in the CTC, COMACO was approved as a vendor of high energy protein supplement (HEPS) for World Food Program-Zambia. This brought significant revenue to COMACO, contributing to increased livelihood for the region.
- SANREM helped to build COMACO's capacity in food processing by attracting additional resources into the project.
 - General Mills, through its philanthropic arm General Mills Foundation, made significant contributions to the projects. The foundation enhanced processing capacity by donating a second extruder for soy products to the CTC; and enhanced local knowhow and skill base in food processing and product development by offering eight weeks of free training at the corporation's U.S. facilities for the local food processing specialist and the Cornell master's student who will assist COMACO in new food-product development.
 - A self-funded Cornell master's student with significant product development expertise was attracted to the project. The student was trained together with the Zambian food processing specialist at General Mills on processing methods directly relevant to COMACO. The student will travel to Zambia this summer, where he will further assist with food processing and product development.

Veterinary sciences

Poultry data collection for the efficacy of vaccination against the Newcastle disease virus continues.

Objective 3. Determine the extent to which the COMACO model provides self-sustaining social institutions and meaningful roles for COMACO participants.

Progress on aspects of this objective were delayed due to unanticipated health problems with personnel. However, progress is being made on several important surveys.

- Surveys on family health and wellbeing were finished, and data are being analyzed.
- The meat trafficking survey comparing Lundazi and Nyimba areas was completed, and data are being analyzed.

Objective 4. Determine the extent to which the COMACO model improves biodiversity and watershed conservation.

Progress in the form of data analysis continues on this objective.

- Data on poacher capture and anti-poaching activities from the Zambian Wildlife Authority are being analyzed.
- Data from aerial surveys are being analyzed.
- Data on hippopotamus distribution and numbers are being mapped.

Significant training, capacity building, and networking activities

Of special note, advanced training in the food sciences was provided by General Mills, which became highly engaged with COMACO. Food processing and new product development – U.S.-based training by General Mills not funded by the project but resulting from SANREM-based activities – was completed by Jimmy Chikahya of CTC Lundazi and Colin Seeley of Cornell. The training period was Feb. 9 through April 10.

In November, Principal Investigator Alex Travis met with USAID Mission Director Melissa Williams and her economic growth team in Lusaka. Updates were given on the scope and impacts of SANREM research and the current status of COMACO's business, social, and environmental activities. New possibilities for future synergies were identified.

We are currently planning a meeting with multiple stakeholders and researchers to discuss COMACO and the findings of SANREM research. This meeting is tentatively scheduled for the end of June (pending the ability of key individuals and institutions to attend).

Vignettes

Economics

SANREM researchers performed the first financial analyses of COMACO. This work helps COMACO personnel understand the profits and costs associated with each specific activity that is part of its triple bottom line model of seeking to impact family income and wellbeing, as well as the environment. This insight into their business helped them understand the importance of scaling up the production of value-added products, the importance of large, stable (predictable) contracts and access to larger markets, and the importance of transportation costs. This latter point resulted in the relocation of the Feira CTC to Nyimba. In conjunction with food science research and capacity building, our economic research led to tremendous increases in production scale, product diversity, and profits generated by the large contracts that COMACO has procured. This translated directly into improvements in rural incomes and food security for the most impoverished farmers in Eastern Zambia that COMACO seeks as participants.

In addition, our historical cost analysis helped to identify the capital investments needed to launch a regional trading center, which is crucial because the model is now expanding to the north and west and new trading centers are coming online. Finally, our economic analyses and observations identified an extremely important opportunity to derive profit from current activities that had not been recognized: namely, that COMACO can potentially tap into carbon markets for avoided deforestation, new plantings, and soil carbon sequestration due to conservation farming practices. This last market would allow farmers to benefit directly from their conservation farming practices, further encouraging them to use sustainable agricultural practices.

For development practitioners and agencies such as USAID, our economic research provides an important measure of what it would cost to replicate the COMACO model, what it would cost to build, equip, and staff a regional trading center, and what components of the model could allow it to prosper under different circumstances.

Soils

SANREM research investigated the effects of climate (rainfall, temperature), soil properties (texture, carbon, pH, nutrients), and landscape position on crop yields through conservation farming. We covered

the three agro-ecozones in eastern Zambia, which are widespread across southern Africa so that our work will benefit farmers on a broad scale beyond the Luangwa Valley as well as the farmers within it. We determined that individual aspects of conservation farming do not provide the same benefits as biochar and mineral fertilizers, and that conservation farming is practiced differently by many farmers. Of importance, we found that conservation farming is especially suited to improve productivity in higher rainfall areas. This information will be important for government and non-governmental extension officers to focus their efforts to maximize crop yields and derive the most benefits from improved farming techniques. In the long run, this information is also essential for predicting the effects on farm production of climate change. For example, our data imply that, with decreasing rainfall as a consequence of climate change, yields would be significantly affected in this region, having important consequences on food security and rural livelihoods. These findings can inform policymakers about what adaptive practices to support before deleterious changes occur.

We need to perform further research, including the statistical calculations needed to interpret the data and completing soil carbon and nitrogen as well as soil and plant nutrient analyses. Depending on further funding, it may be possible to generate a map for Eastern Zambia that gives spatially explicit information about average farmer yields and the total yield potential should improved technology be available in the form of access to mineral fertilizers. This would also be an extremely valuable tool for decision making and policy advice.

Food sciences

SANREM research had a dramatic impact on COMACO's production of value-added food products, directly building capacity and directly improving food security and rural incomes. SANREM food scientists made an immediate impact through key recommendations to improve the processing facilities and food handling methods. These suggested changes were immediately adopted, significantly improving product safety. SANREM researchers then held a workshop that included both theoretical and hands-on training in safe and hygienic food production, which allowed COMACO's facilities to pass their certification and quality assurance testing; this led directly to a large new contract for HEPS with the World Food Program. HEPS is a key product in the treatment of malnutrition and for those with HIV/AIDS. Previously, HEPS had to be imported at great cost. Now, COMACO's farmers can meet this critical need locally, at the same time increasing their own food security and family incomes. Electronic and printed materials were produced for continued in-house training.

SANREM researchers also identified and corrected some of the problems affecting COMACO's food processing facilities. For example, research on peanut butter processing and formulations led to an improved product with reduced oil separation and improved packaging to increase shelf life. Rice breakage was reduced, and new products are being researched to reduce wasting of rice that does break. Both changes increase profitability and food security. The tremendous impacts of SANREM's food scientists led COMACO to appreciate their need to build their capacity in this area for the future. This led to a relationship with the University of Zambia for product testing and quality assurance and the hiring of a Zambian food technologist. This individual can now provide continued oversight and training, and develop new products.

SANREM food scientists established a tie between COMACO and General Mills. During their site visit, specialists from General Mills were impressed with the quality of COMACO's food processing facilities, which is in part a result of the activities of this project. As a result of the visit, General Mills donated another extruder to COMACO. They also trained at their own cost COMACO's food processing specialist and a Cornell master's student at one of their facilities. This is a significant boost for increasing the local capacity in value-added processing, which is expected to bring in significant revenue for COMACO's and thus enhance long-term livelihoods of participants.

Overall, these activities and achievements will enable COMACO to approach export markets and develop new products with high added value and longer shelf lives under the difficult environmental conditions of the area.

Veterinary sciences

SANREM researchers identified that more than 80% of poultry were dying before sale or consumption, leading to extremely low yield from this activity that is practiced by the majority of rural households. Research identified the causes of mortality and led to recommended improvements in roost design and husbandry. These changes were taught to thousands of villagers by SANREM veterinary researchers, and the training is being continued by COMACO's extension officers. Husbandry changes alone were able to improve production by about 50%. However, even with perfect practices, Newcastle disease virus is still endemic and can devastate the flocks of entire villages, a major reason why improved practices had not evolved previously. Partnership with the International Rural Poultry Centre led to a vaccination program mounted by community vaccination teams. Tens of thousands of chickens have been vaccinated, and offtake and census data are being collected and analyzed to determine whether this vaccination program can be economically self-sufficient. If so, it would provide increased food production and nutrition, an additional income source, and professions for the vaccinators.

Social sciences

For COMACO's activities to be sustained, they must provide tangible advantages to the participants. Social data continue to be collected to evaluate the impacts on income, nutrition, health, gender equality, and natural resource management practices. If COMACO is not having its intended social benefits, then policy changes can be made to improve the COMACO model. One very positive finding is that COMACO is indeed gender equitable in terms of the prices it provides male and female farmers for the same products. It is important to promote gender equity, and is especially important given the high percentage of families run by a single female head of household. SANREM social research brought gender to the fore, resulting in new appreciation that affects COMACO staffing practices. For example, before the start of the SANREM project, there were no female extension officers. Now, gender is strictly balanced in vaccination teams. Social science research must continue to provide a continual assessment of whether COMACO is having its desired impacts.

Natural resource management (wildlife and watershed analyses and preservation)

Several areas of SANREM research are having direct impacts on multiple stakeholders. The results of a "willingness to pay" survey of foreign tourists will help the Zambian Wildlife Authority to understand the values that tourists place on varied species of wildlife and of particular conservation efforts. This can help them adjust park entrance fees, publicize the presence of different non-game species, and promote specific activities.

Data on wildlife numbers have documented the large impact of COMACO in stabilizing numbers of hoof stock in the COMACO core area relative to controls (new areas into which COMACO is moving). These data in turn will allow scientists to see whether animals will move back into the areas in which they were previously found but were poached to extermination. This will inform Zambian government authorities as they set new wildlife use policies and will inform COMACO as to the success of its indirect approach to biodiversity conservation. Aerial counts of Africa's largest hippo population show species numbers and map their distributions. These data will provide a critical picture of this population as it faces increasing pressures from siltation, changes in river morphology and is increasingly coming into conflict with local fishermen and farmers due to net destruction, attacks, and crop predation.

Watershed analysis shows that clearing of forests on the slopes (escarpment of the Luangwa Valley) has the greatest potential to increase runoff and siltation. This is essential information because the clearing of forest for cotton and tobacco farming and charcoal production is intensifying. This information provides federal and regional government officials, as well as traditional rulers, with key insights into how they should develop land-use strategies to avoid deleterious downstream effects.

LTRA-3: Watershed-based Natural Resource Management in Small-scale Agriculture: Sloped Areas of the Andean Region

Lead PI: Jeffrey Alwang, Virginia Tech

Research progress by objective

Objective 1. Identify economic, social, political and environmental conditions in the watersheds and understand the determinants of these conditions.

Task 3.1.A – in progress. All Cs-137 soil analyses have been completed, and we are finishing publication on soil loss (Ecuador). In Bolivia, we are monitoring our field trial to examine how practices affect runoff. In this experiment, we have four treatments and the second year of data are currently being collected. The first year of data were compromised by unusual weather events.

Task 3.1.B – completed. Results from tasks 3.1.A and 3.1.B are currently being incorporated into a manuscript that will be submitted to a peer-reviewed journal.

Task 3.1.C – in progress, Ecuador and Bolivia. Baseline data have been collected and are being analyzed for both countries. Student Robert Andrade completed and defended his thesis on work from Ecuador, and the thesis was approved in October 2008. A paper from the thesis was presented at the International Symposium on Integrated Pest Management in Portland, Ore., on March 22, 2009. A book summarizing conditions in Ecuador and a draft journal article from Andrade's thesis have been completed. Bolivia data have been analyzed. Ongoing analysis is being conducted as a part of a master's thesis by Nadezda Amaya and a doctoral dissertation by Catherine LaRochelle.

Task 3.1.D – completed, Ecuador and Bolivia. Available geographic information system (GIS) data were assembled. Rainfall and stream-flow data collection were initiated under the cross-cutting project with Virginia Tech Professor Conrad Heatwole. Sistema de Información Geográfica y Agropecuaria (SIGAGRO) in Ecuador incorporated the socioeconomic data into the GIS. Bio-monitoring continued at eight sites in Illangama and Alumbre watersheds in Ecuador. Data are being entered on aquatic species and chemical composition of water. Chemical values are generally within expected limits. A publication was completed on a new species of aquatic insect. Monitoring of biodiversity is being undertaken in Tiraque, Bolivia, with the Center for Genetics and Biodiversity at Universidad Mayor de San Simón. Indicator species have been identified, and monitoring is proceeding. Data being collected from water monitoring stations in Ecuador and Bolivia are being analyzed to determine the impacts of land-use changes on water flows and water quality.

Task 3.1.E – in progress. In Ecuador, baseline data were collected, but gender analysis has not begun. In Bolivia, we have identified the main focus of the analysis (access to markets and gender roles in product marketing). Several participatory interviews have been designed to be undertaken with market participants.

Task 3.1.F – in progress in Bolivia

Task 3.1.G – completed

Task 3.1.H – in progress, both countries. See Knowledge to Action report for further information.

Objective 2. Generate and validate environmentally sustainable alternatives to improve production systems and enhance income generation.

Task 3.2.A - in progress. Since February 2007 in the Alumbre sub-watershed, we have collected data on daily precipitation, runoff, and weight of solid materials. Data collection is ongoing. This year we established runoff trials in the upper Illangama sub-watershed. Analysis is being undertaken. We have information on the relative cost-effectiveness of alternative erosion control strategies in Ecuador.

Task 3.2.B – in progress. Several results of the fertilizer and nutrition trials are now available. Following are highlights from Ecuador.

- No difference was found in yields between minimum and conventional tillage.
- Nitrogen is the limiting nutrient in maize trials. Other elements (phosphorous, potassium, magnesium) did not affect yields.
- Information on the distribution of nutrients within the plants is available.
- High rate of economic return was seen with adoption of the recommended fertilization package.
- We are continuing the study on rainfall and runoff in our test plots.

The following are highlights from Bolivia.

- Three fava bean trials have been established with planting density as the main treatment. Evidence to date shows that density is inversely associated with disease frequency. Complete analysis will be prepared by September.
- The *cañahua* trials show this crop to be an excellent part of a potato-pasture rotation. Inclusion of the crop lowers erosion and leads to sustainable yields, but the plant is very sensitive to soil moisture and drainage. This crop is most appropriate at middle elevations in good soils.
- The maca in higher elevations produces well in rotation with potatoes, but market constraints (few purchasers) make it financially less attractive than alternatives.
- Erosion trials in the upper- and medium-elevation zones of the watershed are now being evaluated. We are finding that live barriers are an effective means of maintaining soil fertility while costing less in terms of loss of planting areas than alternatives. The grass “*pasto falaris*” was tested in these trials, and the variety is now being made available to producers based on the findings from the field trials.
- Alfalfa trials, though only in the first year, show this crop to be a viable alternative to fix nitrogen and maintain soil productivity in lower and medium elevations. The cover crop handles water stress quite well, and farmers accept it for feed.
- Our trials for bio-control of main potato diseases are finishing their first year. We are examining endophytes to control *R. solani*, *S. subterranea*, and *H. solani*, and are not finding satisfactory results. Preliminary results indicate that endophyte bacteria are not an effective control unless they are combined with chemical treatments. The test approach and methods have been transferred to our partners in Fundación PROINPA, who assure us they will continue to investigate the techniques as a potential control for fava bean diseases.
- Bio-control trials have also been established to examine effectiveness in suppression of nematodes on tomatoes and potatoes. In the potato trial, bacterial biological control agents are being evaluated for their ability to suppress *Globodera* and *Nacobus* nematodes. The results from this trial are not yet available.
- Trials are evaluating management of crown gall pathogen, *Agrobacterium tumefaciens*. This pathogen affects peaches in the lower watershed. Five treatments are being evaluated: surgery control, diesel fuel + surgery, *Bacillus subtilis* + surgery, *Bacillus ameliofaciens* + surgery, and a non-pathogenic *Agrobacterium radiobacter* isolate PB + surgery. All bacterial treatments appear to reduce gall regrowth with *B. subtilis*, and isolate PB providing the best results. In another farmer’s field,

PROINPA is running a larger-scale trial on biological control of crown gall in peaches using the same isolates mentioned above. Small trees previously treated with the same bacteria were transplanted into a severely infested field. Preliminary results are promising.

- More than 100 soil samples and crop samples have been taken to analyze nutrient balances in the conventional crop rotation system. Results will be used to understand constraints to improved production.

Task 3.2.C – in progress. Economic viability of livelihood alternatives is being investigated using the baseline survey data. In Ecuador, Robert Andrade’s thesis systematically and quantitatively established the relationship between livelihood strategies and household wellbeing. He finds that livelihoods are responsive to investments in human and financial capital (access to credit) and that efforts to improve wellbeing must consider that much of the fixed household assets will be difficult to change over time. Several meetings have been held with local farmers to understand their perceptions relative to income-earning possibilities based on Andrade’s findings. These meetings have helped deepen our understanding of adoption of livelihoods and wellbeing outcomes. They also helped focus our attention on soil conservation and soil fertility improvements as a central means of improving wellbeing.

We have identified and validated several best management practices (BMPs) for soil conservation on the steep slopes. Eleven alternatives have been identified using soil conservation techniques, soil maintenance techniques (mostly fruits like blackberry, avocado, lemon and tree tomato) and native forest products (piquil, chachacoma, aliso, nogal, higuerón, tilo, yagual, romerillo, guarango, laurel de cera, musancetas, and siete cueros). These BMPs, their costs, and their spread will be analyzed by SANREM interns in May and June.

In Bolivia, we are collecting information on costs of production but have not yet analyzed the results. Catherine LaRochelle is completing an analysis of the relationship between household asset bases and livelihood strategies. She is finding that, partly due to the relative absence of off-farm alternatives and partly to socioeconomic conditions in the watershed, the determinants of livelihood adoption are more difficult to model than in Ecuador. Using the same data, Nadezda Amaya is investigating how market access affects household wellbeing. We have been working with farmers by using the results from our watershed modeling alternatives to begin to prepare land-use plans for individuals and groups of farmers. We have discovered that the local government is not accepting of scientific research results (we explain this in the Knowledge to Action report) and that the best means of gaining acceptance in the watershed is by working with individuals. Farmers and farmer groups have been active participants and have helped us to identify livelihood clusters, alternative crops, and obstacles to profitability.

Task 3.2.D – completed for Ecuador. The dairy chain analysis was finalized for the Illangama watershed, and the report is being prepared. In Bolivia, Amaya is undertaking an analysis of determinants of access to potato markets and the roles of gender and access to information. Preliminary findings show that women largely control the Tiraque-area potato markets, but access to information (proxied through access to cell-phone signals) helps inform market decisions. Marketing behavior of families with access to cell-phone signals is different from those without such access.

Task 3.2.E – completed for Ecuador. An article was prepared from this analysis. In Bolivia, we are still evaluating the alfalfa rotation (see above).

Task 3.2.F – ongoing. We are examining the effectiveness of a variety of bio-control methods. We have found that bio-control of cacao diseases is a promising strategy (see publications for further information). Bio-control for diseases of perennial and annual crops in Bolivia is still being evaluated (see above). In Ecuador, study of flora and fauna and their roles in preserving water quality in hydric recharge zones is

ongoing. This study is being undertaken in a participatory fashion, taking advantage of significant local knowledge of the situation. There are stark differences in floral biodiversity in the two watersheds.

Table 1. Biodiversity in Alumbre and Illangama

Indicator Comparisons	Illangama	Alumbre
Total individuos (N)	53	151
Riqueza de las familias	30	49
No. total de especies (S)	47	118
Índice de Shannon – Weaver H' (loge)	3.94	4.87
Índice de Simpson	31.78	110.08

Table 2. Families and species in the Alumbre River watershed

Families	Most representative and useful species
Solanaceae	<i>S. asperolanatum</i> , <i>S. oblongifolium</i> , <i>S. aphyodendron</i> , <i>Cestrum megalophyllum</i> , <i>C. tomentosum</i> , <i>Cuatresia sp.</i> , <i>S. altissimum</i> , <i>S. umbellatum</i> , <i>S. abitaguense</i> , <i>S. aff. Leptopodium</i>
Asteraceae	<i>Critoniopsis sodiroi</i> , <i>Piptocomoa discolor</i> , <i>Vernonanthura patens</i> , <i>Erato sodiroi</i> , <i>Erato polymnioides</i> , <i>Smallanthus fruticosus</i> , <i>Dendrophorbium llórense</i>
Lauraceae	<i>Nectandra</i> , <i>Ocotea floribunda</i> , <i>O. sodiroana</i> , <i>Nectandra acutifolia</i> , <i>Nectandra laurel</i>
Piperaceae	<i>Piper longispicum</i> , <i>P. bogotense</i> , <i>P. barbatum</i> , <i>P. obtusilimbus</i>
Euphorbiaceae	<i>Euphorbia pulcherima</i> , <i>Alchornea glandulosa</i>
Melastomataceae	<i>Miconia rivetii</i> , <i>M. theizans</i> , <i>Monochaetum lineatum</i> , <i>M. hatwegianum</i>
Urticaceae	<i>Myriocarpa sp.</i>

This together with information from Alumbre was used to identify areas appropriate for reforestation.

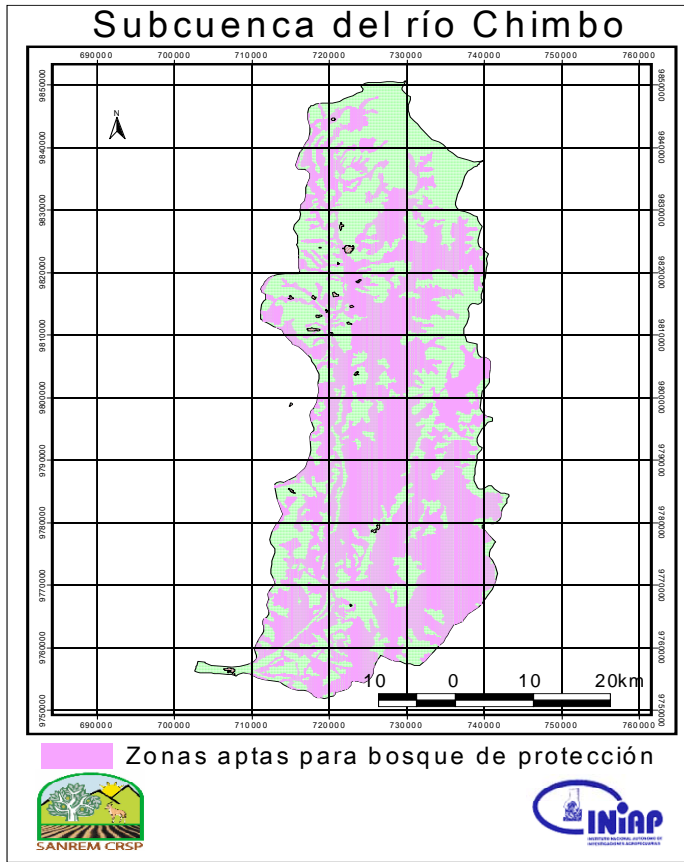


Figure 1. Zones for reforestation with protective woodlands

Objective 3. Create a means of evaluating the impacts of alternative actions, policies and interventions on income generation, and social and environmental conditions.

Task 3.3.A. We have constructed household models using the baseline data from both countries (Andrade and LaRoche theses). We are including this socioeconomic information in our watershed models.

Task 3.3.C – in progress. Evaluation continues of the SWAT watershed model for applicability in Ecuador and Bolivia. Several model runs have been simulated. We are now incorporating livelihood information into the analysis. Model runs are being validated through regular interactions with stakeholders at both sites.

Objective 4. Build local capacity to evaluate policy alternatives, make and enforce decisions, and strengthen social capital.

Task 3.4.A – in progress. Workshops on watershed planning were held in September and October 2008 in Cochabamba and Tiraque, Bolivia, by Virginia Tech Professors Mary Leigh Wolfe and Brian Benham. These have already been reported on. We have conducted ongoing workshops in Ecuador and Bolivia to continue the adaptive watershed management process. In Ecuador, we hold monthly meetings with the provincial government, the prefect, and other decision makers in the watershed.

In Ecuador, the watershed plan is being modified as further information about the relationship between land use and water quality impacts are known. As part of this exercise, researchers have created a vulnerability map for the two sub-watersheds.

Table 3. Vulnerable areas in sub-watersheds according to SANREM classification

Vulnerability Levels	Illangama		Alumbre	
	Area (ha)	Percentage	Area (ha)	Percentage
0.0 – 0.25	79.39	0.62	379.46	5.79
>0.25 – 0.50	1035.14	8.07	2514.73	38.38
>0.50 – 0.75	5852.64	45.62	2712.19	41.39
>0.75 – 1.00	5837.08	45.50	896.40	13.68
Total	12830.00	100.00*	6552.54	100.00**

* 0.20% urban area.

** 0.76% urban area

Vulnerability levels: 0=no vulnerability; 1= high vulnerability.

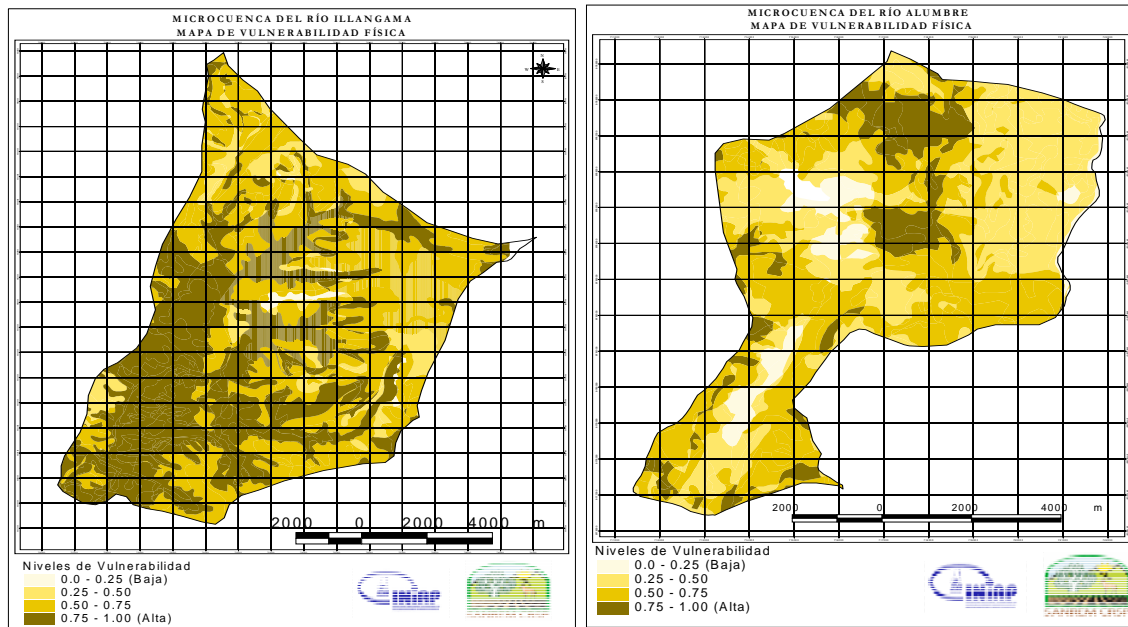


Figure 2. Areas of topological vulnerability in sub-watersheds of the Alumbre and Illangama rivers

Task 3.4.B – in progress. Watershed models are being used in Ecuador and Bolivia to help inform local watershed planning decisions. In both sites, the research teams are regularly geo-referencing production systems and using the geo-referenced information to create maps and guide land-use plans.

Task 3.4.C – in progress.

Significant training, capacity building, and networking activities

The project in Ecuador created networks with several actors in the region, including Proforestal, Instituto Nacional de Meteorología e Hidrología (INAMHI), and Fundación Mujer y Familia Andina (Fundamyt). Also in Ecuador:

- Luis Escudero, Edwin Chela, Carlos Monar, and Elena Cruz participated and presented papers in the XI Congreso Ecuatoriano de la Ciencia del Suelo, Quito, Oct. 29-31.
- Víctor Barrera, Carlos Montúfar, Elena Cruz, and Fernando Chamorro participated in the workshop “Socialización del análisis integral de la vulnerabilidad a amenazas naturales en el cantón Saraguro,” Quito, Feb. 3.
- Carlos Montúfar received training in soil management in CLIRSEN, Guayaquil, March 23-31.
- Víctor Barrera participated in an international workshop on climate change and livestock systems in Bogotá, Colombia, March 24-27.

Bolivia

Name	Event	Place and date	Organized by	Supported by
Mirko Delfin	Short course on payments for environmental services	Oct. 27-31, Lima, Perú	INWENT – GTZ	PROINPA
Mirko Delfin	Short course on payments for environmental services	Nov. 10-14	INWENT – GTZ	SANREM - PROINPA
José Carlos Claros	Short course on payments for environmental services	Nov. 10-14	INWENT – GTZ	SANREM - PROINPA
José Olivera	Short course on pressurized irrigation	Oct. 10-15	Centro AGUA - UMSS	SANREM – PROINPA
Ana Karina Saavedra	Diploma in community development	May 2008- April 2009	UNICEFF – Universidad NUR	PERSONAL
Jaime Cossio	English	Cbba - Bolivia	CBA - PROINPA	PROINPA
Ruben Botello	English	Cbba - Bolivia	CBA – PROINPA	PROINPA
Ana Karina Saavedra	English	Cbba - Bolivia	CBA – PROINPA	PROINPA
Mirko Delfin	English	Cbba - Bolivia	CBA – PROINPA	PROINPA
José Carlos Claros	English	Cbba - Bolivia	CBA - PROINPA	PROINPA

LTRA-4: Adapting to Change in the Andean Highlands: Practices and Strategies to Address Climate and Market Risks in Vulnerable Agro-ecosystems

Lead PI: Corinne Valdivia, University of Missouri

Research progress by objective

Objective 1. Develop a shared understanding of the ecosystem, and the social and economic drivers of change in highland vulnerable communities.

Progress toward completing critical Annual Work Plan tasks

Climate, livelihoods, and markets. Valdivia and others developed a poster and presentation for the Global Risks, Challenges and Decisions Climate Change Conference. However, due to budget constraints, only Karen Garrett was able to present a talk on the impacts of disease on agriculture under climate change. Jere Gilles and Edwin Yucra worked on a publication on local knowledge and forecast skills. Anji Seth revised and resubmitted an article on projections of climate change. The second survey instrument was developed and includes questions on the knowledge shared with community research groups to capture information flows and use.

Evaluate impacts of climate and market changes on cropping systems and soil quality. The data have been analyzed and placed in tables and figures for a publication on the effects of climate and socioeconomic changes on crop and soil systems. Literature was collected for this task, and a draft publication is being worked on by several collaborators.

Evaluate management of organic and inorganic soil inputs, using household survey data, key informants, and analysis of manure samples from the communities to determine variation. Survey and participatory data have been collected for this study, and manure samples have been collected and analyzed. Additional manure samples were collected in Bolivia and sent to the University of Missouri for analysis to increase the sample size, ensuring a representative sampling of organic resources from the communities. The Ph.D. student is including this study in his thesis and will be writing a publication involving this data.

Evaluation of soils in fallow to determine the effects of fallow length and cropping pattern on soil organic matter and quality. Laboratory analyses were completed on field samples collected from Umala, and a laboratory controlled microcosm study was conducted and completed to determine differences in CO₂ flux and potential soil nitrogen mineralization among the soils of different fallow length. A Ph.D. student is completing the analyses from the laboratory study. One difficulty encountered during this period was in collecting corresponding fallow samples in the second community, Ancoraimes. The soil science faculty collaborator went on study leave, which delayed completion of sampling at that site. Additional results for this study will be obtained through the cross-cutting soil quality project, for the same fallow soil samples are being tested for soil quality characteristics using spectroscopic methods. This work is also linked with the soil metagenomics project, in which we are evaluating microbial communities in soils associated with changes in fallow length. The first samples from the microbial investigation have recently been submitted for sequencing. Along with this analysis we are preparing training materials based on a metagenomics workshop in La Paz and a manuscript on key issues in the design and analysis of studies that use pyrosequencing to characterize communities.

Evaluate the effects of changes in cropping systems on fallow length in communal and private lands and comparison of impacts of individual and communal management on soil fertility in Peru. Protocols were

developed, and a graduate student was identified and began work in this project. Right now it is in the laboratory phase of soil sample analysis at Universidad Nacional Agraria la Molina. According to plans, it is likely that devolution of results to farmers will be programmed for this month.

Pest dynamics. Research on potato moth was set up at Fundación PROINPA to monitor the development of this pest under controlled temperature conditions to obtain data to validate the International Potato Center (CIP) model. Larvae of pests of quinoa and third-year monitoring of the Andean weevil are ongoing in farmer fields. Weather data is being collected for multiple studies in Umala, including the dynamic of pests. Study of the dynamics of Andean weevil and white moth is being conducted in Chinchaya, Cohani, Calahuancane Baja, and Chojñapata in Ancoraimes. We are developing a data analysis that will include evaluation of lag periods in environmental effects on pest development to help with comparisons across sites.

Agro-biodiversity. Crop identification in the micro-watershed Huanquisco del municipio de Ancoraimes through remote sensing and GIS by a *licenciatura* student is lagging. The study only began in March of this year.

Landscapes. An inventory and zoning of productive resources in Ancoraimes watershed is underway as a *licenciatura* student thesis. Monitoring of land cover and change in land-use patterns through temporal image analysis of Chojñapata in Chinchaya watershed is being conducted by a master's student. In Umala the vegetation study is being conducted by a *licenciatura* student who is collecting materials and geo-referencing them. Samples have been classified with help from the Bolivian Institute of Ecology and Biology. This will provide input to describe the vegetation landscape in this region. Zorogastua carried out the planned training for the biodiversity mapping research in Bolivia. There are budget constraints to access high-resolution images for Umala and Puno. The focus for detailed landscape analysis will be Ancoraimes. Zorogastua is also studying peat bogs in the landscapes of Ancoraimes and Apopata as part of his dissertation research.

Water. Efficiency in the use of rainwater for potato cultivation in rainfed areas of three rural communities is underway as a *licenciatura* thesis: "Assessment of water resources in the Ancoraimes watershed based on availability through time." A study to determine soil erosion due to water runoff is being carried out by *licenciatura* thesis research.

Changes in research design or methods, obstacles encountered, and actions taken

Monitoring of plowing and soil preparation to install integrated pest management (IPM) experiments were rescheduled because the Santa Maria community had conflicts with other activities. Hand-picking of adult Andean weevil was rescheduled due to adverse climatic events in Santa Maria. This finally took place at the end of January at night.

Significant research findings

Climate change and socioeconomic factors in the central Altiplano region have led to changes in soil management practices such as reduced fallow periods that have generally reduced soil organic matter and increased soil degradation.

Objective 2. Perceptions

Progress toward completing critical Annual Work Plan tasks

Compare local classifications of soil quality and organic matter with laboratory analyses and soil taxonomy. The work to identify local classification systems for soil quality and maps that identify the location of different soils in the communities was completed.

Livelihood strategies, networks, and perceptions of risk. This research was completed for Umala and Ancoraimes and the thesis defended. Lisa Rees analyzed the household survey using an Ordinal Logistic Regression.

Livelihood strategies, hazards, and gender. Rees in her regression analysis did not show significant differences between men and women in their perceptions of risk hazards. The hazards – captured as an aggregate of frosts, droughts, floods, and climate changes – were analyzed jointly. Disaggregated analysis of risks may yield different results, for these impact household activities differently. This will be tested next.

IPM research. Hand picking of adult weevils has recently taken place. So far 70% of this research was completed. This activity runs according to the phenological phases of the crops. It is undertaken as a student thesis project in Santa María Puno.

Landscapes. Work continued in Umala and Ancoraimes with the perception maps to validate initial results. These were incorporated into posters, leaflets, and reports that integrate local and new knowledge.

Changes in research design or methods, obstacles encountered, and actions taken

A University of Missouri faculty member specializing in soil classification was going to visit Bolivia and work with local collaborators to identify those soils using U.S. taxonomy. The trip was postponed due to insufficient funds available for travel and to complete needed analyses to support the classification. It was decided to limit the study to the local classification information, and then combine that information with the survey information obtained from the cross-cutting soil quality project.

The development of landscape research in Umala and Puno is limited due to the lack of high-resolution images. Maps are being developed with low-resolution images, the main purpose being to return the information to communities. Ancoraimes remains our proof-of-concept site where the study uses an image purchased in 2007. Universidad Mayor San Andrés coordinated with Conrad Heatwole to find other images for this site.

Significant research findings

Analysis of Bolivian households showed that perceptions of risk decrease when they have outside community networks. Access to credit, which is mostly informal, also reduces the perception of risks from hazards. Households that feel higher dread about hazards also have higher perceptions of risks. Households that have experienced shocks and knew how to manage these had lower risk perceptions. Households with a diversity of activities had lower perceptions of risks.

Objective 3. Bridging knowledge systems for practices and information

Progress toward completing critical Annual Work Plan tasks

Evaluate agronomic response to alternative soil fertility interventions to improve the soil organic matter under climate changes and conduct incubation studies of organic amendments to determine fertility and buffering impacts (nitrogen mineralization, carbon release and buffering). The final year of this field study is being completed with a second year in Umala examining the residual effects of inorganic and organic amendments. In Ancoraimes the second year of response to these amendments is also being completed. A Ph.D. student is completing the analysis of soil and plant tissue samples from last year and completed a controlled microcosm study in which he is examining rates of decomposition and nitrogen mineralization with additions of organic amendments to the soil. He also evaluated the addition of these amendments at different rates on soil water-holding capacity and heat capacity. Several Bolivian undergraduate students have been involved in this study as part of their undergraduate thesis requirements.

Landscape research in Peru and Bolivia. Zorogastua from CIP provided training in Bolivia to the team of students and faculty conducting landscape research and also conducted ground truthing of peat bogs as part of his thesis research analyzing the bogs of Apopata and Ancoraimes. In Peru the sites were geo-referenced to develop landscape maps where the communities can be identified using low-resolution images.

Demand for animal health knowledge workshops to train “barefoot” veterinarians was an identified demand by community leaders in Santa Maria. The training was completed this semester.

Pest dynamics management – validate Andean weevil IPM practices in farmer fields in Chichaya through thesis research (completed 40% of activities). We are also predicting future late blight risk in Peru and Bolivia under climate change scenarios. Preliminary models have been developed, and we are now developing the final models and extending the techniques for potato tuber moth in the region. We have also published a paper evaluating the effects of climate on the utility of crop diversity for disease management (Garrett, Zúñiga, et al., in press), a paper on plant disease in the context of ecosystem services (Cheatham et al., forthcoming), and a chapter evaluating the use of plant pathogens as indicators of climate change (Garrett, Nita, et al., 2009).

Knowledge sharing and training. Knowledge sharing (*socialización*) is occurring after development of protocols since December 2008. The themes covered included climate, pests, soils, and markets. Information products were developed to accomplish this activity. These included leaflets, reports, and posters. Four training courses were completed in Ancoraimes focusing on pest control, IPM, and potato cultivation practices. Several workshops were held to return knowledge to the communities in Umala, Ancoraimes, and Puno.

Changes in research design or methods, obstacles encountered, and actions taken

Rescheduling of potato planting and installation of live barriers for Andean weevil control (IPM) due to delay in rains in Peru. Geo-referencing of natural resources in the Apopata community encountered problems due to rains that impeded travel within the community, causing delays to the work plan. In Ancoraimes the main problems encountered were lack of time by farmers to participate in activities such as interviews, monitoring of their plots, and programming of training. To address this constraint, more activities were carried out by accompanying producers in their daily chores and by participating in community meetings. Another strategy to engage farmers was to include test/monitoring field of peas, onions, quinoa and cañahua because of their importance as cash crops to community members. In Umala

there were rain shortfalls that affected quinoa planting. Intense precipitation started recently, which reduced the presence of pests. On the other hand, humidity increased the prevalence of diseases.

Significant research findings

- Use of both organic and inorganic soil amendments for potato crop production significantly improved crop performance, but addition of organic amendments, including alternative organic soil amendments such as compost and a commercial microbial activator, also had benefits for improved soil organic matter, water retention, and bulk density reduction. These improvements may help mitigate soil degradation.
- The portable Cardy nitrate meter, a rapid method to determine the nitrate content in potato petioles, may assist in nitrogen fertilizer management of potato in this region where soil and plant testing resources are limited, but more testing of this method is needed to determine factors that affect measurements.
- Participant farmers in the knowledge-sharing workshops were very interested in the findings on climate and pest dynamics. They believed this information to be useful, but it needs to be repeated several times.
- Sharing of the climate projections for mid-century and beyond, especially findings about loss of soil moisture in the northern Altiplano, raised concerns among stakeholders about what to do and how to prepare. This is a step in changing attitudes from reactive to proactive in our framework.

Objective 4. Bridging knowledge systems and strengthening capitals for market strategies for integration

Progress toward completing critical Annual Work Plan tasks

Assessment of institutions to facilitate market integration. The research on two institutions – one that facilitates integration to markets and one that provides access to technologies to increase marketability of potatoes – were completed this semester. These are Collective Action among Stakeholders of the Market Chain to Link with High Income Markets (Bolivian Andean Platform, BAP), and Collective Action among Potato Producers to Get Integrated In High Income Markets (Native Potato Varieties Program, NPVP).

Knowledge sharing about markets in Bolivia. Four workshops were organized in Ancoraimes to share the market participation results obtained from the survey along with the climate shock effects. In Umala, only one workshop took place (Vinto Coopani) because of other activities in the other three communities.

Markets, marketing, and gender (conducted with gender cross-cutting initiative). A proposal for the study was formulated, students were selected, and visits were made to local fairs and urban markets. A report with insight from these visits was prepared. A methodology for interviewing families and a literature review on markets, gender, and bargaining power were developed. Students are working at both sites on surveys of main marketed products.

Marketing survey. Questionnaires were developed to interview people (include producers, middlemen, and wholesalers) along the potato marketing chain in Umala, which. Quinoa marketing is also being monitored. This information will then be part of the advocacy coalition workshops.

Coalitions and formation of interest groups. This activity was 40% completed in Apopata and continued through follow-up to signed agreements with other institutions external to the community and through work being developed with the community interest groups. A diagnosis and a small work plan have been developed with these groups.

Research on production and commercialization in Puno. Advances have been made regarding compilation of information on alpaca fiber commercialization in Juliaca and Mazocruz. This activity is 40% completed. Semi-structured interviews with key informants have taken place. However; focus groups still are needed to complete data collection.

Changes in research design or methods, obstacles encountered, and actions taken

PROINPA modified the schedule to return knowledge about markets prepared by Universidad de la Cordillera. Due to time constraints, posters and reports were handed out, but the protocol was not followed. Leaflets and posters about pests, soils, climate, and markets were distributed.

Significant research findings

The main strength of Bolivian Andean Platform (BAP) is its promotion of collaborative interaction between market-chain actors and formal organizations of support. It reduces search, information, and contracting costs for all stakeholders. BAP increases participation costs for all members, and monitoring and enforcement costs for the producer associations. These are offset by reduction of information and search costs.

Weaknesses related to motivation for participants include the following:

- There is no formal commitment in the form of contracts.
- Organizational strategies of the platform about negotiation processes, entry and exit rules for participants are not formally established.
- The platform is not a full financial service entity, limiting the capacity to provide financial support.
- The platform offers a price that does not cover the costs of producers' improved quality of *chuño* and *tunta*.
- Farmers who experience lack of time and labor constraints do not participate in the Native Potato Varieties Program (NPVP).
- Outmigration of men is a main source of shortage of labor.

Those who participate benefit in three ways:

- BAP promotes and supports long-term access to technological improvements.
- BAP promotes sustainable livelihoods because NPVP disseminates local knowledge about native varieties adapted to the conditions of the area.
- In terms of transaction costs, farmers search and information costs about the technologies are lower.

Objective 5. Capacities and capabilities – the ability to act

Progress toward completing critical Annual Work Plan tasks

A central activity this year is to prepare and share the research products developed jointly with farmers, as well as the analysis completed to date. This addresses the transformative hypotheses of the project. We are testing how the various project approaches contribute to learning, and we are sharing the information across communities – among participants and non-participants. In October we developed a protocol to share knowledge that links local and new knowledge. The output products to be shared were determined, as well as how these would be combined to integrate climate and markets. In November these were completed for the research available. In December knowledge-sharing workshops were initiated in the

communities. Two phases will follow. Coalition-building activities with organizations outside the communities are planned, along with a household survey in which knowledge change and networks will be identified.

Systematization of farmer participation in capacity-building workshops, Peru. The information-processing phase in Peru is 60% complete. A first draft will soon be ready.

Knowledge sharing of survey results from Apopata and Santa Maria. This activity was completed in both communities. Advances within the frame of development of the project were achieved in activities aimed at the strengthening of technical capacities¹ of the *comuneros* from Santa Maria and in strengthening of organizational and management capacities through the coalitions' group in Apopata. Interest groups were identified and organized around gender (16 members) and alpaca genetic improvement (28 producers). An agreement was signed with Comisión Nacional de Comercialización de Alpacas (CONACS), and coordination was established with other institutions such as Caritas, Evangelical Christian Church, and the non-governmental organization Red Social. Information collected through household surveys at the beginning of the project was processed and shared. An information kit composed of a large poster (*gigantografía*) and a written report was prepared and used for knowledge sharing.

Knowledge sharing with stakeholders and the academic community. Several presentations were given at scientific meetings and with USAID Missions and government organizations responsible for policies and science on adaptation and climate change. Two research papers were presented at the climate change conference in Copenhagen. Papers from this conference will be shared at United Nations climate-change meetings in November. In Peru a scientific presentation on the SANREM project is being coordinated for SEPIA XIII, an agriculture and social sciences conference.

Changes in research design or methods, obstacles encountered, and actions taken

There have not been changes in the design. There were changes in how to coordinate the meetings to share knowledge with community groups. This is because there are multiple results and agricultural production activities being carried out at the same time, so new strategies to meet and share knowledge were developed. In Peru, sharing of survey information was rescheduled in Santa María due to problems as a result of the election of new authorities. This was solved by meeting the new authorities. In Apopata knowledge sharing took place without major obstacles, but transportation was a problem. Public transportation is scarce from Ilave to Mazocruz and even more so to the community itself. A vehicle owned by a community member living in Mazocruz was hired for a reasonable cost.

Significant research findings

The knowledge sharing process includes a series of workshops at which community participants have the opportunity to share their perceptions and insights. These workshops have been well received. Farmers find that the information is useful, but they feel that it needs to be repeated on various occasions. The poster format was judged as appropriate for the community center and schools. Farmers found that the leaflets were useful to take home. Reports were delivered to officials. Women indicated that more diagrams and pictures were helpful for them. During meeting in January with community leaders in Ancoraimes, farmers became aware of the efforts the government is making in climate change communications. A video provided by PNCC was shared and responses recorded.

¹ Areas of expertise include soil sampling and classification, soil plowing and its relevance, animal health management, differences between *aynocas* and private plots, and weevil control practices.

Significant training, capacity building, and networking activities

Students who joined the project this year are doing research on soils, pests, markets, biodiversity, landscapes, and water. This is the third year of field/on-farm research. La Molina now has five students with full scholarships and one with a partial scholarship. In Bolivia two students developed their protocols for market research, which was initiated this semester. The master's students are progressing well at UMSA, with the exception of one due to difficulties in finding a program that fits her schedule. Her field training for landscape vegetation took place this semester.

Two Ph.D. candidates studying soil science at University of Missouri passed their comprehensive exams, and two Ph.D. candidates in rural sociology passed their qualifying exams. Three master's students in agricultural economics completed, defended, and submitted their theses. A Ph.D. candidate in climate change modeling at University of Connecticut passed her comprehensive exams and is working on her dissertation. One Ph.D. candidate and one master's student at Kansas State University completed their first year of work in soil metagenomics.

In Peru, meetings were held:

- with Red Social to work with Apopata interest groups on organization
- between CONACS Puno representatives and the Apopata local research group to establish and sign a work agreement that fits within the alpaca breeding and management calendar, and
- with SENAMHI Peru and the Ministry of the Environment to identify areas of common interest in the modeling of climate change for Altiplano and Andean ecosystems.

Presentations were made to the USAID Mission in Peru about research on social, human, and political capitals and the approach to building coalitions. A second presentation was made in January to USAID officers.

Meetings in Bolivia included:

- a workshop with communities leaders of Ancoraimes in La Paz to share climate and market information, along with the PNCC video on climate change
- presentations to the National Program on Climate Change and SENAMHI, and
- presentations to the USAID Mission in October and January.

Two concept note proposals were submitted to McKnight, and Jere Gilles and faculty of Universidad Mayor San Andrés were invited to develop a full proposal. Cornelia Flora and Jan Flora worked with the World Bank and colleagues from Peru and Bolivia to use the advocacy coalitions approach to measuring adaptation to climate change. Karen Garrett represented LTRA-4 at the Climate Change Conference with two presentations. Anji Seth and a team led by Peter Motavalli presented at the American Association of Geographers and the American Soils Association respectively.

Vignettes

The information of the project aims to improve knowledge about the factors that affect their livelihoods and the environment where they live. Changing from coping to adapting requires on the one hand knowledge, and a process that facilitates the use of the information in planning alternatives. This process takes time, as it involves understanding from the decision makers, and the research, what is, as well as the process of building the human and social capitals that enable rural families to plan and develop alternatives. Following are some of the statements learned this semester, from the processes of sharing the knowledge produced in the past three years.

After showing the results of the research on climate and the future projections on global warming, Ancoraimes community members were very interested in continuing a process of deepening their understanding to identify their knowledge and think about mitigation strategies. As the process developed, participants suggested various alternatives that could be adapted if there were advance warning of an extreme event, especially related to the management of their plots, such as the design of channels to control the increased flow of water during heavy rainfall periods. On the other hand, they felt powerless about controlling events like frosts and drought.

Sharing the findings about market functioning fostered an exchange of knowledge among farmers. Some participants, mostly elderly, were not engaged. On the other hand, most of the producers showed a lot of interest in the survey results. Reflecting on the findings and their trading experiences, it was learned that many were not aware of the prices of some potato varieties that a few producers in the region sell. This helped them to identify certain producers among themselves with special knowledge about these varieties.

The majority of farmers are aware of market prices for their products in various localities, but their knowledge is limited to certain periods, particularly around harvest time. This generated an interest among the participants to learn more about price dynamics throughout the year and the reasons driving variability. They expressed interest in having more information to help decide the timing of when to sell small quantities of their products.

LTRA-5: Agroforestry and Sustainable Vegetable Production in Southeast Asian Watersheds

Lead PI: Manuel Reyes, North Carolina A&T State University

Research progress by objective

Progress toward completing critical Annual Work Plan tasks

Most work plan tasks are progressing well. Several have been completed. See Table 1 in the appendix for progress on each task.

Changes in research design or methods, obstacles encountered, and actions taken

For all objectives, most of the tasks were not changed except that a key scientist left the Vietnam team for Ph.D. study in Europe. This affected the workload of TMPEGS-Vietnam. Changes made in Vietnam included replacing the drip irrigation study for vegetables with a study on viability of Cu nang, a vegetable root crop, for production under rubber trees.

Significant research findings

Technology

- Optimal operating conditions were determined for International Development Enterprises' low cost Easy Drip Irrigation System, and the research was published in the journal *Applied Engineering in Agriculture*.
- The SWAT model was validated using measured data in the Philippines and has good prospects as a tool to predict environmental impacts of changes in land use and management practices.
- Yields of cabbage, Chinese cabbage, tomato, and bell pepper were higher with drip irrigation than in rainfed systems despite frequent rainfall while the experiment was being conducted.
- In the Philippines, initial results indicated that low-statured vegetables such as carrots, Chinese cabbage, and common cabbage were significantly outcompeted by the cover crop *Arachis pintoi*. However, positive response was observed in taller vegetables like bell pepper and tomato. In Vietnam, both complementarity and competition between vegetable and *A. pintoi* were observed. *A. pintoi* as a soil cover reduced weeds and improved soil fertility but competed with okra, kangkong, and bitter melon for nutrients, water, and sunlight. As a cover crop, *A. pintoi* reduced labor in weeding by about 40% and reduced irrigation time and therefore amount of irrigation water by about 30%. In Indonesia, *A. pintoi* had no effect on the abundance of the aphid or ladybird beetle on yard-long bean. Yard-long bean yields were lower in the plots with *A. pintoi* than in those without. It was concluded that *A. pintoi* provides no ecological benefits in terms of reducing pest numbers.
- Indigenous vegetable Cu nang (*Tacca pinnatifida* Forst) was found to be growing well under rubber trees. The planting of this root crop helps to increase farmers' income but does not reduce the yield of rubber.
- In the study on soil quality and cashew plantations, soil quality was highest for cashew-cacao systems, followed by non-cultivated land with natural weed development, then by cashew plantation with no weeding; cashew plantation with clear weeding had the poorest soil quality.
- Cashew yield with clear weeding is lower than without clear weeding.
- Twenty-two Indonesian farmers grew katuk, chili, and eggplant under the tree and open systems. Yield for chili and eggplant were 14% and 60% less in the tree system when compared with the open

systems. Hence, many farmers did not want to continue growing those vegetables; however, the high price of fertilizer and farmer preference for growing rice were the main reasons for discontinuing vegetable farming. For katuk, yield increased 2.5 times, hence some farmers responded positively to VAF.

- When trees were planted closely, tree-crop interaction became apparent as tree hedgerows or components grew and started to develop heavy canopy in later years. In year 1, SANREM researchers found that young trees did not influence vegetable production; in Year 2, vegetable yields with trees were higher than in open systems; and in Year 3, most vegetables tested had significant decreases in yield except for cucumber and eggplant. As trees matured, yield loss in vegetable crops was compensated by fruit production in intercropped trees.
- Reduced Tillage Implement Prototype:
 - A 12-tooth coulter performed better than coulters with lesser or greater numbers of teeth.
 - Curved-tooth coulters required less horizontal draft force than straight-tooth coulters.
 - An opener shoe with a larger rake angle required less horizontal draft force.
 - Use of plastic siding on the opener reduced the horizontal draft force and can help control the width of the soil opening.
 - Use of spikes on the sides of the opener shoe were more helpful in breaking the soil.
 - Motorcycle parts can be retrofitted in the design of the no-till equipment.

Marketing

Women in Indonesia are developing their own katuk marketing system and slowly moving away from reliance on middle person marketers.

Policy

- Knowledge to action (will overlap with report of the knowledge-to-action team), Philippines and Vietnam
 - In the knowledge-to-action (K2A) study, the team identified weak linkages and lack of coordination among research institutions and universities in the research and development (R&D) systems in Vietnam and the Philippines. R&D activities, technology transfer, and training have not been closely linked. Sharing of scientific information is weak. Research outputs have not been transferred to decision makers and end users in a timely and adequate way. A better K2A approach will help to improve the efficiency of the R&D system
 - Research-proven technologies are the main factor that can influence farmers' practices.
 - Policy support, diffusion of technologies to the local government (capacity-building), and the use of effective extension strategies (on-farm trials, training and seminars, field visits) are the factors identified that would better link knowledge to action.
 - Farmers' recommendations to researchers are to conduct research feedback (meetings) and to transfer the technologies developed (training and seminars).
 - Researchers are encouraged to interact with farmers informally to reduce education and status barriers between them and to treat farmers as equals.
- Incentive-based policy intervention, Philippines. A municipal ordinance was enacted supporting the implementation of an incentive-based program to promote the adoption of a sustainable farming system (SFS) in a Lantapan. The SFS Investment Plan was finalized and is now ready for implementation. The LGU allocated budget for the program, particularly the institutional arrangements required to implement the development plan.

Environmental, economic, and social impacts

SWAT simulation in the Philippines showed that runoff volume increases by 14% and sediment yield nearly tripled when 50% of pasture and grasslands are converted to agricultural uses. An increase of 32% in runoff volume occurs when the entire test watershed is converted to agricultural land; this amounts to 45% of the annual rainfall lost as surface runoff.

Gender

Vietnam

Women's roles and division of labor within their households leave women little time to attend formal or scheduled training courses and social activities. However, women can learn through informal networks such as neighbors or relatives. Taking advantage of informal gender networks during development of programs by the government and other agencies in the future is recommended.

Philippines: gender organization

- Women actively participate in ensuring family wellbeing by mobilizing human and non-human allies constituting a network.
- Human allies include the family, middle people, employers, government and development agencies such as the Department of Agriculture and the World Agroforestry Center.
- Before the entry of TMPEGS in the research site, there were already farms practicing VAF, particularly the Binahon farm. Their research showed that the farmers' view of their relationships – with people, livelihoods, the environment, scientific possibilities (SANREM 1 and 2, and International Centre for Research in Agroforestry [ICRAF] Landcare), and how these are mobilized as allies – makes the difference between farmer who practice VAF and those who do not.

Indonesia

The “Defiant Women of Hambaro” caught the attention of SANREM researchers in Indonesia. These women in the lower-elevation villages of the SANREM site in Indonesia are part of the changing norm and take a very different approach than that of the traditional women in the middle- and upper-elevation villages. They are developing their own katuk marketing system and slowly moving away from reliance on middle person marketers.

Scaling up

- Presentation of the integrated approach of SANREM on drip irrigation and VAF systems stimulated participants' interest in the technology. It likewise enhanced their awareness and knowledge, particularly in recent developments in various aspects of VAF technology that could contribute to the promotion of VAF practices.
- Presentation is considered a strategic move to expand the area of collaboration from researchers and development workers to policymakers. Upgrading the discussion to policy level will ensure that other aspects of supports to technology promotion could be addressed systematically. Support may include finance and credit facilities as well as marketing support and infrastructure development.
- Results of the study on pesticide use and farmers' health cost conducted in Nghia Trung have been used by Dang Ha of Nong Lam University, Vietnam, in a course on environmental and natural

resource economics. The case teaching material was used for two on-the-job bachelor's degree programs in Binh Phuoc province (60 students on rural development and 78 students in agricultural economics). The majority of these students are currently staff members of various government agencies and local leaders from village to provincial levels in Binh Phuoc province.

Significant training, capacity building, and networking activities

- The seminar-workshop was undertaken in collaboration with the Bukidnon State University, Malaybalay, Bukidnon. Fifty-eight participants from farmer groups, non-governmental organizations, government institutions (local government units, Department of Agriculture, Department of Environment and Natural Resources), and academia attended.
- A SWAT workshop in Vietnam drew 30 participants. Nguyen Loi established a SWAT users group like the one in South Korea, which has at least 150 members
- A SWAT workshop in Thailand drew 41 participants from 13 countries
- The first International SWAT Conference in Southeast Asia, held Jan. 5-8 in Thailand, drew more than 80 participants from 16 countries, mostly in Southeast Asia. The conference website logged 12,500 visits.
- The second International SWAT Conference in Southeast Asia was set for Jan. 4-7, 2011 (<http://ssc.hcmuaf.edu.vn/>). The website logged 2,201 visits.
- The SWAT book was published, and about 2,000 copies were distributed, mostly in Southeast Asia. Nearly 60 sponsors were involved in publication of the book.

Vignettes

1 'C' becomes 2 with growing success

A SANREM site in Nghia Trung, Vietnam is a sea of cashew trees as far as the eye can see. But local farmers learned from researchers that they should diversify and not depend on only one crop for their livelihoods. With Vietnam looking to expand its production of cacao, farmers and researchers worked together to add cacao under the cashew canopy, testing eight varieties of the small evergreen shrub whose beans are used to make cocoa. Cacao grew exceptionally well under cashew until termites began attacking the tender seedlings. SANREM found a solution – Vetiver grass, abundant in Nghia Trung, is a natural pest repellent that controls termite attacks. That problem solved, farmers found that cashew and cacao were complementary in other ways. Cacao improved soil quality, and a low-cost drip irrigation system designed by SANREM partners for cacao also increased cashew yield compared with cashew-only fields. SANREM proved that two crops were better than one, and three is the charm: Home vegetable gardens also thrive under cashew trees.

Food for all seasons: Tree vegetables

When trees and vegetables grow well together, the benefits are many: larger fruit and vegetable crops, and the potential for harvesting high-value timber. SANREM researchers in Lantapan, Bukidnon, Philippines, discovered that women in particular were interested in vegetable agroforestry. The reason: Tree vegetables such as bago are productive year round, ensuring household food security, a main concern for women. Indigenous vegetables also drew great interest because they require fewer external inputs, particularly pesticides, thus are less costly to grow. In November 2008, seedlings of tree vegetables and brochures about vegetable agroforestry possibilities were distributed to members of a women's group at Lantapan after a focus group discussion. The women planted the seedlings when they returned to their respective farms and are now waiting to see how they grow.

Lowly worms are gold in the garden

Seeking low-cost ways to improve the soil without harming the environment, women farmers in Songco, Philippines, looked beneath the surface and found an answer: vermicompost. What is it? A mixture of decomposing vegetable waste, bedding material, and worm manure (known scientifically as vermicast). As certain earthworms eat their way through piles organic matter, the castings they leave behind are rich in nutrients that fertilize and condition the soil. Women farmers asked SANREM researchers for training in vermicompost production, and the scientists obliged, also donating 20 kilos of worms. The farmers were so excited about the worms, they nicknamed them “bulawan” – Tagalog for “gold.”

Development programs: Do you consider informal networks?

SANREM scientists identified that women’s roles and division of labor within their households leave little time for women to attend formal training courses and social activities or access market information. In response to this situation, women are using informal networking such as neighbors, relatives, women’s groups, or “close partners” (*moi* in Vietnam, *suki* in the Philippines), as sources of training, knowledge, connectivity, and clout. SANREM is therefore recommending that both informal and formal networks be considered in development and assistance programs.

Take a look at katuk

SANREM scientists found that an indigenous vegetable, katuk, yields up to 2.5 times more if planted under trees than in open field conditions. In Indonesia, katuk was used for decades as herbal medicine and is known to increase breast milk production. Fresh katuk has market demand in Jakarta. Therefore, SANREM organized several women and provided six of them with katuk seedlings and fertilizer. A workshop was provided on proper post harvest handling of katuk. The women were networked to a katuk middle man. The six women have now provided katuk seedlings to four other women. SANREM partners also taught them record keeping. The women realized that they can market katuk themselves and are about to detach their umbilical cords from their original katuk seller. It is good that SANREM took a look at katuk, and you may want to do so as well.

SANREM camp and the fertilizer book

How can we grow vegetables in the shade when we don’t even know what the nutritional and management requirements of vegetables are in our research site? That question resulted in a vegetable fertilizer book published by SANREM scientists in Indonesia. Research on vegetable spacing and fertilizer requirement was done in land owned by a SANREM collaborating farmer. A SANREM camp was established with a graduate student named Tesna assigned to the camp. Several farmers have been visiting the camp, and Tesna, fertilizer book in hand, served and engaged the community’s farmers, both women and men. SANREM partners are using this approach to improve the agricultural extension model in Indonesia.

Strike 1, 2, and 3: Is vegetable agroforestry out?

SANREM was instrumental in the establishment of a vegetable agroforestry research at the World Vegetable Center. Year 1 results showed that at close spacing of 7 meters, young fruit trees did not influence vegetable yield. In Year 2 fruit trees increased the yield of most vegetables. In Year 3, most vegetable yields decreased except for cucumber and eggplant. So is vegetable agroforestry out? No, because yield loss in vegetable crops was compensated by fruit production in intercropped trees. Also, there is evidence that some marketable indigenous vegetables can thrive under those fruit trees.

First guide in establishing vegetable agroforestry systems

A vegetable agroforestry system provides multiple benefits, including provision of micro-nutrients to the diet of rural communities, enhancement of on-farm agro-diversity, and environmental sustainability. It also improves the provision of environmental services, particularly in sequestration of carbon that can contribute to global warming, eventually resulting in climate change. If properly integrated with vegetables, trees can improve a farm's productivity by serving as windbreaks and improving micro-climate; increasing the income of farmers due to agro-diversity; maintaining soil organic matter due to litter fall and decayed roots; and reducing soil erosion as contour hedges, especially in farms on sloping land. Based on the experiments of SANREM scientists, vegetable agroforestry systems can increase production of certain vegetables by 20% to 100%. SANREM researchers developed an extension guide: "Improving Vegetable Production through Vegetable Agroforestry (VAF) Systems." SANREM provided training, and the guide is being used in the Philippines by farmers, both women and men. As far as we know, this is the first guide in establishment of vegetable agroforestry systems.

System coordinator grant (policy and governance) and former bridging grant, Southeast Asia

Gerald Shively, Purdue University.

Synopsis

System coordinator activities focus on documenting and summarizing the current state of the science regarding how economic policies and governance influence incentives for sustainable agriculture and natural resource management. This work is coming to fruition as a chapter in a book, *The Sciences and Art of Adaptive Management*, now in production. The original intent of the bridging grant was to maintain continuity of SANREM CRSP Phase II activities in Southeast Asia. Much of that work was completed and summarized in the *SANREM CRSP Annual Report 2005*. New and ongoing activities are described below.

Research accomplishments

System coordinator activities

Objective 1. Review literature reflecting the state of the science in your system.

This work is completed, and the book chapter was finalized.

Objective 2. Identify state-of-the-art projects for case study analysis.

Project lessons have been distilled for inclusion in the book.

Objective 3. Develop case studies characterizing critical SA and NRM system issues.

Case studies were developed for the book chapter.

Objective 4. Draft a review of the state of the science.

This is incorporated in the book chapter.

Bridging grant activities

Gerald Shively cooperates with Long-term Research Award partners in Vietnam and continues research on a wide range of topics related to smallholder agriculture and environmental pressure, in part in collaboration with partners in the Poverty Environment Network of the Center for International Forestry Research (CIFOR). Research on the sustainability of smallholder cocoa production systems was undertaken in Sulawesi with the financial support of Mars Inc. and Masterfoods. A survey was completed in 2006 among 750 cocoa farmers resulting in a student thesis in 2007. A journal article is in press. Research aimed at better understanding agricultural resource allocation in Indian agriculture through cooperative research with the International Crops Research Institute for the Semi-Arid Tropics is mostly complete, and a journal article is in revision. One Ph.D. student was identified for SANREM support in follow-up work on the topic of vulnerability and climate change. Collaborative work with Rodale Institute on sustainable agricultural systems was initiated this year as a result of conversations that grew out of

SANREM Technical Committee interactions. A master's thesis will be completed later this spring with SANREM support.

Degree and non-degree training activities

Two students are being funded by SANREM. See THE accompanying table.

Publications, presentations, and other SANREM CRSP products

Tadese, G. and G. Shively. "Food aid, food prices and producer disincentives in Ethiopia." *American Journal of Agricultural Economics*. Forthcoming.

Networking

- Shively is currently serving as the editor in chief of the journal *Agricultural Economics*, the journal of the International Association of Agricultural Economists. He is also serving as an associate editor of the journal *Environment and Development Economics*.
- Shively has a project titled "Natural Capital and Poverty Reduction" with the AMA BASIS CRSP. Research is being undertaken in Uganda and Malawi in collaboration with Makerere University, the University of Malawi, and CIFOR through the Poverty Environment Network. Research will continue through 2011.

Cross-cutting initiatives

Gendered Access to Markets: Gendered Networks and Livelihood Alternatives

Lead PI: Maria Elisa Christie, Virginia Tech

Research progress by objective

Objective 1. Provide guidance and support to individual LTRAs, including host country students, throughout data gathering.

In an effort to continue providing guidance and support for individual LTRAs, including host country students, three documents containing strategies and frameworks for gender integration developed by international development organizations and projects were posted on the SANREM website. There was also continued individual and group correspondence with the researchers regarding their questions about methodologies, and support was provided for the revision of abstracts and literature reviews.

A new case examining gender relations and decision making in the Illangama River watershed in Ecuador was incorporated in the cross-cutting research. The gender equity coordinator worked with the researchers to make sure they are at the same point in the research process as the other cases and can be included in the analysis, comparison, and dissemination of findings.

Nadezda Amaya organized the initial findings of her case study and developing a cohesive and informative presentation given on Nov. 20 at Virginia Tech as part of a discussion series on women in international development. Her presentation was then posted online to be accessed by any interested parties, including students and researchers from the LTRAs. Continued posting of literature on gender integration and research methodologies through the SKB also provided guidance and support for the cross-cutting research.

Objective 2. Data analysis and comparison, and writing of case studies

Profiles of case studies (including abstract, brief literature review, key references, and in some cases an initial draft of a full case study) from eight out of nine cases from three out of four LTRAs have been compiled and posted on the SANREM website. When all research was completed, researchers will submit final versions of their case studies, including findings, implications, and recommendations, to be compiled and submitted to a peer-reviewed journal as a collection or special issue. The delay in field work and submission of abstracts, literature reviews, and initial findings prevented the comparison of case studies among researchers.

Significant research findings

LTRA 3. Analysis of gender roles within the farmers' economy in the Jatun Mayu watershed communities of Tiraque, Bolivia

- Women are extremely important in the potato marketing chain.
- The whole family participates in production and marketing of agricultural products, but responsibilities are clearly differentiated by gender. Men have the leading role in production, while women lead in marketing.
- The women-dominated marketing networks allow women farmers better access to information.
- Women are in charge of generating and managing farm income.

LTRA 3. Gender disaggregated analysis of markets in highland Ecuador: Alumbre and Illangama watersheds

- Men are twice as likely as women to market household agricultural production.
- Neither men nor women have access to higher-value markets for potato and other products.
- Neither men nor women capture much value added from food processing.
- Ethnicity is a major factor in explaining the structure of marketing networks.
- Dairy-market production and marketing chains are strongly gendered in the upper watershed, with women dominating small-scale production and men from communities outside the study dominating the market-intermediary nodes.
- Research methodology may have contributed to an underreporting of women's involvement in several resource-control domains and in marketing of crops.

LTRA 3. Characterization of gender relations within the life strategies for family and community decision making in the management and conservation of natural capital and marketing networks in the Illangama River watershed, Ecuador

- Gender differences in households and the community clearly exist within this watershed: Women have clear disadvantage in terms of participation and decision making.
- Family subsistence is based on a potato and dairy production system. Men are responsible for crop production, marketing of products, and investments and production decision making; women are responsible for livestock production and cheese processing, and accompanying transport of products to market.
- Potato production involves all family members at various levels.
- Men are in charge of investments and decision making at the community organization level; women attend meetings but do not participate in decision making.
- All family members have access to natural capital, but it is controlled by men.

LTRA 4. Women's participation in commerce and development of market strategies – a case study of the Ancoraimas and Umala communities in Bolivia

- Researchers identified rural and urban markets to include in research and traced the basic marketing circuit for key agricultural products: potato, chuño, peas, and onions in rural markets of Patacamaya, Chejepampa, Morocollo, and Achacachi; and urban markets in La Paz and El Alto. They also identified and interviewed key players (producers and intermediaries) in the circuit and interviewed half of the 27 families selected.
- Participant observation of 27 families in the collection centers and retail markets
- The project developed a literature review on gender and marketing, markets and production chains, and bargaining power.
- A database was created for quantitative and qualitative information collected.
- Following are key findings by market:
 - Patacamaya (Umala) is primarily a wholesale market selling mostly potato and chuño from Umala, Luribay, and Muruta.
 - Chejepampa (Ancoraimas) is mostly for peas from Cohani, Karcapata, and Canta. It has several collection points not dominated by one family, allowing for producers to sell product directly.
 - Morocollo (Ancoraimas) is a collection point for peas and fava beans (dried and fresh) from distant communities. Unlike the previous market, two of its three collection centers are controlled by one family, preventing farmers from selling products to the highest bidder.

- Achacachi (Achacachi) is for potatoes, chuño, and onions from communities in bordering municipalities including Challuyo, Chinchaya, and Humacha. There are few potato or chuño wholesalers, who prefer to sell in more strategic points in the street near the plaza. Onions and peas are sold directly to consumers by producers or intermediaries.
- Women, both producers and buyers, are the main negotiators in the rural markets, with men serving primarily as drivers or helpers.
- Findings at wholesale markets in the urban centers of La Paz and El Alto are as follows.
 - Faro Murillo (El Alto) sells large quantities of onions from Oruro, Tarija, Cochabamba, and Sucre, and communities such as Pocoata, Humacha, and Chinchaya on the shore of Lake Titicaca.
 - Feria 16 de Julio (El Alto) primarily sells potatoes from Altiplano communities in large quantities. It receives chuño in smaller quantities. Peas and onions are sold to small vendors or directly to consumers.
 - Río Seco (El Alto) sells small quantities directly to consumers. Products include potatoes, quinoa, chuño, fava beans, and onions originating in Lake Titicaca communities such as Compi and Achacachi.
 - In Villa Dolores (El Alto), potatoes, potatoes, fava beans and dried peas are sold in the street. Several agencies sell potatoes from Araca, Palca, and Sorata. Relations are between wholesaler and retail intermediaries and the final consumer.
 - Chijini (La Paz) mainly sells potatoes from Cochabamba, Araca, Challuyo, and Umala; onions from Oruro and Cochabamba; and peas from Palca. Intermediaries range from rural wholesalers to small intermediaries.
 - As with rural markets, most intermediaries at all levels are women, as are the producers.
- A total of 50 intermediaries were interviewed, of whom 50% purchased from farmers in weekly rural markets, 30% were wholesalers primarily in urban markets, and 20% were small vendors. In all cases, women were the primary negotiators and actors.
 - Intermediaries in the first group own their means of transportation. Men, in some cases the husbands, drive the trucks and serve as assistants. The women obtain products from farmers at low prices, arguing the high costs of transportation and booths. Relations with producers are generally strictly commercial.
 - The second group of intermediaries is primarily in urban markets, where they own agencies that are generally run by a woman with one to three assistants who help to carry heavy loads. These increase the prices significantly and are the least communicative of all informants.
 - The last are always women, buying from intermediaries and selling directly to consumers. They have strictly commercial relations with the first but sometimes friendships with consumers.

LTRA 5. Gendered networks linking upland women farmers to urban markets in the Philippines

- In general, women's market networks are female dominated and have fewer nodes than male-dominated networks.
- Regular transactions among women and their respective networks confer obligations and privileges on the partnership, including exclusive patronage, preferential treatment, lenient or reduced pricing, and quality assurance for products or services exchanged.
- Networks empower farm women's productive roles but have not been found to directly influence their household bargaining status.

LTRA 5. Women's access to markets: A case study on gendered networks at Nghia Trung Community, Bu Dang district, Binh Phuoc province, Vietnam

- Women's roles and division of labor within households as well as laws, institutions, market structures, and technologies designed to assist women actually leave them with little time for

agricultural extension, training courses, social activities, or access to markets: in response, women have formed informal networks.

- Gendered networks are complicated, comprising local government, households, buying stations, middle people, traders, and women themselves. These are divided further into formal and informal networks.
- Informal networks provide women access to markets, trading, micro-credit, information, education, and health care.
- Results show that improving women's abilities in marketing, information analysis, accounting, and risk reducing behavior (especially on seasonal price of agricultural products) improves their chances to gain access to formal networks.

LTRA 5. Gender analysis in access to markets for vegetables in Nanggung, Indonesia

- Men produce and sell main agricultural products such as rice, corn, and cassava; women produce and sell vegetables.
- Most agricultural products are used for home consumption, surplus sold within the village, or to middlemen
- Access to markets is open to everyone but dominated by men—few women use it
- All nodes in marketing network are dominated by men.
- Intermediaries provide information on demand and price of products.
- Men and women obtain the same price when they use the same network. Men get higher prices when they go directly to big markets.
- Most women do not negotiate prices, only terms of payment.
- Although men dominate market for vegetables and fruit, allocation of expenditures is similar between men and women.
- Source of power for men is long-established networks with intermediaries, institutionalized farmer groups, and access to capital.
- Women's source of power is mainly family networking and support.
- Women who actively participate in marketing gain support from husbands in production and marketing of vegetables and are more confident in negotiating obstacles by selling directly to consumers and obtaining higher prices than from middle people.

Objective 3. Disseminate SANREM gender research

Four modules on issues of gender and development (specifically gendered knowledge, gendered space, micro-credit, and NGOs and participation) have been drafted for posting on the SANREM website. Each module is designed as a lesson comprising key readings, questions to guide reading, and an outline of significant points. Final findings from the case studies will be added to these modules once research is complete. Fourteen other topics have been outlined and will be completed and added to the website for dissemination by the end of the fiscal year. The goal is to have an electronic presentation with key readings and questions from each case study by the end of the fiscal year.

An initial draft of a literature review of scholarship pertaining to gender and social networks was produced and will provide the foundation for a more lengthy review of gendered networks, access to markets, and bargaining power once all case studies are complete. This will serve as an introductory chapter for a publication compiling the findings of the case studies. A collective bibliography was compiled from lists of key references submitted by researchers. Both the literature review and collective bibliography have been posted on the SANREM website.

Research of 10 possible publication outlets for a future special issue or collection of the case studies was conducted. A general letter of interest for publication was drafted in preparation for submission. This awaits final abstracts and confirmation from each gender PI that a manuscript will be submitted.

Significant training, capacity building, and networking activities

Under the direction of Elizabeth Jiménez, four students at the Universidad de la Cordillera formed a study group titled “Markets and Gender” that met weekly for four months before beginning fieldwork in February. The students used a collection of gender readings provided by the SANREM Management Entity (ME) at the 2008 annual meeting as well as other resources to prepare a reaction paper and discussion each week. This, together with the field work undertaken in markets for this project, is an important host country capacity-building contribution.

Challenges

- Apples and oranges. It is clear that the late start of the cross-cutting project made it impossible to create a collective effort with similar foundations. Each LTRA was well underway, thus the new research was attached to existing and very different approaches and research questions. Despite agreement on common research questions and theoretical framework, most of the participating projects are neither parallel nor complementary. They do not share a common literature despite attempts to bring them into alignment by collecting and periodically disseminating information from each project.
- Team integration and social science. Each LTRA has a different structure and integration of social scientists, making it difficult to coordinate a cross-cutting project when there is a lack of clear coordination and communication even within teams. While this has to some extent been overcome by interest among the gender researchers and with the support of LTRA PIs, clearly setting up a gender team (and assuring its integration into the LTRAs and support of advisors in the case of students) from the beginning would facilitate cross-cutting gender research in the future.
- Communication difficulties. To some extent electronic media allow for coordinated communication across LTRAs. However, different communication cultures, infrastructural obstacles, overloaded gender PIs, incommunicative advisors, and hierarchical relationships all contribute to limiting the possibilities of sustaining a team effort. In the case of LTRA 2, which appears to be ahead of the rest in terms of research and writing, the gender PI ceased to communicate, so it is not clear if she will be contributing a final product to the project.
- Late start. While there will be research results in each project, some (such as LTRA 4) involve students who became involved only in the second year of this two-year project. The late disbursement of funds meant that students were not funded until this second and last year of the SANREM CRSP and that research is only now underway. In such cases, it is likely that only a preliminary analysis of data will take place within the fiscal year.
- Delays. The ME on two occasions compiled a collective bibliography based on submissions, but a comprehensive literature review was impossible at the initial agreed-upon deadline in October, and the new deadline in February was only met by one researcher. The delay in data gathering meant that projects were not prepared to share agreed-upon products by the deadlines established; as a result, they did not all follow the same format that would allow comparisons; some showed preliminary results, and others did not provide updated abstracts. Without considerable effort, it seems unlikely that each LTRA will have a completed manuscript of one or more case studies by the end of the fiscal year. Thus it will be impossible for gender researchers to compare their own cases with others and include the originally proposed cross-cutting reflections in their findings.

Vignettes

LTRA 2: Socioeconomic change and gender equity in Luangwa Valley, Zambia

Vongai Kandiwa, a Cornell Ph.D. student in development sociology, completed her field work examining social networks and gender equity in Luangwa Valley, Eastern Province, Zambia. The study includes smallholder farmers participating in the Wildlife Conservation Society's Community Markets for Conservation (COMACO), a model project that seeks to link farmers to the market. Data gathered from 1,500 household surveys, along with focus group discussions and interviews, suggest that social networks are less important in facilitating people's access to market information than other factors, such as notice boards or fliers, which can disseminate information in areas accessible to all members of a community regardless of gender or group membership. Kandiwa found that the main determinant of women's market participation and consequent empowerment lies in the terms of trade for the crops for which they have control as well as the structure of the broader market that provides goods and services. Through this participatory research, women's awareness of markets and access to information have been identified and evaluated, and can now be used in recommendations to researchers and institutions in efforts to increase the bargaining power and ultimate empowerment of women.

LTRA 3: Analysis of gender roles within the farmer economy of Jatun Mayu watershed communities (Tiraque, Bolivia)

Nadezda Amaya, a Virginia Tech master's student in agricultural and applied economics, is conducting research of the Jatun Mayu watershed communities in Tiraque Province, Cochabamba, Bolivia, to investigate gender-differentiated responsibilities within agricultural production and marketing of potatoes. After extensive observation, interviews with farmers, and visits to markets, Amaya found that, despite the widely held assumption that women are relegated to reproductive roles within male-dominated Andean societies, all family members in Jatun Mayu watershed communities participate in agricultural activities, and women maintain a strikingly high level of participation in the marketing process of agricultural products, specifically potatoes. This is due to their negotiating capacities, bargaining power, and relationships with wholesalers, who are also women. The phrase, "Among women, there is a better understanding," commonly cited by farmers in the watershed, represents the gendered nature of marketing networks. The outputs from this research will help to focus gender approaches in the SANREM project activities (Tiraque, Bolivia), improving women's market participation as well as their involvement within the process of watershed management. It will also give a reference framework in the current and future research activities (innovation and technology transfer) in the watershed area. Amaya presented her initial findings as part of a discussion series on women in international development at Virginia Tech in November 2008.

LTRA 4: The role of building social and political capital through advocacy coalition formation on women's ability to face market changes in the Peruvian Altiplano

In the community of Apopata in the Mazocruz District, Province of El Collao of Puno, Peru, LTRA-4 is conducting research on building social and political capital with women's groups as a strategy to increase women's ability to adapt to market changes. Finding women who want to participate from the beginning to the end of the research was a slow process, but regular meetings and workshops have occurred since the initial presentation of the project to the community, and the interest group has grown to eight regularly participating women. The group discussed the concept, use, and steps of formation of strategic alliances and advocacy coalitions, specifically with government and NGOs, which can benefit the group and the community as a whole. A list of key institutions was generated, and the women's interest group is signing a cooperation agreement with Red Social, an NGO dedicated to community and group organizational strengthening. This research will not only increase awareness of and access to markets and information

among the women of Apopata, it will also produce a strategic alliance between the women's group and an institution that can address the gap in networks and build social and political capital to empower women to gain better access to markets and increase their bargaining power. Also, the participative nature of the methodology will ensure a more thorough understanding of the major issues facing the women. Finally, the formation of an advocacy coalition will serve as an example that can be included in recommendations to NGOs, government, and researchers to empower women.

Assessing and Managing Soil Quality for Sustainable Agricultural Systems

Lead PI: Peter Motavalli, University of Missouri

Research progress by objective

Progress toward completing critical Annual Work Plan tasks

Objective 1. Assess community perceptions and indicators of soil quality, including differences in perceptions of soil quality due to gender, environment, and socioeconomic factors

This work was elaborated through the development and conduct of a survey and participatory workshops for assessing perceptions and indicators among community members, and by developing and conducting a separate survey and participatory workshops for agricultural professionals and community members to determine appropriate characteristics of a soil quality testing procedure.

Surveys were completed and distributed to collaborators for revision and translation. Surveys are being conducted among community members and agricultural professionals in Bolivia (Umala and Cochabamba), Indonesia, and the Philippines. In Cochabamba, the communities of Toralapa Baja (relatively low land area), Waylla Pujru (relatively intermediate land area), and Sancayani Alto (relatively high land area) were selected, and 88 men and women community members were surveyed. In Umala, 30 community members (20 men and 10 women) from four communities (Kelihuri, San Juan Circa, San Jose, Vinto Coopani) and five agricultural professionals have been surveyed. Additional surveys are planned in these communities. The master's degree candidate in Bolivia is involved with this task. These surveys examine community and agricultural professional perceptions of soil quality and appropriate characteristics of a soil quality testing procedure. The influence of gender on these perceptions is also being examined. Difficulty was encountered in identifying a collaborator in Zambia, so the survey is not being conducted with the SANREM project there.

Objective 2. Conduct an extensive literature review on soil quality assessment techniques used around the world.

The Ph.D. student based at the University of Missouri is currently conducting this literature review as part of her dissertation project.

Objective 3. Compare analytical procedures for organic matter characterization using visible, near infrared, and mid infrared spectroscopy.

Significant progress was accomplished with this task. The Ph.D. student compared the laboratory and field methods for use of the KMnO_4 test and analyzed soils collected from a long-term field study in the United States and from Bolivia (i.e., the comparison of soils with different fallow length) for water-soluble, KMnO_4 -extractable, and particulate organic matter (POM) labile C. These results are then being correlated with results from the near-infrared (NIR) and DRIFT analysis. An initial comparison was done to determine the most appropriate method (i.e., HF digestion, humic acid extraction, or whole soil) for

preparing samples for DRIFT analysis because the soil mineral fraction often needs to be removed to reduce interference with C peaks. Among these methods the KMnO_4 and NIR tests appear to be the most promising as field methods for determination of soil quality because they are rapid and correlate well with measures of labile C.

Objective 4. Determine the effectiveness of a field test procedure for soil quality using potassium permanganate.

The field kits for the KMnO_4 test were distributed among the collaborators, they were given training, and they are testing two versions of the kit: one with a portable spectrometer and the other with a visual color chart for interpretation of the test results. The Ph.D. student compared the field-based method with the laboratory-based method, which includes more rigorous weighing and shaking, and extracting samples. One problem encountered with the kit was with restrictions and high costs associated with obtaining KMnO_4 reagent in several countries. The method also required too many steps in preparing standards, and the strong solar radiation encountered in tropical countries may cause degradation of the reagent in the field. Therefore, we modified the procedure to reduce the number of steps required in standard preparation and suggested that the field test be conducted early in the morning or later in the afternoon.

Objective 5. Share in the collection, shipping and analysis of soil samples

Initial coordination was done with the soil metagenomics cross-cutting project during the collection phase of its project. We have emphasized strengthening ongoing efforts among the collaborating SANREM projects so that data collected for soil quality analysis supplements ongoing efforts. For example, we are utilizing the soil samples collected in Bolivia for a study of the effects of cropping and fallow length for our soil quality analysis. Shipping costs and increasing customs restrictions on importing soil and manure samples from foreign countries hampered project activities.

Significant research findings

- Laboratory and field-based tests that measure more biologically available forms of soil organic matter can be sensitive indicators of changes in management practices and are relatively rapid and inexpensive tests of soil quality and soil degradation.
- Near infrared spectroscopy (NIR) is a rapid and non-destructive field method for evaluating changes in soil organic matter fractions, but its cost may make it less favorable for developing countries.

Soil Metagenomics to Construct Indicators of Soil Degradation

Lead PI: Karen Garrett, Kansas State University

Research progress by objective

Progress toward completing critical Annual Work Plan tasks

- We have three primary graduate students working on the project, and other students are collaborating.
- Lorena Gomez began work on this project as her master's thesis at Kansas State and gave five presentations about her work in meetings in Kansas and Oklahoma in addition to the metagenomics workshop in La Paz last year.
- Soil samples have been collected from all experiments as planned.
- The first samples have been completely prepared for sequencing in the past week. We should have results for the first sample in about one month.

- We published several synthesis papers related to metagenomics and plant-associated microbes such as pathogens.
- **LTRA-4**
 - Purchasing and installation of equipment at UMSA related to project
 - Sampling of soil in Umala and Ancoraimes
 - Processing soil samples
 - Soil samples submitted for first sequencing run to characterize soil fungi
 - Other samples are in preparation for more detailed analyses and analyses of other groups of microbes
- **LTRA-2**
 - Organizing with Lydiah Gatere for soil sampling in Zambia
 - Extracting DNA from samples
 - Preparing for sequencing
 - Presentation by Lorena Gomez in African Issues Symposium at Kansas State
- **LTRA-3**
 - A student with Fundación PROINPA initiated work on the project.
 - We are preparing to sequence microbes from her samples soon.

Changes in research design or methods, obstacles encountered, and actions taken

Because of problems getting equipment through customs in La Paz in a timely fashion, we ended up doing the DNA extractions back in the United States. This means that project collaborators in Bolivia did not get quite as much experience with the research as they might have, but they still received training in DNA extraction from soil from Lorena Gomez as part of the soil metagenomics workshop in La Paz.

Significant research findings

For the new samples, we should have the first results soon. In ongoing synthesis activities:

- A chapter was published on plant pathogens as indicators of climate change (Garrett, Nita, et al., 2009). Currently, the many factors that interact to cause disease make it difficult to conclude definitively that observed changes in disease risk are evidence of climate change effects.
- A manuscript was submitted on emerging plant diseases and strategies for their management (Garrett, Jumpponen, and Gomez, in review). Two of the most important risk factors – and ones for which management is most controversial – are the great homogeneity of many agricultural landscapes and the intensive trade networks that move potentially contaminated plant materials around the world.
- A paper on plant disease and ecosystem services was accepted pending revision (Cheatham et al., forthcoming). Plant disease influences ecosystem services through both direct effects and the effects of disease management. We summarize these relationships as well as the relationships between system biodiversity and policy. The need for more complete information about microbial communities and how they interact with other levels is one conclusion.
- A paper on biological complexity in response to climate change was published from the International Scientific Conference on Climate Change in Copenhagen March 10-12 (Garrett, Forbes, et al. 2009). We have developed key queries that can be used to classify pathosystems in terms of how high the level of complexity is likely to be and thus where research is particularly needed to prepare for climate change effects.
- We have evaluated the interaction between use of crop mixtures and seasonality for plant disease risk (Garrett, Zúñiga, et al., in press). When season lengths increase, the regional inoculum load may

increase, thus the utility of plant disease management techniques that depend on lowering local inoculum loads may decrease.

Significant training, capacity building, and networking activities

The seminar on design and analysis of pyrosequencing experiments is providing important information to help students understand the work. The publication we are preparing should be of wide use.

The publication based on the soil metagenomics workshop last year in La Paz is nearing submission. It will be submitted to the journal *Plant Health Instructor* to be available in both English and Spanish.

Lorena Gomez was awarded a grant from the American Phytopathological Society to present another workshop in Bolivia on agricultural experimentation with Karen Garrett.

Linking Knowledge and Action: Meeting NRM Challenges

Lead PI: Esther Mwangi, Kennedy School of Governance, Harvard University

Research progress by objective

Objective 1. Collection of qualitative and quantitative data on the multiple strategies used by the four resource teams in linking knowledge to action and the analysis and reporting of the data

Task 1: Key informant interviews with policymakers, practitioners, and community representatives to find out which knowledge-to-action strategies and processes they considered effective and ways to strengthen these processes and improving those they find useful but relatively ineffective.

All teams (i.e., LTRAs 1-4) have completed gathering data and information from primary and secondary sources, including interviews with all parties. In the Philippines and Vietnam, 80 interviews (40 in each country) were conducted with key informants such as researchers, local government officials, policymakers, extension agents, farmer-cooperators, and farmers. In Uganda, 40 key informant interviews were completed with similar stakeholders. Here, additional interviews with members of the National Advisory Committee and two participatory rural appraisals were conducted in the sites selected for study. For all sites, secondary data were obtained from project reports and other documents. In Ecuador and Bolivia round-table discussion were held with key policymakers, i.e., community-level elected officials, to understand their perceptions of the research and the extent to which they found it useful and relevant to them. This team engaged in an ongoing dialogue with farmer and community groups during project research activities, training efforts, and research team participation in community meetings. All stakeholders in Ecuador and Bolivia research sites were exposed to the team's model results, and they now use these and research findings to create individual and watershed-level land-use plans. LTRA-4 is conducting an extensive literature review to connect advocacy coalition and participatory approaches linking the construction of social human and political capital to the participatory nature of the institutions in our sites. A research assistant supported by LTRA-4 is contributing to this literature review.

In Uganda (LTRA-1) policymakers, forestry officials, and community members and leaders found the SANREM research valuable. For forestry practitioners, the SANREM approach to research involved all stakeholders as part of the team, which stimulated dialogue between community members and forest officers. This dialogue helped to clarify the roles of key actors in forestry at national and district levels, strengthening the process of devolution. Communities and their leaders found that the SANREM approach served to lower resource conflicts, valued local knowledge, and provided new knowledge. Although the majority of respondents considered the SANREM research as beneficial, a few felt it was a

hindrance to their daily activities. Most hindrances were met by people who were directly deriving their income from activities in the forests and whose activities had to be stopped as result of the research findings, e.g., timber harvesters, commercial firewood harvesters, and charcoal burners.

Policymakers interviewed identified several challenges in transforming research findings and recommendations into viable policies and actions. First, research reports targeted at policymakers are often bulky and technical, limiting accessibility by busy people. Second, the transformation of research into policy usually takes a lot of time because practices are not easily revised. However, information generated by SANREM led to changes in practice within the National Forest Authority. After the SANREM research recommended fair distribution of both the intangible and tangible resources from the forest, ownership of trees planted as boundary markers between community and government land is now vested in communities, unlike previously when communities' labor was used for plantings that belonged to government. Communities now own the trees that they plant as boundary markers. Communities are now allowed to plant annual crops such as beans, peas, and maize (which do not lead to destruction of the root system of the trees) in return for tending the tree seedlings. Thus communities in research sites now manage and own boundary plantings plus the crops they plant contribute to their livelihoods.

Practitioners in local and central governments indicated that forestry organizations' strategic planning of every five years makes more frequent introduction of new research findings difficult and policy responses can rarely be immediate. However, annual budgeting processes can allow for some implementation of new findings in cases where recommendations fit well with already planned for activities.

At the local community level, different dissemination strategies have had different outcomes. For example, community meetings, especially those concerning environmental issues, are not well attended because communities do not see direct or quick benefits; women and youth often complained that they were not involved in research activities. Community leaders suggested that the most effective dissemination strategy is to piggyback on broader poverty reduction programs that are well attended.

In Ecuador (LTRA-3) acceptance of research findings differs between sites in the upper (Illangama) and lower (Alumbre) watersheds. In Illangama, community members are actively engaged in research and have begun to use findings to modify their land-use practices. Progress is slow in Alumbre. This difference can be attributed to two factors. First, the indigenous population in the Illangama watershed has a relatively long history of working with partners such as scientists and agriculturalists from Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), while the mestizo population in the lower watershed (i.e., Alumbre) had previously had only weak contacts with INIAP. Second, the experimental method (mainly the use of demonstration farms) is much better accepted in the upper watershed. In terms of knowledge-to-action strategies, we have found universal effectiveness in the upper watershed: Our participatory research; our dialogue with decision makers; our field schools, field days, and other extension-like activities; and our ongoing engagement in adaptive watershed management have all been successful. In Alumbre, there is a definite need to sequence activities; exposure to agricultural experiments and establishment of a model farm have helped build legitimacy among local stakeholders. Earlier efforts to engage decision makers at the political level did not work; however, local government is increasingly interested, especially where we engage local producers.

In Bolivia, as in the Alumbre watershed in Ecuador, LTRA-3 finds acceptance and uptake from community and farmer stakeholders, but the political leadership lags. Here, our local partner PROINPA, the Andean research institute, has a long history of working in the Tiraque watershed. The institute has an agricultural research station at Toralapa in the middle of the watershed. However, local political leadership is extremely skeptical, partly because area is affiliated with Bolivian President Evo Morales' party, while Cochabamba is firmly part of the opposition; and partly because of historical enmity between mestizo and indigenous groups. PROINPA is largely mestizo, and the institute is finding that it must build

legitimacy in indigenous areas by working closely with producers. The politicians then will follow. The strategy in Tiraque was modified to recognize this reality, and the LTRA-3 research team focused on engaging producer groups in the watershed management plan. Research results are being used to create land-use management plans at the levels of individual plots and *sindicatos*, or smaller producer groups. Producers have been excited about these plans, and demand for them far exceeds the supply. The local government, even though it has a central government mandate to create watershed-level land-use plans, was reluctant to use our research findings. Following success with individual farmers, however, the government is beginning to warm to the idea.

In Alumbre, Ecuador, and Tiraque, Bolivia, round-table discussions and meetings with local authorities were of only limited effectiveness in shaping decisions. It was extremely important to establish legitimacy with local (non-political) stakeholders before engaging in the political arena.

LTRA-5's review of the national agricultural research, development, and extension system (NARDES) in the Philippines found that, because it is composed of many agencies spread across different regions with little coordination, there is fragmented or overlapping effort, which results in duplication and inefficiency. The link between research and extension is weak, and many research projects rarely produce the kinds of knowledge the end users need most. In addition, projects are influenced by implementing agencies or funding agencies, which do not necessarily serve the knowledge needs of end users. Research, development, and extension management is top down instead of a two-way interactive process. Feedback mechanisms to develop user-driven research and opportunities for farmers to articulate their needs are rare. At the local level, little attention is given to developing extension agents with technical competence and social skills needed to disseminate knowledge and skills to farmers. Despite these deficiencies, a rich body of knowledge available for use by policymakers, extension agents, and farmers can be translated into usable tools, technologies, and information, and can also be communicated to relevant stakeholders. In sum, only a few research and development projects implemented in the Philippines sites have resulted in policy uptake, and the gap between research investment and local benefits is wide. This can be attributed to the missing link between research (knowledge) and end users (action). More efforts are needed to reconcile the supply and demand of knowledge.

Interviews with key informants (policymakers, extension agents, farmer-cooperators, and farmers) on current SANREM vegetable agroforestry (VAF) activities in the LTRA-5 sites showed that the VAF research is appropriate, for the majority of farmers are engaged in vegetable production. Farmers appreciate the additional knowledge gained through participating in research activities, which they can apply to improve their practices. Three strategies of knowledge to action that farmers prefer are: training, on-farm trials, and field visits. Research-proven technologies have a particularly high influence on farmers' decisions and actions. Farmers recommend that researchers provide feedback and that they interact with farmers more informally and treat them as equals.

Task 2. Analysis of results from the key informant interviews to evaluate the effectiveness of multiple strategies and processes (e.g., advocacy coalitions, national advisory committees, policy round tables) in influencing the adoption of new actions, including practices and policies at multiple levels.

LTRAs 1, 3, and 5 have conducted qualitative analysis of their results, outlined above. The findings in Uganda suggest that different linking strategies are effective at different levels of governance, where different decisions must be made. For example, the National Advisory Committees, which included representation from national-level policymakers, non-governmental and research organizations, were more effective in facilitating a change in practice (e.g., tree ownership and non-resident cultivation/*taungya*), ahead of policy. The inclusion of local-level actors in data gathering served to increase local knowledge contributions, while the policy round tables provided a platform that brought

together forest officials, communities, and researchers, allowing officials to hear first hand of local-level resource use and access problems; this in turn contributed to their endorsement of changes in practices.

In the Philippines, farmers found training, on-farm trials, and field visits to be the most influential in their decisions to adopt certain actions. Overall, research-proven technologies have a particularly high influence on farmers' decisions and actions.

Based on grassroots experience in Ecuador, higher levels of government are now interested in the watershed approach to land-use planning. In fact, the constitution of Ecuador was recently revised to include the watershed basis of land-use planning.

Objective 2. Dissemination and outreach of findings generated by participating research teams

Task 1. Continued training of communities in the formation and maintenance of advocacy coalitions

LTRA-4 focused this year in ensuring that researchers are trained in Advocacy Coalitions (AC), a concept that includes an evaluation of institutions to understand who benefits from the research and who has the ability to incorporate information into decision making. The markets theme focuses on the use of the AC in the process of knowledge sharing in the area of markets (Umala, Ancoraimes, and Puno); the second theme focuses on knowledge sharing on climate (Ancoraimes). Bolivian researchers attended training led by Edith Fernández-Baca in Peru. Four researchers were trained and developed a proposal on incorporating AC in the socialization of market information in Bolivia. AC is an essential element in the Peru program, a capacity skill shared with their Bolivian colleagues.

Two male and two female research assistants who are master's degree students in various fields participated in the graduate module in Puno Peru in November 2007. At that time, funding for the knowledge-to-action cross-cutting research was not yet in place, so LTRA-4 funded this activity, which benefits both the LTRA-4 research and the case studies on climate adaptation (Edwin Yucra and Justina Condori) and markets (Olga Yana and Griselda Gonzales). Two of the student researchers (Yana and Yucra) are involved in the case studies in Bolivia on markets and climate.

Task 2. Information exchange between community representatives, practitioners, and policymakers intended to provide feedback and stimulate discussion on the attributes of knowledge they are most likely to use and to sensitize each of these categories of actors on the knowledge needs of the other.

LTRA-4 researchers met with the National Program on Climate Change in Bolivia, presented their climate information-sharing plan, and invited the program to include their information products in this plan. The team is now in the initial stage of determining how to collaborate and how to evaluate the information shared with resource managers. In Peru, LTRA-4 presented its case study to the USAID Mission in October. This presentation focused on pathways for linking knowledge systems and for identifying agency.

Task 3. Cross-case analysis that synthesizes findings, presents the lessons learned for policy, practice, and methods, and recommends future research areas.

The cross-case analysis of results and lessons were not completed. However, the teams are in the process of consolidating their case studies. Uganda, Kenya, the Philippines, and Vietnam have completed their case studies, which await review. In addition, a comprehensive literature review that maps out strategies, problem domains, knowledge systems, and effectiveness of strategies will be conducted by a Harvard student as a summer project. This literature review and that being conducted by LTRA-4 will feed into a

conceptual framework that will be used to place and assess the different case studies in our bid to draw general lessons and insights on how to link knowledge with action.

Publications, dissemination, and outreach

LTRA-4 is currently working on the guidelines to generate products that integrate AC in a protocol of sharing information with the communities for markets and climate. The Uganda team (LTRA-1) completed and circulated a video that explains its strategies for linking knowledge with action and their effectiveness. LTRA-5 (Philippines and Vietnam) conducted two presentations at international forums where feedback was received, while Uganda conducted an exchange workshop that brought together Kenya and Uganda teams and where knowledge and experiences were shared.

Watershed Modeling and Assessment

Lead PI: Conrad Heatwole

Research progress by objective

Objective 1. Support natural resource management at a watershed and policy analysis scale by documenting landscape conditions, quantifying natural resources, and defining land-cover and land-use change using geospatial imagery and analysis.

Specific activities and accomplishments

- A land use /land cover map of the four Zambia study watersheds was developed on a parcel (field) unit based on visual classification from a 1m resolution Ikonos image (May 2007) with field verification. This work will support the land-use change analysis and the watershed modeling analysis of runoff and erosion.
- Field data collected in December 2008 and March 2009 will be used for verification and also to identify areas with land-use change.

The primary challenge is the acquisition of satellite imagery for the preferred time periods to enable specific classification goals (e.g., to distinguish between crops and pasture). Cost, unavailability of satellite services, and difficulties with cloud cover (Andean sites in particular) have been factors beyond our control.

Objective 2. Assess the impacts of climate variation and land-use practices on agricultural sustainability and natural resource management at a watershed scale.

The primary focus for this project period was field data collection during the rainy/cropping season from December through April. Site visits in December (Zambia) and January (Bolivia and Ecuador) were used to check and calibrate field instruments. Additional rain gauges (automatic and manual observation) were added in several watersheds to improve areal coverage. The responsibilities of field observers were expanded in Ecuador and Zambia to include estimation of flow rates during high-flow events.

A key expansion of the watershed monitoring program for the 2008-09 season was to add selected water quality measurements along with the basic hydrology. The primary focus was measurement of total suspended solids (TSS) as a way to estimate sediment loss from the watersheds. Appropriate procedures, equipment, and training were selected and provided for the different project partners. In Ecuador, an external laboratory is providing TSS and nutrient analysis of water samples. Locally, the field observer was trained to sample and analyze for bacteria. For Zambia, TSS filter papers are preweighed at Virginia

Tech, and samples are filtered in the field at Emusa. After air drying, the sample papers were brought back to Virginia Tech for oven drying and accurate weighing. The following analyses were implemented.

- Ecuador (Illangama and DelAlumbre watersheds): TSS, bacteria, total N, total P
- Bolivia (Ancoraimes): TSS
- Bolivia (Tiraque): TSS, nutrients
- Zambia: TSS

Acquisition and analysis of the field data are in process.

In addition to the watershed-scale monitoring, field studies are being conducted in the Jatun Mayu watershed in Bolivia for two specific objectives. The first is a replicated plot study to examine the effect of tillage in the high-altitude zone in the watershed, and the second is to quantify nitrogen dynamics as related to different cropping systems and nutrient management practices.

The second major area of effort is in the development and evaluation of appropriate watershed models to assist in the analysis and extrapolation of the field data. Modeling studies in progress in this reporting period include:

- comparison of runoff and sediment from headwater catchments in the Eastern Luangwa plateau (Nyirongo, master's thesis), and
- evaluation of GLEAMS nutrient model and evaluation of cropping systems in Jatun Mayu (Walker, master's thesis).

Objective 3. Evaluate the accuracy and value of low-cost community-based monitoring of watershed hydrology.

The network of field observers was expanded at sites in Zambia and Ecuador. A full-time assistant was hired in Zambia to provide better continuity of field monitoring programs and to do the water sampling and filtering for TSS analysis. Local observers have been arranged at each stream monitoring point, and additional rainfall records have been kept at other locations in the watersheds. Preliminary review of the observer data shows a range in quality, as might be expected. However, the data in general are very valuable to the overall monitoring effort.

An interesting outcome to date is that in Ecuador and Zambia, where community involvement was sought and incorporated in the monitoring program, there is strong community support and interest (and now institutional interest in Zambia). To date, there were no incidences of vandalism of equipment at watershed sites in Ecuador and Zambia (to the surprise of local partners), but vandalism occurred at the sites in Bolivia where we do not have local observers as part of the study implementation.

Significant training, capacity building, and networking activities

Two master's degree students at Virginia Tech (Walker, Nyirongo) are on track to complete their research and theses by August 2009. Sally Walker is adapting and evaluating a field-scale agro-ecosystem model for Andean conditions with the goal of evaluating nutrient management practices in the Jatun Mayu watershed (Tiraque, Bolivia). Victor Nyirongo's work focuses on modeling the land-use impacts in upland dambo watersheds in Zambia. Both efforts are relying on data collected through the watershed assessment monitoring program.

The master's degree programs of Mirco Penaranda (Bolivia) and Carlos Montufar (Ecuador) are supported by the field training and data from the watershed assessment program. Part of the outcome of their work is the watershed-scale evaluation of land-use impacts through planned modeling studies that will follow the data analysis. Additional non-degree training in watershed assessment, including field and laboratory measurements and data analysis and modeling, is provided to technical specialists in Bolivia (Saavedra, Delfin).

A journal article was accepted for publication. The entry to the SKB will be made when the complete citation and published article are available:

Caiado, M.A.C. and C.D. Heatwole. 2009. Improved nutrient parameters for modeling diffuse pollution in the tropics. *Trans. ASABE* 52(3): (in press).

Special events and networking activities

In March 2009, I met in Lundazi, Zambia, with Charles Phiri, head of the Lundazi District Meteorology Department. The Lundazi station is at the government office building complex. Data (air and soil temperature, rainfall, cloud cover, wind run) are recorded hourly during the day. The director learned about the weather stations operated by us in the Emusa area and initiated the contact with me to discuss the possibility of collaboration and sharing of data. He is interested in having data from additional points across the district to provide a better representation of rainfall patterns and amounts. There is significant local variation in rainfall because the majority of rainfall is from convective storms. I shared data from the past season (2008-09) and assured him of our interest in making all data available. Phiri included the Emusa and Chazovu stations in his weekly radio and TV weather reporting. The increased interest in community records and in maintaining and sharing data is a positive outcome for increased community awareness of environment and implications for crop production.

Appendixes

Long-term degree training

Student Name	Sex (M/F)	Nationality	Discipline	Country Supported	Sandwich Program (Y/N)	Program			Funding		SANREM CRSP Advisor/PI	University or degree-granting institution
						Start Date	End Date	Degree	SANREM CRSP	Non-SANREM CRSP		
Evelyn Lwanga	F	Ugandan	Political Science	Uganda	N	Sep 08	Dec 08	PhD	Y	N	E. Ostrom	Indiana University
Pam Jagger	F	Canadian	Political Science	Uganda	N	Sep 08	Sep 08	PhD	Y	Y	E. Ostrom	Indiana University
Diego Pacheco	M	Bolivian	Political Science	Bolivia	N	Sep 02	Apr 07	PhD	Y	Y	E. Ostrom	Indiana University
Patricia Uberhuaga	F	Bolivian	Economics	Bolivia	N	Aug 05	Dec 08	PhD	Y	Y	P. Pacheco (CIFOR)	RVAU, Denmark
Gustavo Garcia Lopez	M	USA	Political Science	Mexico	N	Aug 05	May 10	PhD	Y	Y	E. Ostrom	Indiana University
Amy Duchelle	F	USA	Forestry	Bolivia	N	Aug 03	Jun 08	PhD	Y	Y	P. Pacheco (CIFOR)	Univ of Florida
Forrest Fleischman	M	USA	Public Policy	All	N	Sep 07	May 12	PhD	Y	Y	E. Ostrom	Indiana Univ
Alexandra Silva	F	USA	Natural Resources	Zambia	N	Oct 08	May 09	BS	Y	Y	Travis	Cornell
Samuel Bell	M	Australian	Applied Economics	Zambia	N	Sep 05	May 10	PhD	Y	Y	Schulze	Cornell
Lydia Gatere	F	Kenyan	Soil & Crop Science	Zambia	N	May 06	May 10	PhD	Y	Y	Lehmann	Cornell
Vongai Kandiwa	F	Zimbabwean	Development Sociology	Zambia	N	Sep 04	Jul 09	PhD	Y	Y	Eloundou-Enyegue	Cornell
Nahunda Katoma	F	Zambian	Sociology	Zambia	N	Oct 07	Sep 09	MS	Y	N	Eloundou-Enyegue	University of Zambia
Chisha Chungu	F	Zambian	Gender	Zambia	N	Jan 08	Sep 08	MS	Y	Y	Eloundou-Enyegue/Katundu-Liatto	University of Zambia
Emily Steubing	F	USA	Veterinary Medicine	Zambia	N	May 08	Sep 09	DV M	Y	Y	Travis	Cornell
Colin Seeley	M	USA	Food Science	Zambia	N	Sep 09	Sep 09	MPS	Y	Y	Moraru	Cornell
Richard Sánchez	M	Bolivian	Economics	Bolivia	N	Aug 07	Mar 08	BS	Y	N	Amaya, Botello	Universidad Técnica privada Cosmos
Carlos Montúfar	M	Ecuadorian	Environmental Sciences	Ecuador	N		Mar 10	MS	Y	Y	Barrera	Universidad SEK
Amelia Henry	F	USA	Soils-Horticulture	Ecuador	N	Jun 06	Jun 08	PhD	Y	Y	Lynch	Penn State
Moazir Celleri	M	Ecuadorian	Social Science	Ecuador	N	Jan 07	Jan 08	BS	Y	N	Barrera	Universidad de Bolívar
Marta Gonzalez	F	Ecuadorian	Social Science	Ecuador	N	Jan 07	Jan 08	BS	Y	N	Barrera	Universidad de Bolívar
Eugenia Núñez	F	Ecuadorian	Social Science	Ecuador	N	Jan 07	Jan 08	BS	Y	N	Barrera	Universidad de Bolívar
Victor Barrera	M	Ecuadorian	Social Science	Ecuador	Y	Aug 06	Nov 08	PhD	Y	Y	Alwang	Universidad de Madrid
Raul Jaramillo	M	Ecuadorian	Soils-Horticulture	Ecuador	N	Jun 06	Jun 08	PhD	Y	Y	Lynch	Penn State

Student Name	Sex (M/F)	Nationality	Discipline	Country Supported	Sandwich Program (Y/N)	Program			Funding		SANREM CRSP Advisor/PI	University or degree-granting institution
						Start Date	End Date	Degree	SANREM CRSP	Non-SANREM CRSP		
Edwin Chela	M	Ecuadorian	Soil Science	Ecuador	N	Jan 07	Jan 08	BS	Y	N	Valverde	Universidad de Bolivar
Anurag Mishra	M	Indian	Biological Systems Engineering	global	N	Aug 05	Sep 08	PhD	Y	Y	Benham/ Mostaghimi	Virginia Tech
Anissa Polatewich	F	USA	Plant Pathology	Bolivia	N	Sep 07	Dec 09	PhD	Y	Y	Backman	Penn State
Not Named		Bolivian	Economics	Bolivia	N	Sep 08	Sep 09	BS	Y	N	Botello	UMSS
Robert Andrade	M	Ecuadorian	Economics	Ecuador	N	Aug 06	Aug 08	MS	Y	Y	Alwang	Virginia Tech
Catherine LaRochelle	F	Canadian	Economics	Ecuador Bolivia	N	Aug 06	Aug 09	PhD	Y	Y	Alwang	Virginia Tech
Nadezda Amaya	F	Bolivian	Economics	Bolivia	Y	Aug 07	Dec 09	MS	Y	N	Alwang	Virginia Tech
Mike Castelhana	M	USA	Economics	Ecuador	N	Aug 06	Aug 08	MS	Y	Y	Alwang	Virginia Tech
Rachel Melnick	F	USA	Plant Pathology	Ecuador Bolivia	N	Jun 06	Jun 10	MS (08) PhD	Y	Y	Backman	Penn State
Luis Escudero	M	Ecuadorian	Agronomy	Ecuador	N	Aug 08	Jul 10	MS	Y	N	Barrera	Universidad Cotopaxi
Not Named		Bolivian	Agronomy/ Biology	Bolivia	N	Sep 08	Sep 09	BS	Y	N	Botello, Figueroa, Cossio	UMSS
Not Named		Bolivian	Agronomy/ Biology	Bolivia	N	Sep 08	Sep 09	BS	Y	N	Botello, Figueroa, Cossio	UMSS
Maria Quispe	M	Bolivian	Rural Development	Bolivia	N	Sep 08	Sept 09	MS	Y	N	Elizabeth Jiménez	CIDES - Universidad Mayor de San Andres
Marcos Willy Quispe	M	Bolivian	Soil Science	Bolivia	N	Oct 07	Sep 08	ING	Y	N	R. Miranda	Universidad Mayor de San Andrés
Freddy Navia	M	Bolivian	GIS Landscape	Bolivia	N	Jul 07	Jun 09	MSc	Y	Y	Magaly Garcia	Universidad Mayor de San Andrés
Gerson Alejo Aruni	M	Bolivian	Agronomy	Bolivia	n	Oct 08	Sep 09	Lic	Y	N	Peter Motavalli	Universidad Mayor de San Andrés
Griselda Gonzales	F	Bolivian	Rural Development	Bolivia	N	Apr 07	Oct 09	MS	Y	N	Elizabeth Jiménez	CIDES - Universidad Mayor de San Andres
Helen Villanueva	F	Peruvian	Biology	Peru	N	Nov 06	Nov 08	MSc	Y	N	Karen Garrett	Universidad Nacional Marcos de San Marcos
Javier Aguilera Alcón	M	Bolivian	Soil Science	Bolivia	N	Aug 06	Sep 10	PhD	Y	Y	Peter Motavalli	University of Missouri Columbia
Jeanne Thibeault	F	USA	Climate/ Geography	USA	N	Aug 06	Aug 09	PhD	Y	Y	A. Seth	University of Connecticut
Jenny Choque Flores	F	Peruvian	Ag. Innovation for Rural Dev	Peru	N	Mar 07		MS	Y	N	Jan Flora	Universidad Nacional del Altiplano

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						Start Date	End Date	Degree	SANREM CRSP	Non-SANREM CRSP		
Jorge Pretel	M	Peruvian	Statistics	Peru	N	Mar 06	Sep 07	ING	Y	N	Karen Garrett	Universidad Nacional Agraria La Molina
Julio Sarmiento Vargas	M	Bolivian	Agronomy	Bolivia	N	Nov 06	Aug 07	ING	Y	N	J. Cusicanqui / D. Cruz	Universidad Mayor de San Andrés
Erin Frank	F	USA	Plant Pathology	USA	N	Aug 07	Sep 07	MS	Y	Y	Karen Garrett	Kansas State University
Blas Mamani Vargas	M	Bolivian	Soil Science	Bolivia	N	Oct 06	Sep 08	ING	Y	N	R. Miranda	Univ. Mayor de San Andres
Justin Thomas M.	M	USA	Rural Sociology	USA	N	Sep 07	Sep 09	PhD	Y	Y	Jere Gilles	University of Missouri Columbia
Justina Condori	F	Bolivian	Agronomy	Bolivia	N	Oct 08	Jun 10	MS	Y	Y	Jorge Cusicanqui	Universidad Mayor de San Andrés
Lisa Rees	F	USA	Agricultural Economics	USA	N	Jun 06	Aug 09	PhD	Y	Y	C. Valdivia / L. Marks	University of Missouri Columbia
Lorena Gomez	F	Colombian	Soil metagenomics	USA	N	Jan 08	Sep 09	MS	Y	N	Karen Garrett	Kansas State
Juan Sipe	M	Bolivian	Soil Science	Bolivia	N	Oct 07	Sep 08	ING	Y	N	Miguel A. Gonzales	Universidad Mayor de San Andrés
Cecilia Turin Canchaya	F	Peruvian	Rural Sociology	USA	N	Aug 07	Dec 10	PhD	Y	Y	Jere Gilles	Universidad Nacional Agraria La Molina
Alan Callisaya	M	Bolivian	Geography	Bolivia	N	Nov 08	Sept 09	Lic	Y	N	Karen Garrett / Jorge Cusicanqui	Universidad Mayor de San Andrés
Alejandro Romero	M	Bolivian	Rural Development	Bolivia	N	Apr 08	Sept 09	MS	Y	N	Elizabeth Jiménez	Universidad Mayor de San Andrés - CIDES
Alex Fernandez	M	Peruvian	Ag Innovation for Rural Dev	Peru	N	Mar 08	Sep 10	MS	Y	N	Silvana Vargas	Universidad Nacional del Altiplano
Angélica Quenta Callisaya	F	Bolivian	Agronomy	Bolivia	N	Sep 08	Sept 09	Lic	Y	N	Elizabeth Jiménez	Universidad Mayor de San Andrés (UMSA)
Antonio Paz Arcani	M	Bolivian	Agronomy	Bolivia	N	Nov 06	Aug 07	ING	Y	N	M. Peñaranda / T. Ruíz	UMSA
Betty Cruz	F	Bolivian	Agronomy	Bolivia	N	Nov 07	Jan 08	Lic			Jorge Cusicanqui	UMSA
Dieter Fabiani Hurtado	M	Bolivian	Ecology	Bolivia	n	Oct 08	Sep 09	Lic	Y	Y	Karen Garret	UMSA
Carola Chambilla	F	Bolivian	Agroecology	Bolivia	Y	Oct 08	Sep 09	MSc	Y	N	Peter Motavalli	Universidad Mayor de San Simon
María Figueroa	F	Ecuadorian	Agricultural Economics	Ecuador	N	Sep 06	Aug 08	MS	Y	Y	C. Valdivia	University of Missouri Columbia

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Elvio Herrera Aruquipa	M	Bolivian	Soil Science	Bolivia	N	Oct 06	Sep 07	ING	Y	N	R. Miranda	Univ. Mayor de San Andres
Christian Candela Barra	M	Peruvian	Ag. Innovation for Rural Dev	Peru	N	Mar 07	Sep 09	MS	Y	N	Edith Fernandez Baca	Universidad Nacional Agraria La Molina
Claudia Jarandilla	F	Bolivian	Plant Pathology	Bolivia	N	Sep 06	Mar 08	ING	Y	N	Miguel A. Gonzales	Universidad Mayor de San Andrés
Clovis Bailon Flores	M	Peruvian	Ag. Innovation for Rural Dev	Peru	N	Mar 07	Sep 09	MS	Y	N	Sandy Garcia	Universidad Nacional del Altiplano
Dora Aguilar Endara	F	Bolivian	Agronomy	Bolivia	N	Sep 07	Mar 08	ING	Y	N	J. Cusicanqui / J. Pascuali	Universidad Mayor de San Andrés
Doris Bartolo	F	Peruvian	Ag Innovation for Rural Dev	Peru	N	Mar 07	Sep 09	MS	Y	N	Silvana Vargas	Universidad Nacional del Altiplano
Edwin Yucra	M	Bolivian	Agronomy	USA	N	Jul 07	Jun 09	MSc	Y	N	Magaly Garcia	Universidad Mayor de San Andrés
Eliceo Tangara	M	Bolivian	Soil Science	Bolivia	N	Sep 06	Sep 07	ING	Y	N	Javier Aguilera	Universidad Mayor de San Andrés
Carlos Cladera	M	Bolivian	Soil Science	Bolivia	N	Oct 07	Sep 08	ING	Y	N	Miguel A. Gonzales	Universidad Mayor de San Andrés
Adam Sparks	M	USA	Plant Pathology	Bolivia, Peru, Ecuador	N	Jan 07	Apr 09	PhD	N	Y	Karen Garrett	Kansas State University
Bunjirtluk Jintaridth	F	Thai	Soil Quality	Bolivia	N	Aug 07	Sep 09	PhD	Y	N	Peter Motavalli	University of Missouri-Columbia
Viviana Vera	F	Bolivian	Plant Pathology	Bolivia	N	Oct 07	Sep 08	ING	Y	N	Miguel A. Gonzales	Universidad Mayor de San Andrés
Rina Beatriz Paredes Torrez	F	Bolivian	Biology	Bolivia	N	Oct 08	Sep 09	Lic	Y	N	Karen Garret	UMSA
Virginia Quispe Herrera	F	Bolivian	Agronomy	Bolivia	N	Sep 08	Sep 09	Lic	Y	N	Gonzales/ Jimenez	Universidad Mayor de San Andrés
Virginia Mamani	F	Bolivian	Agronomy	Bolivia	N	Oct 08	Sep 09	Lic			Miguel Angel Gonzales	Universidad Mayor de San Andrés
Teresa Canaviri	F	Bolivian	Agronomy	Bolivia	N	Nov 07	Sep 08	Lic	Y	N	Karen Garrett / Jorge Cusicanqui	Universidad Mayor de San Andrés
Sonia Tola	F	Bolivian	Plant Pathology	Bolivia	N	Nov 07	Sep 08	Lic	Y	N	Jorge Cusicanqui	Universidad Mayor de San Andrés
Shauna P. Dendy	F	USA	Plant Pathology	USA	N	Jun 06	May 07	MS	Y	Y	Karen Garrett	Kansas State University
Rubi Raymundo	F	Peruvian	Plant Pathology	Peru	N	Aug 06	Aug 07	MS	Y	Y	Forbes/Garrett	UNALM

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Miriam Gomez	F	Bolivian	Plant Pathology	Bolivia	N	Sep 06	Sep 07	ING	Y	N	Miguel A. Gonzales	Universidad Mayor de San Andrés
Miguel Angel Gonzales Aldana	M	Bolivian	Plant Pathology	Bolivia	N	May 07	May 09	MS	Y	N	Karen Garrett	UNALM
Romulo Torrez	M	Bolivian	Soil metagenomics	Bolivia	N	Aug 08	Sep 09	MS	Y	N	Karen Garrett / Roberto Miranda	Universidad Mayor de San Andrés
Mirco Peñaranda	M	Bolivian	Agronomy	Bolivia	N	Apr 08	Sep 09	MS	Y	N	Conrad Heatwole/ Magaly Garcia	Universidad Mayor de San Andrés
Milan Mamani	M	Bolivian	Biodiversity	Bolivia	N	Sep 06	Sep 07	ING	Y	N	Miguel A. Gonzales	Universidad Mayor de San Andrés
Nelly Calle Kantuta	F	Bolivian	Agronomy	Bolivia	N	Nov 06	Aug 07	ING	Y	N	M. Peñaranda / T. Ruíz	Universidad Mayor de San Andrés
Olga Rita Quispe	F	Peruvian	Ag. Innovation for Rural Dev	Peru	N	Mar 08	Sep 09	MS	Y	N	Edith Fernandez Baca	UNALM
Olga Yana (UC)	F	Bolivian	Sociology	Bolivia	N	Sep 06	Jun 09	MS	Y	Y	Elizabeth Jiménez	Universidad de la Cordillera
Pedro Camacho	M	Peruvian	Agricultural Innovation for Rural Development	Peru	N	Mar 08	Sep 09	MS	Y	N	Edith Fernandez Baca	Universidad Nacional Agraria La Molina
Porfidia Ajata (UC)	F	Bolivian	Economics	Bolivia	N	Sep 06	July 09	MS	Y	N	Elizabeth Jiménez	Univ. de la Cordillera/ Univ. Andina Simón Bolívar
Ana Siñani	F	Bolivian	Agronomy	Bolivia	N	Nov 09	Aug 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/ Peñaranda	Universidad Mayor de San Andrés
Jhony Machaca	M	Bolivian	Agronomy	Bolivia	N	Nov 09	Aug 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/ Peñaranda	Universidad Mayor de San Andrés
Rene Luque	M	Bolivian	Agronomy	Bolivia	N	Nov 09	Aug 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/ Peñaranda	Universidad Mayor de San Andrés
Jhonny Plata	M	Bolivian	Agronomy	Bolivia	N	Feb 09	Sep 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/ Peñaranda	Universidad Mayor de San Andrés
Gerardo Mamani	M	Bolivian	Agronomy	Bolivia	N	Nov 09	Aug 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/	Universidad Mayor de San Andrés

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											Peñaranda	
Reynaldo Mamani	M	Bolivian	Agronomy	Bolivia	N	Nov 09	Aug 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/ Peñaranda	Universidad Mayor de San Andrés
Marco A. Vasquez	M	Bolivian	Agronomy	Bolivia	N	Feb 09	Sep 09	BS	Y	Y	Cusicanqui/ Navia/Yucra/ Condori/ Cabrera/ Peñaranda	Universidad Mayor de San Andrés
Nathaniel Jense	M	USA	Agricultural Economics	USA	N	Sep 09	May 10	MS	N	Y	Corinne Valdivia	
Duong Tran Lan Anh	F	Vietnamese	Agronomy	Vietnam	N	Sep 05	Sep 09	BS	Y	Y	LV Du	Nong Lam University
Isidra Bagares	F	Filipino	Strategic Planning and Public Policy	Philippines	N	Jun 08	May 09	MPA	Y	Y	Agnes C. Rola	Univ of the Philippines-Los Baños
Juang G. Kartika	F	Indonesian	Horticulture	Indonesia	N	mm m 06	mm m 08	MS			Anas D. Susila	Bogor Agricultural University
Nelsa J. Olila	F	Filipino	Agricultural Economics	Philippines	N	Jan 08	Mar 09	PhD	Y	Y	Victor B. Ella	Central Mindanao University
Nathaniel R. Albuyog	M	Filipino	Agricultural Engineering	Philippines	N	mm m 07	mm m 08	PhD	Y	Y	Victor B. Ella	Univ of the Philippines Los Banos
Tisna Prasetyo	M	Indonesian	Horticulture	Indonesia	N	mm m 08	mm m 10	MS	Y	N	Anas D. Susila	Bogor Agricultural University
Tin Herawati	F	Indonesian	Family and Consumer Science	Indonesia	N	Aug 08	May 11	PhD	Y	Y	Trikoesoemangtyas	Bogor Agricultural University
Andre Quiray	M	Filipino	Environmental Science	Philippines	N	Jun 08	Mar 09	MS	Y	N	Ma. Victoria Espaldon	Univ of the Philippines-Los Baños
Charmaine Pailagao	F	Filipino	Environmental Science	Philippines	N	Jun 08	Mar 09	MS	Y		Ma. Victoria Espaldon	Univ of the Philippines-Los Baños

Short-term training

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
GLOBAL						
Seminar Linked with other institutions using Adobe Connect	Spring semester	Students and faculty at KSU, PROINPA, WSU, and OSU	9	6	Kansas State University	Gaining a shared knowledge of soil metagenomics experimental design and analysis that use pyro- sequencing to characterize microbial communities, including joint preparation of a manuscript for publication
BOLIVIA						
Seminar	October 17 2008	Masters students in UMSA's Natural Resource Management Class	9	6	Jere Gilles, University of Missouri	Bridging local and scientific knowledge
Seminar	October 18	Students in the Universidad de la Cordillera's bilingual education program	14	8	Jere Gilles, University of Missouri	Impacts of climate change
Seminar	January 9 2009	USAID Bolivia officers and stakeholders	13	8	University of Connecticut University of Missouri	Advances in Research on Climate Projections for Altiplano mid- & end-century, and implication for soils
Short Course	7 de septiembre 2008	Agricultores	47		PROINPA	Control del Gorgojo de Los Andes
Short Course	30 de octubre de 2008	Agricultores	19		PROINPA	Elaboración de compost
Short Course	10 de diciembre de 2008	Agricultores	25		PROINPA	Elaboración de compost
Short course	January 2009	Farmers from Cohani community.	4	8	Universidad Mayor de San Andrés	Strengthen and refresh the knowledge about the life cycle of the Andean weevil and the potato moth.

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Short course	January 2009	Farmers from Calahuancane Baja community.	6	11	Universidad Mayor de San Andrés	Strengthen and refresh the knowledge about the life cycle of the Andean weevil and the potato moth.
Short course	January 2009	Farmers from Chinchaya community.	30	4	Universidad Mayor de San Andrés	Strengthen and refresh the knowledge about the life cycle of the Andean weevil and the potato moth.
Short course	January 2009	Farmers from Chojñapata community.	6	7	Universidad Mayor de San Andrés	Strengthen and refresh the knowledge about the life cycle of the Andean weevil and the potato moth.
Workshop	October 2008	Vinto Coopani Farmers	16	8	PROINPA	Research products and quinoa varieties informaiton
Workshop	Oct 2008	San Juan Circa	20	5	PROINPA	Sharing research products and quinoa varieties
Workshop	October 2008	Llujturi/Kellhuiri	6	4	PROINPA	Returning research results and quinoa varieties
Workshop	October 21-23, 2008	Bolivian Graduate Students supported by SANREM	2	4	Jere Gilles, University of Missouri	Recording and analysis of qualitative data
Workshop	October 23 2008	Team of researchers and students in Bolivia	6	7	University of Missouri	On <i>socializacion</i> , the process of knowledge integration and sharing with community research groups
Workshop	December 2008	San Jose Llanga	18	2	PROINPA	Sharing research results with the community
Workshop	December 2008	Kellhuiri	12	3	PROINPA	Returning findings to the farmers
Workshop	December 2008	Farmers from the community of Chojñapata, Municipality of Ancoraimes. La Paz, Bolivia	5	8	Universidad de la Cordillera	To present and socialize research results on Climate and market changes

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Workshop	December 2008	Farmers from Chinchaya community.	21	17	Universidad Mayor de San Andrés	Present the research results of the 2 past efforts in management of plagues, soil, and climate.
Workshop	December 2008	Farmers from Cohanila community.	7	14	Universidad Mayor de San Andrés	Present the research results of the 2 past efforts in management of plagues, soil, and climate.
Workshop	December 2008	Farmers from Calahuancane Baja community.	12	9	Universidad Mayor de San Andrés	Present the research results of the 2 past efforts in management of plagues, soil, and climate.
Workshop	December 2008	Farmers from Chojñapata community.	11	12	Universidad Mayor de San Andrés	Present the research results of the 2 past efforts in management of plagues, soil, and climate.
Workshop	December 2008	Farmers from the community of Calahuancani, Municipality of Ancoraimes. La Paz, Bolivia	12	9	Universidad de la Cordillera	To present the research results on Climate and market changes
Workshop	December 2008	Farmers from the community of Cohani, Municipality of Ancoraimes. La Paz, Bolivia	7	14	Universidad de la Cordillera	To present the research results on Climate and market changes
Workshop	December 2008	Farmers from the community of Chinchaya, Municipality of Ancoraimes. La Paz, Bolivia	21	17	Universidad de la Cordillera	To present the research results on Climate and market changes
Workshop	February 2008	Farmers from the community of Vinto Coopani, Municipality of Umala. La Paz, Bolivia	15	13	Universidad de la Cordillera	To present the research results on Climate and market changes

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Workshop	February 2009	Agricultores	41		PROINPA	Calidad de suelos
Workshop	March 2009	Agricultores	47		PROINPA	Calidad de suelos
Workshop	February 2009	Farmers from Cohani community.	6	8	Universidad Mayor de San Andrés	Integrated management of the Andean weevil (first part). Knowing the different control methods and which can be applied in the community.
Workshop	January 2009	Farmers from Cohani community.	7	8	Universidad Mayor de San Andrés	Strengthen and refresh the basic knowledge about the use of agrochemicals. Handling and applying pesticides.
ECUADOR						
Workshop	02/10/200 8	Professionals INIAP and partners	16	10	INIAP	Livelihoods: used methodology and their implications for the analysis of economics political.
Workshop	23/10/200 8	Farmers	25	15	INIAP	Training on natural resource management. Watershed of the Illangama river
Field day	19/11/200 8	Farmers, Professionals and partners	105	35	INIAP, MAGAP	Implementation of activities in Integrated Pest Management for Blackberry. Watershed of the Alumbre river
Workshop	09/12/200 8	Farmers	25	10	INIAP	Training in Integrated Management of tomato in the watershed of the Alumbre river
Workshop	10/12/200 8	Farmers	13	12	INIAP	Training in Integrated Pest Management in the cultivation of potatoes. Watershed of the Illangama river
Workshop	11/12/200 8	Farmers	23	14	INIAP	Training in Integrated Pest Management in the cultivation of grass. Watershed of the Illangama river

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Workshop	12/03/2009	Farmers	69	49	SENAGUA	Socialización de la institucionalidad del agua. Watershed of the Illangama river
Workshop	19/03/2009	Farmers	23	14	SENAGUA	Socialización de la institucionalidad del agua. Watershed of the Guaranda river
Workshop	24/03/2009	Farmers	51	11	SENAGUA	Socialización de la institucionalidad del agua. Watershed of the Illangama river
INDONESIA						
Short course	12/1/08	Professionals and students from Bogor Agricultural University	2	1	University of Missouri	To train professionals and students in Bogor Agricultural University to use the soil quality kit.
MEXICO						
Workshop	Jan-Mar 2009	Community reps from 42 communities in Oaxaca, Mexico	30	12	UNAM	Discuss the national survey conducted by Mexico, develop community strategies
PERU						
Seminar	October 17 2008	Participants at the Peruvian National Association of Animal Sciences	95	100	University of Missouri	Share the perspectives of the role of livestock in Andean Livelihoods in the Context of Climate Change
Seminar	October 21 2008	USAID officers Peru Mission	8	7	Universidad Nacional Agraria La Molina and University of Missouri	To present the climate change projections for the Altiplano results, and adaptation strategies approach focused on social capital, human capital and building coalitions.
Workshop	November 2008	Farmer from Santa María Community	07	08	UNALM	Identify and differentiate types of soils in private plots and aynocas. Soil sampling.
Workshop	December 2008	Farmer from Apopata Community	25	19	UNALM	Share survey information with community.

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Workshop	January 2009	Farmer from Santa María Community	20	05	UNALM	Share survey information with community.
Workshop	January 2009	Farmer from Santa María Community	10	0	UNALM	Soil sampling of the community.
Workshop	January 14, 2009	SENAMHI Peru and the Ministry of the Environment	0	16	University of Connecticut and University of Missouri	Advances in research on adaptation and climate change projections for the northern Altiplano, and research experiences of SENAMHI
PHILIPPINES						
Short course	11/26/08	Professionals from Central Mindanao University	0	2	University of Missouri	To train professionals in Central Mindanao University to use the soil quality kit.
UGANDA						
Workshop	Jan-Mar 2009	Community based organizations involved in the Mabira forest (Uganda Site #1)	5	4	UFRIC	Create awareness and train local communities and schools about conservation, managing trees planted to demarcate forest boundaries, patrolling of the forest boundaries to reduce illegal forest resource use, and establishing alternative income generation activities such as bee keeping
ZAMBIA						
Short Course	October 2008	Extension Officers	5		Kasisi Agriculture Training Centre (Zambia)	Sustainable Agriculture and Biological Pest Control
Field Day (Seed Multiplication)	March and April 2009	Farmers	172	39	COMACO (Zambia)	To teach farmers on how to raise early maturing seed for maize

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Seminars	9 th Feb 2009 And 25 th March 2009	Bee Keeping Officer	1		Ministry of Tourism and Natural Resources (Zambia)	To form an Eastern Province Bee Keeping Association
Training externship	10 th Feb to 10 th April 2009	Food Processing Technologist Jimmy Chikahya, Cornell MPS student Colin Seeley	2		General Mills (USA)	To learn about extrusion technology and product formulation
Short courses	2day courses, between Feb 2-18, 2009	Farmers raising bees	61	9	COMACO	Train farmers in bee raising and honey collection

Publications, presentations, and other products

Category	Bibliographic citation
Articles in refereed publications	<p>Melnick, R.L., N.A. Zidack, B.A. Bailey, S.N. Maximova, M.J. Gultinan and P.A. Backman. 2008. Bacterial endophytes: <i>Bacillus</i> spp. from vegetable crops as potential biological control agents of black pod rot of cacao. <i>Biological Control</i> 46: 46-56.</p> <p>Bae, H., R.C. Sicher, M.S. Kim, S.H. Kim, M.D. Strem, R.L. Melnick and B.A. Bailey. 2009. The beneficial endophyte, <i>Trichoderma hamatum</i> isolate DIS 219b, promotes growth and delays the onset of the drought response in <i>Theobroma cacao</i>. <i>Plant Physiology and Biochemistry</i>. <i>In review</i></p> <p>Melnick, R.L., K.S. Hidalgo, C. Suárez and P.A. Backman. 2008. Field evaluation of endophytic endospore-forming bacteria with cacao successions for management of witches' broom of cacao during the dry season, 2007. <i>Plant Disease Management Reports</i> 2(V): 136.</p> <p>R. Wills Flowers, 2009. A new species of <i>Thraulodes</i> (Ephemeroptera: Leptophlebiidae, Atalophlebiinae) from a highly altered river in western Ecuador. <i>Zootaxa</i> 205(2): 55–61.</p> <p>Barrera, V., J. Alwang and E. Cruz. 2008. Análisis de la viabilidad socio-económica y ambiental del sistema papa-leche en la microcuenca del río Illangama-Ecuador. Artículo presentado a la Asociación Latinoamericana de Producción Animal. 20 pp.</p> <p>Garrett, K. A., G. Forbes, S. Pande, S. Savary, A. Sparks, C. Valdivia, C. Vera Cruz and L. Willocquet. 2009. Anticipating and responding to biological complexity in the effects of climate change on agriculture. IOP Conference Series: Earth and Environmental Science 6: 372007. Available at http://www.iop.org/EJ/article/1755-1315/6/37/372007/ees9_6_372007.pdf</p> <p>Gilles, J. and C. Valdivia. 2009. Local forecast communication in the Altiplano. <i>Bulletin of the American Meteorological Society</i> 90(1): 85-91.</p> <p>Margosian, M.L., K.A. Garrett, and J.M.S. Hutchinson. 2009. Connectivity of the American agricultural landscape: Assessing the national risk of crop pest and disease spread. <i>BioScience</i> 59(2): 141–151.</p> <p>Ella, V.B., M.R. Reyes, and R. Yoder. 2008. Effect of hydraulic head and slope on water distribution uniformity of a low-cost drip irrigation system. <i>Applied Engineering in Agriculture</i> 25(3): <i>In press</i>.</p>

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	<p>Flora, C.B. 2008. Knowledge Networks for a Versatile Countryside. European Eemland Conference, Eemlandhoeve, Bunschoten, The Netherlands, 22 October 2008.</p> <p>Flora, C.B. 2008. Conservation Agriculture, Innovations Platforms and Community Capitals. Impact Assessment and Targeting Unit, CIMMYT, El Batan, Mexico, 25 February 2008.</p> <p>Seth, A., M. Rojas, S. Rauscher, J. Thibeault and M. Garcia. 2009. Projected Changes in the Annual Cycle of the South American Monsoon: Implications for Seasonal Extremes. American Association of Geographers Annual Meeting, Las Vegas, NV, 22-27 March 2009.</p> <p>Ella, V.B. 2009. A low-cost drip irrigation for small farms. Paper presented as seminar for the HORT 115 class, Department of Horticulture, Crop Science Cluster, College of Agriculture, University of the Philippines Los Banos, Audiovisuals Room, Agronomy Building, 5 March 2009.</p> <p>Ella, V.B. 2009. Potential applicability of the IDE drip irrigation system in vegetable-agroforestry systems. Paper presented at the SANREM Upscaling Conference, Bukidnon State University, Malaybalay, Bukidnon, 23 January 2009.</p> <p>Espaldon, M.V.O. 2009. Climate change and agriculture: Adaptations mitigation strategies. A paper presented in the BAR-DA. 26 February 2009.</p> <p>Espaldon, M.V.O. 2009. Knowledge system in climate change adaptation among upland farming communities in the Philippines. A paper presented on Climate Change in Ateneo de Manila University. 5 March 2009.</p> <p>Loi, N.K. et al. 2009. Application of SWAT for Nghia Trung sub-watershed in Bu Dang District, Binh Phuoc Province, Vietnam. Paper presented in First International SWAT Conference in Southeast Asia, Chiang Mai, Thailand. 7-8 January 2009.</p> <p>Catacutan, D. 2008. Linking knowledge with action: Typologies and dynamics of boundary organizations in RUPES-Asia and implications for PRESA. Powerpoint presentation during the Seminar at Center for International Development, Harvard University, Boston, Massachusetts, USA. 14 October 2008.</p> <p>Catacutan, D., D.T. Ha, C. Duque-Piñon, L.T. Loan. 2009. Linking knowledge with action: Meeting NRM challenges through SANREM. Powerpoint presentation during the Seminar at North Carolina Agricultural</p>

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	<p>Castelhano, Michael. Potato Diversity and Risk Management Among Tiraque, Bolivia Potato Producers. Sixth International IPM Symposium, Portland, Oregon, USA, March 2009.</p> <p>Amaya, N. Market access and gender roles Jatun Mayu watershed communities (Tiraque, Bolivia). Presentation at WID meeting at OIRED, Virginia Tech, Blacksburg, VA, 20 November 2008.</p> <p>Andrade, R. Medios de Vida de los Productores de Bolívar Ecuador: Metodología utilizada y sus implicaciones para el análisis de políticas económicas, Bolivar University, Bolívar, Guaranda, Ecuador, September 2008. (Spanish)</p> <p>Melnick, R. Enfermedades de cacao y control biológico con endófitas. March 2009. Presented at USAID/PROINPA Colloquium on Biological Control of Common Diseases. Cochabamba, Bolivia. (Spanish)</p> <p>Melnick, R. Ability of endophytic Bacillus spp. to activate plant defense genes of Theobroma cacao. March 2009. American Phytopathology Society Potomac Division Meeting. Gettysburg, PA.</p> <p>Melnick, R. Suppression of cacao diseases with native endophytic Bacillus spp. November 2008. World Cocoa Foundation Roundtable, Penn State University.</p> <p>Melnick, R. Studies on the suppression of cacao diseases with native endophytic Bacillus spp. September 2008. Penn State University Department of Plant Pathology, Departmental Seminar.</p> <p>Melnick, R. Endospore-forming bacterial endophytes of cacao: Ecology and biological control of witches' broom. July 2008. American Phytopathology Society Annual Meeting, Minneapolis, MN.</p> <p>Melnick, R. Biological control of cacao diseases using endophytic Bacillus spp. April 2008. USDA-ARS Sustainable Perennial Crops Lab, Beltsville, MD.</p> <p>Figuroa, M. 2008. Strategies to develop market access that contribute to resilience in the Bolivian Highlands: Two case studies for chuño and tunta. Master's thesis defense presented to the Graduate Thesis Committee, Department of Agricultural Economics, University of Missouri, Columbia, MO, 20 November 2008</p> <p>Rees, L. 2008. What is the impact of livelihood strategies on farmers' climate risk perceptions in the</p>

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