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GLOBAL LIVESTOCK CRSP

Global Livestock CRSP Annual Report 2001

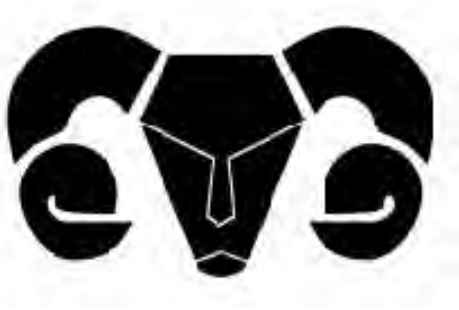

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TABLE OF CONTENTS

FOREWORD i

OVERVIEW iii

PROJECTS

EAST AFRICA

Early Warning System for Monitoring Livestock Nutrition and Health for Food Security of Humans in East Africa 1
Improving Pastoral Risk Management on East African Rangelands 30
Integrated Assessment of Pastoral - Wildlife Interactions in East Africa 61
Role of Animal Source Foods to Improve Diet Quality and Growth and Cognitive Development in East African Children 77

CENTRAL ASIA

Livestock Development and Rangeland Conservation Tools for Central Asia 91
Increased Lamb Production from Kazah Finewool Flocks 109

LATIN AMERICA

Community Planning for Sustainable Livestock-based Forested Ecosystems in Latin America 119

APPENDIX

Glossary 191

PREFACE

Each year, the Global Livestock Collaborative Research Support Program publishes an annual report in compliance with grant requirements. The 2001 Annual Report documents work completed during the fiscal year, October 2000 - September 2001. The principal investigators for each project submit reports on research conducted with GL-CRSP funding. Each report is the expression of the principal investigator with minor editing by the Management Entity. All individual reports give the name, address, telephone, fax number and email address of the principal investigator for that project. Inquiries are welcome.

Susan L. Johnson
Annual Report Coordinator

FOREWORD
9/11: LINKING NATIONAL SECURITY AND DEVELOPMENT ASSISTANCE

By Dr. Montague W. Demment
Director, Global Livestock CRSP

One can not comment on our year's activities without discussing the implications of the events of September 11 for the country's international perspective especially with regard to development assistance. While Americans as a people have benefited almost unconsciously from the economics of globalization, we now have suffered quite deliberately from the globalization of terrorism. The country is now focused internationally as it has not been since the collapse of the Soviet Union.

Let me state up front that in my discussion of these issues I am in no way attempting to justify or rationalize terrorist acts but wish to understand their causes as a means to make our world more secure and just. The first reactions and discussions that have permeated our lives over these months have been focused on direct action against Al Qaeda. However with time, more fundamental issues are being raised about the nature of US interactions with the developing world. Universities are seeing remarkable increases in enrollment in courses related to Islam and the Middle East. The press is scouring our institutions for scant capacity in expertise related to events of 9/11. In this short period Americans are beginning to realize how little they understand of that part of the world and how poorly connected we are to events in the region.

In the last decade as the world leader, the US has neglected its responsibility to uplift the poor. We have diminished or abandoned much of our positive foreign engagement that addresses the global issues of the poor. Our foreign assistance budget is small (35th among nations as a proportion of GDP, less than France in absolute terms, less than 0.25% of our overall federal budget). Foreign assistance was supported politically in the past as a means of staving off the Soviet influence but with the breakup there has been little political will for foreign affairs. Our attention span for development has been short and fragmented in a process that is long-term and integrated. In effect we have practiced the politics of disengagement. Nowhere is this more obvious than in Afghanistan. We backed the "freedom fighters" in Afghanistan against the Soviets and supported the Mujahideen with military training and weapons. When the Russians left we pulled out our support and disengaged from the situation. Disengagement has had its costs. The situation in Afghanistan is in part a result of a lack of positive foreign engagement on our part. America was not there to present an alternative view of the world for Afghanistan that might have assisted them to develop a stable, economical viable society.

I know people whose views are similar to those who caused this horror although I think none of them would carry out such acts. I believe they started life as human beings just like all of us but their lives became so desperate and convoluted that they think that we are the evil in the world. They think this because of distortions of reality but they believe these distortions in part because they have so little contact with the truth and in part because there

is some truth even in the distortions.

In the Middle East, perhaps understandably, the US has gone through cycles of engagement, sometimes intense support of the peace process, and withdrawal over the seemingly endless violence and despair. Yet we have failed to exert true leadership in the Middle East. A plan for US long-term involvement, sufficiently focused, intense and balanced, has never emerged. In hindsight the resources now committed to war would likely have brought development and peace to the region yet the situation continues unresolved, fomenting violence that fuels the distortions of our national values in the eyes of the region's Muslims.

The Israelis have always taken the hard line in the cycle of violence, and the situation is now as bad as it has been in 20 years. Violence alone is not the answer. The French after the 1986 terrorist bombings in Paris rooted out the guilty (primarily disaffected Islamic youths from Algerian resident in France) but the government also recognized the causes of the frustrations for this population and reached out to their community with a comprehensive series of social and political programs. The result is that the terror disappeared.

The US continues to be active internationally, not in a sufficiently intense way with long term goals appropriate for development, but in a reactionary way where we feed the starving or provide disaster assistance (not figuring out how to improve food systems in the first place or prevent disasters made more intense by poverty, poor land use or faulty construction) or police local conflicts that could at least be dampened by our leadership to defuse situations before they become violent (Rwanda and Somalia are a classic example of lack of leadership responsibility).

The terrorists are truly fighting a war in their eyes and we need to understand the conditions that give them their cause and remove them. I support intensive action to route out their networks and extinguish them individually. But at the same time we will never be safe from terrorism by only constructing shields, becoming less engaged and providing good counter intelligence. Moreover there are great prices to pay in personal freedom and the quality of life for America if we only have a defensive action.

America needs to attack the disease as well as the symptoms. We need to use our resources to create the foundations for broad based economic growth that nutures stable democratic societies and eliminates terrorism as the only avenue for action to achieve a reasonable standard of living. We must engage so we not only change the conditions but we also understand the national political, social and economic landscape well enough to be effective partners. Part of the failure of our intelligence has been that we are not sufficiently engaged in these areas to know what is happening.

So I am arguing that we can not in this globalized world just put up walls and enact a military solution. Terrorism in NYC is globalization's dark side coming back to bite us. The US should go out not only to punish, but to engage and provide a means for the poor to achieve the visions of our world that we think should be the fundamental principles of a world order. Development assistance is a principal means to that end.

THE GLOBAL LIVESTOCK CRSP

AN OVERVIEW

INTRODUCTION

The Global Livestock CRSP (formerly known as the Small Ruminant CRSP) has expanded its research to address important topics in the international livestock development sector. The program, comprised of seven broad-based interdisciplinary projects, focuses on human nutrition, economic growth, environment and policy linked by a global theme of agriculture at risk in a changing environment. The projects involve researchers from 13 US universities, 3 international agricultural research centers and 74 foreign institutions. The program is active in three regions of the world: East Africa, Central Asia and Latin America.

HISTORY

Established in 1978 as the Small Ruminant CRSP, the Global Livestock CRSP is one of eight CRSP programs developed under Title XII of the International Development and Food Assistance Act of 1975. The CRSP model, pioneered by the SR-CRSP, was built on the structural strengths of US land-grant universities and collaborative partnerships with international organizations. Four characteristics ensure the effectiveness of this model: 1) Collaboration with US land-grant universities; 2) International training; 3) Long-term scientific relationships; 4) Program cost-effectiveness.

REENGINEERED

In 1995, the CRSP began a major restructuring of the program in response to USAID's own reengineering efforts and the changing needs of the international development community. The process, a comprehensive planning and assessment procedure, was initiated with priority setting workshops in the three regions. As forums for client input, the workshops were intended to maximize the opportunity of regional professionals to present their views on the development issues confronting them. The problem models they developed established the scope for activities within the region. Assessment teams, selected in an initial competition, developed projects that addressed the top priorities within the regions. The problem model was the central component of the assessment process with each team charged with refining their problem model through in-field explorations. To ensure grass roots input, over 20 regional workshops involving 35 countries were conducted during the assessment period. The teams submitted final proposals for a competition to be

included in a proposal to USAID. The seven final projects are headed by University of California-Davis, University of California-Los Angeles, University of Wisconsin-Madison (2), Texas A&M University System, Utah State University, and Colorado State University. The process was designed to be problem driven and produced results oriented projects.

A Global Program

The GL-CRSP global program builds effectively on complementarities between projects in different regions. Centered on a theme of managing risk in our unpredictable world, the program is developing the capacity to predict risk so it can be better managed, improving the tools to cope with risk, and contributing to the mediation of risk. The GL-CRSP has chosen to work in ecosystems and regions where human populations and natural resources are most vulnerable and in most cases, where biodiversity is most valuable. The model of risk management is most highly developed in our East African program where the four complementary projects cover prediction, adaptation and management of risk.

Predict the Future

The project, *Early Warning System for Monitoring Nutrition and Livestock Health for Food Security of Humans in East Africa*, headed by Texas A&M University System (TAMUS), addresses risk by adapting already successful U.S. technologies to East Africa in order to increase the lead time on the forecast of drought and famine, and allow policy makers to visualize the impact of their interventions on food crises. The project combines predictive and spatial characterization technologies with the formation of a network of collection and measurement sites in East Africa. The data from these sites, in coordination with the Famine Early Warning System (FEWS) project, will allow 6-8 weeks of increased lead-time for drought forecasting.

Mitigating, Coping and Adapting to Perturbations and Change

The project, *Integrated Assessment of Pastoral -Wildlife Interactions in East Africa*, headed by Colorado State University (CSU), addresses the relationship between pastoralists and wildlife conservation in the context of the unpredictability of semi-arid environments. This project will adapt models already in use in U.S. national parks to assist policy makers at the national and local level to establish approaches that are compatible with both pastoral life and conservation of biodiversity. The project intends to identify, in an integrated manner, the tradeoffs of different management decisions on wildlife conservation, livestock production and pastoralist food security and health.

The project, *Improving Pastoral Risk Management on East African Rangelands*, headed by Utah State University (USU), uses four systems to cope with risk and destock livestock in semiarid ecosystems: resource tenure, closer links to markets, rural finance and public service delivery. These activities represent mechanisms to allow asset diversification, improved ability to interact with markets, increased investment in rural institutions and commerce, and better capacity to cope with

an unpredictable environment. The impact of these alternatives will likely reduce conflict, improve the economic conditions of pastoralist and their communities, provide higher productivity and stability to their livestock systems and greater protection for the biodiversity in their environments.

The project, *Role of Animal Source Foods to Improve Diet Quality and Growth and Cognitive Development in East African Children*, headed by the University of California-Los Angeles (UCLA), targets mechanisms to cope with malnutrition of rural populations, particularly children. The project is definitively testing the link between animal source foods (ASF) and cognitive and physical development in children. Additional project work, after testing, will consider the effectiveness of different interventions in delivering ASF into the diets of children.

The Global Livestock CRSP is also active in Central Asia and Latin America. The Central Asia program addresses a rapidly changing and unstable political and economic environment, where little effort has been made, particularly in rural areas, to "cushion" the effects of transition to a market economy. The Latin America program faces sustainability issues, with a growing population, more firmly entrenched poverty, and a rapidly diminishing resource base.

In Latin America, the project *Community Planning for Sustainable Livestock-based Forested Ecosystems in Latin America*, headed by the University of Wisconsin-Madison (UW), deals with the impact of increasing human population on the conversion of forest and the management of integrated livestock systems that protect and use the biodiversity of these ecosystems. The importance of water emanating from the mountain forest is central to the project, which is organized at the watershed level. The project uses a strong community based involvement to address how to develop productive, profitable and environmentally sustainable food systems in marginal environments for livestock production.

The project, *Integrated Tools for Livestock Development and Rangeland Conservation, in Central Asia*, headed by the University of California-Davis (UCD), emphasizes both adaptation and mitigation. This project will have significant global and local impacts in four main areas: atmospheric CO_2 sequestration, rangeland conservation, enhanced productivity and sustainability of livestock systems, and socio-economic aspects of livestock production.

Program Goal

The goal of the GL-CRSP is to increase food security and improve the quality of life of people in developing countries while bringing an international focus to the research, teaching and extension efforts of U.S. institutions. This goal is to be met through collaboration between U.S. land-grant institutions and national and regional institutions abroad that are active in livestock research and development.

Strategic Objectives

To achieve this goal, the following objectives have been identified:

- To strengthen the ability of institutions in developing countries to identify problems in livestock production and develop appropriate solutions.
- To increase employment and incomes among livestock producers and associated value-adding agribusinesses.
- To improve livestock production while monitoring the effects of production on the environment and exploring the integration of production systems with the rational use of natural resources, such as wildlife.
- To enhance the nutritional status of targeted populations through increased availability and utilization of animal source products.
- To provide support to decision-makers in developing policies that will promote livestock production, marketing, and processing of animal products; human nutrition and child physical and cognitive development; and natural resource conservation and management.
- To identify, study, and strengthen communication systems (including but not limited to extension) among livestock producers, businesses, researchers, and consumers.

Resources

Funds for the GL-CRSP are granted for a five-year period by the United States Agency for International Development. A minimum cost-sharing contribution of 25 percent from participating US institutions is required. The projects also receive substantial contributions from host country collaborators and leveraged funds.

STRUCTURE

The Global Livestock CRSP is administered as a grant to the University of California, Davis, which, as the *Management Entity*, administers subgrants to participating US institutions and maintains fiscal responsibility.

The GL-CRSP *Program Director* is responsible for program development, coordinating activities of the projects across and within regions, and oversees the daily operations of the GL-CRSP.

The *Program Administrative Council* provides input on the overall program goals, recommends strategies for programmatic development and advises and concurs on the program budget.

The *Technical Committee* provides intellectual exchange and input on programmatic planning for the CRSP to the Program Director and the Program Administrative Council.

The *External Evaluation Panel* provides objective evaluations of the CRSP programmatic process.

OVERSIGHT GROUPS

Global Bureau, United States Agency for International Development (USAID)
Board for International Food and Agricultural Development and Economic Cooperation (BIFADEC)
Strategic Partnership for Agricultural Research and Education (SPARE)

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James Scott, Assistant Director
Susan L. Johnson, Program Coordinator
Yolanda Reina-Guerra, Bookkeeper

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Central Asia

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Center for Sheep Selection and Genetics (CSSG)
Institue of Feed and Pasture
Institute of Ecology and Sustainable Development
Institute of Economics
Kazakh Scientific Research Technological Institute of Sheep Breeding
Ministry of Science - Academy of Science RK (MS ASRK)
National Federation of Private Farmers of Kazakstan
Research Technological Institute of Sheep Breeding

Uzbekistan
Academy of Science
Karakul Sheep Research Institute
Samarkand State University
Uzbek Livestock Research Institute
Uzbek Research Institute of Market Reforms
Uzbek Sericulture Research Insititute

Turkmenistan
Academy of Sciences
National Institute of Deserts, Flora and Fauna

Kyrgyzstan
Kyrgyz Research Institute of Animal Husbandry

East Africa

African Wildlife Foundation
Crisis Mitigation Office - ASARECA
FARM Africa

Ethiopia
Adami Tulu Agricultural Research Center
Ethiopian Agricultural Research Organization (EARO)
Holetta Research Center
Livestock Policy Analysis Program (LPAP)
Mekelle University
Oromia Agricultural Development Bureau
Oromia Cooperative Promotion Bureau
Norwegian Church Aid (NCA)
Save the Children USA
Southern Rangelands Development Unit (SORDU)
USAID Mission to Ethiopia
Volunteers in Overseas Cooperative Action (VOCA)

Tanzania
Livestock Production Research Institute (LPRI)
Ministry of Water and Livestock Development
Ngorongoro Conservation Area Authority
Selian Agricultural Research Institute, Tanzania
Sokoine University, Tanzania
Tanzania National Parks (TANAPA)
Tanzania Wildlife Reserach Institute (TAWIRI)
University Collgege of Lands and Architechtural Studies (UCLAS)
University of Dar es Salaam

Kenya

African Conservation Centre (ACC)
Arid Lands Resource Management Project (ALRMP)
ATGRCA (Amboseli Tsavo Group Ranch Conservation Association)
Drought Monitoring Centre
Egerton University
Kenya Agricultural Research Institute (KARI)
Kenya Department of Resources, Surveys & Remote Sensing
Kenya Wildlife Service (KWS)
Ministry of Agriculture and Rural Development
Ministry of Agriculture
Ministry of Education
Ministry of Health
Mpala Research Centre
National Dryland Farming Research Center
National Range Research Center
Regional Centre for Mapping and Resources for Development (RCMRD)
Semi Arid Rural Development Programme (SARDEP)
University of Nairobi

Uganda

Makerere University
Namulonge Agricultural and Animal Research Institute
Serere Animal and Agricultural Research Institute

LATIN AMERICA

Servicios Agro-Informaticos de Apoyo a la Planificacion para el Uso y Manejo de los Recursos Naturales (AGROSIG), Bolivia
Centro de Datos para la Conservacion (CDC), Ecuador
Centro Interdisciplinario de Estudios Comunitarios (CIEC), Bolivia
Centro de Estudios Regionales para el Desarrollo de Tarija (CER-DET), Bolivia
Fundacion Antisana (FUNAN), Ecuador
Heifer Project International, Ecuador
Instituto Manantlan de Ecologia y de la Conservacion de la Biodiversidad (IMECBIO), CUCSUR,Universidad de Guadalajara, Mexico
Comunidad de Estudios JAINA, Bolivia
Terranueva, Ecuador

INTERNATIONAL

Food and Agricultural Organization (Italy)
International Center for Agricultural Research in Dry Areas (ICARDA)
International Livestock Research Institute (ILRI)

United States

Colorado State University
Cornell University
South Dakota State University
Texas A&M University
University of California, Davis
University of California, Los Angeles
University of Colorado
University of Kentucky
University of Wisconsin - Madison
United States Department of Agriculture (USDA), ARS
Utah State University
Yale University

EARLY WARNING SYSTEM FOR MONITORING LIVESTOCK NUTRITION AND HEALTH FOR FOOD SECURITY OF HUMANS IN EAST AFRICA

NARRATIVE SUMMARY

The Livestock Early Warning System, currently under development, in East Africa involves linkage of several new technologies capable of predicting forage supply relative to long term productions and trends in future body condition of livestock using a network of carefully selected households reflecting a variety of effective environments across diverse landscapes of East Africa. GIS co-kriging and kriging techniques are used to extrapolate point-based model output to non-monitored areas. These tools include spatially coherent satellite-based weather data and NDVI greenness data, geospatial tools such as ArcGIS, GS+ and Almanac Characterization Tool (ACT), fecal profiling technology near infrared spectroscopy (NIRS) linked with a livestock nutritional model (NUTBAL PRO) and a point-based biophysical grazingland model using PHYGROW.

Spatial stratification of regions forms the sampling frame for defining "effective environments" or climatic clusters where sampling points are assigned throughout a given monitoring zone. Specification of actual monitoring points are targeted for maximum impact and representation of variations across the region. The focus is on accessible pastoral households, which share common climatic, edaphic and production system attributes distributed throughout a region. For each sampling point, dominant landscapes are assigned modal or typical plant community which would fill the "pixel" of the 8x8 km grids generated from METEOSAT satellite weather data and the AVHRR NDVI greenness data.

Once a sampling point has been defined (geo-referenced) and modal vegetation characterized, herd populations are estimated based on a survey of the household herd structure, movement/destock/restock rules and known livestock population densities in the grazing radius of the household. In zones with sufficient human resources within the network, fecal samples are collected monthly from these households, sent to a national NIRS fecal profiling lab to determine diet protein and digestible organic matter. Using the survey information and satellite weather data in conjunction with the diet quality data, projections can be made of changes in body condition in a spatial context. Advisories can also be provided to the livestock owners, as well working through community based organizations.

Critical to the process is automation of the modeling process of linking biophysical models with satellite monitoring weather systems in collaboration with FEWS NET, EROS and NOAA RFE satellite-based weather data. These automated products are found on the following web sites http://cnrit.tamu.edu/aflews and http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi where daily deviations, percentile ranking and estimates standing crop of available forage by major livestock species is computed every 10 days along with daily satellite weather and dekadal NDVI or greenness data, processed by Texas A&M University's Center for Natural Resource

Information Technology from NOAA and EROS, respectively.. The ASARECA Crisis Mitigation Office working with an IGAD sponsored consortium including the DMC, RCMRD, FEWS NET, UNEP and Kenya Met Services as well as the UN Office of Coordination for Humanitarian Affairs, channel LEWS advisories to key regional organizations, ministries, national EW agencies, and NGO. An emerging communication network is forming using Internet material delivered by WorldSpace satellite radio in collaboration with the Arid Lands Information Network via the African Learning Channel. These radios with a low-end laptop computer and printer are placed in key district offices, NGOs and community-based organizations (CBO). Assisting with the districts, NGO and CBO network in Northern Kenya is an emerging collaboration with PANOS Institute and Interlink Rural Information Services to deliver voice and oral report to pastoral communities.

RESEARCH

Problem Statement. The recurrent drought and famine, followed by floods are regular features that induce limitations within the natural environment in East Africa. The chances of drought occurring in parts of the Greater Horn have increased from a probability of one in six years to one in three years for areas affected. Repeated occurrences of drought and high variability in precipitation have reduced the ability of many smallholders, such as pastoralists, to maintain their assets or respond when conditions are good. The phenomenon reduces livestock productivity and threatens food security of pastoral communities in the regions. Other natural disasters, such as pest infestations and periodic flooding, destroy area-specific production levels. Migration, as a coping mechanism, can result in conflict/ethnic strife over available resources, such as grazingland and water. Crisis prevention involves the ability to project emerging conditions and execute actions to prepare for and mitigate, or resolve, crisis and conflict. Effective prevention requires monitoring and analytical capacity at the regional, national and local levels, as well as the ability and desire to respond to warning signs of all kinds. The current set of weather and remote sensing information generated by donor-based monitoring programs (e.g. NOAA RFE, NASA NDVI) offers information on locations of "initiating conditions" while the on-ground monitoring programs of markets, human conditions and animal herd situations reflect, mainly, a "post-effect" appraisal system. However, many of the problems besetting livestock (e.g., weight and body condition loss) have already occurred before the human eye can detect the response. Other human indicators are further down the food chain within the pastoral ecosystem and offer even more delayed post-effect monitoring of emerging crisis. Analysis of these factors supports arguments for a more quantitative early warning system in the region that effectively captures early indicators of emerging drought, especially as it affects livestock throughout the pastoral and mixed farming region of East Africa.

The emerging monitoring and analysis system, based on point-based biophysical modeling of emerging forage conditions from satellite based weather data and animal condition from NIRS fecal profiling technology, add a new dimension to the existing monitoring programs in East Africa. The ability to project responses, such as impending livestock condition mortality by kind and class of animal, losses in forage supply and decline in body condition or milk production allows more flexibility in decision making from the household level to the policy maker. A more timely movement/destock/restock strategy will allow pastoralists to maintain their assets through crisis. It will also aid in the assurance of greater ecosystem integrity

by allowing more rapid response after droughts have run their cycle.

The challenge is to demonstrate the usefulness of these technologies, in East Africa, while organizing a critical mass of personnel and institutions for information delivery system and mitigation of nutritional and forage supply crises among livestock and humans and the resultant social conflicts, in a manner that provides timely and high quality information on trends in the well-being of livestock. As the foundation to this process, is the use of the same suite of tools as routine monitoring and management advisory systems used by outreach organizations (e.g. NGO, CBO, Extension).

Approach. With respect to the LEWS project, warning signs refer to forage imbalance, and livestock nutritional well-being in a timely and appropriate manner. A number of nutritional crises among humans and their livestock and the resultant social conflicts can be mitigated if empirical relationships between weather, livestock feed resource base and animal performance and productivity are established. One of the most innovative methods, to date, involves the systems approach being taken in this LEWS project - a supplemental monitoring mechanism that can be readily incorporated with existing monitoring networks. The sustainability of the system requires relatively simple monitoring and decision support tools integrated in a low-maintenance computer automation system whose output is linked to relevant organizations at the international, national, district and local level.

The major goal, reflected in the project's approaches, is to mitigate nutritional and social crises for humans in pastoral areas who are dependent on livestock for the majority of their livelihood. The approaches to this goal involve the development of tools and institutional capacity to project impending crisis in livestock nutrition, in East Africa. These approaches are designed with the intent to quantify emerging negative trends and interject the information into current early warning systems in East Africa to allow more timely decision making and support decision making of early warning systems, donor organizations, NGO, and pastoral CBO under normal and abnormal conditions.

To establish empirical relationships between weather, vegetation and regrowth potentials, soil and climate dynamics and nutritional status and livestock productivity, tools for monitoring these components have been implemented. These same tools are also being used to establish an inventory of indicators for impending nutritional and livestock health crises. The tools include: (1) geospatial tools (ArcGIS, GS+, WinDISP, ACT to assist in the characterization of the selected zones and projection of response, (2) the Nutritional Management System (NIRS/NUTBAL PRO) for monitoring forage quality from feces of free-ranging ruminant livestock and (3) Phytomass Growth Model (PHYGROW) for monitoring grazingland herbage and crop production, respectively. A complete description of these tools can be viewed at:

http://cnrit.tamu.edu/lews.

Progress.

Core Program – Development of Advanced Monitoring Systems to Better Support Livestock Early Warning Systems for Pastoralists in East Africa

This past year has been spent finalizing our network of monitoring sites in our original six zones in Central Tanzania, Northern Tanzania, Southern Kenya, Central Kenya, Northern Kenya, Southwestern Uganda, and Southern Ethiopia as well as expanding into several new zones in the Afar region of northeast Ethiopia, the Mwanza region of Western Tanzania and the

Karamoja region of Northeast Uganda. We have struggled with stabilizing zonal coordinators given the pressures for simultaneous capacity building within LEWS, ministry transfers of personnel and attraction of better salaries to NGOs. We have been working diligently to increase the depth of personnel in the networks and stabilize the actual monitoring points to minimize time impact on our network personnel.

To allow a geostatistically correct analysis we must locate a minimum of 30 spatially stratified monitoring points in each zone. As of this writing, the status of each zone is as follows:

Central Tanzania - Zonal Coordinator, Angello Mwilawa, has established a robust network of extension and NGO's in his zone based out of Mpwapwa. There are 13 site monitors located across this site with all 30 points characterized on the ground and model stabilization/verification conducted on 24 of the points with the remaining six scheduled for completion in December, 2001.

Northern Tanzania – Zonal Coordinator, Margaret Kingamkono, has recently taken over this coordination of this zone. There has been a high turnover of personnel in this zone due to transfers and capacity building and limited access to range management specialist who could identify the plants to support the field sampling efforts. Therefore, we can only report at this stage that locations of the 30 points have been set, 12 of those sites have been sampled and the remaining 18 to be completed before January. We will have to also undergo model stabilization and site verification procedures after we received the results of the field sampling. Completion of the Northern Tanzania site will fill a spatial gap in our regional analysis, which will increase the predictive power of our current geostatistical model of the entire Intergovernmental Authority on Development (IGAD) region. LEWS is currently producing the regional pastoral lands outlook for the monthly IGAD Early Warning Bulletin.

Southern Kenya-Zonal Coordinator, Peter Wandera, has done a remarkable job of moving this zone forward and has resulted in many improvements in techniques and organization. Unfortunately he has been offered a position in Botswana to run a major research program there and we have lost his leadership in that zone. William Mnene, national coordinator and Jean Ndikumana, regional coordinator have several KARI staff identified to replace Dr. Wandera. The test of LEWS stability was proven in this zone, as there was no disruption of information flow and analysis in the zone down to the site level. Southern Kenya has the most advanced analysis of all our zones at this writing.

Northern Kenya - Zonal coordinator, Joseph Ndunga, has recently agreed to coordinator activities for the central and eastern part of this zone based out of Marsabit National Arid Lands Center of KARI. His zonal assistant is Mr. Aphaxarfd Ndathi. This zone was set up by Dr. Robert Kaitho, LEWS technical officer, Mr. Rapheal Marambii and Mr. Peter Kamau, professor of range management at Egerton University. Mr. Kamau is now pursuing his Ph.D. via LEWS funding through Egerton University. The northeastern sector of the zone is coordinated by Ms. Jane Sawe, lecturer in range management at Egerton University. Lake Turkana creates a logistical barrier making it difficult for coordination out of Marsabit and therefore Egerton University has taken responsibility for this zone. All 30 sites have been established and stabilized in the model with some site verification in key locations completed.

Laikipia Central Kenya Zone-This zone is a special high density area coordinated by LEWS staff located in the ASARECA Crisis Mitigation Office at ILRI but currently an integral part of the research project of graduate student, Ms. Zola Gibson in collaboration with the Mpala Research Center and the Laikipia

Wildlife Forum (a large group of private ranches, pastoral group ranches and pastoral communities in Laikipia district). As of this writing, all 30 sites have been characterized and submitted for model stabilization. Ms. Gibson is working with 12 Maasi group ranches via the Laikipia Wildlife Forum's community liaison officers to establish communication infrastructures in the region. Worldspace Satellite radios are being installed at the NGO offices of the Semi Arid Rural Development Program (SARDEP) offices in DolDol, the Mpala Research Center and on strategically located private ranches to allow a good flow of information from the LEWS automated computing environment to the community liaison officers.

Southwest-Central Uganda Zone-Zonal Coordinator Steven Byenkya has established 30 monitoring sites and set up the modeling runs with partial site verification. Mr. Byenkya was awarded a Ph.D. training program by DANIDA and is currently doing coursework at Texas A&M University. He will be returning to the zone in January 2002 and take up his responsibilities as zonal coordinator as he works no his Ph.D. program research. We have worked to build depth in personnel in this zone and it worked fine while Steven was TAMU this past 12 months.

Southern Ethiopia Zone-Zonal coordination for this zone was originally run out of the Adami Tulu site but with the Ph.D. training of Mr. Abule Ebro we had to recruit a new zonal coordinator, Mr. Bayessa Hatewu who is currently in the process of moving his office to Yabello, Ethiopia to run the zone. Mr. Hatewu is seconded by EARO to this site by our national coordinator, Dr. Zinash Seleshi, EARO director of livestock research. Given this disruption in leadership, we have spent a considerable amount of time capacity building for Mr. Hatewu to effectively use and apply the LEWS technology package, requiring two major site visits by LEWS personnel to get the process moving forward. Currently, there are 18 active sites set up and 12 more sites have been set up and sampled but the model stabilization is pending with anticipated completion in early December 2001. We will add 7 new sites to provide overlap of the PAIRMA project to help support the analysis for the joint PAIRMA-LEWS livestock market analysis component in GL-CRSP. We have commitment of Mr. Hatewu to get these sites characterized in the coming months.

Afar Northeastern Ethiopia Zone – Zonal coordinator, Dr. Kasasye with FARMAFRICA has established 30 points with the help of Mr. Hatewu and Dr. Abdi Jama. The sites have been sampled but must be resampled, as the techniques used did not adequately capture the sparse grass cover of the region. Dr. Jama recently returned from a site visit where the technique was improved and now we expect the characterization to be completed in January 2002. FARM AFRICA will be fully responsible for this site in terms of personnel and budget. EARO is providing technical assistance in characterizing the vegetation and soils of the 30 sites.

Western Tanzania Zone – Zonal coordinator, Mr. Suleiman Kaganda, has been supported solely by ASARECA CMO funds with technical training provided by LEWS. Mr. Kaganda recently established 30 locations for site monitoring and is awaiting assistance from the Northern LEWS and Central LEWS zonal teams in Tanzania in site sampling and training of his site monitors. We hope to have this new site operational in early 2002.

Karamoja Northeastern Uganda Zone - This zone is currently being organized by Uganda LEWS national coordinator, Dr. Cyprian Ebong in collaboration with ASARECA CMO and OAU-IBAR. Dr. Ebong is under negotiations with Lutheran World Federation to weave the LEWS monitoring system within

their network of assistance providers in high conflict zone. OAU-IBAR is also working with us to see if we can integrate our technology within their para-vet network being established in collaboration with the Lutheran World Federation. Dr. Sarah Ossiya, pastoral communication director for PANOS Institute, has committed her time to help us get this site set up as well. She was the original coordinator of this zone.

Eritrea Zone- This zone was originally planned in the LEWS network but due to the conflict between Eritrea and Ethiopia our contacts in Eritrea was lost. However, in recent months, Mr. Negusse Kadine reestablished contact with LEWS and requested the opportunity to establish a LEWS monitoring zone as part of his Ph.D. program. We recently were notified that the Netherlands Government will fund ($58,000) his Ph.D. program at Texas A&M University via the NUFFIC (Netherlands Organization for International Cooperation in Higher Education). Mr. Kadine has received basic training in use of the LEWS technology for setting up sites (GPS, sampling) but has no training in use of the models and geospatial tools. He will start work at TAMU in January 2002 and this will be part of his Ph.D. program.

The NIRS fecal profiling labs are stable in Ethiopia and Kenya and funding secured for the labs in Uganda and Tanzania. DANIDA funded the laboratory and training of personnel ($85,000). The NIRS equipment has been ordered and it is currently undergoing standardization with the NIRS spectrophotometer at GANLAB at Texas A&M University as well as loaded with the necessary calibration software. We were very fortunate that FAO approved our TCP grant ($185,000) for establishing a NIRS lab in Dar es Salaam and provide training to lab and field personnel in use of the NIRS/NUTBAL nutritional management system in Tanzania. The equipment is currently being ordered via FAO-Rome as of this writing. We have also acquired and readied the EARO NIRS machine to be transferred to Ethiopia in the coming months. We are currently arranging training of the EARO staff at Holetta via our lab personnel at ILRI that we originally set up at the start of this project. Copies of Memorandum of Understandings (MOU) with each ministry in Ethiopia, Kenya, Tanzania and Uganda are provided in the appendix of this document.

A preliminary training session was conducted in Naivasha by Mr. Doug Tolleson, GANLAB director at TAMU for the Naivasha lab personnel, and the designated trainees for Uganda and Tanzania. As of this writing, Ms. Rose Omaria and Mr. Charles Erobot from NARO in Uganda are undergoing training at GANLAB-TAMU along with Dr. Constantine Shayo from Tanzania's Ministry of Water Development and Livestock. They were funded by DANIDA and FAO-TCP funds, respectively. This 30-day training program focuses on lab management, use of NIRS spectrometers and associated ISI software as well as development of calibrations. Ms. Omaria is here as part of Ph.D. training program supported by DANIDA ($50,000) where she is learning how to use NIRS technology for pregnancy testing of livestock.

This past year has also been focused on building computing and communication capacity of ASARECA's Crisis Mitigation Office housed on ILRI campus and headed by Dr. Jean Ndikumana, coordinator ASARECA-AARNET and regional LEWS coordinator. We now have new high speed Windows 2000 computers with ArcGIS, ArcINFO, GS+ and PHYGROW installed in their offices as well as a high speed LINUX model server set up to do model runs to help them speed up the model stabilization process. Dr. Robert Kaitho was provided a 90-day training program at Texas A&M University in use of the models and geostatistical software. LEWS-TAMU sent Mr. Jay Angerer to Nairobi

to provide Dr. Katho and Mr. Rapheal Marambii additional training in use of the PHYGROW models and the geostatistical tools. During these training workshops Mr. Angerer also provided training to the zonal coordinators who did not received training at TAMU in the prior year's activities in use of the PHYGROW model. We established a fully automated mechanism for ASARECA CMO to acquire the household portal analysis that comes out every 10 days and distribute the information to the Arid Lands Information Network's container that goes out to the African Learning Channel.

Mr. Rapheal Marambii, information officer of ASARECA CMO has taken leadership in design and deployment of the WorldSpace Satellite radios linked to computers to receive an abbreviated LEWS reports to key ministries and NGO's in the region. We have deployed several systems to key locations in Kenya to test the system before full deployment. Tests were conducted at Kiboko and the Mpala Research Center to make sure that issues of battery life, download integrity and report capacity were worked out in a manner that required low maintenance. The system is comprised of a WorldSpace Radio ($58 US), a serial adaptor ($30 US) and a power source (battery $30 US) or electricity. The serial adaptor translates the analog signal comprising the LEWS html and WORD document into digital downloads from the Africa Learning Channel from the Afristar Satellite. The files are provided via 20 megabyte containers provided by our collaborating NGO, the Arid Lands Information Network. We originally wanted to have a unique LEWS container but the $10,000 annual bandwidth fee assessed by WorldSpace Foundation was beyond our budget and ALIN was a good collaborative institution with a viable network already in place throughout the region. LEWS is now a major component of the ALIN homepage that is downloaded in a 15-minute packet each day. It takes approximately 7-12 minutes to download our LEWS advisories embedded in the ALIN information that is downloaded as well.

Currently, LEWS is negotiating the placement of WorldSpace radios with serial adaptors ($90 US), inexpensive printers ($50 US) and low-end laptops ($600 USA) in key locations throughout the region. We are seeking funding to place at least 50 of these communication nodes ($40,000) throughout the region with a goal of 100 nodes with full implementation by the end of the project ($80,000). We have sufficient budgets this year to set up approximately 12 key nodes in ministries, zones and NGO's. The cost of the radios is not a major issue but the access to a computer is the key. The regional efforts to close the digital divide should offer opportunities to integrate these communication nodes with other funding sources in the region with help from our USAID partners (mission, REDSO).

Considerable efforts were expended this year in verification of the projections of the LEWS computational technology and the on-ground observations. Extensive testing was conducted in Southern Kenya. We found that our site monitors require additional training in use of photoguides to estimate standing crop of forage. However, our current methods of forage standing crops has resulting in standard errors of prediction approaching 300 kg/ha. We are finding that the establishment of movement rules need to be collected in a more careful manner than currently acquired with household interviews. Also, movement has been occurring when forage supply is not exhausted due to water or livestock remain on sites with exhausted forage due to proximity of riparian sites in river bottoms or trespass on privately held lands where forage is abundant. A new site monitoring and verification protocol has been jointly developed by our zonal coordinators which we feel will improve our model parameterization and tuning process next year.

The results of the pastoral coping mechanism survey were published in book form by ILRI press. We have published a proceedings paper on the field verification results in Southern Kenya to be presented at the special session on geostatistical applications in the annual meetings of the Society for Range Management, February 2002. We completed a book chapter entitled "Strategies for Monitoring Forage Production as an Indicator for Agricultural Drought" to be published in Agricultural Drought Monitoring Strategies in the World, Kluwer Academic Press. This chapter represents the best thinking in the world on our current strategies to deal with monitoring drought. We are currently assisting ASARECA COM in their regional study of "Pastoral Community Resource Mapping and Mitigation Strategies" by providing geospatial analysis of those data requiring analysis spatial processes associated with pastoral response to drought.

Institutionalization efforts of the LEWS technology package gained considerable momentum this year with focus on forming key strategic partnerships and ultimate targeting of institutional infrastructures that could carry on the LEWS concepts into the future. After intensive discussions with USAID REDSO staff (Diane Putman, Dan Evans and Calum McLean), it was suggested that we seek closer partnerships with the Drought Monitoring Center (DMC), the Regional Center for Mapping of Resources for Development (RCMRD) and eventually OAU-IBAR. Discussions were started in June 2001 with DMC, RCMRD and OAU-IBAR. Dr. Laban Ogallo, director of DMC proposed that we move forward on developing a letter of intent to pursue a MOU with DMC via their IGAD affiliation. This letter has been established and meetings held with Prof. Benson Mochoge, Director of IGAD's Agriculture and Environment Division who has encouraged a broader level of engagement with IGAD via DMC. A MOU was completed with Dr. Wilbur Ottichillo, Director General of RCMRD.

This series of discussions has resulted in appointment of LEWS technical officer, Dr. Robert Kaitho to the IGAD early warning newsletter steering committee and technical committee working with DMC, RCMRD, FEWS NET, UNEP and Kenya Met Center. The first IGAD early warning newsletter was produced for the month of October 2001. The LEWS technology package and output has been selected by IGAD to represent pastoral conditions in the IGAD region. GL-CRSP LEWS recently presented DMC a high end WINDOWS 2000 computer with advanced publishing software (Microsoft Office and Publisher) and geospatial software (ARCGIS, GS+). Training of DMC staff in use of the geospatial software is scheduled for February 2002. Preliminary training is being provided by Dr. Kaitho until more advanced geostatistical courses can be arranged by TAMU LEWS staff.

Recently, the UN Office for the Coordination of Humanitarian Affairs has requested that monthly analysis be provided for their Humanitarian Alert bulletin produced each month for all the UN organizations, donor organizations, NGOS, and key ministries in the region. Ms. Tracy Vaughan, Information officer and Mr. Fernando Larrauri, Head of Kenya office for UN-OCHA are our primary contacts.

Discussions with key ministry personnel has consistently emerged a mechanism to develop institutional infrastructure to acquire, interpret and report data generated by LEWS. We plan to place the WorldSpace radios and necessary equipment into key offices of the ministries responsible writing advisories to key policy makers until stable Internet connections can be established throughout the region. Administrators of pastoral early warning information analysis indicated that the WorldSpace radios placed on their desks would insure that a steady predictable flow of

quantitative information came to them in a manner that was accessible for on-demand request from other government entities. This requires that a computational capacity be developed in one or more regional organization which can manage information dissemination to key communication nodes. To meet these needs we are working on a plan with DMC and RCMRD to determine what institutional structures would be required to insure that the automation technology could be mirrored in these organizations along with the mass computing capacity of the Center of Natural Resource Information Technology at Texas A&M University (CNRIT). Given the low maintenance of the LEWS automation systems, it is possible to maintain a computing environment that is maintained by CNRIT system administrators and accessible via firewall access of our regional collaborators who have good Internet connections. We would then consider a mirrored computational system at DMC, RCMRD and perhaps ASARECA CMO. DMC would be responsible for preparation of the IGAD reports and basic climate related probability projections while RCMRD would be responsible for the geo-spatial analyses and LEWS site monitoring/ coordinator training. The triple redundancy allows depth of expertise in the region and stability of the analytical system, thereby significantly reducing the probability of loss of the capacity to produce reports and deliver those to key ministry people in the region and to NGO's desiring the information using the IGAD and UN OCHA. Our challenge is reaching pastoral communities with information on emerging trends as well. ALIN, PANOS Institute and Interlink Regional Information Services are three NGO's that appear to be emerging as a potential consortium to pursue radio and voice interpreted reports to pastoral communities using their networks in the region. Where possible other NGO networks are being pursued as well including SARDEP and ALRMP in Kenya, FARMAFRICA in Ethiopia and the Lutheran World Federation in Uganda. We are finding that NGO's express stronger interest in the LEWS system once they see the steady stream of quantitative information flow into their spheres of influence.

Module 1 – Application of Advanced Spatial Analyses to Extrapolate Point-Based Output from Biophysical Models to Better Server Regional Early Warning Systems

In the first phase of the GL-CRSP-LEWS project, we had to establish a viable network of scientists that could test and help organize the LEWS monitoring network. We then were able to test the viability of the technology and now ultimately establish actual monitoring sites and established an automated computational environment capable of providing biophysical assessments of emerging forage conditions and map those responses using kriging and co-kriging geostatistics. One of the major elements of LEWS is the cost-effective point based modeling coupled with co-krigging with NDVI data to estimate forage conditions in areas not directly monitored. This past year has been spent verifying the geospatial techniques and intensifying field research efforts to improve our ability to predict conditions of forage in areas where we do not run the models in our monitoring network.

Ms. Zola Gibson, a M.S. graduate student from TAMU, working with the Laikipia Wildlife Forum and the Mpala Research Center has established an intensive monitoring site designed to test the concept of density points needed to improve the prediction of forage conditions. She has completed her points and will be comparing forage predictions with all 30 points of her site verses a limited number of points coupled with the regional co-kriging of the other zonal sites to determine how much improvement we can

achieve in prediction forage conditions across large regions.

Jay Angerer, a Ph.D. graduate student and assistant research scientist, is working on new improved techniques using alternative imagery available for the region to test whether co-kriging predictions could be improved. With the relationship emerging with DMC in IGAD and RCMRD's relationship with FAO, we anticipate that this coming year will allow more access to the other satellite based products that could be used to improve our methodology.

We are realizing that mapping of changes in animal condition is going to require improved weather data acquisition and automation of the computations like we developed for PHYGROW linked to the NOAA RFE satellite weather data sites. Discussions with Mr. Tim Love at NOAA's unit responsible for delivering METEOSAT RFE weather data has resulted in access to new expanded weather products. NOAA is now allowing access to their 8x8 km relative humidity and wind data. When coupled with the minimum and maximum temperature data, we are well on our way to automating computation of animal weight loss on a spatial basis. The key now is to develop a strategy to get the geospatial assessment of forage quality either directly from fecal NIRS or by combining NIRS fecal profiling with model generated forage quality computations of crude protein and digestible organic matter to feed the NUTBAL PRO model.

Recently, Mr. Robert Ford USAID G/EGAD/AFS, Office of Agriculture and Food Security Office, determined that the LEWS geospatial approach should be part of the Geographic Information for Sustainable Development (GISD) program and showcased at the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa in September 2002. A total of $45,000 was provided to LEWS to augment our existing program and increase the robustness of our analysis to insure that we can showcase the full analytical capacity of LEWS at WSSD. The geospatial approach that is being tested with LEWS is emerging as one of the more innovative uses of GIS technology in the development community.

We successfully established a fully automated site to acquire and organize geospatial information on weather and NDVI. The weather data is accessible at http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi and the analytical part of the LEWS toolkit can be found at http://cnrit.tamu.edu/aflews. The AFLEWS site automatically updates itself every 10 days and provides detailed analysis of the current monitoring sites. We added the capacity of the PHYGROW model to stop computations at the end of the weather file, store all the intermediate calculations and then wait until the next 10-day NDVI data comes out and acquire the weather data that had accumulated and rerun the PHGYROW model for each site. These analysis do not require human intervention unless there are electrical or computer component problems. Currently, 153 simulations are run every 10 days with 300 sites planned for initiation in early January 2002, assuming the newly designated sites will be able to stabilize their networks.

We are currently working on automation of the mapping process. The GSTATS library of geo-statistical algorithms is being tested along with alternative techniques linked to GS+ or ARCGIS software. Use of an open source code is more desirable for LEWS to allow introduction of the technology with minimal overhead to adopting agencies.

Finally, the 3.0 version of the ACT software was delivered to all our zonal teams and training provided by John Corbett. Unfortunately, Dr. Corbett has gone to work for a Swiss crop insurance company but has assured LEWS team members that they have full access to the ACT 3.0 software and future updates made to the software from USAID funding. We are

anticipating that much of the regional spatial analysis will be absorbed by RCMRD in the future.

Module 2 – Development of mitigation strategies to reduce impact of drought on livestock in pastoral regions of East Africa

LEWS has made commitments to address mitigation issues by investing in graduate student research programs in the region. DANIDA funded a Ph.D. program Texas A&M University for Steven Byenkya in Uganda where he will be modeling the effects of bush encroachment and replacement of better grasses by low quality Cymbopogon on capacity of pastoralists in the Ankole cattle corridor to respond to fluctuations in forage production. Currently Steven Byenkya is completing course work at TEXAS A&M University and will return to Uganda for his field work in January 2002.

An additional study funded by the European Union and partially support by LEWS funds, was focused on development of adapted germplasm and seeding preparation techniques to restore ecological function of Maasi pastoral reserve lands in Southern Kenya. Mr. William Mnene is our national coordinator and pursuing his Ph.D. through University of Nairobi. He has completed all field work and is currently working at ILRI to conduct genetic profiling on native plant species from different ecological sites.

Mitigation research is also being pursued in collaboration with ASARECA CMO via EU and USAID funds. LEWS is providing on ground network of survey enumerators and TAMU LEWS is providing geospatial analysis of the survey data. Much of the tabular data has been compiled by ASARECA CMO but it is in need of spatial analysis as well.

Module 3 – Enhanced Effectiveness of NIRS Fecal Profiling Monitoring Technology to Improve Livestock Management in East Africa Pastoral Region

One of the major breakthroughs this year has been the development by Egerton University in Kenya and successful testing by KARI scientist of a fecal solar drier that is capable of drying feces quickly and not significantly affecting our NIRS analysis of the feces. This allows us to eliminate the need for cool boxes, ice packs and reoccurring expendables to collect the feces. Using a paired t-test and two seasons of testing, mean crude protein was 9.81% and 9.74% for normal oven dried species and solar dried feces with no significant differences ($P=0.74$). Digestible organic matter was 60.07% for oven dried samples and 59.67% for the corresponding solar dried samples. Again, there was no significant difference in values reported ($P=0.22$). The Naivasha LEWS NIRS lab conducted the fecal analysis.

As in the case of Module 2, LEWS is supporting research of several graduate students in the region to address issues of improved NIRS fecal profiling technology. Ms. Rose Omaria is funded by DANIDA to pursue her Ph.D.program at Mekerere University in Uganda while LEWS funded the research and NIRS training component. Ms. Omaria is developing NIRS technology to conduct pregnancy testing in cattle, sheep and goats. She is currently here at TAMU for a 30-day training program in development of discreet and continuous spectral analysis with NIRS technology. She returns in December 2001 to initiate animal trials.

Mr. Peter Kamau is pursuing his Ph.D. program at Egerton University to improve the goat NIRS equation and expand the sheep NIRS equations to predict diet crude protein and digestible organic matter. He has developed his proposal and fed 30 diet fecal pairs, requiring

an additional 70 pairs before developing a new improved equation to be tested in 10 pastoral households in Northern Kenya under field conditions using the new NUTBAL PRO metric version of the nutritional management software. Feeding trials are scheduled for completion in January 2002.

We have been working with Alemaya University in Ethiopia to identify a MS student to conduct research on NIRS fecal profiling for donkeys and camels but given the sequence of classes and availability of students we have only been able to assemble a group of students to select among for this project. University officials recently met with Dr. Jama, LEWS TAMU, to assure him that a student will be selected in the coming month. If this is not done, we have plans to transfer the work to Egerton University in collaboration with the Mpala Research Center.

As mentioned earlier, we have completed a new metric version of NUTBAL PRO that has multi-language capacity. The software has been deployed to all zonal coordinators and training provided. Our teams have requested that additional workshops be conducted for key site monitors to allow them to decentralize analysis. The FAO TCP funds acquired for the NIRS lab in Tanzania has a significant training component for such activities in Tanzania.

Module 4 – Developing Capacity of NAR Scientists to Conduct Spatial and Biophysical Modeling Analyses for Sustainable Scientific Support of the Livestock Early Warning Systems in East Africa

As stated earlier Dr. Robert Kaitho was given a 90-day training session at Texas A&M University in use of the PHYGROW model, ARCGIS, and GS++ as well as trouble shooting of the LINUX modeling environment. Dr. Kaitho plays a pivotal role in the region as primary technical officer for LEWS based in Nairobi but working in all the LEWS countries as a technical advisor and liaison to the collaborating agencies, NGOs and donor organizations. We also provided 2-10 day workshops in Nairobi for all the zonal coordinators in LEWS with an intensive 3-day training in geostatistics for Dr. Kaitho and Mr. Rapheal Marambii.

Special training needs were analyzed in September for the upcoming year to target key personnel in DMC and RCMRD for intensive training as well.

Module 5 – Pastoral Livestock Marketing in Northern Kenya and Southern Ethiopia: Identification of Priority Interventions to Promote More Timely Livestock Sales in Relation to Stress Periods

This module was not originally funded under the guise of the LEWS annual workplan but later Dr. Demment provided an opportunity for LEWS and GL-CRSP PAIRMA to jointly develop a module in each program to jointly address livestock marketing issues in the Southern Ethiopia and Northern Kenya region of East Africa. To date, we have prepared a proposal and initiated the ground surveys as well as assemble some of the geospatial data collected by PAIRMA. Agreements have been reached with ALRMP and ASARECA CMO to acquire all the spatial marketing data and support information.

LEWS will be responsible for assembling of spatial data and conduct of spatial modeling linked with a bioeconomic model using the LEWS modeling environment linked to an economic complementary modeling technique to track the pastoral move/sell/buy decision matrix relative to changes in market, forage, water and conflict conditions. Dr. Jeff Vitale, Ag. economist with our SANREM CRSP team at TAMU has agreed to provide one month of his time each year to work with Chris Barrett

on the economic analysis. Mr. Laban Macopiyo has been recruited for a Ph.D. program at TAMU to conduct the GIS geospatial analysis component of the research beginning January 2002. Mr. Macopiyo is a Kenyan working for the GIS unit at ICIPE in Nairobi.

The ultimate goal of the LEWS contribution will be an analytical framework to explore various intervention policies for improved marketing of livestock from pastoral lands. The PAIRMA group will have the primary responsibilities of assembling the socio and decision making processes to test the six hypotheses proposed in the proposal in the pastoral communities. LEWS is in the process of expanding its monitoring sites to better overlap with the region and acquiring necessary imagery data to support the analysis.

To date through a series of conference calls a clearer picture of actual techniques to be used in the analysis have emerged. Dr. Vitale made a 10-day site visit to the region to get a better feel for the situation as he has done most of his research in West Africa. Dr. Stuth has been to Nairobi recently to firm up the commitments of ASARECA, EARO, ILRI, RCMRD and ALRMP to acquire the large amount of livestock marketing data and study findings for the region. Plans are for Mr. Macopiyo to remain in Kenya for 5 months to assemble all the spatial data on markets, migration routes, trader routes, holding grounds, quarantine areas, disease risk areas, water sources, conflict zones, roads, transport refueling, border transit points, etc.

GENDER

There are two categories of women that are impacted by the LEWS project. The United States and in-country women team scientists and in-country women within the targeted pastoral communities. This past year we had one female research scientist, two female graduate students and one female systems analyst working in the LEWS project in the USA. Currently, there are seven in-country women team scientists involved in the LEWS program. Two of the female scientists are the country coordinator for LEWS in Ethiopia and Tanzania. Two of the women are zone coordinators and the other two women are site managers. The following are their specific responsibilities, by country.

United States

Recently, a female M.S. graduate student, Ms. Zola Gibson joined the project in August, 2000 and will be working on establishment of an NGO based LEWS on the Mpala Research Centre (http://www.nasm.edu/ceps/mpala) in Central Kenya. She will establish the Mpala research center as a node in the Livestock Early Warning System focusing on assessment of the monitoring technology and potential validation. She would focus essentially on setting up a prototype EWS for Mpala Ranch. She is currently based in Mpala working with both the ranch and the surrounding farmers and pastoral communities. She is making good process in realizing that objective and is expected to return to the United States in May 2002 to write up her work.

Mrs. Kristen Zander, a systems analyst, has been in the forefront on the efforts on the development of the decision-support software, Nutritional Balance Analyzer (NUTBAL-PRO), and its integration with fecal profiling technology using near infrared spectroscopy (NIRS). Kristen updated the DOS-based version employing many new biological concepts and screen interface functions. A multi-language version of the software is also in development to include Spanish and French.

Ethiopia

Dr. Zinash Sileshi, Animal Scientist, is the in-country coordinator. Dr. Sileshi has been a member of our LEWS team in Ethiopia since the beginning of the project but was promoted

to a National Coordinator in 1998. She was also the Director of Livestock Research for the Ethiopia Ethiopian Agricultural Research Organization (EARO).

Tanzania

Ms. Stella Bitende has assumed the role of National Coordinator of LEWS in Tanzania after moving to Dar es Salaam as Assistant Director - Livestock Research, Ministry of Agriculture & Co-operatives, Division of Research & Development. In the current ministerial reshuffle, livestock has been included in the Ministry for Water and Livestock Development headed by Hon. Edward Lowassa. The Assistant Director's position is intended to provide a focal point for consultation on technical and operational details of the relevant commodity and research for the sub-program. Ms. Bitende in her capacity as a Lead Scientist represents the livestock program on collaboration issues with external partners in research and development as the need arises. Margaret Kingamkono, an Animal Scientist at the Selian Agricultural Research Institute, Arusha, has re-joined the LEWS as the zonal coordinator for the Northern Zone.

Uganda

Dr. Sarah Ossiya has completed the remaining tasks for the final report of the Coping Mechanism survey jointly conducted by ASARECA and LEWS. The final report was published by ILRI. Dr. Ossiya was leading the efforts to set up a LEWS monitoring zone in North Eastern Uganda, which was delayed by the intensified conflict between the Karamojong and Iteso tribes in the area. Recently, Dr. Ossiya left the National Agricultural Research Organization of Uganda to take a position at the PANOS as a Coordinator of Pastoralist Communication Program, which will cover eight Eastern Africa countries. Dr. Ossiya will be based in PANOS regional office at Uganda. Dr. Ossiya will continue to work with LEWS as a collaborator since her main mandate is to highlight pastoral issues so that they can be reflected on public agenda targeting both the communities, through radio programs and other media, and the policy makers through advocacy and sensitization.

Grace Ebyau is a Site Assistant/Technician in Uganda. She has been a member of the LEWS team from its beginning, collecting and processing a major portion of the original samples and data.

Dr. Emily Twinamasiko is LEWS team member in Uganda. She was recently named as the center manager for the Agricultural Research and Development Center at Mbarara. The center covers most of the LEWS monitoring sites in the South Western districts of Uganda. She is currently at Reading University in U.K. wrapping up her Ph.D. studies. Dr. Twinamasiko will continue to be an integral member of the national coordination team in Uganda as she had been since the inception of the project when she returns.

Recently, DANIDA funded a Ph.D. program at Makerere University for Ms. Rose Omaria who is a researcher at the National Agricultural Research Organization in Uganda. Ms. Omaria will be provided intensive training funds by LEWS to come to TAMU to learn how to use the NIRS technology to develop pregnancy-testing calibrations for cattle and goats. Recent breakthroughs in pregnancy testing with NIRS at GANLab makes this a very important training event. Ms. Omaria has had preliminary training by Doug Tolleson when he set up the Naivasha NIRS lab in Kenya this year.

Two female technicians at Namulonge Agricultural and Animal Production Research Institute (NAARI) have been active on the project. They are: Ms. Agnes Namagembe and Ms. Clementine Namazzi. They have participated in vegetation characterization, training of field staff, fecal sample collection and

processing. Three of the nine weather stations monitors are women.

Kenya

Mrs. Jane Sawe, a lecturer at the Department of Animal Science, Egerton University, has joined the LEWS zonal team in Northern Kenya. She is the coordinator of the LEWS Northwest monitoring zone in Kenya.

Pastoralist Women

All of our Zonal and Country Coordinators have been advised to be gender sensitive in employment for the project activities and in planning training and technology development for livestock production. This was done in recognition of the important role that women play as livestock resource managers within pastoral societies.Accordingly, the LEWS program addresses itself to various types of livestock and spatial/temporal availability of feed. Within many pastoral societies, livestock ownership and management are typically specific, with women owning/gaining income from small types of livestock and men controlling the larger ones. Engendering LEWS efforts facilitates the integration of socioeconomic concerns such as division of labor and equitable access to resources.

In addition, many of the site monitors selected for monitoring in the pastoral areas are women. Extensive efforts have been made to identify households headed by women for selection into our monitoring route programs in all of the host countries. Three of the 15 households in SW Uganda are headed by women. However, women are known to be key players in livestock management and husbandry in East Africa even in the households headed by men.

POLICY

Processes of Institutionalization of LEWS in East Africa

Based on early feedback from the ME, PAC and EEP of the Global Livestock CRSP, the LEWS teams were challenged to design institutionalization plans for the coming years of the next funding cycle. These plans are summarized below by country:

Kenya. In Kenya there is an extensive planning program under way to reorganize information flow from different EWS organizations in Kenya under a single, self-reliant unit called the "Early Warning and Food Information System Unit (EW&FISU) in the Ministry of Agriculture and Rural Development. The MoARD has submitted a TCP to FAO to help this process to go forward. LEWS representatives including the PI of the LEWS project have met with Mr. James Oduor, coordinator in MoARD to discuss how best LEWS could be institutionalized in the reorganization process. The Arid Lands Resource Management project (ALRMP) is being viewed by MoARD as a good working model to integrate LEWS technology in the EW&FISU framework. Recent meetings with Ministry personnel in Kenya has identified key communications nodes in the livestock division and range management division as key points of entry to directly impact decision making along with ALRMP and the new emerging EW&FISU unit.

Uganda. NARO has been identified as a focal point for LEWS because of its comparative advantage. NARO is under the Ministry of Agriculture, which is responsible for early warning. The stability of leadership in NARO is seen to lend stability to the needs for institutionalization in Uganda. An EWS unit

is being established in NARO this year to remedy the high turn over in the Ministry of Agriculture. LEWS will be focusing training and infrastructure development in this unit.

LEWS country coordinator has been in close contact with various national and regional institutions and Non-Governmental Organization involved in early warning systems to develop a national institutional mechanism to integrate LEWS within existing framework for disaster management in Uganda. The LEWS team is planning to hold a workshop in October to gather all the concerned institutions to form a National Forum on Early Warning Issues to be located in the newly formed Department of Disaster Preparedness in the Office of the Prime Minister of Uganda. LEWS is expected to be the lead institutions in these efforts. Institutions expected to attend the workshop include the following:

- Department of Meteorology
- Uganda Land Management Project (ULAMP)
- Famine Early Warning Network
- UN Coordination for Humanitarian Assistance (UNCHA)
- Ministry of Agriculture, Animal Industry, and Fisheries
- World Food Program
- Representatives of various Non-Governmental Organizations
- Members of the National Forum for Desertification.
- National Action Plan (NAP) for drought and desertification.

Ethiopia. Continued dialogue with the national Early Warning Systems and Relief agencies has been maintained with the expectation that the technology and training will move forward once the system is functional and EARO has been set up with a functioning NIRS fecal profiling lab.

An automated system on forage production report for Southern Ethiopia is about to be completed. This automated computer environment captures geo-referenced weather data to drive pre-parameterized soil and plant communities along with livestock stocking rates and decision rules to generate and update forage production simulation both text and graphs. The information can be accessed through the Web and via strategically located WorldSpace Radios.

An Ethiopian Network on Food Security was initiated by USAID's Famine Early Warning System Network (FEWS Net) and the European Union's Local Food Security Unit (LFSU) to coordinate and disseminate early warning and food security information. The Ethiopia Network on Food Security publishes a Monthly Report on Food Security Update in the country. The main contributors are the members of the National Early Warning Working Group, which consists of the following institutions:

- The Disaster Preparedness and Prevention Committee (DPPC),
- Ethiopian Grain Trade Enterprise (EGTE), LFSU,
- National Meteorological Service Agency (NMSA),
- Save the Children (UK),
- Canadian International Development Agency (CIDA),
- World Food Program Vulnerability and Mapping Unit (WFP/VAM),
- UN Agencies, and USAID's FEWS Net.

The Disaster Prevention and Preparedness Commission (DPPC) of Ethiopia also produces the "Ethiopian Early Warning System Monthly Report". This covers agro-climatic information, price analysis, human health and nutrition and update on emergencies.

LEWS team has had initial contacts with the above mentioned institutions including the

information generated by LEWS on forage productions estimates and surface maps for the pastoral regions of Ethiopia into their reports. . It was noted that quantified information on forage production in pastoral regions would be invaluable to these reports. The LEWS Team is currently working on formalizing membership in both the Ethiopian Food Security Network and the National Early Warning Working group.

Moreover, LEWS is trying to institutionalize the technology in the national system and assist in capacity building with regard to Livestock Early Warning Systems in pastoral regions.

Tanzania. There was a reshuffle in the government ministries in Tanzania. The livestock department in the country is no longer under the Ministry of Agriculture. It is now under a new ministry called the Ministry of Water and Livestock Development. The Ministry of Agriculture and Food Security has an established crop monitoring and livestock disease-monitoring program. The livestock component now in the Ministry of Water and Livestock Development is linked with OAU-IBAR. We are targeting the LEWS technology suite to link with the OAU-IBAR. The national coordinator of LEWS, Ms Stella Bitende is heading up discussions with all the relevant ministries and OAU-IBAR representatives in the country.

The National Coordinator organized a LEWS sensitization workshop in Dar Es Salaam in August, 2001 to discuss issues related to institutionalization, dissemination of information generated by the project, capacity building, and sustainability of the LEWS project in Tanzania. The institutions invited into the workshop included:

- Ministry of Water and Livestock Development
- Selian Agricultural Research Institute, Arusha
- Animal Disease Research Institute
- Ministry of Agriculture and Food Security Livestock Production Research Institute

ASARECA Crisis Mitigation Office

As stated earlier, transfers of personnel, loss of personnel and reorganization of Ministries has created a fluid environmental for institutional integration of LEWS. That is the reason we are still focusing on a multiple scale delivery system. We still see ASARECA CMO as one of the key institutions for stability and infusion of the LEWS technology into East Africa. Recent funding by EU is making it possible for ASARECA to support CMO on a more sustained basis, limiting the reliance of the office on ILRI assistance. ASARECA has a strategic plan that focuses on early warning systems and we see the tight integration with ASARECA on this issue as a major stabilizing factor for the technology.

LEWS has invested and will continue to invest in capacity building of ASARECA CMO personnel, particularly with skills of their information officer, Mr. Rapheal Marambii. As noted previously LEWS has provided computers, software and training in advanced modeling concepts and geospatial analysis this past year. Much of this is on site training provide by LEWS TAMU personnel.

The goals of ASARECA CMO Information System are:

1. To facilitate data and information flow between the LEWS teams in East Africa (NARS and universities), ASARECA-CMO and TAMU
2. To facilitate data and information flow between the national and international institutions involved in early warning regarding weather, agriculture, and livestock.
3. To facilitate the dissemination of livestock

early warning alerts from the LEWS project to pastoral communities, local government leaders and national policy makers in East Africa.

Forming Linkages with other Regional Organizations.

Strong collaborative partnerships have been formed with Drought Monitoring Center, the Regional Center for Mapping of Resources for Development, FEWS NET, UNEP, and Kenya Meteorological Service. DMC and RCMRD are being targeted as recipients of the LEWS analytical system that will mirror the existing automated system at CNRIT in TAMU-LEWS. Agreements have been made to do upgrades of their computing and geo-spatial software as well as train key staff. They will then support information flow to our other collaborative organizations at the ministry, NGO and community levels. By placing the advanced technology in these institutions we will have a lower costs of infusion of technology and still have high impact with information flows into the key ministries of each of the IGAD countries and Tanzania. Both DMC and RCMRD can operation within and outside of IGAD.

Outreach

LEWS is faced with a multi-scale information delivery system that addresses the needs of regional organizations such as IGAD, DMC, RCMRD, FEWS NET, UNEP, UN-OCHA and OAUIBAR but at the same time infuse information at the national early warning agency level by addressing country-level decision makers. At the sub-national level, we find ourselves targeting NGO's and district level officers in key pastoral regions. To deliver information at the pastoral community level, we see targeting community-based organizations that liaison directly with pastoral communities.

The regional organizations will be instrumental in moving information into the ministries and to some degree certain NGOs. However, we feel it is going to take a concerted effort with such organizations as ALIN, PANOS Institute and IRIS to devise effective outreach instruments for CBOs operating in pastoral communities. We have come to agreement with ALIN, PANOS and IRIS to identify a target region in Northern Kenya to experiment with different methods of information infusion into these rugged pastoral regions. As other sites come on line and the LEWS teams begin to mature working relationships with NGOs and CBOs in their respective zones, LEWS will move the needed technology into those zones. It is our hope RCMRD could take the lead in the future to add new sites and press the agenda LEWS technical capacity with the help of the ASAREC CMO.

Developmental Impact

Agricultural Sustainability. Timely decision making by livestock owners concerning availability of forage supply, movement, destocking and restocking of livestock will be valuable for sustainable livestock production in East Africa. The indigenous knowledge of the pastoral societies regarding range and livestock will be much more effective if they can have access to near real-time information on impending forage shortages for livestock and location of forage supplies that minimize conflict during periods of restrictive conditions. A combination of the indigenous knowledge and modern science can be used by decision makers to formulate clear mitigation strategies to reduce risk from weather extremes. Recent technology breakthroughs in computer modeling, weather monitoring, animal nutrition profiling and communication infrastructures offer an unprecedented opportunity in accurately assessing impacts of emerging weather events on

forage supply for livestock and wildlife and their ability to acquire nutrients to sustain themselves.

Some environmental impact will be realized in the decrease of land degradation by notifying pastoralists of the changes (decreased nutrient composition) occurring to the range 6-8 weeks earlier than the current information provides; thereby, leading to the rotating (migrating) off the affected range before an irreversibly detrimental trend intensifies.

Contributions to U.S. Agriculture. The establishment of improved NIRS predictions of diet quality of livestock will have significant impact on the quality of predictions provided to ranchers throughout the USA via the national service lab at the Grazingland Animal Nutrition Lab, at Texas A&M University. Currently, this lab provides nutritional advisories to over 2000 ranchers throughout the USA via the NIRS/NUTBAL nutritional management system. The linking of the incoming weather data on a near-real time basis for both the PHYGROW models has laid the foundation for the regional drought and stocking advisory systems recently approved for the Texas Agricultural Experiment Station and funding by USDA NRCS to start a pilot site in Texas.

The technologies assembled and used in this project will be directly transferable to USA grazinglands. The new emerging Grazing Lands Conservation Initiative (GLCI) will be a direct beneficiary since the technology can be directly adopted by NRCS for application nationwide. This should reduce drought and market induced risk to USA livestock producers and improve production efficiencies, all objectives of the new Farm Bill and the Funds for Rural America program. Currently, we are assisting Agrilogic (agricultural insurance analysis company) with the national feasibility study of forage insurance for the ranching industry. Rancher listening sessions have been conducted in 9 regional meetings with the clear consensus that if forage insurance policies could be written and the LEWS technology used as the quantitative, unbiased trigger mechanism for issuing payments for forage short falls, the industry would support such a system for the USA. A similar approach is being discussed by World Bank for drought insurance feasibility study in Ethiopia. We are making inquiries as to the feasibility to link our work in Ethiopia with this study.

A national white paper on the role of the LEWS technology was submitted to USDA-NRCS that may result in formation of a national grazinglands education center where this technology is an integral part of the program and eventually deployed nationwide within the agency if it survives the US farm bill.

Furthermore, stable livestock industries and societies in East Africa are both a direct and indirect benefit to the USA in terms of direct aid costs and costs of political instability. This project is expected to provide US policy organizations with more timely information to allow a more precisely measured response to developing conditions. With the climate of the fight against terrorism, studies such as LEWS that attempt to improve the livelihood of pastoralists in East Africa help diffuse potential social conditions that lead to formation of terrorist cells in collaborating countries.

Contributions to Host Country. The contributions to the East African nations involved in the LEWS project include the ability to foresee and prevent, prepare for and mitigate or resolve crisis and conflict in a more timely manner. The current set of monitoring programs offers information of initiating conditions (e.g., weather and remote sensing information) and a delayed post-effect (e.g., cattle weight and body condition loss) appraisal system. The innovative LEWS state-of-the-art contribution, based on NIRS livestock fecal profiling technology and spatially referenced

modeling of emerging forage/crop conditions, will add a new dimension to the existing monitoring programs in East Africa. The LEWS addition to the current monitoring programs allows more flexibility in decision making from the household level to the policy maker by providing the ability to predict responses, such as impending livestock mortality by kind and class of animal and losses in forage supply and decline in milk production. Thus, more timely destocking strategies will allow pastoralists to maintain their assets through crisis and assure greater ecosystem integrity to respond more rapidly after droughts run their cycle.

Also, during this third year, the LEWS project has focused on the formation of human capital through a network of scientists and organizations across the East Africa region, which is founded on a common purpose and protocol to establish an advanced livestock early warning system that is regionally cohesive. The project has organized various training workshops for the LEWS teams in East Africa to use the various technical modeling tools. Two issues that have become apparent in the interactions and exchanges of views between the teams during these gatherings are:

a) Improved collaborative approach and regional outlook on livestock issues among LEWS host countries. An awareness that most of the problems related to livestock production and development are cross-border problems and

b) Improved shared understanding and recognition of the importance of livestock in early warning systems. As is evident from the national agricultural early warning systems currently in place, the livestock sector in all of the host countries is either ignored or marginally covered. The policy makers of various livestock ministries in East Africa have intimated to the project that they are looking up to the LEWS project to remedy this situation. There seems to be an improved collaborative approach and shared understanding of their livestock systems.

The national scientists participating in the project were given training in the use of the various biophysical models and the spatial analysis tools employed for this project. The goal is to enable the national institutions and their staff to become proficient in the use and application of these tools. Other educational and technical contributions include: graduate training for some of the national scientist and technicians trained to use the instrumentation and various workshops designed to establish monitoring routes and protocols. Other equipment (e.g., GPS units, computers, software, etc.) has been provided to the in-country team leaders and zone coordinators.

Linkages and Networking

The LEWS project is co-located in an office in the ASARECA office, at ILRI, Nairobi, Kenya, as part of the Crisis Mitigation Program. A portion of a program manager's time has been allocated from ASARECA crisis mitigation funds to serve as an ASARECA-CRSP-LEWS coordinator. This person works under the supervision of Dr. Jean Ndikumana, ASARECA Animal Agricultural Research Network Coordinator. ILRI has hired an information system manager for the Crisis Mitigation Office to facilitate the dissemination of information and flow between the various LEWS teams, Texas A&M and national and international organization involved in early warning.

Mr. William Mnene, LEWS Kenya country coordinator made a presentation of LEWS activities in Kenya followed by a subsequent meeting with the ALRM staff to get that important dialogue going in Kenya.

In Ethiopia efforts are underway to integrate LEWS information with the Ethiopian Disaster Prevention and Preparedness Commission (DPPC), Ethiopian Network on Food Security and the National Early Warning Working Group, which encompasses national,

regional and international organizations that deal with issues related to drought, early warning and food security. We had discussions with the USAID Famine Early System Network in Ethiopian on ways to improve our linkages and collaborative efforts in our objectives of collection and dissemination of information drought, famine and early warning systems.

LEWS project strengthened linkages with the DMC, RCMRD, FEWS NET, UN OCHA and NOAA has been greatly expanded and discussed previously in this document.

Collaboration with International Research Centers (IARCS) and other CRSPs. The primary IARC collaborators are scientist located at the International Livestock Research Institute located at Nairobi, Kenya and Debre Zeit, Ethiopia. The first NIRS laboratory was established at ILRI-Debre Zeit. We also assisted ASARECA at ILRI-Nairobi to establish a Crisis Mitigation Office with the LEWS reporting system as a primary link to NGOs, regional organizations, national policy makers and international early warning and relief organizations. ILRI has collaborated with LEWS on a SPAN grant with USAID focusing on capacity building for use of biophysical models.

A newly designed module on livestock marketing in Southern Ethiopia and Northern Kenya was co-developed with the GL-CRSP-PAIRMA group involving scientists from Texas A&M University, Utah State University, Cornell University and University of Kentucky. Our national collaborators include EARO, KARI, Egerton University and ASARECA CMO.

Because several of our TAMU-LEWS team members are on the global project within the SANREM CRSP, there is strong collaboration between that component and GL-CRSP as it relates to modeling and monitoring technologies. The technical staff working with SANREM CRSP have interacted with the LEWS team members in Uganda, Kenya and Tanzania as it concerns evaluation of the impact of small holder dairy technology in those regions.

Other Contributions

Support for free markets and broad-based economic growth. An early warning system will allow a broader assessment of emerging conditions, which will increase the level of preparedness and mitigation of the effects of droughts. This reduced drought risk will help promote the pastoral assets, which in turn can bring about local economic growth and purchasing power. It will also give the local governments opportunity to concentrate on development rather than relief. This is likely to result in increased trade and emergence of agricultural enterprises.

Contributions to and Compliance with Mission Objectives. Achievement of food security and improvement of the livelihood of the people in the Greater Horn of Africa by mitigating the effect of recurrent droughts and famine has been an important objective of the Greater Horn of Africa Initiative spearheaded by USAID. It is anticipated that the development of an improved early warning system, and finding better ways of linking it to responses from government and various donor agencies, will go a long way in meeting this objective.

Concern for Individuals. The project is designed to secure working relationships with households and individual pastoralists. The project recognizes the fact that the pastoralists, whose livelihood depends on livestock, are the keys to the success of the project. To a large extent, the success of the project and sustainability will depend upon the participation and the commitment of the local people and

the ability of the project personnel to empower, motivate and involve them.

Support for Democracy. A livestock early warning system will improve the capacity of the peoples in East Africa to monitor and understand the dynamics of food security within their borders and throughout the region. Alerts, with respect to droughts and other natural disasters, from a livestock early warning system will reduce mass movements of people and livestock, which have been traditionally sources of conflicts. An improved early warning system, such as this, will create more stable and democratic societies where individual opportunity for prosperity and well-being is greatly enhanced.

Member of the LEWS project, John Corbett and Paul Dyke published a paper on "Institutional adoption of spatial analytical procedures: Where is the bottleneck?" in which they argue that "equity" in decision-making is the real goal of the spatial information sciences. When information for agriculture and natural resource management is accurate, spatial, timely, and accessible to all parties, then decisions and compromises can better meet goals of immediate needs and long-term sustainability.

Humanitarian assistance. The need for humanitarian assistance usually emanates from poverty-related degradation of natural resources. An early warning system for livestock is essential both for food security by protecting the natural resource base and disaster preparedness. A proactive early warning system will help in making people in the region less vulnerable to disasters by alerting them of impending crisis and provoking a humanitarian assistance response from local and international relief systems (e.g., governments, donor and NGOs). Various humanitarian organizations have shown interest in LEWS, including the United Nations Office for the Coordination of Humanitarian Affairs and Action Contre la Faim (ACF).

Leverage funds and linked projects

The LEWS subproject has been able to leverage funds and personnel from multiple sources to ensure that the program is moving forward and up to date technologies are being used in the project. A total of $1,270,140 was funded this year alone within the group. This is more than a 3 to 1 leverage against USAID funds provided to the LEWS subproject, not counting the normal cost share funds of TAES salaries noted in the grant budget for 2000-01.

Specific grants and funding levels are as follows:

DANIDA - $85,000 – "Establishment of NIRS fecal profiling laboratory for NARO in Uganda to Serve the GL-CRSP-LEWS Program"

DANIDA - $26,500 – "Ph.D. Training Program for Ms. Rose Omaria" . Ph.D. program is funded to development pregnancy testing calibration equations for cattle and goats to meet both training and science objectives in the LEWS project. She is attending Mekerere University and with short term training at Texas A&M University GANLAB.

DANIDA - $35,000 – "Ph.D. Training Program for Mr. Steven Byenkya". This is the first year installment on a compressed Ph.D. program at Texas A&M University. Mr. Byenkya is conducting research on modeling effects of brush encroachment on pastoral land capacity and traditional coping strategies as stated in the LEWS objectives.

DANIDA - $6500 – "NIRS training program at TAMU for Charles Erobot – NARO NIRS Lab Manager". Mr. Erobot will be running the national NIRS lab for NARO and will be trained in NIRS lab management and calibration equation development for 30 days at TAMU.

FAO-TCP - $185,000 – "Near Infra-Red

Spectrophotometry (NIRS) for the Livestock Early Warning System in Tanzania

TCP/URT/0169 (A). Funding for complete NIRS lab, training of Dr. Constantine Shayo to run the lab, series of field monitor training workshops and equipping LEWS zonal coordinators with latest computer equipment.

SANREM CRSP same as last year $170,000- "Global Decision Support System for Assessing Impact of Policy and Technologies Related to Food Security," Personnel in TAMU-FEWS are value-added funded via funds in SANREM CRSP as many of the technology/ methodology enhancements helps supports efforts in LEWS as well as SANREM. A bulk of funding for SWAN crop model, PHYGROW, NUTBAL PROm, and ACT 3.0 came from this funding source. Funded to Dr. Stuth, Dyke, Corbett.

USAID G/EGAD/AFS - Office of Agriculture and Food Security - $ 45,000 - Multi-Scale Aggregation of Biophysical Processes Affecting Pastoral Communities In East Africa. This is an augmentation grant to the LEWS project to insure that spatial analyses will be ready for the World Summit on Sustainable Development in September 2002. Improve spatial sampling, accelerated zonal links to the fecal sampling, fostering multiple scale communications in the region on early warning, and capacity building at DMC and RCMRD are the primary activities in the project.

USDA NRCS – $25,000 "Development of livestock early warning outreach programs". Design protocols for effective communications with ranchers as it relates to the Texas Livestock Early Warning System.

Texas Agricultural Experiment Station - $127,650 – Matching funds as part of the unrecooperated indirect costs. TAES only places a 10% indirect charge to this project with at 44.5% overhead normally charged.

USDA-NRCS - $190,000 - "National Nutritional Well-being Program for USA using the NIRS/NUTBAL PRO Nutritional Management System", This is the 4th year of funding. All technology generated in this program is deployed in LEWS. Funded to Dr. Stuth.

USAID-Office of Disaster Relief - $75,000 - "Establishment of a Crisis Mitigation Office (CMO) via the ASARECA in East Africa". 2nd years funding provided to ILRI via Dr. Jean Ndikumana, Regional Coordinator of LEWS. LEWS is an integral component in the CMO.

EU Funding for ASARECA CMO $150,000 – Developing mitigation strategies for pastoralists in East Africa.

US Department of Defense - $170,000 - "Refinement of the Soils of the World Database and Maps". Funded via Dr. Dyke. 2nd years funding provided for development of critical soil attribute databases which allows our LEWS teams access to critical soils information for our models as we expand into new operational zones in East Africa.

Training

In Progress

Stephen Byenkya, Ph.D., Dec. 2003, Range Science, Texas A&M University College Station, Texas

William Mnene, Ph.D., Dec 2003, Range Science, University of Nairobi, Nairobi, Kenya

Peter N. Kamau, Ph.D., Dec. 2003, Range Science, Egerton University, Njoro, Kenya

NegusseKadine, Ph.D., Dec. 2005, Range Science, Texas A&M University, College Station.

Rose Omaria, Ph.D., Jan 2004, Animal Science, Makerere University, Kampala, Uganda

Zola Gibson, M.S., Sept 2002, Range Science, Texas A&M University, College Station.

Laban Macopiyo, Ph.D, Jan 2004, Range Science, Texas A&M University, College Station.

Completed

Amsalu Sisay, M.Sc, Dec. 1999, Range Science, Alemaya Univ., Dire Dawa, Ethiopia

Sarah Ossiya, Ph.D., August 1999, Range Science, Texas A&M Univ., College Station.

Short term

Field training on: characterizing and setting up modal soil and plant communities for each of these households, calculation of stocking rates for major livestock grazers and determining grazing decision rules for the livestock for each of the households identified and filling out and administering herd monitoring and pastoral household surveys was conducted by Dr. Abdi Jama from Texas A&M University and Raphael Marambii from ASARECA-AARNET/CMO Nairobi on February 16 – March 15, 2001, Southern Ethiopia and Afar rangelands.

Participants included: Asefa Haile Selasse, Adami Tulu Research Center, RangeManagement/Taxonomy; Amsalu Sisay, Adami Tulu Research Center, Range animal production; Zeleke Asaye, Adami Tulu Research Center, Veterinary officer; Tekebe Tsige, Adami Tulu Research Center, Veterinary officer; Abraham Getachew, Werer Research Station, Agricultural Economics; Melkaye G/Selasse, Holetta Research Station, Forage agronomist; Gebremedhin Hagos, Holetta Research Station, Forage agronomist; and Dubale Adamsu, FARM Africa, Animal production.

An "Advanced Training Workshop on Biophysical Models and Spatial Analysis" was held March 26 – April 3 in Nairobi Kenya. Participants from Kenya included: Peter Wandera, Southern Kenya Zonal Coordinator; Jane Sawe, Egerton University; Benson Wafula; Peter N. Kamau, Egerton University; and William Mnene, Kenya Agricultural Research Institute. Also participanting were: Angello Mwilawa, Mpwapwa Agricultural Research Institute; Dr. Nicholas Massawe, Northern Tanzania; Sarah Ossiya, Namulong Ag. & Animal Research Institute, Uganda; and Negusse Kidane, University of Asmara, Eritrea. Dr. Jerry Stuth, Dr. Robert Kaitho, Mr. Jay Angerer, and Raphael Marambii conducted the training.

COLLABORATING PERSONNEL

United States of America

Jay Angerer, Assist. Research Scientist, Texas A&M University
Jim Bucher, Systems Analyst, Texas A&M University
John Corbett, Mud Springs Geographers, Inc. (Adhoc)
Paul T. Dyke, Research Scientist, Texas A&M University
Robert Blaisdell, Assist. Research Scientist, Texas A&M University
Abdi A. Jama, Assist. Research Scientist, Texas A&M University
Clint Heath, Senior Systems Analyst, Texas A&M University
Jerry W. Stuth, Kelleher Professor, Texas A&M University
Doug Tolleson, Assist. Director, GANLAB, Texas A&M University
Kris Williams, Lab Manager, GANLAB, Texas A&M University
Kristen Zander, Systems Analyst, Texas A&M University
Jeff Vitale, Assistant Research Scientist, Texas A&M University.

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Azage Tegegne, Animal Scientist, International Livestock Research Institute
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Abule Ebro, Animal Scientist,
Adami Tulu Agri. Research Center
Kassaye Hadgo, FARM Africa, Afar Region
Bayissa Hatewu, Ethiopian Agricultural

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Dawit Negessa, Lab Technician, ILRI-Debre Zeit,
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Kenya

Henry Cheruiyot, Director Research Inst, Kenya Agricultural Research Inst. (KARI)
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Robert Kaitho, SANREM/LEWS/KARI/ ILRI, Liaison Research Scientist
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Margret Kingamkono, Animal Scientist, Selian Agricultural Research Institute

Uganda

Felix Bareeba, Professor, Makerere University, Uganda
Stephen Byenkya, Forage Scientist, National Agricultural Research Organization.
Grace Ebiyau, Technician, National Agricultural Research Organization
Cyprian Ebong, Livestock Production, National Agricultural Research Organization
Sarah Ossiya, Range Scientist, National

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Oromia Regional Agricultural office/Southern Rangeland Development Unit
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Abstracts and Presentation

Doug Tolleson and Jerry Stuth were invited to present a paper on emerging trends in nutritional and physiological profiling of free-ranging livestock via fecal NIRS scans. For the Southern Section of the American Society of Animal Science meetings, Ft Worth, TX in February 2001.

Dr. Stuth provided an overview of the LEWS program to Mr. Doug Sheldon, USAID Mission Director of Ethiopia at UCDavis in March 2001.

Dr. Stuth made a presentation to FAO in Rome on the application of spatial technology integrated with WorldSpace radio for early warning systems in March 2001.

Dr. Stuth made a presentation to the Laikipia Wildlife Forum on the LEWS system in Laikipia in June 2001.

Dr. Robert Kaitho made a presentation to the IGAD steering committee on application of the LEWS technology package in July 2001.

Dr. Stuth provided an overview of the LEWS technology package to the USDA Risk Management Agency in July 2001 in Kansas City.

Dr. Robert Kaitho, made a presentation of the spatial techniques at the Climate Outlook Forum in Kampala in August, 2001.

Dr. Stuth provided an overview of the LEWS technology package to the South Carolina Cattleman's Association in October 2001 as part of the USDA RMA Risk Management education program.

Mr. Jay Angerer made a presentation on the geo-spatial techniques used in LEWS at the planning meeting of the USAID Geographic Information for Sustainable Development (GISD) program in Washington DC in October 2001.

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Improving Pastoral Risk Management on East African Rangelands

Narrative Summary

This was the fourth year of work for the pastoral risk management (PARIMA) project. The overall goal of our project is the discovery and application of knowledge pertaining to improving risk management—and thus improving livelihoods—for pastoral and agro-pastoral people in northern Kenya and southern Ethiopia. Foundation concepts include the exploration of opportunities to better diversity incomes and assets and how to improve the use and delivery of information and various public services. We had 20 major outputs planned for research, outreach, and training during 2000-01 and made good progress on 17 of these. The year is best characterized by the following successes: (1) Continued implementation of a quarterly research survey across 11 communities throughout our study area; (2) hosting a Second Biennial Research and Outreach Workshop at Egerton University; (3) expansion of outreach activity to include facilitation and oversight for eight workshops and short-courses involving 355 participants from research, development, and policy sectors; and (4) ongoing supervision of field studies conducted by 14 graduate students and post-doctoral associates. We have remained true to our original problem model. Work plans and outputs in Year 4 are almost exactly on track with what we outlined in the original project proposal. Team members have been very productive and creative with resources provided through the GL-CRSP.

Research

Activity 1: Regional Assessment of Risk Variability for Communities and Households, led by Drs. Christopher Barrett and Peter Little with Participation from Drs. John McPeak, Getachew Gebru, and Others.

Problem Statement and Approach. One of the core issues in the PARIMA project is the extent to which pastoralists share a common perception and experience of risk. The frequent assumption is that most risk experiences are common to most pastoralists. This assumption has important implications for the way in which interventions are structured. When risk is broadly shared across a population, external resources are essential to enable recovery from shocks and rural financial, marketing, and social insurance systems are prone to failure. When the risk experience is highly variable (idiosyncratic) within a population, systems have greater capacity to manage risk internally so long as a basic physical and institutional infrastructure is in place. So one of the project's first research activities has been to explore intra-regional variability in risk exposure and risk perceptions. Two different research efforts have contributed to this activity. We started with a participatory risk mapping activity documented in the GL-CRSP Annual Reports for 1999 and 2000. This was followed by a more detailed, repeated survey implemented for 330 households in 11 communities (six in Kenya and five in Ethiopia) using a cluster sampling approach. Five communities are Boran, with one each from the

Rendille, Ariaal, Il Chamus, Gabra, Samburu, and Guji. The survey was launched during March, 2000, and repeated quarterly over the subsequent 19 months. The survey will continue until June, 2002. The survey work is devoted to: (1) Delineating sources of risk affecting individuals, households, and communities; (2) understanding the effectiveness of various indigenous tactics for reducing risk exposure such as livestock accumulation, livestock mobility, and social insurance systems; and (3) understanding the effectiveness of various introduced tactics for reducing risk exposure such as livestock marketing, access to rural financial networks, economic diversification, and use of relief as well as other forms of external assistance. Communities have been stratified and purposively chosen so as to capture important differences in agro-ecology, access to towns and infrastructure, and ethnicity. We are fielding individual-level surveys not only of household heads, but also of a randomly selected junior male and female adults from each household in order to gain evidence on gender and generational differences that condition risk exposure and response. The survey instruments capture information on household structure, asset holdings, activities, consumption, mobility, livestock transactions, experience with raiding, risk assessments, past risk exposure, etc. Effort is being made to capture actual behaviors as well as perceptions.

Progress. Results from participatory risk mapping have been reported in previous GL-CRSP Annual Reports and the peer-reviewed literature and will not be repeated here. The general outcome, however, confirmed that risk exposure is highly variable with respect to locality, wealth class, gender, major economic activity, and agro-ecological zone. This supports our hypothesis that risk has an idiosyncratic component. This progress report will thus focus on preliminary results from the repeated survey.

Conventional wisdom indicates that pastoralists have traditionally self-insured themselves through livestock accumulation. Preliminary data illustrate the utility of having larger herds in our study area. When contrasting herd dynamics before, during, and after a recent drought, patterns suggest that the best predictor of post-drought herd size is pre-drought herd size. Post-drought recovery of livestock numbers in absolute terms should be faster for households having larger herds. In the coming year we will examine patterns of herd re-building and poverty dynamics. Specifically, who suffered the most from drought losses and why? Who recovers from drought most quickly and why? We are also interested in whether different livestock species are sequenced in particular ways that could maximize rebuilding of herds following drought. For example, do some households initially focus on rapidly reproducing small ruminants, and then trade these for larger (but slower reproducing) cattle and camels?

Conventional wisdom indicates that pastoralists have traditionally relied on a high degree of livestock mobility and opportunistic resource exploitation tactics to manage drought risks. In theory, pastoralists in our study area are losing options for mobility due to annexation of key resources to cultivation, over-population, insecurity, growth of towns and settlements, gazetting of protected areas such as parks and ranches, and localized range degradation. Our work in this area focuses on case studies of water point use and resource tenure in addition to the quarterly surveys. Our preliminary results suggest that some communities that retain options for mobility—such as a larger number of remote satellite camps—appear more successful at maintaining livestock numbers under stress than those that must maintain herds close to homesteads.

Conventional wisdom indicates that pastoralists have traditionally relied on informal social support networks to help mitigate risks

of livestock loss from drought or raiding. For example, those households that happen to lose large numbers of stock can petition others in the community to donate food and animals to promote recovery. In theory, these social support networks may become fragile and less responsive if demand for herd replenishment outstrips supply. This situation can occur when too many households repeatedly suffer heavy losses of stock. Our preliminary survey evidence suggests that transfer of cash, food, and livestock among households within our 11 communities does not provide much of a social safety net. For example, in two of the Ethiopian communities over 75% of the households reported that they neither gave nor received any cash transfers during the last nine months of 2000—this was when the last drought reached its peak and households began struggling to recover (Figure 1a). In the other three Ethiopian communities significantly more households (50-82%) were net receivers of cash transfers than net donors. All but one community was a net receiver of cash inflows, reflecting the role of remittances from those outside the pastoral system. Similarly, in each of the Kenyan communities, at least 58% of the households reported being net recipients of cash transfers, and all communities showed net transfer inflows of cash (Figure 1b). However, most of the transfer amounts were relatively small. When compared with cash expenditure over the nine-month period, the average amount of a transfer—for those that received transfers—was less than 15% of total cash expenditures for all but four of the communities. When comparing these results to herd dynamics reported above, it appears as though the many households appear to mostly rely on self-insurance through livestock accumulation. Without adequate social safety nets or informal means of insurance, people whose animals die and who lose their sources of livelihood are forced to drop out of the pastoral system. This often has detrimental consequences for those who drop out since they are often ill equipped to succeed in urban settings. In addition, there can be detrimental effects to smaller towns and villages in pastoral areas. They cannot absorb an influx of unskilled labor, and their immediate environment can suffer as pastoral dropouts bring their few animals and concentrate around towns, leading to increased likelihood of localized range degradation.

Conventional wisdom indicates that pastoralists are reluctant to sell livestock and thus they appear to make limited use of markets. This appears to be true even when pastoralists are

Figure 1 (a, b). Net cash transfers among 330 respondent households during the year 2000 in (a) five communities in southern Ethiopia (reported in Ethiopian Birr) and (b) six communities in northern Kenya (reported in Kenya Schillings).

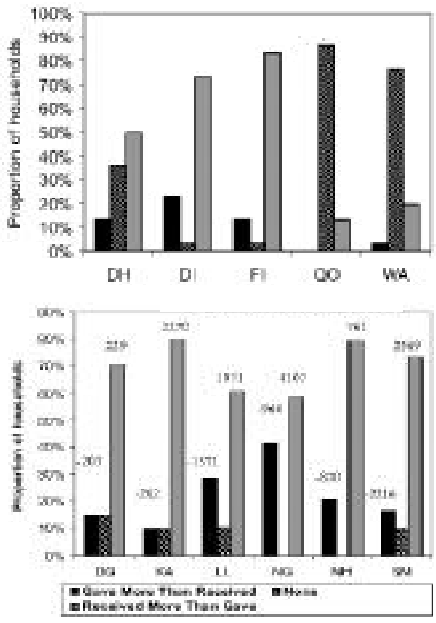
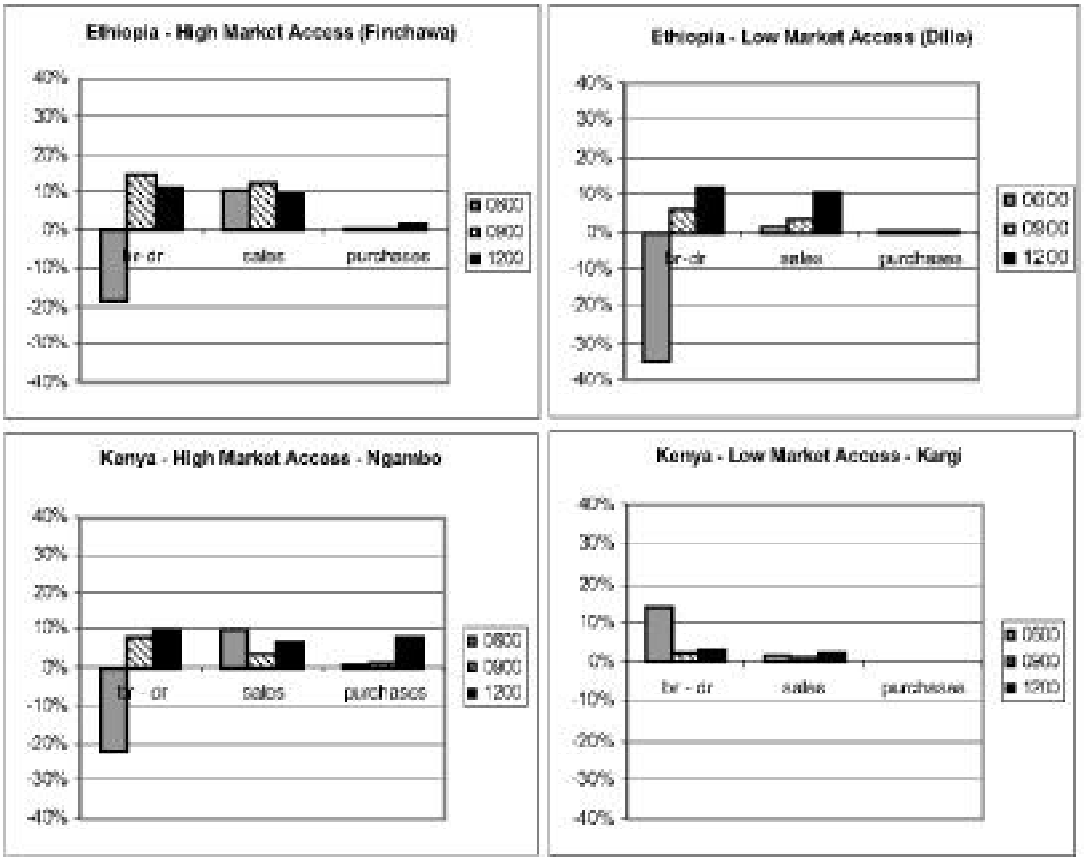


Figure 2 (a-d). Use of livestock markets during the year 2000 by respondents in four communities across two countries that vary in terms of having high or low market access.



faced with a drought that could decimate most of their herds. Clever use of markets could help pastoralists mitigate asset losses in response to changing forage conditions. We are interested in the extent that our target population sells animals (why, how, and when) and how this is related to market access. Here we review some preliminary findings based on data collected between March and December 2000 across 11 communities. A drought was in progress during this time, and median herd sizes decreased from 25 to 44% in southern Ethiopia and northern Kenya, respectively. Use of markets varied among the communities, with market access being a key determinant of market use. This is illustrated by considering contrasts annualized sales rates from households in sites with high market-access (Finchawa in Ethiopia and Ngambo in Kenya) versus that for households from sites having low market-access (Dillo in Ethiopia and Kargi in Kenya). Figure 2(a-d) depicts data from surveys fielded during June 2000 (0600 in the legend), September 2000 (0900 in the legend), and December 2000 (1200 in the legend). The graphs incorporate three different livestock variables that could also affect sale rates: (1) Birth rate minus the death rate (br-dr); (2) sales rate (sales); and (3) purchase rate (purchases). The first implication of these figures is that—perhaps not surprisingly—higher market access is

associated with higher annualized sales rates. Overall, livestock sales rates for households were relatively high by pastoral standards. The annualized sales rate for the Ethiopian sites was 22% and for the Kenyan sites it was 12%. However, even with these high sales rates, the observed decrease in herd size was due more to mortality than to sales. The annualized death rate in Ethiopia was 43% and in Kenya 53%. Overall on average, the annualized sales rate in the two sites having higher market-access was 37% compared to 14% for the two sites having lower market-access. More importantly from a risk-management perspective, the ratio of the sales rate to the death rate in sites with higher market-access is 66% compared to 24% in the sites having lower market-access. Finally, we see that particularly in the Ngambo site the market was being used for both de-stocking (sales are highest when the birth rate minus the death rate is lowest) and restocking (purchases are highest when the birth rate minus the death rate is highest). Market access appears to be a critical factor influencing market participation and risk management via livestock sales by pastoralists. Pastoralists with better market access sell livestock at a higher rate. Marketing played a greater role in modifying herd sizes in high market access sites than in low market access sites during a drought period in 2000. Pastoralists with high market access used the market for self-restocking. Data from the high market-access sites also indicates that the current market structures are not perfect. Death rates still dominate sales rates and restocking through markets is only significant in one site. These preliminary findings suggest that the welfare of pastoralists in areas where market access is already high should be improved by investing in measures that increase market efficiency. Welfare of pastoralists currently poorly served by markets should be improved by investing in basic marketing infrastructure. In the coming year the current work will be augmented. In addition, preliminary data will be analyzed concerning the following topics: (1) Effects of conflict on livestock marketing; (2) analysis of the nature and effects of market power; (3) analysis of the determinants of pastoral marketing behavior; (4) potential synergies between savings institutions and livestock marketing; and (5) influence of intra-household rights to animals on marketing behavior.

For the rural finance component we are investigating several hypotheses, including: (1) That there is a latent demand for financial savings; (2) that conversion of pastoral wealth through financial savings will improve pastoral welfare by reducing risk of asset loss; and (3) that savings will lead to asset and income diversification. Data collection includes analyses of the performance of Financial Services Associations (FSAs) in northern Kenya (see work by Osterloh below) and use of the repeated survey to collect basic information on use of financial systems by our target population. For Kenya our preliminary data indicate that less than 10% of the inhabitants of five of six sites have a savings account with a formal financial institution; for one site (Ngambo) this rose to about 30%. Amounts saved were typically less than the KSH equivalent of USD 100, although a few had savings equivalent to USD 500. For Ethiopia our preliminary data indicate that less than 1% of households had savings accounts with formal financial institutions. In the coming year the current work will be augmented. In addition, preliminary data will be analyzed concerning the following topics: (1) Relationships between household wealth and savings and credit behavior; (2) analysis of the institutional design of rural savings and credit institutions; and (3) exploration of the links between access to formal finance options and income and asset diversification.

Conventional wisdom suggests that asset and income diversification are key ways to improve risk management by pastoralists. To

address these issues we are relying on focus group interviews, interviews with entrepreneurs, and results from the quarterly surveys. Some preliminary findings include: (1) That much activity diversification in the study area has resulted from poor households attempting to cope with poverty—diversification often occurs from "push" factors rather than "pull" factors; (2) people with education and/or good market access can be relatively successful with diversification compared to those without these attributes; (3) women often have different opportunities than men in terms of diversification, and women are commonly less successful; and (4) salaried income and remittances have a stabilizing effect on household economies. Although inter-community variation is high, preliminary results from the repeated survey suggest that the Ethiopian households have lower and less diverse incomes than Kenyan households. Income from non-livestock trade, salaries, and wages are considerably higher in Kenya compared to Ethiopia. In the coming year the current work will be augmented. In addition, other work will address issues that include: (1) Potential of non-pastoral activities to support households and financial systems; (2) identification of the types of diversification that increase risk exposure and reduce welfare versus those that mitigate risk and improve welfare; and (3) the role of activity diversification in assisting drought recovery.

It is apparent that pastoral populations have become: (1) increasingly dependent on disaster relief; and (2) increasingly neglected by providers of public services. Some observers feel that much of the previous assistance for pastoral development has been misdirected. To address questions pertaining to the scope and influences of external assistance, we rely on the repeated survey, action research, and an extensive review of secondary literature. Our preliminary findings include that: (1) Food aid distribution is ubiquitous and doled out in equal shares and thus non-responsive to variation in need; (2) food aid volumes are modest, commonly making up less than 15% of the total value of household food budgets; (3) food aid distribution typically encourages unsustainable settlement patterns for refugees, and this may have negative environmental consequences; and (4) service providers come from multiple sectors. To give some examples of the last point, veterinary, medical and educational services are useful. For Kenya, the private sector dominates veterinary delivery in most of our study sites, while government and evangelical organizations support most of the educational opportunities. Medical services, in contrast, are provided by a variety of governmental, private, evangelical, and NGO sources that vary by location. For Ethiopia, government dominates education and veterinary services, while government and the private sector appear to share delivery of medical services. In the coming year the current work will be augmented. In addition, other work will address issues that include: (1) Analysis of whether intra-household transfers ultimately get food aid to people who need it most, in spite of the fact that food aid is equally distributed; and (2) analysis of the environmental implications of food aid distribution in terms of effects on human settlement patterns and the add-on influences of fuelwood over-harvesting as well as localized over-grazing.

To summarize preliminary highlights from our repeated survey, we see the following patterns. First, there is an idiosyncratic component to household and community risk exposure. Second, some pastoralists indeed make aggressive use of markets in response to drought. Third, income diversification is relatively widespread in Kenya and rare in Ethiopia. Note all forms of diversification are equally helpful. Fourth, herd mobility, livestock accumulation, and salaried income are effective risk management strategies. Fifth, use of formal financial institutions and informal social

support networks is minimal. Sixth, although food aid is pervasive, it appears that few households are heavily dependent on food aid.

These preliminary results have some practical implications. For the short-term, technical interventions and policies should support—and not undermine—pastoralists' traditional means of managing risk, namely herd mobility, livestock accumulation, and opportunistic marketing. This means that re-stocking of herds from viable base sizes is a useful thing to do. Investment in security should also help reduce risks associated with resource access and hence favor some restoration of herd mobility. Investment in primary education is important because it can lead to skills that enable people to augment pastoral livelihoods with salaried incomes. Investment in marketing infrastructure and institutions is important, and particularly so for populations residing in remote locations with poor market access. What our results also suggest are some interventions that could be detrimental to pastoral welfare. This would include de-stocking programs for moderate-sized herds and food aid distribution that is non-responsive to variation in need for food among households and communities. For the longer term, more investment could be directed to marketing infrastructure and institutions to reduce price volatility and transactions costs. More effective means should be developed to distribute emergency relief. The potential for sustainable financial systems needs to be re-evaluated once market activity and income opportunities expand. Finally, one could promote investment in non-pastoral economic activities to widen the range of desirable employment and investment opportunities.

Activity 2: Local Assessment of Risk and Change for Communities and Households, led by Prof. Abdillahi Aboud with Participation by Dr. Francis Lelo, Prof. Dankit Nassiuma, Dr. William Shivoga, and Others.

Problem Statement and Approach. The regional perspective of pastoral risk is being supplemented with local case studies. Such work is particularly appropriate as training projects for graduate students. In contrast to the quarterly survey approach outlined above, each case study has a unique character that reflects local issues as well as the priority interests of students and their supervisors. The studies initiated in Year 4 variously examine risk as related to system change, conflict, coping strategies of refugees, and resource tenure. Approaches are based on household survey methods.

Progress. In the GL-CRSP Annual Report 2000, we reported on final results from one doctoral dissertation and four master's theses. This represented work by two Ethiopians and three Kenyans. Some results from the dissertation have been submitted for peer-reviewed publication. One master's thesis has been published (see Publications) and the other three are in the final stages of external examination and will not be published until early 2002. There is no need to repeat any of this material here.

We have matriculated, however, another three master's students into the PARIMA collaborative program with Egerton during 2001. The students and their tentative project titles, project objectives, and Egerton supervisors are as follows:

(1) Mr. Abdullahi Dima Jillo (Kenyan national). His project is entitled "Pastoral Resource Administration, Tenure and Conflict among the Wasso Borana of Northern Kenya." The main objective of his work is to investigate sources of conflict in resource access and use

among the Wasso Borana. The supervisors are Prof. Abdillahi Aboud and Dr. William Shivoga;

(2) Mr. Godfrey Nyongesa Nato (Kenyan national). His project is entitled "Plunging into and Coping with Destitution: The Case of Settled Pastoral Populations in Kampi Turkana of Marigat, Baringo. The main objective of his work is to investigate the reasons why pastoralists migrate to the refugee site of Kampi Turkana on the outskirts of Marigat town, and how they cope once they arrive there. The supervisors are Prof. Abdillahi Aboud and Prof. Dankit Nassiuma;

(3) Mr. Waktole Tiki Uma (Ethiopian national). His project is entitled "Indigenous Institutions in Resource and Risk Management among Borana Pastoralists of Southern Ethiopia." The main objective of his project is to investigate social change among the Borana and how such change influences tenure and use of natural resources. The supervisors are Prof. Abdillahi Aboud and Dr. Francis Lelo.

Activity 3. Special Topics on Enabling Systems to Mitigate Risk, Led by Drs. Peter Little and Chris Barrett with Participation from Mr. Hussein Mahmoud, Dr. John McPeak, Dr. Getachew Gebru, Ms. Sharon Osterloh, and Others.

Problem Statement and Approach. The ability of indigenous populations to mitigate risk fundamentally depends on enabling systems such as marketing, rural finance, public service delivery, and natural resource tenure. In the GL-CRSP Annual Report 2000 we described preliminary work that focused on producer price risk for livestock marketing and resource tenure issues, and much of this has been submitted for peer-review or published in the past year. Here we focus on on-going work concerning social networks of traders as they pertain to livestock markets, rural finance, and how subject populations in our study region use predictive climate information. All of these projects rely heavily on survey approaches.

Progress. The following report is organized with respect to three distinct projects.

Livestock trading and trader networks in northern Kenya and southern Ethiopia. Mr. Hussein Mahmoud, a Kenyan national, started fieldwork for his doctoral dissertation in Development Anthropology in February 2001. Fieldwork is scheduled to continue through April 2002. His research supervisor is Dr. Peter Little. The main theme of his project is to achieve a better understanding of trader networks that deal with livestock throughout our study area. Livestock trade is a very important economic activity in the rangelands, and effective livestock marketing is crucial to improving pastoral risk management (see the GL-CRSP Annual Report 2000). Knowledge of the structure and function of the existing marketing system is required before we could prescribe effective interventions to improve efficiency and hence pastoral welfare.

The main hypothesis for this work is that livestock traders in the region engage in different types of social networks to better confront the risks and uncertainties imposed by poor dissemination of market information, a weak market infrastructure, insecurity, and highly volatile livestock prices. It is presumed that many of these network interactions are conducted on a highly personal and individualized basis. Trader networks span the entire marketing chain from production centers in the southern Ethiopian rangelands to the main terminal market in Nairobi. Since trade in sheep and goats does not require as much investment—and has fewer risks—compared to trade in cattle, it is suggested that the sheep and goat trade entails fewer actors and a lesser degree of personal and individualized trader network interactions than that for the cattle trade.

Work thus far has focused on cattle markets

and several different categories of cattle such as bulls, cows, and immatures. The major factors that appear to have significant roles in cattle trading networks include wealth status, age, and ethnicity of traders.

Wealthy cattle traders are more likely to enter into personalized trading relationships than are poorer traders. In particular, wealthy Borana traders of southern Ethiopia often have strong networks with Kenyan traders—even to the extent that informal credit is provided without collateral security. Importantly, this practice facilitates sales and movement of goods across the Ethio-Kenya border. There are social mechanisms in place to help recover cash in the case of a loan default. These mechanisms thus lower risks for lenders.

Age is especially critical for Kenyan cattle traders. Ethiopian cattle traders tend to screen Kenyan merchants based on their ages prior to establishing a trading relationship or giving credit. Ethiopian cattle traders prefer dealing with older over younger and less experienced traders. Ethiopian cattle traders have learned that there is a considerably higher default rate among younger Kenyan traders compared to that for older ones. One reason this is the case is because younger traders have not accumulated enough capital to buffer themselves against unavoidable trading circumstances and thus are more likely to renege on repayment.

Ethnicity is also an important factor in livestock trading relationships. There is some evidence that several ethnic-based clusters are engaged in trade in the study area. At the same time, however, one can see clusters and trading partnerships also occur across ethnic groups. Preliminary findings from Moyale suggest that the majority (63%) of livestock traders in northern Kenya are Burji, followed by the Boran (20% of traders) in northern Kenya and southern Ethiopia. The Gabra, Garre, and Arsi ethnic groups contribute another 13, 1, and 1%, respectively.

Traders often rely on personal and informal means to secure resources. For example, only 19% of traders interviewed thus far in northern Kenya use a formal bank account to move money. The majority tends to rely on ethnic-based social networks for cash transactions and holding savings. The most successful traders must have considerable language skills to serve as a bridge between various ethnic clusters. For example, 41% of traders interviewed thus far speak at least 4 languages, 36% speak three languages, and 23% speak two languages or less. This language facility is indeed a strong indicator of networking potential. The more languages one understands, the easier the process of buying and selling cattle will be.

The study so far indicates that several factors influence the development of trader networks in the region. At this early stage of research the possibility that cattle quality affects trader relationships cannot be ruled out—that is the higher value cattle may invoke more elaborate trader networks than other categories of marketed stock. The presence of ethnic clusters and the high language capability among the majority of traders facilitates networking. This therefore helps reduce transaction costs, but it could also promote some patterns of market exclusion and distortions. Dominance of informal types of credit access and cash transfers has important implications for cattle trading in northern Kenya. Formal institutional options for increasing trader access to credit and cash could be explored, especially given problems with insecurity in the region.

Micro-finance in northern Kenya. Micro-finance refers to financial services such as cash loans, deposit savings accounts, and insurance made available in relatively small amounts to poorer populations throughout the developing world. Many different forms of micro-finance have been fielded worldwide, including in east Africa. Here we present some preliminary

findings on one type of micro-finance institution, namely the Financial Services Association (FSA) recently introduced into pastoral areas of northern Kenya by the Kenya Rural Enterprise Program Development Agency, henceforth referred to as KDA.

Under the FSA model, local inhabitants own and operate the institution, electing the Board of Directors and committees and deciding whether to reinvest profits or distribute them among share owners like dividends. The FSA mobilizes local financial resources through share ownership and deposit-taking savings accounts for lending back to the community for productive investments. The idea is for FSAs to take advantage of the informal local rules, customs, relationships, knowledge, and solidarity networks believed to increase loan repayment, while introducing formal banking concepts and methods believed to improve allocation of scarce financial capital. The hope is that this fosters community empowerment and local democratic institution-building, encourages pastoralists to diversify asset holdings away from the traditional and heavy concentration on livestock, and provides local lending capital for investment in non-pastoral enterprises.

Research has been recently undertaken by Ms. Sharon Osterloh in partial fulfillment of a master's degree in Agricultural Economics at Cornell University. The goal was to investigate the performance of five FSAs recently established in northern Kenya. This has involved site visits and interviews of various stakeholders. One theme that guides PARIMA efforts is the idea that increased access to rural savings and credit institutions is an important development intervention for pastoralists. Therefore, understanding how FSAs function (or do not function) in a pastoral rangeland setting is important to evaluate this strategy.

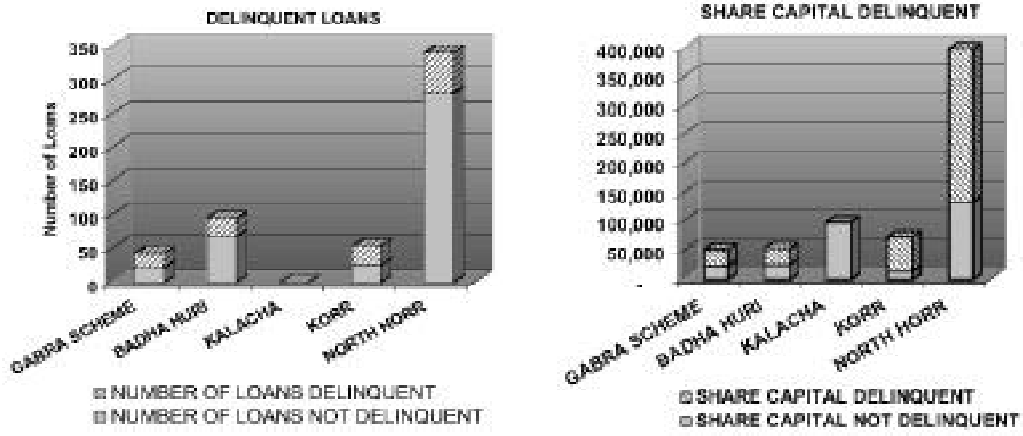
In northern Kenya's Marsabit District, the KDA has launched FSAs that sell shares at KSh 300 (about USD 3.80). Share capital constitutes the loan fund as the KDA provides no loan funds per se. The contribution of KDA is purely in the form of initial start-up assets including a strongbox, building subsidy, and bookkeeping materials. The KDA also provides on-going auditing and other training and technical support services. Members of an FSA can apply for loans up to the lesser of four times the value of their shareholdings, or 10% of their total share capital. Members can also open savings accounts up to ten times the value of their share capital. Those who invest more in the FSA can thus save and borrow more.

As previously mentioned, the KDA has opened five FSAs in northern Kenya. These include: Korr and North Horr (1998), Badha Huri (1999), and Kalacha and the Gabra Scheme (2000). These presently have nearly one thousand members, about KSh 671,000 and KSh 318,000 in share capital and savings, respectively, and more than KSh 2.5 million in disbursed loans. North Horr is by far the largest of the five by each of these indicators.

Loans to date have been small, with a mean of only KSh 4800 (the median equals KSh 2400). This is far too small to provide working capital for an enterprise of minimum-efficient scale in trading or light manufacturing. There seem to be few business opportunities in Marsabit District that are both feasible given the small loans available from the FSAs and profitable enough to support the necessarily high rate of interest charged for FSA loans. As a consequence, more than 40% of loans are extended in support of consumption rather than production activities.

Savings remain meager. Only 48 of the 925 FSA shareholders in Marsabit District have ever made savings deposits. Of these, only 13 accounts have had more than two transactions, namely the initial deposit and a complete withdrawal. Only one savings account is presently active. Plainly, demand for loans far

Figure 3 (a, b). Delinquent share capital and delinquent loans for five Financial Service Associations (FSAs) in northern Kenya during 2001.



exceeds demand for savings under present conditions. Pastoralists are not taking advantage of the opportunity to convert livestock wealth into cash savings, even during a period of drought that brought considerable herd stress and relatively high marketed off-take (see Activity 1 above by Barrett et al.).

Of the four FSAs in Marsabit District that have been operating at least twelve months, only one shows a profit (North Horr, at 4%). The primary reason for poor initial profitability has been high delinquency for share capital and loans [Figure 3(a,b)]. Delinquency rates are no greater on loans extended for consumption purposes than those made in support of investment objectives. So, the unexpectedly low repayment rates cannot be attributed to the relatively high proportion of the FSAs' lending portfolio comprised of consumption loans.

Participation in FSAs has likewise proved somewhat less than expected. A small minority of residents in any FSA site purchase shares and thereby become members of the FSA (Figure 4a). Of that minority of local residents who become FSA members, a smaller share still are active, meaning they have taken out loans, opened deposit savings accounts, or both (Figure 4b). Only one-third of FSA members has ever used savings or loan services provided by the associations.

While local ownership and control may be necessary for good stewardship and satisfactory loan repayment rates, the evidence from the FSA experience to date in Marsabit District shows it is not a sufficient condition. The FSAs there are experiencing high rates of loan and share capital delinquency, low rates of savings deposits, poor profitability, and a weak level of local participation. Supply of micro-financial services does not appear to be a factor limiting either diversification of savings out of livestock or investment in non-pastoral business enterprises in Marsabit District. In order for micro-finance under the FSA model to succeed in such locales, it appears that greater efforts need to be made in several areas. These include: (1) training local board members, management, and shareholders so as to bolster FSA capacity and improve performance incentives; (2) studying pastoralist behavior and re-design FSA financial services packages to meet their current and prospective needs; and (3) bolstering business skills and non-pastoral investment opportunities in the region.

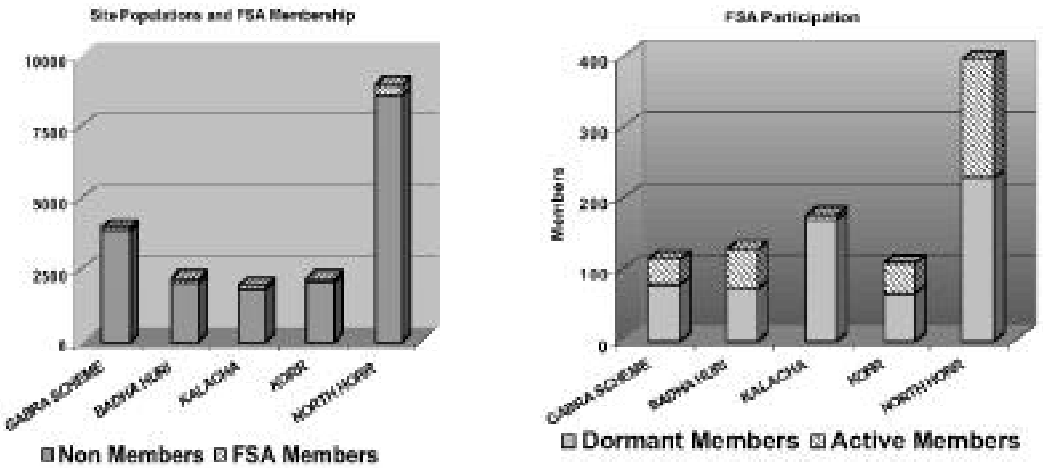
Use of predictive weather forecasts by

pastoralists. The emergence of sophisticated climate modeling, and its apparent successful use in cueing humanitarian efforts that averted drought-related crises in southern Africa, has prompted significant interest in climate forecasting for the Greater Horn of Africa. Early-warning systems are being developed with the thought that climate forecasts might help pastoralists mitigate risk more skillfully, thereby helping avert crises. There remains a dearth of empirical evidence as to pastoralists' access to, confidence in, or use of emerging forecast information. In the interest of trying to help fill that important empirical gap, just prior to the onset of the 2001 long rains in March we fielded the first round of a brief household survey module on climate expectations and use of climate forecast information. Our goal was to better understand pastoralists' awareness of, access to, and confidence in seasonal weather forecasts—both locally-based or "traditional" and externally generated or "modern"—and to assess the current and potential value of seasonal climate forecasts for pastoralists at their current skill levels. We surveyed 323 households across 11 research sites (see Research Activity 1 above) and complemented the survey with open-ended, qualitative research to establish prevailing indigenous forecasting methods.

In spite of the rapid growth of climate forecasting in the region and efforts at widespread dissemination of seasonal forecasts by institutions such as the Drought Monitoring Center (DMC) in Nairobi, survey responses indicate that less than 20% of our study households receive modern climate forecasts. The overwhelming majority of these households access modern forecasts via radio. Newspapers, television, and government or NGO extension services reach a negligible portion of survey respondents with climate forecast information.

Our households nonetheless hear seasonal forecasts, as more than 80% received information based on traditional methods including reading clouds, stars, the moon, livestock intestines, and by observations of livestock and wildlife behavior. Typically, our respondents received traditional forecast information from several sources. For example, 54% of households received information from

Figure 4 (a, b). Membership features for five Financial Service Associations (FSAs) in northern Kenya showing the proportions of the total population by site that are FSA members, and the proportions of total FSA members by site that are active FSA participants.



at least four different sources for the long rains of 2001.

Our respondents consistently ranked the start date for the rainy season as the weather variable of greatest interest, followed by the amount of rainfall in their home area, the end date or duration of the rainy season, and the rainfall amount in areas where they might migrate. For a forecast to be useful, our respondents living in drier locales reported that they must receive a forecast with a lead-time of at least four to five weeks. Where water is more accessible and cultivation practiced, respondents noted a need for an even longer lead-time of eight to ten weeks.

Confidence in all forms of forecasting markedly varied, but on average, confidence in traditional sources far exceeded that for modern sources (Table 1). More than three-quarters of respondents expressed confidence in traditional forecasts—over three-times greater than that for modern forecasts. These averages mask variation across forecast variables and locations. Ninety percent of respondents had at least some confidence in the accuracy of traditional start-date forecasts versus 39% for the modern variety. Seventy-five percent of respondents had at least some confidence in traditional forecasts of local rainfall quantity, with only 38% expressing confidence in modern forecasts. There was also much site variation, although confidence in traditional forecasts significantly exceeded that for modern forecasts in 10 of 11 survey locations (Table 1). In general, confidence in modern forecasts was greater for respondents in Kenya compared to those in Ethiopia.

Modest awareness of, and limited confidence in, modern forecasts gives rise to rainfall expectations among our respondents that significantly differed from computer-modeling forecasts published by the DMC for the 2001 long rains—these forecasts had been released before our survey began. We elicited probabilistic forecasts of rainfall volume from our respondents in a form directly comparable to the DMC forecast probability of above normal, normal, or below-normal rainfall for the calendar. Most of the Kenyan respondents were significantly more optimistic than the DMC forecasters that 2001 would bring above-normal rains (Table 2). Our Ethiopian respondents, in contrast, were more pessimistic even though the DMC provided more optimistic predictions for southern Ethiopia compared to those for northern Kenya. Deviations of rainfall expectations between traditional versus modern forecasts further underscore the general inattention paid to modern forecasts among pastoralists and agro-pastoralists in our study region.

Table 1: Level of confidence in aspects of traditional or modern weather forecasts as averaged across survey respondents in northern Kenya and southern Ethiopia during 2001.

	Traditional	Modern
Overall	**77%**	**23%**
Ethiopia		
DH	**89%**	**11%**
DI	**97%**	**3%**
FI	**97%**	**10%**
WA	**73%**	**27%**
Kenya		
DG	**72%**	**17%**
KA	**90%**	**7%**
LL	**23%**	**77%**
NG	**77%**	**23%**
NH	**62%**	**34%**
SM	**75%**	**25%**

Overall confidence levels reflect simple means of measures with respect to rains' start date, end date, local rainfall volume, and rainfall volume elsewhere.

Ethiopian sites: DH=Dida Hara, DI=Dillo, FI=Finchawa, WA=Wachille
Kenya sites: DG = Dirib Gumbo, KA=Kargi, LL=Logologo, NG=Ngambo, NH=North Horr, SM=Suguta Marmar

Table 2. Predictions for precipitation volume for the long rains (April to June) of 2001 as expressed by survey respondents in northern Kenya and southern Ethiopia in contrast to the associated rainfall forecasts from the Drought Monitoring Center (DMC) of Nairobi, Kenya.

	Above normal	Normal	Below Normal
DMC: Kenya	25%	40%	35%
All Kenya	41%	36%	20%
DG	25%	39%	36%
KA	35%	31%	27%
LL	13%	59%	24%
NG	51%	33%	13%
NH	61%	25%	11%
SM	63%	30%	9%
DMC: Ethiopia	35%	40%	25%
All Ethiopia	19%	31%	48%
DH	21%	64%	14%
DI	0%	0%	100%
FI	0%	30%	70%
WA	53%	43%	3%

Sites are the same as in Table 1.
DMC = previously published Drought Monitoring Center forecasts

The biggest issue surrounding the potential, as distinct from current, usefulness of climate forecasting for our respondents concerns their use of the information. Information is valuable only in so far as people are willing and able to act on it. Even though the overwhelming majority of our respondents are aware of, and have confidence in, climate forecasts—albeit mainly traditional ones—only a minority act on that information, especially when the forecast calls for above-normal rainfall. Once again, there is much variability across space. A majority of households in relatively wetter, agro-pastoral sites reported that they make cultivation decisions on the basis of above-average rainfall expectations. These same households tend to take rainfall expectations into account when making herd management decisions, although their response to climate forecasts is stronger with respect to cultivation practices than to herd management practices. In general, it appears that cultivators are far more inclined to use forecast information than are herders. Pastoralists move their herds based on scouting reports of realized rainfall and range conditions, not on the basis of forecasts.

The 1998 El Niño floods and the severe 2000 drought have piqued widespread interest in the potential role for emerging climate forecasting technologies in mitigating natural disasters in the dry lands of the Greater Horn of Africa. Preliminary results from our survey suggest, however, that weather forecasts are not especially limiting factors in these populations' struggle to survive. Few of our respondents access, have confidence in, or use modern weather forecasts. Most do not even use the traditional forecasts in which they express at least some confidence. This evidence calls into question arguments that improved production and dissemination of weather forecasts should be a high priority investment as donors and governments strive to reduce pastoralists' vulnerability to drought and other weather-related shocks.

Activity 4: Training for US-Based African Graduate Students, led by Drs. Chris Barrett and Peter Little

Progress. Ms. Winnie Luseno completed the second year of her Ph.D. program in Agricultural Economics at Cornell University under the guidance of Dr. Barrett. She finished

her course work and sat for qualifying exams in August. She traveled to Kenya in late September of 2001 to begin fieldwork. Her research focus deals with understanding the following issues: (1) How transaction costs associated with search and bargaining and price risk affect the marketing behavior of pastoralists; (2) how the institutional structure of markets (dyadic versus auction-based systems) affect conditional price-distributions faced by pastoralists; (3) how market and climate information might affect pastoral livestock management and marketing behavior; and (4) how frictions in market systems affect the value of climate and market information.

Mr. Amare Teklu is likewise a second year doctoral candidate in Agricultural Economics at Cornell University under the guidance of Dr. Barrett. He completed his course work and also sat for qualifying exams in August. His research focus deals with crop-livestock integration in the study region, exploring the role of limited livestock herds in ameliorating poor soils and il-liquidity for the poor who have been driven off the rangelands to live in the proximity of towns and settlements. Mr. Teklu also wants to explore the role of livestock in soil nutrient cycling in these settings. Better use of livestock manure could enable more efficient production of high-value, nutrient-demanding cash crops like vegetables and contribute to sustainable agricultural diversification among peri-urban agro-pastoral producers.

Mr. Hussein Mahmoud is a doctoral candidate in Development Anthropology at the University of Kentucky. His advisor is Dr. Peter Little. Since Mr. Mahmoud has begun fieldwork and produced preliminary results, his efforts are documented above under Activity 3.

Activity 5: Action Research in Support of Pilot Risk Management Interventions, led by Dr. Solomon Desta with Participation by Dr. Layne Coppock, Dr. Francis Lelo, Dr. Getachew Gebru, Mr. Naseer Mohamed, Mr. Kebede Folle, and Others.

Problem Statement and Approach. In the GL-CRSP Annual Report 2000, the Outreach Unit of the PARIMA project was described. The overall goal of the Outreach Unit is to increase awareness and build capacity among project beneficiaries, development partners, and policy makers for implementation of risk management interventions. One component of the PARIMA outreach activity is the initiation of pilot risk-management interventions among pastoral communities in southern Ethiopia. In this role PARIMA serves as a catalyst to promote more creativity in pastoral development initiatives and tries to increase awareness among development agents and pastoralists regarding the key role of risk management interventions. In general, the approach has involved: (1) Training local development agents (representing GOs and NGOs) in Participatory Rural Appraisal (PRA) techniques to better diagnose priority problems of communities; (2) providing a framework whereby communities partner with development agents and submit proposals for funding pilot intervention concepts; (3) facilitating implementation of pilot interventions by development agents; and (4) partnering with development agents and the USAID Mission to Ethiopia to document impacts of intervention through an active, reiterative monitoring and evaluation process we refer to as "action research." Action research involves a rapid analysis of step-wise constraints encountered after pilot interventions have been implemented. Remedial efforts are then recommended to overcome constraints and help make the intervention successful. Funds to support pilot interventions have been provided under the

Figure 5. Participants at the PARIMA Second Biennial Research and Outreach Workshop for Kenya and Ethiopia, held at Egerton University, Njoro, Kenya, from June 24 to July 3, 2001. Photo by John Muniu.

auspices of the Southern Tier Initiative of the USAID Mission to Ethiopia. Other details of the outreach approach, including description of the African advisory group known as the Outreach Review Panel (ORP), is summarized in Outreach Section below.

Progress. In 2001 the ORP of PARIMA received eight community proposals for funding consideration. All were based on a full or partial PRA conducted by development agents recently trained by the Egerton University PRA team and that also have participated in the PARIMA Outreach Network since 1998. Most of these community proposals have been at least recently approved for funding after one or two revisions. Two, however, were in the initial stages of implementation by September 2001. These proposals involved the Dida Hara community, located about 50-km southeast of the town of Yabello on the Borana Plateau. The development partner is Action for Development (AFD), an indigenous Ethiopian NGO with an office in Yabello. The AFD has worked on the Borana Plateau for about 10 years. A full PRA revealed that the people wanted better access to education and a means to create a local savings and credit capability. Therefore, one proposal deals with establishing five savings and credit associations for 175 households at a cost of USD 18,000 over one year. The second proposal deals with creating a non-formal rural education center to serve about 660 men, women, and children. The cost for this is USD 15,000 over three years. Both AFD and the community must contribute a 25% match for each proposal. By the end of Year 4 PARIMA was partnering with the monitoring and evaluation specialists of the USAID Mission to Ethiopia (Mr. Naseer Mohamed, Mr. Kebede Folle) and the staff of AFD to devise a process of baseline documentation and action research covering impact documentation for both proposals. The AFD has been involved in several forms of community-led development in recent years. Their track record includes establishment of several savings and credit groups and several non-formal education centers in the Yabelo area in the past five years.

Activity 6: Second Biennial Workshop and PARIMA Regionalization, led by Dr. Layne Coppock and Prof. Abdillahi Aboud with Participation by the Full PARIMA Team.

Problem Statement and Approach. The PARIMA project holds a comprehensive

Figure 6. Poster session at the PARIMA Second Biennial Research and Outreach Workshop for Kenya and Ethiopia. Photo by Susan Johnson.

workshop every two years. Progress in research, outreach, and training is reviewed and changes in project orientation may occur as a result of input from participants. The first biennial workshop was held in Addis Ababa in 1998 and attracted over 80 participants. The second was held at Egerton University in Njoro, Kenya, in late June and early July of 2001, and attracted over 75 participants (Figure 5). Unlike the first workshop, however, the second also had an objective to regionalize PARIMA beyond Kenya and Ethiopia. We therefore invited representatives from the Livestock Production Research Institute (LPRI) of Tanzania and the National Agricultural Research Organization (NARO) of Uganda to attend the Njoro meeting. We saw them as future participants in pilot action-research activities modeled after our experiences in southern Ethiopia (see Section 2 under Activity 5 above and Outreach Section below). Funding for the workshop came from PARIMA core monies, the USAID Mission to Ethiopia, and the GL-CRSP Management Entity.

Progress. We feel the second biennial workshop was a success. The program started on June 24 and ended on July 3. The first two days were informal and allowed for meetings of the PARIMA research team and the Outreach Review Panel (ORP). Formal workshop sessions occupied the next two days. Nineteen presentations and three discussion sessions

Figure 7. Participants in the Participatory Rural Appraisal (PRA) short-course held during the PARIMA Second Biennial Research and Outreach Workshop. Photo by Susan Johnson.

comprised the formal agenda. A poster session to display research for Egerton graduate students and non-PARIMA professionals was held on the third evening (Figure 6). Following the formal workshop sessions, a day-long field trip around Baringo District was held for over 50 participants. This was valuable to introduce many participants to the special development and conservation problems facing Rift Valley ecosystems and helped promote fellowship within the network. On the day after the field trip a special short-course was held in Participatory Rural Appraisal (PRA). It was taught to about 20 participants from Kenya, Ethiopia, Uganda, and Tanzania by Dr. Francis Lelo and his expert PRA team over several days. Participants included students, researchers, and policy makers (Figure 7).

Content of some of the key presentations is reflected in the activities above. More detailed documentation is available in the Summer 2001 issue of the GL-CRSP Ruminations newsletter and in forthcoming workshop proceedings (see Publications).

GENDER

Gender dimensions of our project are reflected in terms of: (1) How our team is organized; (2) research questions and issues being pursued; (3) how training benefits are allocated; and (4) types of people participating in our outreach. For example, we have two female scientists on our team, namely Dr. Cheryl Doss of Yale University and Dr. Nancy McCarthy of IFPRI. Both are economists. We are studying how risk affects female pastoralists differently from males. It is well known that perturbations in our study region often result in female-headed households being re-established nearer to towns and settlements. These are often the poorest households with few assets. These women heads of households are often forced to diversify their income-generating activities to survive. These women are a major focus of our research and outreach efforts. We have given various forms of support to female trainees in our project. During this year a Kenyan woman (Ms. Winnie Luseno) has continued in her PhD program in economics at Cornell. An American woman named Sharon Osterloh was matriculated this year at Cornell and started her fieldwork on rural finance in northern Kenya. For our outreach network we have included roughly 52 organizations, with 25 in Ethiopia and 27 in Kenya. Senior women represent nine of these organizations in the network. We have also initiated a 10-member Outreach Review Panel (ORP) that will help guide outreach efforts. There are currently three senior women on this review panel including Ms. Miriam Cherogony, a Kenyan specialist in rural finance, Ms. Felekech Lemecha an official with the Oromia State government in Ethiopia, and Ms. Allyce Kureiya, a Kenyan pastoral development specialist working with an NGO in Isiolo.

POLICY

We have two main goals regarding policy. The first is to build a general awareness of our existence among key policy makers and institutions. The second is to engage key policy makers in project activities. To achieve the first goal we have continued to widely distribute copies of project publications. To achieve the second goal we have invited key individuals to workshops, field tours, and training opportunities—and they have responded. Policy makers have attended our workshops and given presentations, and have even participated in short-courses in topics such as Participatory Rural Appraisal (PRA) at project expense. We feel this process of gradual engagement is working fairly well.

OUTREACH

The Outreach Unit of the PARIMA project has been previously introduced in the GL-CRSP Annual Report 2000 and some activities have already been alluded to here. One focus of the Outreach Unit is dissemination of project research results within an Outreach Network consisting of over 50 organizations in Ethiopia and Kenya. During the past year we have worked to keep our network membership lists updated and our project website current (this can be viewed at www.cnr.usu.edu/research/crsp) A second focus of the Outreach Unit comes from a pilot project funded under the auspices of the Southern Tier Initiative (STI) developed by USAID Mission to Ethiopia. The STI was initiated in 2001 and is a five-year plan to promote development impact in the southern rangelands of Ethiopia. The STI is reviewed in the Winter 2000 issue of Ruminations). The overall goal of our pilot project is to develop a sustainable capacity for risk- management intervention in the southern Ethiopian rangelands.

The general objectives of the pilot project include:

(1) Increasing awareness and build capacity among project beneficiaries, development partners, and policy makers for implementation of risk management interventions. This involves transfer of information and capacity building for communities, development agents, and policy makers;

(2) Facilitating implementation and monitoring of at least five community demonstration projects by September 2002. Such projects are intended to help empower pastoral and agro-pastoral communities to better conserve and create wealth as well as to diversify and increase their incomes and assets to enable them to cope more effectively with drought and problems related to increasingly restricted access to natural resources. The project will rely on a participatory approach where communities take a lead in problem identification and design of interventions; and

(3) Documenting interventions and outcomes to guide future development initiatives.

The pilot project began its activities with a reconnaissance of southern Ethiopia and northern Kenya in late 1999 and 2000. Public discussions were held with pastoral and agro-pastoral communities to review how people could better cope with emerging negative trends in their production systems. About 30 communities were visited, with 20 in Ethiopia and 10 in Kenya. Focus groups were formed to discuss and identify real needs. In most cases, issues of marketing, efficient use of natural resources, and need for education and economic diversification emerged as dominant. The reconnaissance process has largely confirmed that our PARIMA problem model is on track and gave us ideas as to how to further develop outreach activities. We were convinced that broad-based community participation was a foundation for effective interventions.

A structure and protocol for outreach at the grass-roots level has been created. The structure now consists of about two-dozen governmental and non-governmental development partners that are active and distributed throughout our study region. The PARIMA project interacts with outreach partners through the Outreach Coordinator and the Outreach Review Panel (ORP). The ORP is an elected body of 10 distinguished African development professionals that guide outreach activities. PARIMA's effort to create the network of the partners began in 1997/8 and has been evolving and maturing since then. In Ethiopia we have developed strong relationships between PARIMA and the Oromia Agricultural Development Bureau (OADB), the Oromia Cooperative Promotion Bureau (OCPB), Action for Development (AFD), Volunteers for

Overseas Cooperative Action (VOCA), Save the Children USA (SCF/USA), and Norwegian Church Aid (NCA/EECMY). In Kenya our strongest relations are between PARIMA and the Arid Lands Resource Management Project (ALRMP), the Community Initiatives Facilitation and Assistance (CIFA), the Pastoral Integrated Support Program (PISP), and the Moyale (Kenya) District Agricultural and Livestock Extension Office (MDALEO) .

As part of the effort to raise awareness among development agents on risk management principles and the importance of risk management in planning development interventions, the Outreach Coordinator held a number of informal meetings and discussions on risk management principles with development organizations operating in the project area. Development organizations such as SCF/USA, NCA/EECMY, AFD, the Borana Zone Agricultural Development Department (BZADD) and the Borana Zone Cooperative Promotion Department (BZCPD) have started to include risk management in their field programs.

As part of an effort to facilitate sharing of experiences among development agents in Kenya and Ethiopia, PARIMA facilitated a one-day exchange visit to Sololo, Kenya for a team of development workers from Moyale, Ethiopia and Yabello. The ALRMP and MDALEO in Kenya helped coordinate the visit.

Two workshops intended to explain the implementation strategy of PARIMA's Outreach program were held in Negelle and Yabelo in October 2000. A total of 50 persons attended both workshops. Participants were from our partner organizations and some ORP members also attended. The forum was used to invite submission of community-based proposals for funding consideration by the ORP. A proceedings has been prepared (see Publications).

A PRA course for 41 development agents from GOs and NGOs operating in the project area, and who are partnering with PARIMA to implement pilot risk management projects, was organized in February 2001. This was intended to increase the capacity of development agents to assess community's real needs and develop solutions and implement projects in a sustainable manner. The training was held at Yirga Cheffe, Didahara, and Finchewa. The training was co-hosted by PARIMA and VOCA. The training was given by Dr. Francis Lelo from the Dept. of Environmental Sciences at Egerton University, Kenya. Following the theoretical training a field PRA was done with communities in Didahara and Finchewa. The exercise benefited the two communities in terms of building their capacity to identify and plan their own development needs. Both communities produced a Community Action Plan (CAP) for their respective areas.

PARIMA has been working closely with partner organizations to develop community-based risk management intervention proposals for funding consideration by the ORP. Eight proposals were developed and submitted. Two proposals (savings and credit and non-formal education or NFE) from the Didahara community were funded and are under implementation. The local NGO Action for Development (AFD) is assisting the Didahara community to implement the projects. The other six proposals have been reviewed by the ORP and have been approved for funding. Final comments have been solicited from USAID Ethiopia prior to implementation.

A cross-border information sharing, activity harmonization, and problem-solving workshop for pastoralists, development agents, livestock traders, and policy makers from Ethiopia and Kenya was held in Moyale, Kenya, during May 2001. About 50 persons attended. The workshop was co-hosted by PARIMA and CIFA. The BZADD played a key role to facilitate participation of the Ethiopians.

A review of community proposals was conducted on June 25, 2001 by the Outreach Review Panel. The panel discussed draft criteria prepared by the Outreach Coordinator for proposal evaluation, ranking, and prioritization for funding. After reviewing and modifying the draft, the panel members unanimously approved the document, henceforth called the Community Proposal Review Document (CPRD). Subsequently, the ORP used the agreed criteria to evaluate and rank six community proposals. All proposals scored above the minimum expected value (60) for funding eligibility. These proposals were (1) the Korate Savings and Credit Cooperative; (2) the Liben Milk Groups; (3) the Negelle Savings and Credit Women's Groups; (4) the Negelle Fisheries project; and (5) the Kargi Water Development Project. The ORP made useful comments on each proposal that need to be addressed by each implementing agency. All proposals except the Negelle Fisheries Project have been subsequently resubmitted after incorporating ORP comments. The USAID Mission in Addis Ababa now has copies of the proposals and we await comments.

Training on rural finance, small business development, community planning, and proposal writing was conducted during a 12-day course during late July and August 2001. As part of the effort to build the capacity of development agents to assist communities in the creation and management of savings and credit entities, identification of viable non-pastoral economic opportunities is needed. Development agents were seen to also be in need of learning how to write proposals to help communities solicit donors for seed funds. We felt it was thus important to train development agents in these skills. PARIMA therefore recruited and funded 19 participants to enroll in a short-course at the Furra Institute of Development Studies in Yirgalem, southern Ethiopia. The course had the following components: (1) Saving and credit scheme management; (2) small business development and management; and (3) project planning and proposal writing. The trainees included six female and 13 male development workers. The trainees were selected from the BZADD, the BZCDD, SORDU, and from NGO partners working with PARIMA as key actors in community outreach.

PARIMA facilitated its first pilot-project intervention in the Didahara madda in Yabelo Wereda. Currently two projects (savings and credit groups and non-formal education) are under establishment by the Didahara community (see Activity 5). Action for Development (AFD), an indigenous NGO, is the implementation agent. Five savings and credit groups, with a total membership of 175 people, has been established in Didahara by AFD with seed funding from PARIMA. Ledger and passbooks for each member have been issued and by-laws prepared. The process to get the groups legally registered and opening of a central bank account is underway. Regular weekly sessions on savings and credit issues has begun at Didahara under the guidance of AFD. The non-formal education centers were built in two sites accessible to all community members. Enrollment is expected to be around 660 people including adults and children. Registration has started and lessons will commence soon. A non-formal education officer has been employed by the community and recruitment of teachers is underway.

In order to upgrade PARIMA's physical presence in the pilot project area and increase efficiency in implementation, we established a field office at Yabelo. An outreach field supervisor, based in Yabelo, has been employed and started work on July 1, 2001. Given our cordial development relationship with SORDU we were given an office space in SORDU campus. Office furniture and field equipment have been procured with PARIMA funds.

We are still soliciting for additional

community proposals. We recently received a proposal from the Telemado community near Moyale. They want to establish a savings and credit cooperative. The Moyale branch of the BZCPD will be the implementation agent in this project. The proposal will be submitted to the ORP for evaluation.

A follow-up cross-border workshop to the one held in Moyale, Kenya, was conducted for two days (September 6 and 7, 2001) in Yabelo. It was attended by 110 participants (102 male and 8 female) of which 30 (3 female and 27 male) were from northern Kenya. Two of the Kenyan women who participated are members of the Umoja and Borole Women's Groups in Sololo. Both made a presentation on their group experiences to workshop participants. The workshop served to direct the attention of the participants of the two countries to note their common problems and concerns and work towards mutual solutions to help overcome problems. It creates a benefit in terms of transferring skills and knowledge from one side of the border to another. The forum was useful to start to work on ideas and identify practices they can easily adopt from each other. Participants focused on major problems such as drought, marketing, animal health, and conflict in which they can work together for mutual benefit. The workshop created an opportunity for the entire group to begin to think about lobbying on policy-related matters. Considerable enthusiasm was demonstrated by workshop participants. Four "cross-border committees" were formed dealing with drought, marketing, animal health, and peace building. Each committee developed its goals and objectives and expected outputs. A steering committee to facilitate and strengthen cross-border collaboration was also formed. The steering committee will help maintain and strengthen interaction across the border and will assist the four committees in their efforts to achieve their objectives. The steering committee consists of members from community representatives, local administration, policy makers, GOs, and NGOs active in northern Kenya and southern Ethiopia. The PARIMA and CIFA of northern Kenya will continue to play a facilitation role until the steering committee and the other four committees become strong and self-sufficient. The BZADD and SORDU played a vital role in the organization of the workshop. The Borana Lowlands Pastoral Development Project (BLPDP/GTZ) made a financial contribution to bring in community representatives from Negelle to attend the workshop.

Planning for an educational cross-border tour for pastoral women from the Borana zone started in September 2001. During the preliminary field reconnaissance by the PARIMA Outreach Coordinator in northern Kenya during 2000, several Borana women's groups were encountered that have achieved fairly remarkable things over the past decade in terms of wealth accumulation, economic diversification, and provision of community social services. These groups could serve as development models for similar situations in Ethiopia. We see linking Ethiopian women with these Kenyan women's groups as a vital step to build awareness of possible activities and outcomes among the Ethiopians. A field tour is planned to take 25 pastoral and agro-pastoral women from southern Ethiopia to northern Kenya under the supervision of various development partners. The women will be taken as far south as Marsabit in Kenya This will occur in December 2001. In the course of planning the tour we have set selection criteria and initiated communication with concerned authorities (security, immigration, administration, etc). The pastoral women will have the opportunity to see other pastoral development activities including pastoral children education centers, non-formal education centers, skill development centers, etc. We are working closely with Kenya's ALRMP,

CIFA, and MDALEO to make the tour as productive as possible.

The Fourth Quarter ORP coordination meeting for Ethiopia was held on September 10, 2001 at Ato Sora Adi's office (BLPDP/GTZ) in Addis Ababa. The purpose was to review outreach progress and planning. Ato Sora Adi, Ato Dadi Amosha, Ato Aliye Hussien, Dr. Getachew Gebru, and Dr. Solomon Desta attended the meeting. Dr. Solomon briefed the ORP on progress. The group was generally happy with the achievements of the program to date. Given new re-structuring of the OADB, the ORP recommended that it should now include a representative from the Natural Resource Development and Environmental Protection Authority (NRDEPA). It was also suggested to link the ORP and PARIMA with regional and zonal representatives of trade, industry, tourism and education to keep policy makers informed. This is particularly important concerning PARIMA's involvement in marketing and non-formal education in the southern Ethiopian rangelands.

Development Impact

Perspectives on developmental impact remain the same as noted in previous Annual Reports. These are summarized below.

Environment. The benefits of our project to the environment are indirect rather than direct, and medium- and longer-term rather than short-term. Our basic position is that improved risk management will mitigate asset loss and poverty among pastoralists and agro-pastoralists. When poverty is mitigated, risk to the environment will lessen. For example, one tenet of our approach is that pastoralists need to make more pre-emptive moves to mitigate crisis induced by drought and growing human populations. One tactic is to sell some animals before a crisis occurs, and use the funds received as household-level savings and community investments. The success of this depends on well-functioning markets, credit union formation, education, etc. The idea is that if such a tactic can be successfully used across a society, the rate of growth in stocking rates would be mitigated. This would reduce the specter of heavy stocking rates on the land during years of lower-than-average rainfall, which is the key window when range vegetation can be degraded. The "boom and bust" in the cattle cycle would also be dampened as a result. The build up in non-livestock capital and investment would then permit societies to diversify their economies. This diversification could spur growth of urban job opportunities and mitigate the incidence of poverty among pastoral and agro-pastoral households. Mitigating poverty would then reduce the specter of poor people being engaged in destructive activities such as charcoal making, harvesting of green fuel wood, and opportunistic cultivation.

Agricultural Sustainability. A sustainable agriculture is one where interventions are: (1) beneficial—or at least neutral—for the environment; (2) socially acceptable; and (3) economically profitable. The premise behind our project is that, left to their own devices, traditional pastoral or agro-pastoral production systems in our study region are unsustainable. For example, there is a loss of land to population growth and environmental degradation. There is an unraveling of the traditional social order in some cases, which can often be traced to competition for limited resources. There is abundant evidence that whether due to poor demand, bad infrastructure, and/or inadequate marketing strategies of producers, pastoralism in the region is typically unprofitable. Evidence of unsustainability includes things like the chronic need to feed tens of thousands of people in the region each year, the re-location of poor households nearer to towns and settlements

where they engage themselves in petty trade to stay alive, and the increasing poverty and declining living standards of pastoralists in general. By coming up with risk management tools, which in part should allow pastoralists and agro-pastoralists to save and invest outside of their traditional sphere, the resulting investment surge for education and entrepreneurial activity in towns and settlements should primary lead to growth of local economies with benefits for the environment, social order, and pastoral economy. As outlined immediately above, our risk management interventions range from neutral to positive for the environment, which conforms to the first criterion of sustainable agriculture. Accumulation of wealth and efforts to mitigate social conflicts should allow the social fabric to heal—poverty is bad for the maintenance of traditional cultures. This fits the second criterion. The third criterion is dealt with by several economic outcomes that vary in terms of the relevant time scale. Short-term benefits would include an expansion of local markets for pastoral products. Longer-term benefits would include allowing more pastoralists to emigrate out of the traditional sector due economic diversification and increased employment opportunities in towns and settlements. Facilitation of emigration is the ultimate humanitarian solution to the risk-management dilemma for pastoralists. This is because population growth reduces resources per capita and therefore increases vulnerability of populations to endogenous and exogenous shocks.

Contributions to United States Agriculture. The main contribution of this project to United States agriculture is primarily in terms of providing a "wake-up call" for research and extension professionals to the importance of risk management for the small to average-sized livestock producer. As will be noted below, the need for risk management by American producers may be increasing as profit margins get slimmer and the social and economic complexity of agriculture increases. It is fair to say that a commodity perspective has been pre-eminent in agricultural research and outreach in the United States. This has contributed to a lack of a relevant systems approach that could better integrate academic disciplines and deal more-effectively with real-world problems. Risk management can be an important contribution in this regard. Risk management is simultaneously economic, social, and ecological. The ability to better manage risks is an important attribute of successful farmers and ranchers. While livestock producers in the United States are under no imminent threat of starvation or extreme destitution comparable to pastoralists in northern Kenya or southern Ethiopia, there are commonalities in terms of how risks are conceptualized and interact to cause problems. For example, it has been forwarded by Holechek et al. that beef producers in New Mexico should diversify their assets and investments to mitigate economic downturns that repeatedly result from cyclic fluctuations in beef prices. This is exactly the same concept that we have for East African pastoralists. Education and access to investments are the main constraints for New Mexico ranchers—similar to prominent implementation constraints for East African pastoralists. Whether drought cycles are predictable or not, and the possible influence of phenomena like El NiÒo on precipitation regimes, is a core issue of debate for agriculture in the United States as well as East Africa. Global trade affects the United States beef producer and the East African pastoralist. The advent of the North American Free Trade Agreement (NAFTA) could serve to dampen peak prices received by American cow-calf operators because of increased importation of cheaper Mexican beef. Research remains to be done that could confirm this widely held suspicion. The specter of NAFTA, however,

probably influences behavior of American producers by increasing their perceived risk on prices and possibly discouraging production investment. Currently, the cross-border flow of live cattle is officially restricted between between Ethiopia and Kenya. We do not know the rationale for this restriction, nor its effects on household economics on either side of the border. Answers to this will be provided by applied research on the GL-CRSP, which may shed new light on the costs and benefits of free trade in general—even as applicable to agriculture in the United States. Our project will communicate such findings and influence the American research community, and hence the United States agricultural community, through a variety of research and outreach publications.

Contributions to Host Countries. Contributions to our host countries will mostly be felt through our outreach activities (described above) and training of host-country nationals. Outreach will primarily have impact on project beneficiaries—pastoralists and agro-pastoralists—but it will also have impact on development professionals and their organizations that link to us directly. In the training sphere our past contributions have also included computers, books, sponsorship for people to attend international conferences and other technical support for our main academic partner in Kenya, Egerton University.

Linkages and Networking. This has been previously covered in our section on Outreach.

Collaboration with IARCs and Other CRSPs. We collaborate with the International Livestock Research Institute (ILRI) in both Ethiopia and Kenya. We typically hold our workshops at ILRI conference facilities. Some administrative and logistical support for field work is provided to us by ILRI. We have a link to the Livestock Policy Analysis Program (LPAP). Dr. Nancy McCarthy is an economist affiliated with LPAP and the International Food Policy Research Institute (IFPRI) has been a member of our GL-CRSP team. We have been strengthening ties in the past year to the Crisis Mitigation Office (CMO), created under the auspices of ASARECA, headed by Dr. Jean Ndikumana of ILRI-Kenya. We have research links to an animal health group, also at ILRI-Kenya, led by Dr. Tom Randolph.

The other CRSP we link to is the BASIS CRSP. Drs. Peter Little and Christopher Barrett, Co-PIs on the GL-CRSP, and Prof. Abdillahi Aboud, regional co-leader of the GL-CRSP, are also co-leaders on the BASIS CRSP. The GL-CRSP and BASIS CRSP share an interest in policy and economic issues that deal with cross-border relations.

Other Contributions

Support for Free Markets and Broad-Based Economic Growth. Interventions that will be advocated by our project will be in direct support of free markets and economic growth. Some of this has been previously described. This prominently involves linkages between markets and formation of benefits-oriented cooperatives to empower pastoralists at the local level. At our recent biennial workshop in Njoro, some presentations dealt with outreach ideas to assist pastoralists to form their own cooperative associations to spur development processes—the idea being that a local association could form and pool capital resources to first organize a community savings and credit association. This would be an impetus for the group to procure production inputs and invest to improve their marketing capability to make themselves less vulnerable to trading bottlenecks. A group, for example, could purchase a large truck and independently handle livestock shipping. The outreach entity would only provide the initial training and a few select inputs to get it rolling.

The success of such an endeavor would rely heavily on the availability of livestock and grain markets and their efficiency of operation. Taken together, these elements all reflect the functioning of free markets, a role for agribusiness, and developing a capability for pastoralists to empower themselves using private enterprise.

Contributions to and Compliance with USAID Mission Objectives. Our project contributes to and complies with Mission objectives in each country by dealing with food security, economic growth, the environment, and privatization issues. We have solid contacts with prominent people in USAID Missions in both Kenya and Ethiopia.

Concern for Individuals. Our project incorporates a concern for individuals in several ways. One is through technical and advanced training opportunities, with a focus on host-country nationals at the master's and PhD level. Training details are given in a subsequent section. Other evidence is provided by how we have organized our applied research and outreach. For research, we realize that improved risk management will ultimately occur at the level of the individual. For outreach, priorities like public education, conflict mitigation, and formation of benefits-oriented cooperatives are a testimony to the value we place on helping individuals improve their lives by being able to deal with risk by making more-informed choices.

Support for Democracy. Voluntary, benefits-oriented producer cooperatives are one form of grass-roots democracy in action. We have also been asked by our outreach partners to help pastoralists in pilot projects to better communicate their needs and desires to local politicians.

Humanitarian Assistance. Our program of applied research and outreach is the embodiment of humanitarian assistance. Outreach will, in large measure, help set an agenda to guide more research as well as outreach. Research will therefore will very relevant to solving problems related to the "human condition" in the study region.

Leveraged Funds and Linked Projects

We had several sources for leveraged funds in East Africa during 2000-01. The International Livestock Research Institute (ILRI) contributed USD 2,000 to our project in accommodation costs. Egerton University has again contributed about USD 7,200 in salary support for PARIMA team members Aboud and Lusenaka, tuition waivers and stipend support for PARIMA students.

In addition, both VOCA (Ethiopia) and CIFA (Kenya) contributed funds in support of various workshops described in the outreach section. This includes support of PRA instructors and travel costs for workshop participants. We estimate this contribution to be about USD 5,000. Overall, the in-region leveraging adds to USD 14,200.

For leveraging in the United States, this has almost exclusively come from Cornell University. Leveraged stipend or operating support for activities of Ms. Sharon Osterloh and Ms. Winnie Luseno is estimated as USD 7,500 for the year.

Our project is linked to many other efforts dealing with outreach and research. For outreach, we have developed linkages to a variety of local, grass-roots development projects in southern Ethiopia and northern Kenya. Prominent organizations in this network include the OADB in Ethiopia, Bilateral German Aid (GTZ in Negelle), SCF/USA (Negele), NCA (Yabelo and Mega), and the ALRMP throughout northern Kenya. For research, our project has a link to several projects. Prof. Abdillahi Aboud

and Drs. Peter Little and Chris Barrett, all project co-leaders in the GL-CRSP, also work with the BASIS CRSP. Dr. Nancy McCarthy is primarily associated with the Property Rights Project in the Livestock Policy Analysis Program (LPAP) at ILRI. In the United States, our project is linked to a new effort at Utah State University led by Dr. Paul Box entitled "A GIS-Based Cellular Automata and Individual-Based Model Simulation Environment." This project provides a GIS framework and spatial modeling capability for our analyses of our project region in northern Kenya and southern Ethiopia. Our project is also linked to an older effort at Utah State University funded by USDA-SARE program and the Utah Agricultural Experiment Station and led by Dr. Layne Coppock since 1995. This involves identification of prominent threats to the sustainability of Utah ranching operations. The need that Utah producers have for improved risk management is a major issue emerging from this work, and provides an important conceptual link between pastoral situations in the western United States and East Africa.

Training

Degree, Completed

Mulugeta Shibru. MS. 2001. Natural resource social science. Egerton University, Njoro, Kenya.

In Progress

Moses Esilaba. MS. 2002. Natural resource social science. Egerton University, Njoro, Kenya

Clement Lenachuru. MS. 2002. Natural resource social science. Egerton University, Njoro, Kenya.

John Tangus. MS. 2002. Natural resource social science. Egerton University, Njoro, Kenya.

Sharon Osterloh. MS. 2002. Agricultural Economics. Cornell University, Ithaca, New York, USA.

Abdullahi Dima Jillo. MS. 2003. Natural resource social science. Egerton University, Njoro, Kenya.

Godfrey Nyongesa Nato. MS. 2003. Natural resource social science. Egerton University, Njoro, Kenya.

Waktole Tiki Uma. MS. 2003. Natural resource social science. Egerton University, Njoro, Kenya.

Hussein Mahmoud. PhD. 2003. Development Anthropology. University of Kentucky, Lexington, Kentucky, USA.

Winnie Luseno. PhD. 2004. Agricultural Economics. Cornell University, Ithaca, New York, USA.

Amare Teklu. PhD. 2004. Agricultural Economics. Cornell University, Ithaca, New York, USA.

Nancy McCarthy. Post-doctoral associate. 1998- present. Economics. International Livestock Research Institute, Nairobi, and the International Food Policy Institute, Washington, DC.

John McPeak. Post-doctoral associate. 1999-present. Economics. Cornell University.

Solomon Desta, Post-doctoral associate. 1999-present. Outreach Coordinator. Utah State University.

Getachew Gebru, Post-doctoral associate. 2000- present. Animal production systems. Utah State University.

Short-Term

Introductory Risk Management Workshops. Sponsored by PARIMA and the USAID Mission to Ethiopia. Held for two days each at Yabelo and Negelle in southern Ethiopia during October 2001. Fifty participants attended both workshops.

Participatory Rural Appraisal (PRA) Training Course. Jointly sponsored by PARIMA, the USAID Mission to Ethiopia, and Volunteers

in Overseas Cooperative Action (VOCA-Ethiopia), with training conducted by the Egerton University PRA Training Unit. Held for two weeks during February 2001 at Yirga Chaffee, Finchewa, and Didahara in southern Ethiopia. Forty-one participants trained in PRA.

First Cross-Border Harmonization Workshop for Kenya and Ethiopia. Jointly sponsored by PARIMA, the USAID Mission to Ethiopia, and the Community Initiatives Facilitation and Assistance (CIFA) of Kenya. Held for two days at Moyale, Kenya, during May 2001. Fifty participants.

Fourth Annual PARIMA Project Planning Meeting. Sponsored by PARIMA. Held for one afternoon at Egerton University, Njoro, on June 25, 2001. Ten participants.

Second Biennial Research and Outreach Workshop for Kenya and Ethiopia. Sponsored by PARIMA and the USAID Mission to Ethiopia. Held for four days at Egerton University, Njoro, Kenya, during June 2001. Seventy-five participants.

Participatory Rural Appraisal (PRA) Training Course. Sponsored by the GL-CRSP Management Entity and organized by PARIMA. Training was conducted by the Egerton University PRA Training Unit. Held for four days during late June and early July 2001 at Egerton University, Njoro, Kenya. Twenty participants trained in PRA.

Extension Training to Support Small-Scale Economic Diversification, Rural Finance, and Development Proposal Preparation. Sponsored by PARIMA and the USAID Mission to Ethiopia. Training was conducted by staff of the Furra Institute of Development Studies in Yirgalem, Ethiopia. Held for two weeks during August 2001. Nineteen participants.

Second Cross-Border Harmonization Workshop for Kenya and Ethiopia. Jointly sponsored by PARIMA, the USAID Mission to Ethiopia, and Community Initiatives Facilitation and Assistance (CIFA) of Kenya. Held for two days at Yabelo, Ethiopia, during September, 2001. One hundred and ten participants.

COLLABORATING PERSONNEL (RESEARCH)

United States

Dr. DeeVon Bailey. Professor, Department of Economics. Utah State University, Logan, Utah.

Dr. Christopher Barrett. Associate Professor, Department of Applied Economics and Management. Cornell University, Ithaca, New York.

Dr. Paul Box. Assistant Professor, Department of Geography & Earth Resources. Utah State University, Logan, Utah.

Dr. Layne Coppock. Associate Professor, Department of Rangeland Resources. Utah State University, Logan, Utah.

Dr. Cheryl Doss, Director of Graduate Studies, International Relations Program.Yale University, New Haven, Connecticut.

Dr. Peter Little. Professor, Department of Anthropology. University of Kentucky, Lexington, Kentucky.

Ethiopia

Dr. Simeon Ehui. Head, Livestock Policy Analysis Program. International Livestock Research Institute (ILRI).

Dr. Gezahegn Ayele. Research Economist, Ethiopian Agricultural Research Organization (EARO).

Ms. Janet Paz Castillo. Project Development Officer, USAID Mission to Ethiopia.

Mr. Naseer Mohamed. Monitoring and Evaluation Specialist, USAID Mission to Ethiopia.

Ato Dadhi Amosha. Technical Expert and PARIMA Liaison, Oromia Agricultural Development Bureau (OADB).

Mr. Steve McCarthy. Technical Expert, Volunteers in Cooperative Action (VOCA).
Dr. Tafesse Mesfin. Technical Expert, FARM Africa.
Dr. Fisseha Meketa. Senior Expert, Save the Children (SCF/USA).
Ato Sora Adi. Senior Expert, Borana Lowlands Pastoral Development Project (BLPDP/GTZ).
Ato Aliyu Hussen. Research Coordinator, Oromia Agricultural Development Bureau (OADB)
Wzo. Feleketch Lemecha. Senior Staff Member, Oromia Agricultural Development Bureau (OADB).

Kenya

Prof. Abdillahi Aboud. Associate Professor and Dean, Faculty of Environmental Studies and Natural Resources (FESNARE), Egerton University.
Mr. Frank Lusenaka, Lecturer, Department of Natural Resources, Egerton University.
Dr. Jean Ndikumana, Team Leader, Crisis Mitigation Office (CMO), International Livestock Research Institute (ILRI).
Ms. Miriam Cherogony, Staff Member, K-REP Development Agency.
Ms. Allyce Kureiya, Staff Member, SNV-Isiolo.
Mr. Boru Halake, Staff Member, Arid Lands Resource Management Project (ALRMP).
Mr. Godana Doyo, Staff Member, Arid Lands Resource Management Project (ALRMP).
Dr. Francis Lelo, Senior Lecturer and Chairman, Department of Environmental Sciences, Egerton University.
Prof. Dankit Nassiuma, Associate Professor and Director of Post-Graduate Studies, Egerton University.
Dr. William Shivoga, Senior Lecturer, Department of Environmental Sciences, Egerton University.
Dr. Daniel K. Too, Senior Lecturer and Chair, Department of Natural Resources, Egerton University.
Dr. P.K. Rono, Lecturer, Department of Sociology, Egerton University.
Dr. W.S.K. Wasike, Senior Lecturer and Chair, Department of Economics, Egerton University.

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Department of Applied Economics and Management, Cornell University, Ithaca, N.Y. 14853-7801. Telephone: 607-255-4489; fax: 607-255-9984.

Kenya

Department of Natural Resources, Egerton University, P.O. Box 536, Njoro. Telephone; 254-37-61464; fax: 254-37-61213.

Crisis Mitigation Office, International Livestock Research Institute (ILRI). P.O. Box 30709, Nairobi. Telephone: 254-2-630-743; fax: 254-2-631-481.

Arid Lands Resource Management Project (ALRMP). P.O. Box 53547, Nairobi. Telephone: 254-2-227-496; fax: 254-2-227-982.

Kenya Agricultural Research Institute (KARI). P.O. Box 57811, Nairobi. Telephone: 254-2-583-301; fax: 254-2-583-344.

Department of Livestock Production, Ministry of Agriculture and Rural Development. P.O. Box 30028, Nairobi. Telephone: 254-2-721-005; fax: 254-2-721-983.

Ethiopia

Livestock Policy Analysis Program, International Livestock Research Institute (ILRI). P.O. Box 5689, Addis Ababa, Ethiopia. Telephone: 251-1-463-495; fax: 251-1-461-252.

United States Agency for International Development (USAID) Mission to Ethiopia. P.O. Box 1014, Addis Ababa. Telephone: 251-1-510-088; fax: 251-1-510-043.

Oromia Agricultural Development Bureau (OADB). P.O. Box 8770, Addis Ababa. Telephone: 251-1-155-303; fax: 251-1-515-905.

Oromia Cooperative Promotion Bureau (OCPB). P.O. Box 8648, Addis Ababa. Telephone: 251-1-158-737; fax: 251-1-515-905.

Ethiopian Agricultural Research Organization (EARO). P.O. Box 2003, Addis Ababa. Telephone 251-1-612-633; fax: 251-1-611-222.

Save the Children USA. P.O. Box 387, Addis Ababa. Telephone: 251-1-164-490; fax: 251-1-653-615.

Volunteers in Overseas Cooperative Action (VOCA). P.O. Box 548, Code 1110, Addis Ababa. Telephone: 251-1-510-508; fax: 251-1-531-530.

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Barrett, C.B. 2001. Climate expectations and use of forecast information by pastoralists. PARIMA Second Biennial Research and Outreach Workshop, Egerton University, Njoro, Kenya. June 26.

Barrett, C.B. 2001. Research evaluation. PARIMA Second Biennial Research and Outreach Workshop, Egerton University, Njoro, Kenya. June 27.

Barrett, C.B., and W. Luseno. 2001. Decomposing producer price risk: an analysis of livestock markets in northern Kenya. Selected paper presented to the Western Agricultural Economics Association Annual Meeting. Utah State University, Logan.

Barrett, C.B., P.D. Little, J. McPeak, and G. Gebru. 2001. Highlights from current PARIMA research findings, 2000-01. PARIMA Second Biennial Research and Outreach Workshop, Egerton University, Njoro, Kenya. June 26.

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INTEGRATED ASSESSMENT OF PASTORAL - WILDLIFE INTERACTIONS IN EAST AFRICA

NARRATIVE SUMMARY

This report covers two grants received in 2001. First, we received an Assessment Team grant in early 2001 to organize a collaborative team and develop a proposal for submission to the GL-CRSP. Secondly, we were awarded a GL-CRSP research grant beginning 1 July 2001. The AT activities took place early in 2001; those activities are reviewed briefly in this report. However, most of the report reviews activities carried out under the GL-CRSP research grant during the period of July 1, 2001-September 30, 2001.

The Assessment Team activities were aimed at greater involvement of East African scientists, managers and stakeholders, to assure that their concerns about pastoral-wildlife interactions would be addressed in the new phase of the GL-CRSP project.

Once we received a new GL-CRSP grant, an extensive planning exercise was undertaken to meet with East African agency, university, and local community collaborators in order to develop more fully the Integrated Assessment agenda for each study area. The information gathered during these meetings contributed directly to the development of project work plans and specific questions/scenarios to be explored in the project's focal areas over the next year.

Research activities conducted during the three-month period were limited. Intensive Integrated Assessment for the Ngorongoro Conservation Area (NCA), Tanzania, commenced with the visit to the NREL by Victor Runyoro, Director for Research and Planning, NCAA. During July-September, we reviewed the status of NCA modeling progress from the first phase of the project and prepared new materials. Progress in model development included SAVANNA modification to communicate with an economic-oriented mathematical programming model aimed at identifying optimal solutions to management questions facing pastoralists.

Field research on Maasai land use and affects on wildlife and the ecosystem was continued by NREL graduate student Jeff Worden. Progress was made on: 1) data collection and analyses of abandoned settlement sites; 2) site selection for vegetation transects; and 3) woody vegetation sampling.

RESEARCH

Problem Statement. As human populations grow and land use intensifies, options for pastoralist-livestock land use and wildlife conservation are reduced and conflicts are intensified. Different patterns of land use (extensive pastoralism, mixed agro-pastoralism, intensive agro-pastoralism, irrigated agriculture within rangelands, etc.) and/or different pathways to development have alternative implications for the future. There is a need to determine how land use policies and patterns will influence wildlife density and diversity, livestock production and health, ecosystem state, and human economic status. There is also a need to promote decisions which optimize positive outcomes for people and wildlife.

We have initiated a demand-driven collaborative program aimed at: 1) identifying critical problems at the pastoralist-livestock-wildlife interface; 2) developing Integrated Assessments to address those problems; and 3) defining the probable outcomes of alternative policies, practices, and decisions and their effects on people, livestock, and wildlife. Our research focuses on assessments at local (site-specific) and regional levels.

Assessment Team Formation and Activities (January -April, 2001)

Progress. The formation of the Assessment Team and its actions, January through April 2001, were aimed at greater involvement of East African scientists, managers and stakeholders, to assure that their concerns about pastoral-wildlife interactions would be addressed in the new phase of the project. This affirmed that the project would be demand-driven and that specific applications addressed in the problem model were determined by East African scientists, institutions and stake-holders. By working directly with our East African team members and partner organizations, they obtained ownership of the process of problem model development. The project team thus formed a broad multi-institutional problem-solving group, not an external advisory group trying to push a specific agenda on the partner organizations.

The problem model and specific research goals were identified and prioritized by East African project team members, collaborators and institutional representatives during the Assessment Team period. The problem model and sites were selected through an iterative process that first involved querying Phase I team members to get suggestions for Phase II. Secondly, these ideas were presented to approximately 40 East African collaborators and institutional representatives, during visits by M. Coughenour to Tanzania and Kenya in February 2001. Thirdly, responses obtained by Coughenour were synthesized by the project team and presented at a workshop convened by Ellis and Reid in Nairobi, and attended by 35 collaborators in March, 2001. Prior to the Nairobi workshop, a series of five one-day stakeholder workshops was held with Maasai pastoral groups in southern Kenya. The purpose of these workshops was to solicit pastoral viewpoints on priority problems that project research should address. Representatives of the stakeholder groups were invited to the Nairobi workshop. Participants at the Nairobi workshop selected and prioritized problems to be emphasized and defined objectives to be pursued, during the second phase of the project. Institutional representatives designated where they were willing to become project partners, and how the partnerships could be implemented. The results of the Nairobi AT workshop formed the basis for the successful research proposal submitted to the GL-CRSP Management Entity in April of 2001.

GL-CRSP Project Activities (July 1-September 30, 2001)

Progress. Although the time period under consideration covered only three months, the project team was active in several areas. Planning for the new GL-CRSP two-year grant took precedence during this 3-month period, however the team also continued ongoing research, initiated new research, conducted community outreach activities, developed publications and carried out numerous administrative activities associated with USAID / GL-CRSP requirements. Research categories include: integrated assessment, model development, field research, regional analysis and literature-based research.

Activity One: Planning

Planning activities consisted of a series of meetings held in East Africa in August. The goal of these meetings was to meet with agency, university and local community collaborators in order to develop more fully the Integrated Assessment agenda for each study area. The information gathered during these meetings contributed directly to the development of project work plans and specific questions/ scenarios to be explored in project's focal areas over the next year. Meetings took place in Ngorongoro Conservation Area, Tanzania and Arusha Tanzania, for the Tarangire/Manyara Ecosystem; and in Nairobi, Kenya for Meru National Park and for the Kajiado District Group Ranches in Kenya. The attendees at the Project Planning Meetings (including title and organizational affiliation) are listed below.

Meru National Park Meeting (August 7, 2001) @ ILRI Headquarters, Nairobi: J. Kinyamario (Kenya PI, GL-CRSP project, and Meru Project Leader- Chairman/Professor in the Dept. of Botany, University of Nairobi); John Mworia (PhD Student, University of Nairobi); G. Olukoye (PhD Student, Kenyatta University); W. Mutero (GIS Specialist, Kenya Wildlife Service); W. Otichillo (Director, RCMRD); J. Ellis (Lead Principal Investigator (PI), NREL-CSU); K. Galvin (NREL-CSU); S. BurnSilver (Project Manager, NREL-CSU); J. Worden (PhD Student NREL-CSU, ILRI Graduate Student Fellow).

Kajiado Group Ranches Meeting (August 16, 2001) @ ILRI Headquarters, Nairobi: J. Kinyamario (Kenya PI; GL-CRSP project-Chairman/Professor in the Dept. of Botany, University of Nairobi); J. Mworia, W. Ekaya (PhD students, University of Nairobi); J. Gathua (Researcher, Department of Remote Sensing, Resource Surveys); E. Muthiani (KARI-Kiboko, ILRI); J. Wandera (Land Use Planning Coordinator, SARDEP- Kajiado); P. Rwambo (Veterinarian, Biosystems); H. Cheruiyot (Director, Kenyan Agricultural Research Institute); J. Grootenhuis (Veterinarian, Veterinaires sans Frontieres); J. Njoka (Professor Range Science Department, University of Nairobi); S. Mbogoh (Agricultural Economist/ Professor, University of Nairobi); J. Ndathi Mwai (Environmental Conservation Dept.-M.E.N.R.); J. Worden (PhD Student NREL-CSU, ILRI Graduate Student Fellow); S. Lemiruni, J. Mayiani (Project Research Assistants- J. Worden); R. Supeet (Project Research Assistant- S. BurnSilver); T. Kasaine (Secretary- Eselenkei Group Ranch (GR)); E. Kesoi (Treasurer- Eselenkei GR); S. Kotoke (Chairman- Imbirikani GR); J. Likampa (Treasurer- Imbirikani GR); L. Partimo (Treasurer- Olgulului GR); K. Seleka (Chairman- Olgulului GR); J. Leyian (Chairman- Amboseli Tsavo Group Ranch Conservation Association (ATGRCA)/ Chairman- Eselenkei GR); J. Kilitia (Secretary ATGRCA/ Secretary- Imbirikani GR); J. Ellis, K. Galvin (NREL- CSU); S. BurnSilver (Project Manager, NREL-CSU).

Ngorongoro Conservation Area Meeting (August 21, 2001) @ NCAA Headquarters/ Ngorongoro Cons. Area, Tanzania: V. Runyoro (Principle Ecologist, Ngorongoro Conservation Area Authority); Angelo Mwilawa (Livestock Research Scientist, Livestock Production Research Institute); Allan Kijazi (Tanzanian PI, GL-CRSP, African Wildlife Foundation); Patricia Moehlman (Biologist, IUCN/SSC-Equid Specialist Group); J. Ellis (Lead PI, NREL-CSU); S. BurnSilver (Project Manager, NREL-CSU).

Tarangire/Manyara Ecosystem Meeting (August 23, 2001) @ AWF Headquarters/ Arusha, Tanzania: E. Gereta (Ecologist, Tanzanian National Parks); A. Kijazi (Tanzanian PI, GL-CRSP, African Wildlife Foundation); P. Moehlman (Biologist, IUCN/SSC-Equid Specialist Group); L. Lynen (Consultant,

Veterinary Investigative Center- Arusha); J. Ellis (Lead PI, NREL-CSU); S. BurnSilver (Project Manager, NREL-CSU)

Meru National Park Meeting. Meru National Park and the adjacent conservation reserves and National Parks including Kora N.P., North Kitui N.R., Basanadi N.R. and Rahole N.R. experienced a prolonged period of insecurity during the 1970's and 80's, resulting in a breakdown of the park's management systems, the loss of resident populations of mega-fauna and a virtual collapse of tourism in the area. Now, with an improved security situation, KWS has identified the rehabilitation of Meru N.P. and the Greater Meru Ecosystem (GME) as one of its urgent priorities, and has embarked on a program to restore the park ecologically and re-establish the tourism base. Recently, KWS has translocated populations of some wildlife species into Meru N.P. Discussions during the meeting highlighted a variety of key issues that will be crucial to the successful management and development of this area. With improvements in security, human populations have increased dramatically at the boundaries of the parks and reserves (e.g. agro-pastoralists and farmers to the East and South, and Borana pastoralists to the North). There are likely to be increasing conflicts both between wildlife and agriculturalists, and competition between pastoral livestock and wildlife for water and forage in the dry season within and near the margins of these protected areas.

Attendees at the meeting made significant progress in identifying extant data sources for the GME on land use types, and the wildlife, human and livestock components of this system. Significant gaps in existing data sources were also identified. Development of GIS data layers (soils, vegetation and land use types), accessing remote sensing images and identifying wildlife distribution patterns and abundance will be important activities for the project team in the near future.

As a follow up to these meetings a planning visit to Meru National Park (MNP) took place between August 19 and 23, 2001, by Jenesio Kinyamario (Kenya PI-GL-CRSP/University of Nairobi), Jeff Worden (GL-CRSP doctoral student), Richard Bagine (Deputy Director, Research and Planning - KWS), and Jim Else (Tufts University). The group met with Mark Jenkins (Senior Warden, MNP), Adan Hokile Kala (Community Warden, KWS) and Timothy Marangu (Botanist Technician, MNP), as well as representatives of the Borana pastoral community to the area north of the Park boundary. The visit reviewed and recommended in detail research and monitoring activities that will be needed for the rehabilitation of the Greater Meru Ecosystem and discussed potential questions that could be addressed through the application of Integrated Assessment techniques.. The working group has identified the existence of some minimal data from MNP and other stakeholders on land use and vegetation biomass within and around MNP. More baseline data will be needed for use in the integrated assessments. Additional debriefing meetings occurred between Colorado-based GL-CRSP team members J. Ellis and S. BurnSilver, and Kenya-based team members, J. Kinyamario, J. Worden, and J. Else upon their return from the Meru area.

Field Trip to Kajiado. Prior to the meeting at ILRI on August 16th, S. BurnSilver and J. Worden traveled to Kajiado District in order to contact representatives of four Maasai Group Ranches within which project researchers had concentrated their work previously. The group ranches of Olgulului/Lolarashi, Imbirikani, Eselenkei, and Osilalei had communicated their interest in continuing to work with the GL-CRSP during Phase II of the project, and this trip was another step in cementing significant ongoing participation by Maasai pastoralists

within the project. S. BurnSilver also contacted the Amboseli-Tsavo Group Ranch Conservation Association (ATGRCA), a coalition of representatives from 7 Maasai Group Ranches in the area around Amboseli National Park, which is working to represent Maasai conservation and development interests in the area. Representatives from the group ranches and ATGRCA were invited to attend the project meeting in Nairobi, in order to contribute actively to the process of prioritising project activities in the Kajiado area. Osilalei Group Ranch respresentatives could not attend the meeting in Nairobi, but Imbirikani, Eselenkei and Olgulului/Lolarashi GR's and ATGRCA sent representatives to attend.

Kajiado District Group Ranches. This meeting at ILRI had three goals: 1) Discussion of project research carried out previously in Kajiado District by GL-CRSP team members, with a view as to what this research suggests regarding the potential activities and future focus of project activities during phase II; 2) a focused discussion of significant land use issues and the people-wildlife-livestock interface in Kajiado group ranches; and 3) establishing a timeline for GL-CRSP activities and communication to occur in the short-term.

Kajiado District, Kenya exemplifies the implications of ecosystem fragmentation for a pastoral society and for wildlife conservation. The group ranches closest to Amboseli National Park have not yet been sub-divided, and these areas are therefore of key importance in terms of wildlife conservation. Yet, while pastoralists have co-existed with wildlife historically, a situation exists currently where they perceive they are bearing significant negative costs of wildlife and receiving few or no compensatory benefits in return. In this situation sub-division seems like a viable alternative to conservation, offering the opportunity for increasing the benefits from pastoral lands accruing directly to individual households. The potential economic and ecological results of sub-division are under debate, but representatives from the group ranches stated there is little useful information available to assist group ranch members in the decision-making process. Local communities are actively posing questions about the potential effects of sub-division and land use change on pastoral production strategies and ecosystem integrity. A comment was made by a representative in the meeting that, "No one is preparing these GR's for their future"— if that future does indeed include sub-division. There is an important role for the GL-CRSP in Phase II to play in evaluating alternative land use outcomes in a realistic way, in order that pastoralists can access and use this information in making future land use decisions.

Discussions occurred between project researchers and group ranch representatives regarding the potential benefits of research, concluding that research is only beneficial if results are communicated. Consequently, the group discussed methods to ensure that research results are transfered systematically to community members by project researchers. Discussion also focused on ways in which the GL-CRSP could use IA methodology to explore the trade-offs between different types of sub-division, the spatial and economic components of wildlife-livestock conflicts, and the economic and ecological benefits/costs of alternative land use options within the Amboseli area.

Additional follow-up meetings with collaborators took place after the Kajiado meeting. J. Ellis, S. BurnSilver and J. Worden met with P. Thornton (ILRI- Kajiado Project Leader) to discuss prioritising activities for the Kajiado area. S. BurnSilver and P. Thornton met with J. Wandera (SARDEP) in order to explore points of similarity between the GL-CRSP Integrated Assessment approach and SARDEP's current efforts to outline future scenarios for pastoralism in Kajiado District.

Ngorongoro Conservation Area. The GL-CRSP project made significant progress in applying IA methodology to the Ngorongoro Conservation Area during Phase I of the project. Subsequently, the goals of the recent meeting held in the NCAA were to: 1) identify further scenarios and assessments which would be useful both to the policy needs of the NCAA and resident population of Maasai pastoralists, and 2) further evaluate the spatial and modelling parameters which were used as a basis for previous assessments.

Recent communications with Tanzanian government and NCAA officials indicate that significant changes in policy vis a vis cultivation allowances within the Ngorongoro Conservation Area may be imminent. Discussions at the NCA meeting highlighted that Integrated Assessment activities could be extremely powerful in illustrating the trade-off effects of disallowing cultivation on pastoral welfare, resident wildlife populations and ecosystem function. The question was asked: "If cultivation is banned, what would be alternatives for increasing livestock production levels as compensation for pastoralists?" Potential options include decreasing livestock mortality from wildlife-transmitted diseases through increased veterinary services, and increasing levels of market offtake by pastoralists. Development of IA scenarios to illustrate potential effects of veterinary programs and increased economic benefits for pastoralists through market development was discussed. It was decided that the issue of carrying capacity will be important within the scenarios under discussion. The modelling parameters underlying carrying capacity within SAVANNA will need to be revisited, and further defined. Similarly, a better spatial representation of human settlement and cultivation patterns is necessary within these new IA scenarios.

After the NCA meeting, J. Ellis and S. BurnSilver met with C. Sorensen from the NGO "ERETO" to discuss general progress within the project. The ERETO organization has very strong contacts with local pastoral communities, and discussion focused on ways to communicate GL-CRSP IA activities to local pastoralists, and solicit local input on the land use and policy scenarios which would be most relevant to them.

Tarangire/Manyara Ecosystem. The Tarangire/Manyara Ecosystem is a new project area for the GL-CRSP. Consequently, the meeting had three goals: 1) Further identification of issues and problems for the area, 2) Description of currently existing databases and work in progress within the project area, and 3) Discussion of GL-CRSP project team member roles.

Discussions regarding the human-livestock-wildlife interface within the Tarangire/Manyara Ecosystem revealed a complex overlay of land use issues and conflicts. Crucial land use issues in the project area include; endangered wildlife corridors and movement patterns out of and between Tarangire and Lake Manyara National Parks, increasing human population pressure, growing areas of agriculture, associated fragmentation of pastoral grazing lands, and conflicts between hunting and photographic tourism in pastoral and agropastoral areas around the edges of the parks. There also seems to be significant confusion and concern among local pastoral populations regarding the potential effects of the new Wildlife Management Areas (WMA's) on their ability to manage local natural resources and tourism activities.

Attendees at the meeting put together a list of published data sources relating to the Tarangire/Manyara ecosystem, as well as identified the location of existing spatial data layers on vegetation, soils and precipitation. Significant discussion time was given over to identifying gaps in existing data, and assigning tasks necessary to beginning a process of synthesizing all extant data sources into a format useful for integrated assessment activities.

Activity Two: Research

The second phase of the GL-CRSP project will build on the progress and successes of the first phase. The main research objective of phase two involves the application of integrated assessment technology to policy-related issues at the interface of conservation and pastoral development. Integrated assessment includes field research, spatial analysis and simulation model analysis, among other things. The GL-CRSP team conducted research in these and other categories.

Integrated Assessment Through Model Simulation. Ecological modeling under the GL-CRSP initiative for the Ngorongoro Conservation Area (NCA), Tanzania, intensified in October 2001, with the visit to the NREL by Victor Runyoro, Director for Research and Planning, NCAA. Runyoro spent approximately two weeks at the NREL, during which the GL-CRSP team devoted near full-time to perfecting our IA approach to policy-related and carrying capacity issues at NCA. Prior to October, (July-September) R. Boone reviewed the status of NCA modeling progress from the first phase of the GL-CRSP project, and prepared new materials for advancing our current objectives and model implementation. We reviewed spatial databases for the NCA, identifying layers that need improvement. During this period, Boone visited ILRI in Nairobi, to discuss GL-CRSP objectives and plans. As a result Boone, in cooperation with Thornton, modified the SAVANNA modeling system to be able to communicate with an economic-oriented mathematical programming model, aimed at identifying optimal solutions to management questions facing pastoralists. Research on carrying capacity concepts and calculations was conducted at NREL to refine our approaches to calculate the number of livestock, wildlife, and humans that may be supported at the NCA. The NCA Integrated Assessment serves as a demonstration 'centerpiece' for the GL-CRSP project, and will be used in demonstrations for Kenyan and Tanzanian managers and policy-makers early in 2002.

Database development for Integrated Assessment has been provided through a livestock production system mapping activity for East Africa, carried out by the GL-CRSP team at ILRI. This has been linked to information on the location and characterization of poor livestock keepers for Kenya, and further work through other projects will enhance this database for Tanzania and Uganda. These databases can provide information on what is essentially the "recommendation domain" for project activities, in terms of human populations, household characteristics, natural resource inventories, and market infrastructure, and how these may change in the future as a result of increasing human population and climate change.

Model Development. The linking of the Savanna ecosystem model to a mathematical programming package, XPRESS-MP, was carried out. This involved only a few changes to the code of Savanna, but the entire exercise has been very useful as a "proof of concept". It means that in the future, it will be possible to use Savanna routinely in resource optimization problems. This is of direct relevance for agro-pastoral systems that are more connected to the market economy, where there are needs to optimize the use of land, labour and/or capital at both household and community levels. This initial work has involved a very simple household model, but this will be made more complex and realistic in the future.

Field Research. Field research on Maasai land use and affects on wildlife and the ecosystem was continued by NREL graduate student Jeff Worden, with joint funding from

GL-CRSP and an NSF pre-doctoral fellowship. Worden's goals for field work during the period in question included 1) enter data and begin analyses of abandoned settlement; 2) site selection for vegetation transects; and 3) woody vegetation sampling.

Worden initiated data processing to stratify abandoned settlement sites in Kajiado for subsequent vegetation sampling. Over 400 abandoned settlement sites in 3 locations – Selengei, Lengesim, Lkarat were identified. At each site, data were recorded on slope, aspect, diameter, and history – including numbers of livestock, and years of settlement and occupation. These data were then used to identify a set of sites in each of five age classes spread between two different intensities (number of cattle x total number of months occupied). The initial group of abandoned settlement sites (n=431) was narrowed to include only those sites that met the following criteria:

1) Relative soil homogeneity
2) not burned
3) not resettled
4) permanent rather than temporary settlements (in this case occupied for >6 months per year)

The new set (n=248) provided the basis for a detailed field assessment. Each potential site was visited and local informants interviewed to confirm and cross-check site history and physical/ecological characteristics. The most important variables used to select sites are soil homogeneity, landscape position relative to other sites, and activity level. Sites in low run-on areas and flood plains as well as those found in areas of high soil heterogeneity were discarded. Work by Western and Dunne, Young et al., and Muchiru et al. on abandoned settlement sites suggest that the impact of a settlement extends to 150m, so all sites within 200m of another site will be removed from the sample. Initial assessment reveals that activity level is another significant component potentially influencing both on and off-site vegetation. With this in mind, all sites are ranked based on the degree of current human impact unrelated to the condition of the site, during its initial occupation or subsequent abandonment. This field assessment will identify a final set of sites. These sites will be divided into 5 age classes (years since abandonment):

1 = 1 to 9 years
2 = 10 to 19 years
3 = 20 to 29 years
4 = 30 to 39 years
5 = 40 plus years

and two intensity classes, High and Low intensity (the ranges will be established from those found in the final set).

Sites will be selected so that each age class is represented over the entire study area. Sites for intensive vegetation sampling will be randomly selected from each of the 5 age classes by intensity. We will sample 60 sites for herbaceous and woody vegetation composition, structure and biomass following the rains in October.

One of the primary goals of this research is to document the large scale changes in settlement pattern across three Group Ranches (Eselenkei, Osilalei, and Olgulilili/Lolarashi). This detailed survey of abandoned sites will be coupled with an aerial photo analysis and interview data from local informants to reconstruct movement and settlement patterns since the 1950s. Early evidence from interviews with elders in each of the study areas suggests that grazing and settlement patterns have changed dramatically. Group Ranch policy now dictates where individuals can settle (or where they cannot) and when certain areas are open for grazing. It appears that the overall system has shifted from one of dry season congregation at permanent water sources and wet season dispersal into areas with only seasonal water sources, to one of wet season congregation at permanent water (pipeline, wells, and boreholes)

and dry season dispersal into protected grazing areas. Whether this is a result of an increasing human population or the development of new water sources (or both) is less clear, but the implications for livestock productivity and landscape level vegetation patterns due to an altered disturbance regime may be significant. An aerial photo analysis will be conducted following the completion of this field season in January.

Regional Analysis. The GL-CRSP team at ILRI (Atieno, Waweru, Muchiru and Reid) initiated a regional analysis of current hotspots of land-use and settlement in pastoral ecosystems of northern Tanzania and southern Kenya. The analysis began with a fine-scale analysis of landscapes that are well known to the team: Amboseli and the Mara. From July to Sept, 2001, the team developed a set of training sites for the analysis and verified the training sites for the Mara site. These 'test landscapes' will be used to develop a reliable set of spectral signatures for current and old Maasai bomas, smallholder crop farming, villages, and large-scale commercial farming. By the end of 2001, these training sites will be used to classify a mosaic of Landsat images for Maasailand. In 2002, the computer classification will be validated on the ground.

As part of the regional analyses for the project, Joyce Acen is finalizing plans to conduct a regional evaluation of the wildlife protected area network for adequacy both to conserve representative wild herbivores in areas used for pastoral livestock grazing, or surrounded by pastoral areas. The main objectives of the study are 1) to predict the potential distribution of wildlife and livestock on the landscape; 2) identify and map the distribution of unprotected or inadequately protected wildlife species and communities; 3) assess the connectivity of habitats and corridors for seasonal migratory wildlife and seasonal livestock movements; 4)assess impacts of surrounding land use type and intensity on the protected areas; and 5) evaluate the impact of future scenarios of land use and management on the maintenance of habitat suitability for wildlife and livestock.

These analyses will be performed at three nested scales: at a coarse regional scale covering Kenya, Tanzania and Uganda, at intermediate scale in the Kenya-Tanzania cross-border region, and at fine resolution in Tarangire-Manyara ecosystem. During the reporting period, research proposal development and the compilation of species-habitat association data from published literature were initiated, and available spatial baseline data sources were documented.

Literature-Based Research. An extensive literature review was of community-based conservation activities and the implementation of the proposed Wildlife Management Areas in Tanzania was conducted by J.T.McCabe and his students. in The literature consisted of articles and books published by mainstream presses and reports and accounts found in the grey literature. The results of this review will 1) summarize work done by researchers and non-governmental organizations working in the northern Tanzanian region; identify individuals and groups that should be contacted, and highlight subject areas where the GL-CRSP team can make important contributions. It will serve as a point of departure for research and integrated assessement in the Tarangire-Manyara Ecosystem.

GENDER

This project has a good balance of female scientists. All but one of our current graduate students are female, including J.Acen, S. Lynn, J Pinho, and several senior investigators are women (Galvin, Reid, Moehlman, BurnSilver). Gender issues, such as access to resources and decision-making roles, are routinely addressed

in our socio-economic surveys. Effects of gender bias on economic and development status of women are topics of research in some of our analyses. Pinho's research addresses gender differences in Maasai attitudes toward wildlife and livestock-wildlife interactions.

Policy

The Integrated Assessment applications that we plan are very directly policy-oriented (NCA IA application, Kajiado IA application, Tarangire IA application Meru Ecosystem IA application). In these situations, contentious issues having to do with land use and conservation policy are under review and policies are very likely to be changed. Our IA applications have an excellent opportunity to enlighten policy makers about the probable outcomes of their alternative policy choices. Some of these applications are also management-oriented (Meru). In these cases, policies may also be influenced by weighing the results of the IAs and the implications for development and conservation policy, nation-wide.

Community Outreach

Prior to the Nairobi AT workshop in March, a series of five one-day stakeholder workshops was held with representatives of the four Kajiado Maasai Group Ranches where S. BurnSilver and J. Worden carried out their PhD. research, and where the GL-CRSP project has continued to focus the project's Integrated Assessment activities (Eselenkei, Olgulului/ Lolarashi, Imbirikani and Osilalei). The purpose of these workshops was two-fold; 1) to present preliminary results from the socio-economic research carried out by S. BurnSilver, and 2) to solicit community viewpoints on priority problems that future GL-CRSP research should emphasize. Community members repeatedly commented during these workshops that this was the first time in their memory that research results had been communicated directly to "pastoralists" themselves. Elected committee members from each group ranch also were invited to the Nairobi AT workshop. The subsequent participation of pastoral stakeholders in these meetings contributed significantly to the direction of Integrated Assessment activities adopted in Phase II of the GL-CRSP.

The analysis of the interactions between people, livestock and wildlife in the Mara ecosystem was completed and presented to stakeholders and community members through community and individual meetings. The communities in the Mara described these meetings as the 'first-ever' interaction between researchers and communities. The GL-CRSP team at ILRI discussed upcoming research with the communities and used their feedback to revise hypotheses and research plans.

As part of the GL-CRSP Assessment Team, Boone developed materials that demonstrated the ecological modelling and Integrated Assessment approaches used in the project. These materials were provided to team members travelling in East Africa, to inform potential collaborators about GL-CRSP activities. A brochure was prepared that was used by Assessment Team members to inform project collaborators and potential participants at workshops and in other forums of our GL-CRSP goals and methods.

Development Impact

Our Integrated Assessment approach was developed to address issues of conflict and complementarity between conservation and livestock development in arid and semi-arid portions of East Africa, where wildlife and pastoralists had traditionally shared the ecosystem. GL-CRSP support provided an opportunity to begin to apply models and other aspects of integrated assessment to livestock

development-related problems. These technologies have, heretofore, been used only to a limited extent in this sort of development context. Our development-relevant goals are to assist pastoral people, policy-makers and agencies to weigh alternative development and conservation strategies before implementing problematic development or conservation policies or procedures. As a result of work and demonstrations carried out in the first phase of our GL-CRSP project, and due to our outreach and communication activities, we have been asked by conservation agencies (i.e., NCAA), wildlife, land and conservation management agencies (i.e., KWS) and pastoral people (i.e., Amboseli-Tsavo Group Ranch Conservation Association) in East Africa to assist them in development planning, using integrated assessment. As we continue with these applications the results will benefit the host countries in terms of development and conservation planning and policy analysis. The project has a large team which has the net result of creating multiple linkages with numerous agencies and institutions in East Africa. IARC collaboration is through ILRI, our primary collaborator.

Other Contributions

Support for free markets and economic growth. Our IA assessments demonstrate (and therefore support) the need for broader market involvement of pastoral peoples and for the growth of national economies of East African countries, in order to improve both human economic welfare and environmental sustainability.

Concern for individuals. The GL-CRSP Integrated Assessments are focused on household level actions and impacts. Therefore the project promotes concern for individuals.

Support for democracy. Project activities involve stakeholder input and responses, therefore promoting linkages within East African societies between stakeholders and policy-makers, a cornerstone function of democracy.

Leveraged Funds and Linked Projects

The following projects contributed leveraged funds to the project during the period July1-Sept 30, 2001:

USDI/USGS/BRD - PI: Mike Coughenour: "Spatial Ecosystem Modeling of Yellowstone Bison and the Environment". Total Award $ 113,034. Project Period; 6/97-5/02 Project uses SAVANNA Ecosystem Model to model interactions between bison populations and vegetation in Yellowstone N.P. Model parameterization and testing in this case contribute to GL- CRSP modeling activities in East African Sites.

EPA/STAR- PI: Mike Coughenour: "Assessing the Consequences of Climate Change for a National Park and its Gateway: Interactions of multiple stressors". Total Award $ 894,846. Project Period, 10/99-9/02. Project uses SAVANNA Ecosystem Model to model the affects of climate on vegetation and herbivore populations. Model parameterization and testing in this case contribute to GL-CRSP modeling activities in East African Sites.

University of Alaska/NSF- PI: Mike Coughenour: "Modeling Spatial Plant-Geese Interactions in the Yukon Delta" Total Award $ 314,403. Project Period 6/00-5/05. Project uses SAVANNA Ecosystem Model. Model parameterization and testing in this case contribute to GL-CRSP modeling activities in East African Sites.

NOAA Office of Economics and Human Dimensions of Climate Fluctuation- PI: Kathleen Galvin: "Responses to Climate Variability and Utility of Climate Forecast Information for the Livestock Sector in Arid and

Semi-Arid Zones, South Africa" Total Award $358,914. Project Period 7/98-7/02. P. Thornton developed a model to identify the impact of climate variability on household economy. Both Thornton (ILRI) and R. Boone (NREL/CSU) linked the household model to the SAVANNA ecosystem model. Funds from the NOAA grant were leveraged to the GL-CRSP to help P. Thornton and R. Boone link the SAVANNA and PHEWS models for applications to the NCA and Kajiado GL-CRSP sites.

NSF Dissertation Improvement Grant.- PhD student: Jeff Worden: "Maasai Settlement, Landscape Mosaics, and the Spatial Patterning of Vegetation and Wildlife in East Africa". Total Award, $20,000. Project Period, 5/01-10/02. The PhD research of J. Worden is funded through a combination of GL-CRSP and NSF funds. Funds leveraged to the GL-CRSP through NSF have increased the scope of J. Worden's PhD research project.

People, Livestock, Environment Program Funds and ILRI Core Funds- Program Head: Robin Reid. Multiple Project Activities under the general project heading of "Land-Use and Settlement Patterns in Pastoral Ecosystems of Northern Tanzania and Southern Kenya". The following research activities were leveraged; Salary for project supervision for R. Reid, travel funds and costs of community workshops in the Mara, the salary of biometrician to assist both A. Muchiru and F. Atieno in data analyses, and overhead costs of GL-CRSP activities not covered by GL-CRSP funds. Amount Leveraged, $3,500.

Government of Finland- PI: Robin Reid/ ILRI Associate professional officer (Finnish): Funds supported activities under general project heading of "Land-Use and Settlement Patterns in Pastoral Ecosystems of Northern Tanzania and Southern Kenya". Leveraged funds supported the salary of an ILRI associate professional officer, contributing to a ground truthing exercise in Amboseli (Kajiado project area) and the Mara. Amount Leveraged, $2,000.

Swedish International Development Agency (SIDA) grant to ILRI- PI: Robin Reid/ ILRI Post Doc: Funds supported activities under general project heading of "Land-Use and Settlement Patterns in Pastoral Ecosystems of Northern Tanzania and Southern Kenya." Leveraged funds supported the salary of an ILRI Post Doc, contributing to ground-truthing land use types and community workshops in Kajiado and the Mara. Amount Leveraged, $2,000

University of Nairobi- J. Njoka/F. Atieno: "Landscape Change Patterns, Land Use and Environmental Diversity in Kenyan Rangelands: The Case of Greater Amboseli Ecosystem 1988-1998" Leveraged funds from the University of Nairobi contributed to the salary of J. Njoka to support collaborative work on the research paper of F. Atieno (ILRI). Amount Leveraged, $500.

Unknown Donor- D. Western/A. Muchiru: "The role of abandoned Maasai settlements on dynamics of savanna vegetation and soils, Amboseli, Kenya" Leveraged funds from an unknown donor contributed to the salary of D. Western to support work on the research paper of A. Muchiru (ILRI). Amount Leveraged, $500.

SAIA- PI: R. Reid/R. Kruska - Funds supported activities under general project heading of "Land-Use and Settlement Patterns in Pastoral Ecosystems of Northern Tanzania and Southern Kenya" Leveraged funds provided a salary for R. Kruska (ILRI) to oversee the research activities of M. Waweru, F. Atieno, and Oderu. Amount Leveraged, $2,500.

DFID- PI: Phillip Thornton: "Poverty and Livestock Mapping" Leveraged funds supported 1 month of salary for an ILRI research technician working on spatial poverty database for East African region. Amount Leveraged, $1,500.

TRAINING

In Progress

J. Acen (Ugandan) PhD student; degree date 2003; Ecology; Colorado State University.
J. Worden PhD student; degree date 2002: Ecology; Colorado State University.
S. Lynn .PhD student; degree date 2003; Ecology; Colorado State University.
J. de Pinho PhD student; degree date 2003; Ecology; Colorado State University.

We anticipate training two to four more East African degree seekers as the project moves along.

Completed

No degree training was completed during the period July-Sept. 2001. However four graduate degrees were obtained as a result of the first phase of our GL-CRSP program.

Short Term

During the period July1 through Sept 30, 2001, a series of planning meetings was held in each of the four project focal areas of the GL-CRSP. Discussions took place which contributed to the development of subsequent project workplans. However, there was also a significant training component to these meetings, as project collaborators and stakeholders were engaged in a process of thinking about land use issues and the alternative managment and policy scenarios which were relevant to each project area. The goals of these meetings/workshops were to discuss the Integrated Assessment methodology, identify land use questions in each project area ammenable to the application of GL-CRSP methodology, and to discuss existing databases of information relating to these questions. Please see section on Planning Activities for more detailed information.

COLLABORATING PERSONNEL

United States

J. Else (Professor of Veterinary Science, Tufts University
T. McCabe (Associate Professor, Institute of Behavioral Science, University of Colorado)
J. DeMartini (Veterinarian, Department of Pathology, Colorado State University)
M. Coughenour (Principal Investigator, Senior Research Scientist NREL- CSU)
J. Ellis (Lead Principal Investigator, Senior Research Scientist NREL- CSU)
K. Galvin (Senior Research Scientist, NREL-CSU)
R. Boone (Post-Doc, NREL-CSU)
S. BurnSilver (Project Manager, Research Associate, NREL-CSU)

Kenya

R. Reid (Program Director- People Livestock and the Environment, ILRI)
P. Thornton (Programme Co-ordinator, Systems Analysis and Impact Assessment)
J. Kinyamario (Kenya PI, GL-CRSP project, and Meru Project Leader Chairman/ Professor in the Dept. of Botany, University of Nairobi)
John Mworia (PhD Student, University of Nairobi)
G. Olukoye (PhD Student, Kenyatta University)
W. Mutero (GIS Specialist, Kenya Wildlife Service)
P. Mulama (Spatial Analyst, KWS)
R. Bagine (KWS, Director of Research)
N. Georiadis (Ecologist/Researcher, M'pala Research Center)

Ole Kamuaro (Ministry of the Environment, Kenya)
W. Otichillo (Director, RCMRD)
J. Gathua (Researcher, Department of Remote Sensing, Resource Surveys)
C. Situma (Spatial Analyst, DRSRS)
J. Wandera (Land Use Planning Coordinator, SARDEP- Kajiado)
P. Rwambo (Veterinarian, Biosystems)
H. Cheruiyot (Director, Kenyan Agricultural Research Institute)
J. Grootenhuis (Veterinarian, Veterinaires sans Frontieres)
J. Njoka (Professor Range Science Department, University of Nairobi)
S. Mbogoh (Agricultural Economist/Professor, University of Nairobi)
J. Ndathi Mwai (Environmental Conservation Dept.- M.E.N.R.)
D. Western (Ecologist, African Conservation Center)
T. Kasaine (Secretary- Eselenkei Group Ranch (GR))
E. Kesoi (Treasurer- Eselenkei GR)
J. Likampa (Treasurer- Imbirikani GR)
L. Partimo (Treasurer- Olgulului GR)
J. Leyian (Chairman- Amboseli Tsavo Group Ranch Conservation Association (ATGRCA)/ Chairman- Eselenkei GR)
J. Kilitia (Secretary ATGRCA/ Secretary- Imbirikani GR)

Tanzania

V. Runyoro (Principle Ecologist, Ngorongoro Conservation Area Authority)
Angelo Mwilawa (Livestock Research Scientist, Livestock Production Research Institute)
Allan Kijazi (Tanzanian PI, GL-CRSP, African Wildlife Foundation)
Patricia Moehlman (Biologist, IUCN/SSC-Equid Specialist Group)
E. Gereta (Ecologist, Tanzanian National Parks)
E. M'talo (Researcher, University College of Lands and Architectual Studies)
F. Banyikwa (Professor, Botany Departmen, University of Dar es Salaam)
C. Nahonyo (Professor, Zoology Department, University of Dar es Salaam)
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PUBLICATIONS

Boone, R.B., K.A. Galvin, N.M. Smith and S.J. Lynn. 2000. Generalizing El Nino effects upon Maasai livestock using hierarchical clusters of vegetation patterns. Photogrammetric Engineering and Remote Sensing 66(6):737-744.

Boone, R.B., M.B. Coughenour, K.A. Galvin, and J.E. Ellis. Addressing management questions for Ngorongoro Conservation Area, Tanzania: Using the Savanna Modeling System. African Journal of Ecology (In press).

Galvin, K.A., R.B. Boone, N.M. Smith and S.J. Lynn. 2001. Impacts of climate variability on East African pastoralists: Linking Social Science and Remote Sensing. Climate Research 19:161-172.

Galvin, K.A., J. Ellis, R.B. Boone, A.L.

Magennis, N.M. Smith, S.J. Lynn and P.Thornton. Compatibility of pastoralism and conservation? A test case using integrated assessment in the Ngorongoro Conservation Area, Tanzania. In: Displacement, Forced Settlement and Conservation. D. Chatty and M. Colester, eds., Berghahn, Oxford. (In press).

Thornton, P.K. and K.A. Galvin and R.B. Boone. An agro-pastoral household model for the rangelands of East Africa. Agricultural Systems (In press).

Comments: Project Administration

A key goal of the project in Phase II was to strengthen the administrative lines of communication between the project team and the GL-CRSP Management Entity, as well as to create and maintain good mechanisms for coordination between our team, its agency collaborators and community stakeholders in East Africa. The hiring of a Project Manager, based at CSU, and two principal investigators in Kenya and Tanzania respectively, has contributed to attaining these goals during this first funding period of the project's Phase II. The Project manager is primarily responsible for 1) liasing with Kenyan and Tanzanian Principal Investigators and other East African GL-CRSP collaborators and stakeholders; ensuring that all collaborators are kept up to date on ongoing project activities; 2) assisting in reporting and administration activities of project personnel and collaborators to the GL-CRSP Management Entity (i.e. annual reports, workplans/logframes, trip reports, budget justifications, travel projections); 3) participating in the development of Integrated Assessment protocols for each of the four project focal areas; and 4) coordinating community outreach activities between the project and community stakeholders in each project focal area.

The activities of the Kenyan and Tanzanian PIs are also pivotal in maintaining active communication and coordination between agency collaborators in East Africa, ILRI and the US-based project team. These individuals have organized consultative meetings with key stakeholders for project focal areas to schedule planning meetings, and inform them of the objectives of the project and their potential role in making it succeed. They continue to liase with key individual participants in the project to coordinate ongoing project research and planning activities in the field.

Principal Investigators

Lead Principal Investigator: Jim Ellis, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523. Tel: 970-491-1806; Fax 970-491-1965; Email: jime@nrel.colostate.edu.

Principal Investigator: Michael Coughenour, Natural Resource Ecology Laboratory, Colorado State University.

Role of Animal Source Foods to Improve Diet Quality and Growth and Cognitive Development in Kenyan School Children

Narrative Summary

The project completed its intervention feeding and data collection in September 2000 and data analysis of Cohort I have been ongoing to test the main hypotheses. This is a collaborative study of the University of California, Los Angeles (UCLA) and Davis (UCD), the University of Nairobi, and University of Hawaii. This controlled feeding intervention study is one of the first to determine if a causal effect exists between meat and between milk intake (animal source foods) and cognitive function, physical activity, school performance, and behavior, physical growth and health compared to children who receive no feeding intervention. All feeding groups received the local dish githeri, a mixture of maize, beans and greens, but in addition, one group received added meat; one group added milk and one added oil for energy. The snack furnished ~315 k Cal/serving. Twelve schools in two sub-locations of a rural area in Embu District, rural Eastern Province, Kenya were randomized into the three different feeding groups and the control group. 555 children from the first grade (Standard I) were enrolled, with 1 to 2 classrooms per school and three schools per group. A second cohort was enrolled a year later and was a replicate of the cohort I study, minus the biochemical tests for micronutrients.

Outcome measures studied were cognitive function using a variety of tests (all used extensively in this age group in Embu in a former study); physical growth included height, weight, fat folds, and arm and head circumferences; physical activity and behavior during free play and classroom behaviors; school performance (test scores) and illnesses; and biochemical micronutrient status. The above measures were collected longitudinally at baseline and over the ensuing 2 1/2 year period. At baseline and annually, physical examinations and blood samples were obtained for biochemical micronutrient analyses, hemoglobin, malaria, and for an infection marker (C-reactive protein). Stool samples were examined for parasites and all children were dewormed every 6-8 months. Children with severe illness, severe anemia, and malaria were referred for treatment.

Usual daily food intake was collected by 24-hour recall factoring in the intervention feeding. Feeding and data collection continued for seven 3-month school terms. At baseline, children were found to have stunting and under weight in a third of the group. The prevalence of iron, zinc, vitamin A and B_{12} deficiencies and anemia were very high.

Data analyses as of September 30, 2001 showed that the meat supplemented groups showed the greatest gain over time which were statistically significant:

- Cognitive Scores-(Ravens and arithmetic)
- Growth-Lean body mass (muscle area)
- Physical Activity- high levels of activity
- Behaviors-leadership, initiative
- Micronutrient Status- in vitamin B_{12} with elimination of moderate and severe deficiencies after two years of feeding

In all groups, micronutrient blood concentrations were significantly lower in those

The Child Nutrition Intervention Study involved over 1,000 first and second grade children. Photo by Charlotte Neumann.

children with evidence of infection and/or malaria.

The milk group also showed statistically significant increases in vitamin B_{12} both at the one-year and the final follow up. Also, the milk group showed a greater, but non-significant advantage, in height growth in the 6 to 7 year old children, but this was not sustained.

Thus, animal source foods in the diet, particularly meat, improves cognitive function, increase in muscle mass, and vitamin B_{12} nutrition which have implications for maximizing the ability of the children to learn, show leadership and initiative, and be physically active. The challenge is to increase the household production and utilization of locally available sources of a variety of animal foods.

Research

Problem Statement and Approach. The original problem statement defined the problem of poor diet quality and low micronutrient content of the diet among the rural Embu people. The proximate causes identified were the lack of animal source foods in the diet and low fat intake: poverty, lack of knowledge of child feeding and poor household food security. Baseline biochemical analyses of the study children have confirmed poor micronutrient nutritional status. Baseline anthropometry data confirmed stunting and underweight to be present in a third of the children. Poor availability and household access to animal source foods and low utilization and erratic rainfall affecting harvests were the barriers identified.

The problem analyses and statement suggested a two-phase sequence. Phase I consists of a controlled feeding intervention study of school children to test if animal source foods, particularly meat, eaten at school each day by Standard I children (ages 6 to 9 years) improves their micronutrient status, cognitive function, growth and health compared to these parameters in children who receive either added milk or extra calories (oil), or no feeding intervention. Phase two will consist of community-based interventions with food-based solutions to improve diet quality and micronutrient nutritional status.

Activities from Oct 1, 2000 to Sept 2001

Progress. The accomplishments of the third year of the GLCRSP Child Nutrition Project (CNP) formally entitled "Role of animal source foods" are described in this section. Also included are additional measurements that were included to better elucidate previous findings.

This year marked completion of the intervention feeding and data collection for both Cohorts I and Cohort II, comprised of the school-age children and the initiation of data analyses for hypotheses testing for Cohort I. Cohort I included 555 children who were enrolled in Standard I (Grade 1) and reached Standard III and included repeaters who remained in Standard II for another year but continued in the study. About 30 children left the study. Because of the continuing drought situation which resulted in serious food shortages and hunger, it was decided to continue to feed the Cohort I children for an additional term (Jan-Mar 2000), with only limited data collection – anthropometry, morbidity, and cognitive testing. The children of Cohort II, a replicate of the Cohort I design, were given intervention feeding for an additional term of feeding ending July 31, 2000. The parents and schools were extremely appreciative of the additional feeding and wished to express their gratitude to those who enabled the Child Nutrition Project to continue the feeding a term longer.

A final round of physical examinations and collection of blood samples were carried out in Cohort I children in July 2000. Blood samples were obtained for a third round of biochemical analyses, hemoglobin levels, blood smears, and tests for malaria as well.

Additional literacy and arithmetic achievement testing was administered to Cohort I children. These were used to further detect differences among the intervention groups and control group.

Dr. Neumann, right, examines one of the children as Volunteer Margaret Demment records the data.

New Measurements

Further Evaluation of Vitamin A (retinol) Status. Two additional measures were obtained on the children to better evaluate the extent and severity of vitamin A status. Low levels in the severe range, with retinol < 10 ug/dL and values in the moderate range with retinol of 11-20 ug/dL, were found at baseline and among slightly fewer children in 1999, after one year of intervention feeding. Baseline food biochemical analyses revealed that 92.0% had deficient levels in the moderate and severe deficiency ranges.

Pupillary Response Test. In collaboration with Dr. Nathan Congdon at John Hopkins School of Medicine, a test of dark adaptation was undertaken using an apparatus developed by Drs. N. Congdon and A. Sommers. The testing had to be carried out in a dark area. We used a darkened tent, which was set up at the rear of classrooms and children were tested in groups of 3 or 4. Also a project enumerator was assigned to help with the testing and sat with the children and the tester in the darkened tent to keep them occupied with singing, conversation and riddles to allay their fears as they dark-adapted for ten minutes. A special

red light was shined into one eye and the pupillary reaction in the other eye is observed for pupillary constriction. This tested for dark vision

If the child was unable to respond to a given light stimulus, the light intensity was progressively increased until pupillary constriction was noted. Mr. Eric Schweitze, a medical student from the University of Kentucky, who was trained by Dr. Congdon joined the team and spent a month in Embu organizing and implementing the testing. He, Dr. Neumann, and a Master's Nutrition student from the applied Nutrition Program, University of Nairobi, carried out the testing. The Kenyan nutrition graduate student, Mrs. V. Betts, will use the data she collected on Cohort II children for her Master's dissertation.

The results of the pupillary response testing will be correlated with the vitamin A levels and the results of the Modified Retinal Dose Response (MRDR), carried out simultaneously. Results of the preliminary analysis of the pupillary response test are consistent with mild to moderate vitamin A deficiency. The test is more useful as a population indicator than as an evaluation tool of individual status.

Modified Retinal Dose Response (RDR) test. In collaboration with Dr. Sherry Tanumihardjo of the University of Wisconsin, a test was carried out at the time of testing for pupillary response, to better define the status and liver stores of vitamin A in the Cohort I children. Vitamin A2, a natural analog of vitamin A, was administered by mouth 4-5 hours prior to blood drawing. Testing for pupillary response was carried out in 4-5 hour intervals between the administration of A2 by mouth and the drawing of blood samples for vitamin A2 and retinol levels. The ratio of A2 to retinol indicates the level of retinol storage in the liver. The results of the MRDR test will be completed within two weeks.

A night-blindness questionnaire was administered to parents about the children. It appeared that the fear of the dark was based on non-nutritional reasons.

Data Analyses

Independent Variables and Co-Variates: Food intake data. Determining usual food intake for Cohort I children, from the baseline visit through the final visit has been an extremely labor-intensive effort, under the direction of Dr. S. Murphy and part time programmers and input from field staff, especially Constance Gewa, to obtain missing values, errors and missing food density values. The 3 baseline visits of usual nutrient intake, the first 3 intervention feeding monthly visits have been completed and ready for use as covariates in other analyses. Three other representative food intake visits are now completed and were obtained during different seasons, including the dry periods and the rainy months. Also, the daily feeding records and quantities of leftovers of the actual intervention feedings are included in the usual daily intake. To represent usual intake for a given period, three rounds of food intake data must be averaged.

The food intake data will result in a very rich and probably among the best data set obtained to date in Kenya, along with that of the previous Human Nutrition CRSP of the 1980's. Now that all programming, and many corrections have been made, the analysis should move along much more quickly and easily. Important reasons for requiring the usual food intake are the following:

a) To see if there are differences in usual intake of animal source foods- i.e. milk, or meat, among the different intervention and control groups other than the intervention feeding. This could potentially "neutralize" or cancel out of the impact of the interventions.

b) To see if the school feeding alters the

amount of food the target school child receives at home. Possibly the parents may reduce the food given at home because the parents may feel that the child is taken care of at school and therefore needs to eat less at home.

A redistribution of the child's food in the household may occur. The baseline food intake showed that the intake of animal protein and fat were low and that there was a substantial prevalence of deficient vitamin B_{12}, iron, zinc, calcium, and vitamin A intakes relative to recommended intakes. The mean energy intake was low normal for recommended intake.

Socioeconomic Data. Socioeconomic Status was obtained at baseline and a second round two years later to see if a change had occurred. Analyses show a very high concurrence at baseline and two years later with very little change using the same instruments.

Death of Project Children. Among cohort I and cohort II (1,050 children), five children died. The diagnoses were based on clinic records and "verbal autopsies". This is an extremely high mortality rate for 6-9 year old children. Because parents did not seek medical care until it was too late, or was not possible in some cases, several children died before they could actually be evaluated or treated. The diagnoses were: Hepatitis with cirrhoses; Sepsis-associated with a pharyngeal abscess; Severe anemia, and Malaria

Morbidity. For morbidity to be used as a covariate in analyses of the outcomes, scores were devised for each child for serious and mild illness. For morbidity as an outcome per se more analyses are under way on how best to define the outcomes.

A study just completed by the District Medical Officer showed that the leading cause of death among children for Embu District was malaria in 2000-2001.

Brief Summary of Findings to date of Selected Hypotheses

1. Animal Source Foods (ASF), particularly meat, lead to improvement in
   - cognitive function
   - physical activity
   - positive behaviors
   - classroom attention
   - physical growth
   - biochemical micronutrient status, particularly for iron, zinc, and vitamin B_{12}

2. Meat and milk intervention are not equivalent in effects:
   - meat promotes cognitive function and physical activity, improved biochemical micronutrient status of Iron, zinc, vitamin A, vitamin B_{12}, and riboflavin
   - milk promotes linear growth and improved vitamin A, vitamin B_{12}, and riboflavin status

3. Infection and malaria have a negative impact on biochemical micronutrient status

Analytic Approach. The intervention studies are analogous to a longitudinal clinical trial. A Hierarchical Random Effects Model (repeat measures) is being used to examine feeding groups and the control group for the following outcomes: cognitive performance, physical activity, behaviors, growth over time, morbidity, and biochemical nutritional status. Rate of change (slope) is estimated for each child and group for the above outcomes and the variability among the changes was estimated as well for each child. These were assigned to the fixed conditions (feeding groups) and the random components of the design comprise the children nested within schools.

Co-variates included are age, gender, time, morbidity, food intake, and parental factors

(literacy, height). At baseline the four groups showed no statistically significant differences in a number of attributes. (In this report, significantly implies statistically significant ($p<.05$)

Cognitive Function. The meat group showed the greatest rate of increase in the Raven's Progressive Matrices Test Scores. The difference was significantly higher than that for the milk, energy, or control groups: The Raven Matrices Test reflects Fluid Intelligence, which includes problem solving ability, special reasoning, and planning ahead.

The meat group and also the energy group showed the highest rate of increase on the arithmetic tests, which reflect arithmetic facts and grasp of numerical concepts (crystal intelligence).

Physical Activity and Behaviors. Children in the meat group exhibited the greatest increase for high and medium activity during free play compared to the energy, milk, and control groups. Differences were statistically significant.

Also children in the meat group displayed a significantly greater rate of increase in behaviors such as leadership, initiation of activities, and less apathy and solitary play.

Biochemical Micronutrient Status. Both the meat and milk groups showed statistically significant increases in vitamin B_{12} blood levels compared to the energy and control groups, with the milk group having slightly higher levels after one year of intervention feeding. After two years of intervention feeding, the meat group had the highest level of vitamin B_{12} compared to all groups but statistically significantly higher levels than the control and energy groups. In the group receiving meat, moderate and severe vitamin B_{12} deficiencies were eliminated and only mild deficiency remained.

Body Composition. Lean Body Mass, as reflected in Arm Muscle Area (AMA) showed the greatest rate of increase in growth in the meat group. This increase was statistically greater than the slopes in the milk, energy, and control groups. A slightly higher rate of linear growth was seen in the milk group but this was not significantly greater than in the other groups and the control group.

Impact of Infection and Malaria on Biochemical Micronutrient Status. Nearly all micronutrients, particularly iron, zinc, vitamin A, and vitamin B_{12} were found to be lower in children with infection, compared to those without infection. The marker for infection used

All feeding groups received the local dish githeri, a mixture of maize, beans and greens. Analysis of data collected is showing that the meat and milk interventions are not equivalent in effects.

was elevated C-reactive protein, an acute phase reactant, which rises with infection. Differences in the micronutrient levels among the above two groups were statistically significant.

As for malaria infection, lower concentrations of vitamin A, vitamin B_{12}, and zinc were found. Malaria was detected both by blood smear and by a relatively new antigen dip-stick Test for the presence of falciparum malaria antigen in the blood. Falciparum malaria is present in 98% of the cases. The latter is better able to detect malaria infection than examining blood smears.

Thus infection and malaria both have a negative effect on biochemical micronutrient status.

Analyses Still in Progress (and not completed by September 30, 2001)

1) Biochemistry
   - Completion of Biochemical Analyses Micronutrients status after two years of feeding will be completed for the 3rd round of analyses in early December 2001 for retinol and vitamin A2 (the Modified Retinol Dose Response for estimating liver stores).

2) Food Intake
   - Complete usual nutrient intake over time for each child: The three baseline visits, the first three post intervention visits, and three representative visits throughout the study period are now completed (November). The remainder will be completed in the next few months. (The Kenyan doctoral student (C. Gewa) will now work on this)

3) Morbidity as an outcome measure
   - Morbidity will be examined as an outcome. Thus far it has been used as a co-variate for mild and severe illness.

4) Anemia will be analyzed in detail in relation to micronutrients (biochemical and nutrient intake), malaria and parasites and functional outcomes.

5) Cohort II study has yet to be analyzed.

LEVERAGING OF FUNDS

Cattlemen, Year II, $60,000

Child Survival Funds, 2000-2003, $300,000 total

Various Donors, C.G. Neumann 2000-2001, $25,000

GENDER

As stated in the previous annual reports, the project, at all levels, is staffed predominantly by women. This came about largely because most nutritionists and people trained in child development and health are women and very few men applied for the above positions. Many of the women were trained in the previous CRSP study in the mid 1980s and wished to be working once again to earn income of their own. Women also enjoy working with the young school children, and are more comfortable with the home visiting aspect, as they obtain information on food intake and illness. The following personnel are women:

Senior level: Principal and Co-Principal and Co-Investigators (C.G. Neumann, S.P. Murphy, M. Sigman, L.H. Allen). These are all senior professors at the University of California (UCLA and Davis) and the University of Hawaii (S.P. Murphy).

Dr. Edith Mukudi, a young Kenyan woman, received her Ph.D. from SUNY at Buffalo in 1998 and she served as Field Coordinator from 1998-2000 and held a teaching appointment of Lecturer at Kenyatta University in the Department of Education. She was recruited by UCLA to a tenure track position as Assistant Professor in African Education and the African Studies program in June 2001. Her research consists of GLCRSP

Child Nutrition Project and other research in Kenya.

Connie Gewa, Kenyan nutritionist and former field coordinator (January –September 2000) has entered a PhD program at UCLA School of Public Health. She plans to use project food intake data for her dissertation.

The senior field staff who are resident in Embu are all women. Three hold Masters and one a Bachelor's degree. Three are nutritionists and one is a psychologist/educator and educated in Kenya. The nutritionists is Susan Nyerere and the psychologist is M. Kamore. One of the Kenyan Nutritionists, who is also the Embu District Nutritionist (R. Ngaruro), was secunded to the project for its duration by the Ministry of Health and has rejoined the project after a study leave of nearly 2 years. A Community Field Nutritionist was secunded to us as well to act as a supervisor for the Food Intake enumerators.

We felt it important to recruit as many Kenyan women as possible who would assume senior positions of leadership in the University or the Government of Kenya as part of infrastructure building. The field coordinator and senior investigators also provide excellent role models and mentoring for the younger scientists who wish to carry out doctoral studies.

Dr. Charity Kabutha, well known in gender issues, especially in Women in Leadership in Agriculture, serves as a consultant to the project and will serve in an advisory role on the steering committee. Dr. Helen Ommeh, an agricultural economist with the University of Nairobi, College of Agriculture, worked on planning the grant and continues as a consultant.

Policy

Even before the research findings are entirely known, the GLCRSP, the World Bank, BASIS CRSP, ILRI and Heifer Project International have discussed policy considerations at a number of meetings, at which the P.I. gave invited presentations. By studying human health, growth, and cognitive development in relation to diet quality improvement through increased intake of animal source foods, the livestock, education and health communities have begun to consider linkages of livestock production with improvement of human well-being and nutrition as one of the outcomes or impacts of improved livestock production. Increasingly the above – mentioned groups are viewing human health and nutrition improvement as a desired positive outcome. Groups such as Heifer Project International (HPI), ILRI, and some of the other GL CRSPs have invited the P.I.s and others in our group to discuss such linkages, and the evidence for the role of animal products in improving diet quality and human function as economic capital investments in development.

By working closely with the school administrators, local physicians, parents and community leaders, there has been awareness raising of the need for school feeding and its improvement, particularly for young school children. Children often come long distances to school without having eaten, and teachers and administrators are becoming very concerned about this. Lack of food intake, poor nutritional status, and poor health interfere with the children's ability to benefit from their educational experience. If the large investment in primary education is to realize a return, the children must be in the best condition to learn. Successful students go on to higher education and become future leaders and contribute to social and economic development.

The health assessment activities of the children continue to have a high visibility with parents accompanying their children while a health professional examines their children for the third year. They get feedback and see their children being checked for anemia, malaria and intestinal parasites, and receiving de-worming medication at school and learning how to

Members of the Child Nutrition Project Team present goats to families in the intervention study who participated in the control group. Team members pictured from left to right, Ms. Minnie Kamore (Field Nutritionist), Mr. Z. Akula (Project Administrator) and Ms. Emmy Nyaga (Nutritionist, Ministry of Health).

prevent parasites. These activities introduce the community to the concept of the role for schools in health and nutrition promotion and community improvement.

Lastly, a food-based, rather than pharmaceutical approach is being used to improve the micronutrient content of the diet and foods available in the community are being used for the school feeding.

Thus the recent study findings call attention to the following policy issues:

Merely increasing dietary energy alone is not sufficient to improve cognitive function and improve micronutrient nutritional status. School feeding and home diet need to be improved so as to increase the micronutrient content of the diet (diet quality). This also has relevance to the USA where all degrees of vegetarism and avoidance of "red meat" is widespread.

High infection burden, especially of malaria need to be dealt, to enhance nutrition status as infection further compromises micronutrient status. This is particularly true for ion, zinc, vitamin A, and B_{12}. The findings have implication for many developing countries where mild-moderate PEM and multiple micronutrient deficiencies, the leading nutrition deficiencies co-exist with high prevalence of infection and malaria.

There is a need for collaboration with the livestock community to increase accessibility and availability and production of animal source foods to small holders to put "meat on the table" and as a source of income. At a more basic level, stimulation of sustainable school feeding with through parent-school partnership are also needed—School activities can help supply animal foods to increase school feeding quality.

OUTREACH

Efforts have been initiated by the CNP to stimulate the former study schools to undertake school feeding on their own, working with the parents to donate food staffs. For those not able to do so, parents would donate some work to the school feeding effort. Every school has a simple or token kitchen and a cook who usually fixes the teacher snacks and porridge for the pre-schoolers (about 30-35 per school).

Through Agricultural Extension (Home

economics) and the project nutritionists, technical advice about the composition of the feedings will be available. Several schools have been approached with teachers and parents willing to initiate this. One school in an area to the study has such a feeding program in place. One teacher takes full responsibility to ensure that the program works.

The eventual addition of adding animal source food to the feedings is under active discussion. NGO assistance may be very helpful. School rabbit projects and other projects have been mentioned involving small livestock and are under discussion.

Developmental Impact

Contributions to U.S. Agriculture and Nutrition Policy and Practices. Iron deficiency and, to a lesser extent, zinc, vitamin B_{12} and calcium deficiencies are problems in the USA, particularly among poorer families in inner cities and in rural areas and among strict vegetarians and groups who have drastically reduced meat in their children's diets. The less severe cognitive deficits associated with iron deficiency, poor linear growth associated with zinc deficiency, and neurological development problems associated with vitamin B_{12} need to be addressed in American children as well. The potential findings of our study would address problems and approaches to prevent micronutrient deficiencies in the U.S.A. and counter the groundswell of negative information and "press" against inclusion of meat in the diet in modest amounts including fowl and fish.

Contributions to Host Country. The development target is to improve the ability of children to learn, to benefit from their school experience and to enjoy better health. This will enhance their ability to contribute to leadership roles and social and economic development of their community and nation. Kenya spends over a third of its budget on education. Better-nourished children who are not iron deficient or suffer other micronutrient deficiencies will learn better, be more physically active and in better position to learn and increase the returns on Kenya's heavy investment in education. In addition to cognitive and school performance we anticipate improvements in physical growth and reduction of anemia which will increase ability to perform physical work and therefore contribute to economic development

With the study results of the controlled intervention study showing a causal relationship between intake of animal foods and aspects of the child's cognitive function and growth. Policy issues are raised in multiple areas - education, nutrition and health, and agriculture, and necessity for school feeding and overall improvement of diet quality .

Linkages and Networking. Interaction with the other East African GLCRSP projects through the common goal of nutrition improvement has been mainly at Annual Review meetings of the GLCRSP. The outcome of improvement in human health and nutrition through enhanced livestock production is a shared theme, ILRI, the BASIS CRSP, and IPFRI, and the World Bank invited the PI to give presentations. Our project still interacts with Makerere University Child Health and Development Center in a shared related project dealing with rabbit production for household consumption to improve diet quality, child growth and food security.

Other Contributions

Support for Free Markets and Broad-based Economic Growth. Stimulation of small animal production, production of milk and local foodstuffs for school feeding, and family diet improvement support income generation and the marketing and sale of the above foodstuffs. The field staff now banks their salaries and

controls the use of their money. Some have started small businesses with their savings in their spare time.

Contribution and Compliance with Mission Objectives. Our project goals and objectives are and consistent with the 1998-1999 revised strategic framework of USAID Agency Goal #4: "World Population Stabilized and Human Health Protected", and specifically REDSO/ESA Strategic Objective #4, that of "Improved Child and Reproductive Health Systems in East and Southern Africa".

In the context of improving diet quantity-quality and growth and cognitive development and health of children, our project will strengthen the following areas:

IR4.1 Strengthening of information networks and improved policy

IR4.2 Improving technical capacity of partners in nutrition assessment and promotion.

IR4.3 Improving policy in the area of food based micronutrient approaches. Importance of school feeding in relation to enhancement of cognitive function and learning.

IR4.5 Improving family diet quality through incorporation of animal source foods, particularly for your children, schoolers and women of reproductive age.

Support for Democracy. This project promotes democracy in several ways:

1. The highly interactive and participatory style of operation of the current Research Team has set the tone for the project. Decisions are mainly by majority vote or by consensus and all experience "democracy in action."
2. In the future intervention phase:
   - Women will obtain experience in leadership skills and be given hands-on experience in the processes of organizing community initiatives.
   - Improved food security, nutrition, and income generation allow community members to obtain better health and to become more active and creative participants in their communities. This leads to increased political stability, which fosters participation in community governance

Concern for Individuals. Children who have severe anemia, malaria or any other serious condition have been referred for medical evaluation and treatment. All children receive anti-helminthics (deworming) as hookworm and ascaris infection is present. Children have all had physical examinations and health histories taken and those with problems are referred for further evaluation and care. All children are having vision and hearing tested and those with problems are referred for further care.

Humanitarian Assistance. Many school children in the study appear to come to school hungry. The school feeding is most welcome and is the only substantial food some children receive prior to or during the school hours. After the informal study ended for cohort I, school feeding at school was continued for another term because of the drought and severe food shortage. This was supported by the GLCRSP.

Leveraged Funding and Linked Projects

Linked Project (unofficial). The project entails a community-based approach to increase animal source food intake by households through rabbit raising. This project targets women and children in Uganda, and is a collaboration with Dr. Jitta of Makerere University's Child Health Development Center and College of Agriculture, and a Ugandan NGO, VEDCO. This NGO has already introduced rabbits into communities in Lowero District through women's credit groups, with a focus on income generation. Nutrition

education components consist of hands on demonstrations, participatory education, and recipe development to increase meat intake of the households, particularly of women and children. This project addresses diet quality improvement through increased meat in the diet, food security and in the future income generation by and for women. Impact will be evaluated by nutritional food intake and economic indicators. This year USAID had funded the project with linkage to the "Orange Sweet Potato" initiative and continuation of the rabbit work.

As mentioned earlier, we received a grant for $60,000 to complete the feeding and data collection for cohort II.

Training

C. Gewa, Ph.D., 2002-3, Nutrition, UCLA

M.Grillenberger, Ph.D., 2002, Nutrition Wageningen U.

R. Ngaruro, MSc., 2001, Nutrition, London School of Hygiene and Tropical Medicine

J. Siekmann, Ph.D., 2001, Nutrition, U.C. Davis

All of the above have or will carry out or use project data for their dissertations. A great deal of training and retraining has gone on of the field enumerators and supervisors. Over fifty have been trained in various areas of food intake, anthropometry, cognitive testing and observations, censuses, morbidity, socioeconomic status, literacy testing, computer and data entry. These are marketable skills for future research or evaluation positions or in relevant ministries.

Collaborating Personnel

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Collaborating Institutions

University of Nairobi
Pediatrics, School of Medicine
Department of Food Science,
Applied Nutrition Program
College of Agriculture

Ministry of Health
Nutrition Division
@ Central and District Level

Ministry of Education
Office of Child Health and Nutrition
Central and Provincial Level

Makerere University

Kenya Agriculture Research Institute - Nairobi

Ministry of Agriculture
Heme Economics and Livestock Central and District Office

Publications

Siekmann, J.H., Allen, L.H., Bwibo, N.O., Demment, M.W., Murphy, S.P., Neumann, C.G. "Micronutrient status of Kenyan School Children:Responses to Meat, Milk, or Energy Supplementation". Submitted to Journal of Nutrtion.

Seikmann, J.S., Neumann, D.G., and Allen, L.H. "Malaria and/or Infection affect estimate of prevalence of micronutrient deficiencies in Kenyan school children." Submitted to the American Journal of Clinical Nutrition.

Whaley, S.E., Sigman, V.M., Neumann, C.G., Bwibo, N.O, Guthrie, D., Weiss, R.E., and Alber, S. "The Impact of dietary intervention on the cognitive development of Kenyan school children." Submitted to Child Development.

Neumann, C.G., Harris, D.M., and Rogers, R.L. "Contribution of animal source foods in improving diet quality for children in the developing world." Nutrition Research (In-press) pp. 1-28, for January 2002 (Special issue on Preventive Nutrition.)

Abstracts and Presentations

Neumann, C.G., Siekmann, J., Bwibo, N.O., Allen, L., and M. Grillenberger. Impact of infection and malaria in micronurtrient status in rural Kenyan school children. Presented at XVII International Congress of Nutrition, August 27-31, 2001, Vienna, Austria Ann. Nutr. Metab 2001; 45 (suppl. 1)

Murphy, S.P., Gewa, C., Grillenberger, M., Bwibo, N.O., and C. Neumann. University of Hawaii, Honalulu, University of California, Los Angeles, University of Nairobi, Kenya. Changes in Dietary Quality for School Children in Kenyan Villages. Presented at XVII International Congress of Nutrition, August 27-31, 2001, Vienna, Austria Ann. Nutr. Metab 2001; 45 (suppl. 1)

Daley, T.C., Whaley, S.E., and M. Sigman, The Flynn Effect in Rural Kenya Paper presented at 30th Annual Meeting of The Society for Cross-Cultural Research, February 2001, San Diego, CA and at the Society for Research in Child Development, April 2001, Minneapolis, Minnesota.

Congdon, E.M., Schweitz, E.M., Neumann, C.G., and J. Siekmann. Dana Center, Wilmer Ege Institute, Baltimore, MD, UCLA School of Health and of Medicine, Los Angeles CA and University of CA at Davis, Dept. of Nutrition at Davis CA Presented at the Association for Research in Vision and Ophthomology, Ft. Lauderdale, May 2001.

Comments

The Child Nutrition was extremely gratified to receive the Child Survival funds for work with the under-five age group. Although challenging, we feel that limited feeding intervention study is extremely worthwhile. Children in this age group have the highest rates of morbidity and mortality from infectious diseases as well as malnutrition and need

relatively requirements for their rapid growth. Therefore, even a short time of intervention feeding may yield some positive results. The real challenge is to keep the mothers bringing their children daily for onsite feeding at eighteen different feeding sites. This requirement is the very reason we chose to work with school children. Also in the spirit of the child survival initiative, these young children are having their growth monitored, and are being dewormed and are being treated for malaria and severe anemia as detected.

PRINCIPAL INVESTIGATORS

Lead Principal Investigator: Charlotte G. Neumann, M.D., M.P.H., Community Health Sciences and Pediatrics, UCLA School of Public Health and of Medicine, Los Angeles, California

Co-Principal Investigators. Nimrod O. Bwibo, MBBS, M.P.H., (Kenya Country Director), Dept. of Pediatrics, University of Nairobi, Faculty of Medicine, Nairobi, Kenya

Suzanne P. Murphy, Ph.D.(Food and Nutrient Intake), Cancer Research Center of Hawaii. University of Hawaii, Honolulu, Hawaii

Marian Sigman, Ph.D., (Cognitive Function), Dept. of Biobehavioral Development, Neuropsychiatric Institute and Psychology, UCLA School of Medicine, Los Angeles, California

Co-Investigator. Lindsay B. Allen, Ph.D., (Biochemistry), Department of Nutritional Sciences, University of California at Davis, Davis, California

Shannon Whaley, PhD., (Cognitive Function), Dept. of Biobehavioral Development, Neuropsychiatric Institute, UCLA School of Medicine, Los Angeles, California

Statisticians. Robert Weiss, PhD., Donald Guthrie, PhD., Dept. of Biostatistics, UCLA School of Public Health, Los Angeles, California

LIVESTOCK DEVELOPMENT AND RANGELAND CONSERVATION TOOLS FOR CENTRAL ASIA

NARRATIVE SUMMARY

In the 1990's, market changes and privatization caused imbalances and dramatic reductions of agricultural stocks, production and productivity in Central Asian Republics (CAR). Central Asia represents a large region in the center of the Eurasian continent that encompasses the territories of Turkmenistan, Uzbekistan, Kazakhstan, Tajikistan and Kyrgyzstan. Rangelands occupy nearly 80% of the territory and provide the main source of forage for livestock. Sustainability of extensive production and human nutritional welfare were negatively impacted by socio-economic changes immediately following independence. Division of state and collective herds into smaller private units caused erosion of animal stocks that started in the early 1990's and is in contrast with the long-term increase of livestock population in the region. The decline in livestock numbers can be attributed to the deterioration of the terms of trade for producers. Lack of winter forages, collapse of marketing networks and poor maintenance of livestock water wells have resulted in hand-harvesting of range plants for feed and fuel and concentration of livestock around populated areas and active wells. In spite of declining livestock numbers, rangeland degradation is accelerating near surface water and populated areas. Rangelands of CAR may constitute a significant part of the "missing sink" that attenuates the increase in atmospheric carbon dioxide. Additionally, restoration of degraded lands may constitute a source of carbon credits for the region. Thus, this project addresses the immediate need to improve welfare of small landowners, to prevent further deterioration of rangelands, and to document their role as carbon sinks.

This research is divided into two modules – GIS/Basic Resources and Range Forage and Carbon Flux; and is supported by two components – Animal Production and Socio-Economics. We take an integrated multidisciplinary approach to improve the welfare of herders that involves not only on-farm solution of technical aspects, but also the assessment of alternatives and policy instruments to support them. Alternatives are evaluated from the point of view of sustainability, impacts on the global carbon budget, and economic profits. Models incorporating ecological and policy scenarios are used to explore the regional impacts of various technical alternatives.

The original plan for the 2000-2001 year included:

1. Augmentation and refinement of regional GIS for Turkmenistan (TK) and Uzbekistan (UZ);
2. Creation and distribution of a spatial tool for each country;
3. Begin regional estimates of C balance in rangelands;
4. Begin cartographic modeling of livestock sector in Kazakhstan;
5. Continued measurements and modeling of carbon dioxide flux in rangelands;
6. Reduction of CO_2 data and development of CO_2 flux models;

7. Installation of 2 eddy covariance systems (EC) for roving measurements of CO_2 fluxes in various ecosystems and under different management practices, conduct roving measurements;
8. Hold 2nd CO_2 Network meeting and conduct regional training on supplemental training and troubleshooting for the BR system;
9. Integrate CO_2 flux and satellite data, process and integrate historical data with recent CO_2 flux and satellite data;
10. Develop technical capacity of Kazak scientist in image processing;
11. Analyze and summarize information on primary and secondary productivity of rangelands for sheep;
12. Establishment of forage laboratory in Samarkand State University and training of scientists;
13. Conduct laboratory assessment of nutritive properties of predominant range vegetation types in target zones;
14. Evaluate existing maps of sampling sites and conduct inventory of literature data;
15. Quantitative assessment of the causes of livestock reduction and prediction of future stock levels utilizing developed model;
16. Model the interaction of livestock, pasture, and the regional economy using a bio-economic approach;
17. Model the behavior of producers that determine the stocking level mainly by controlling the sales and purchases of animals;
18. Calibrate models for regions in Uzbekistan with available data;
19. Dissemination of results to the government and producers.

Most of these proposed activities were conducted as reported below, with slight departures from the original plans.

RESEARCH

GIS and Basic Resources Module

Problem statements and approaches. The GIS and Basic Resources module is designed to serve as the basis for regional application and modeling of research results. The main activities of this component are the creation of a GIS for KZ, TK, and UZ. Information is used for direct dissemination and as a basis for the other modules and components. During the fourth year of the project we proposed to augment the regional GIS, create and distribute a spatial tool for UZ and TK, begin regional estimates of C balance in rangelands (integration with CO_2 component), and begin cartographic modeling of the livestock sector in Kazakhstan (integration with the SE component).

Augmentation and refinement of the databases will emphasize meteorological and remote sensing data. The creation and distribution of a spatial tool will be subcontracted to the Blackland Research and Extension Center. Integration with other components was done to build, synthesize and calibrate spatial models, to validate these models against ground truth data, and to use these models to test alternative scenarios and predict the outcome of management actions. Existing models will be extrapolated to Central Asian vegetation types and then integrated in the GIS over the spatial extent of the region to produce landscape-level estimates of total carbon flux.

Progress. Remote sensing data were acquired by the Range Forage and Carbon Flux module group. It includes 1998 June - July AVHRR, 1999 June - Aug AVHRR NDVI, and 2000 Jan – Dec AVHRR NDVI. Additional images include SPOT Vegetation 2000 – copyrighted, Landsat7 TM data (30 m) for 1999 for Shortandy and the Shetskii Raion,

Kazakhstan, and 2000 MODIS image for the fall (500 m).

Daily meteorological data were acquired for KZ, TK, and UZ for 1999, 2000, and Jan-Jul 2001. In order to develop the relationships between production and rainfall, precipitation data was obtained from 21 climatic stations, interpolated across a 1200 km band in Southern Kazakhstan and corresponding forage types were extracted from the vegetation layer for analyses. This is a preliminary step in developing a cartographic model to provide estimates of the impact of alternative livestock management strategies on rangelands net primary production.

Country Almanacs (Almanac Characterization Tool or ACT) for Turkmenistan and Uzbekistan are under construction by the TAMUS Blackland Research and Extension Center. The ACT is an integrated spatial information system designed for agriculture and natural resource management. The ACT software is complemented by the construction of a foundation database for each geographical region. The foundation data accompanying the ACT include climate, meteorological, infrastructure, population, topographic, and where available, census and other economic and social data. The ACT's analytical and visualization tools enable the rapid characterization of areas within the target geographic regions. The beta version was produced in April 2001 and with the correction of some deficiencies the final version is scheduled for distribution in December 2001. Once the Almanacs are complete, training will be conducted in Central Asia.

GIS data produced in Uzbekistan included layers for political districts, soil types, and vegetation types. These are being rubber-sheeted to overlay existing data layers.

Departures from the original plan were minimal. Delays in receipt of carbon data have delayed the augmentation of the regional GIS database. There were delays in completing the forage map, which continues to be edited and cleaned.

Range Forage and Carbon Flux Module

Problem statements and approaches. The main objectives of the Range Forage and Carbon Flux module are to: 1) quantify annual net primary production (ANPP) on representative Central Asian rangelands and 2) assess the role of Central Asian rangelands in the global carbon budget. Accurate estimates of ANPP from these rangelands will provide important information on carrying capacity to sustain livestock production in the region and are important for evaluating whether Central Asian rangelands are net sources or sinks for atmospheric CO_2. Our studies in Central Asia will provide data necessary to quantitatively assess the role of Central Asian rangelands in the global carbon budget.

The Central Asian Region is dominated by vast rangelands, and we hypothesize that these extensive rangelands may constitute a significant portion of the "missing sink" that attenuates the increase in global atmospheric CO_2. The capacity of rangelands to sequester atmospheric CO_2 could be increased with better rangeland management practices, thereby improving the welfare of small landowners and, if acceptable treaties and protocols can be developed, possibly providing opportunities for trading "carbon credits". Daily and seasonal carbon balances of rangeland ecosystems are measured with a Bowen ratio (BR) technique that calculates net CO_2 exchange between a terrestrial surface (including soil and vegetation) and the atmosphere. The net CO_2 exchange between rangeland ecosystems and the atmosphere was monitored continuously during the growing season in the following study sites in Central Asia:

• Shortandy site – This represents the 'typical steppe', which consists of the vast area of the true steppe spreading from the lowlands of the northern Black Sea through the southern parts of the Russian Plains to the steppes of northern Kazakhstan. This site is located in the field experimental station of the Barayev Kazakh Research Institute of Grain Farming, near the town of Shortandy, about 60 km NNE of Astana, Kazakhstan, (51°40' N, 71°00'E, 367 m a.s.l.)

• Karnap site – This represents the 'sagebrush-ephemeroidal' arid rangelands of the foothills of Central Asia. This site is located in the territory of the agricultural enterprise "Razzok Jahangirov", 150 km NWW from Samarkand Uzbekistan (40°N, 65°30'E, 310 m a.s.l.).

• Karrykul site – This represents the 'shrub sandy desert', which includes the majority of the rangelands of Turkmenistan (26 million ha). This site is located in the southern part of the Central Karakum Desert, 80 km to the north of Ashkhabad, Turkmenistan (38°36'N, 58°24'E, 90 m a.s.l.). The site is part of the Karrykul Research Station of the National Institute of Deserts, Flora and Fauna of the Ministry of Nature of Turkmenistan.

Progress. The CO_2 flux data collected during the 2001 growing season are being processed and analyzed to develop predictive models for carbon flux and aboveground net primary production in three major types of rangelands that cover significant areas of Central Asia. At each BR site, micrometeorological variables were measured and averaged every 20 minutes, and CO_2 fluxes were calculated for each 20-minute period. Data were stored electronically and sent via electronic mail to the USA, where data quality assurance procedures were performed. These micrometeorological variables will be used for each CO_2 flux site to develop mathematical models to estimate daytime CO_2 flux, night-time respiration, and daily net CO_2 fluxes. The daily net CO_2 fluxes will be integrated to estimate the net carbon balance for the entire growing season. A full technical report of the CO_2 flux module is being prepared and will be completed in March 2002.

In Kazakhstan, we are using two eddy covariance (EC) systems to obtain roving CO_2 flux measurements in various rangeland ecosystems. The main objective of these measurements is to assess the variability of CO_2 fluxes across different vegetation types such as: 1) abandoned lands – previously cultivated lands for wheat production and left uncultivated for the past several years; 2) revegetated lands – those that are currently being used to grow crested wheatgrass (*Agropyron* spp.) for hay production; and 3) virgin lands – pristine, uncultivated lands where native vegetation grows. These types of land cover are representative of the majority of the agricultural land area of northern Kazakhstan, with exception of areas currently being used for wheat production. Twelve sites (3 vegetation types x 4 replicates) were identified for the roving EC measurements within the experiment station of the Barayev Kazakh Research Institute for Grain Farming near the town of Shortandy. We are comparing typical rangelands, with improved pasturelands and abandoned croplands, in a statistically valid design with replicates. The EC measurement systems are being used for this effort because they are state-of-the-art instruments for the task. Our approach is innovative because it uses the two EC systems as roving, instead of stationary units. Results from these roving measurements will be used for precise scaling-up of local CO_2 flux measurements to the landscape or regional level. Furthermore, efforts are being undertaken to measure the winter CO_2 fluxes in rangelands of northern Kazakhstan. This will allow us to

estimate the rangeland ecosystem's carbon balance on an annual basis.

Scientists (Drs. Larry Tieszen, Bruce Wylie, and Bradley Reed) at the Earth Resources Observation Systems (EROS) Data Center (EDC) have the task of spatially and temporally extrapolating the CO_2 fluxes measured with the BR systems in rangelands of Central Asia. They have assessed the ability of remotely-sensed data (AVHRR NDVI) to estimate CO_2 fluxes measured at the ground level using data obtained from a sagebrush steppe ecosystem at Dubois, Idaho. A fairly strong relationship between daytime CO_2 flux and NDVI has been found, and a manuscript, "Calibration of remotely sensed coarse resolution NDVI to CO_2 fluxes in a sagebrush steppe ecosystem," is currently in-review for publication. Thus, the above-mentioned roving EC CO_2 flux measurements in Kazakhstan will be useful in improving and streamlining our efforts to apply AVHRR NDVI data in scaling-up the local CO_2 fluxes to the landscape or regional levels.

Regression tree algorithms were developed using spatial and temporal data sets for the Central Asian CO_2 flux study sites. These data included net ecosystem exchange (NEE), night-time respiration, daytime CO_2 flux, and photosynthetically active radiation (PAR). The PAR and NEE algorithms were implemented spatially for the area from June 1 to August 10; four 10-day composite periods. These algorithms relied on coarse spatial estimates of precipitation, which agreed well with precipitation measured at the BR systems. However, the effect of the coarse resolution data set is evident in the resulting 10-day NEE maps. Only NDVI, precipitation, PAR, day of year were used because there were only three CO_2 flux monitoring sites (1998-1999). Thus, other spatial variables like DEM, ecoregions, soil texture, etc. were not used.

Departures from the original plan were minimal. Project funds for EDC were depleted as of the end of August. Dr. Wylie's time on this project was reduced because funds were used to pay for SPOT VEGETATION and Dr. Glimanov's modeling efforts. These expenditures were appropriate and, have been and will be relevant in future research.

Project funds allocated to Dr. Tagir Gilmanov were used to generate daytime respiration estimates from daytime CO_2 fluxes. This will allow quantification of the components of NEE (NEE = gross primary production (GPP) – respiration). Daytime respiration estimates were consistent with night-time respiration and with values published in the literature. We will continue this analysis on other sites and years for the 2002 activities. Smoothed NDVI data were sent to Dr. Gilmanov to assess if relationships were stronger with NDVI and GPP or NEE.

Further information about the collaboration with the EROS Data Center can be found at http://edcsnw3.cr.usgs.gov/ip/index.html.

Animal Production Component

Problem statements and approaches. The Animal Production Module pursues two major objectives: (1) determine the production potential of the semi-arid and arid regions of Uzbekistan and Turkmenistan for sheep production, thereby facilitating the design of appropriate development programs for the livestock sector; (2) create modern planning capabilities in the host countries by establishing laboratories, provide training to host country scientists, and develop computer-based maps of production and development potential. Activities comprise research on diet composition of sheep, determination of nutritional quality of range and its dynamics throughout the forage year, parameterization of a mathematical model

of sheep production for the determination of potential production levels as determined by the ecological characteristics of the natural pastures, and development of computerized maps to facilitate decision making in livestock development and range conservation.

Our project will produce data essential for an improved match between animal genotype and environmental resources in Central Asia. This is the basis for long-term sustainable production. The methods that will be developed in our project are highly relevant for extensive sheep production systems in the United States. The host countries will benefit by acquiring appropriate planning and analysis tools that will help them address the grave environmental problems of livestock production on Central Asian rangelands.

Progress

Animal Experiments. One of the main objectives to the module is to determine diet selection of small ruminants on natural rangelands in Uzbekistan. Field research began in May with an experiment on digestibility of Alhagi pseudoalhagi,(camelthorn, Fabaceae) the major winter forage supplement for small ruminants in Uzbekistan. In the months before, facilities were constructed to conduct these experiments. The first diet selection field experiment began in August, when a group of experimental animals was inserted with Captec slow release devices. Both animal field experiments were completed successfully. An import permit was obtained for the United States for the plant samples in October. Import of animal samples is more difficult, and has not been fully approved yet. The next experiment on forage digestibility using the metabolism crates constructed in the project will begin in December.

Range condition Monitoring. Three expeditions covering a total of more than 3,000 miles to six ecological sites for the establishment of range condition monitoring sites were conducted in August. On all sites, extensive range inventory measurements were conducted for the assessment of mid-grazing season forage resources. On all sites, an exhaustive collection of plants was performed. In the laboratory in Samarkand, complete biomass measurements were performed. Plant samples are scheduled to be imported into the US in November for analysis of their nutritional properties. The second expedition to the monitoring sites is currently underway. Each year, all sites will be inventoried four times, from the end of March to the beginning of November. Statistical analysis of the inventory data is currently under way.

Animal Production Models. Work on the re-programming of the SR-CRSP sheep, goat and beef production systems models began in November of 2000. Work is performed in collaboration with Lahey Computer Systems, Inc. LCS is the world's premier supplier of FORTAN compilers. The CEO of this company, Thomas M. Lahey, accepts selected re-programming and porting projects. We established a contract with LCS for programming services required by the IFAD funded project. To date, we have completed Phase I and part of Phase II of this project. The sheep and goat, and the beef models are functional now. Due to the very large number of software problems encountered in the existing code, the re-programming component of the project is currently 2 months behind schedule. We have begun to compile data for the parameterization of the models for Central Asian production conditions. We have limited data on genotypic and phenotypic animal parameters. The most serious data deficiency is the paucity of data on forage and diet quality of animals in grazing systems in Central Asia. Further, data

collected on mortality and morbidity of sheep and goats in Kazakhstan and Uzbekistan do not seem to be trustworthy. Our Uzbek collaborator is currently working on a forage quality data set, and collecting additional information on mortality data. The next step, Phase II of the programming will start shortly. This phase includes the reprogramming of the database structure of the model and the design of a user-friendly interface for all the models.

Socio-Economic Component

Problem statements and approaches.

Livestock sector in Kazakstan

In 2000-2001 we continued our search for factors that affected and still affect livestock production in Kazakhstan and Uzbekistan. Between 1990 and 1998, Kazakstan lost 73% of its sheep and goat population and 59% of its cattle population. In 1999, the sheep, goat and cattle populations began increasing for the first time since the collapse of the Soviet system. After a review of the existing literature, we conducted field interviews and farm surveys. We identified the following causal factors.

Explanations for the decline:

• The end of the Soviet Union led to dramatic changes in the economic environment in Kazakhstan.

• Lower output prices and higher input prices, as a result of price liberalization, sharply reduced the profitability of livestock production and led to liquidation of livestock capital.

• Privatization of former state and collective farms and distribution of their assets to member workers resulted in the creation of numerous smallholder farms who lack both physical and human capital needed for optimal livestock production.

• Government support, such as price supports, input and credit subsidies, and investment in infrastructure, disappeared altogether.

• Livestock, especially sheep, were used as a means of exchange – animals were bartered away for production and consumption goods during a severe economic downturn when employment and financial credit were unavailable to many farmers.

Explanations for the recent increase in livestock output:

• Relative prices have stabilized and farmers have adjusted output levels accordingly.

• Producers are learning how the new market-oriented system works.

• Smallholders, working within their family, have fewer coordination problems than large farms.

• Smallholders have lower average unit costs than large farms have. Large farms have much higher overhead costs.

Our research has now moved on to the stage where we are starting to analyze how these factors have affected livestock production. We want to explore the mechanism in which the identified causal factors affect livestock production, and assess the relative importance of each factor. Among the factors listed above, we especially focus on the price changes and farm privatization. In analyzing the impact of rapid price changes, we take into consideration of the importance of price expectations in transition economies and livestock production. The identification of the causal parameters will allow us to suggest policy measures that will aid the Kazakhstani livestock sector achieve a new equilibrium level.

Progress. During October 2000 – July 2001, we constructed a dynamic optimization model of population dynamics for sheep. Under the price level for 1998, the model predicted the steady-state level population of 18 million head (the sheep and goat population was 35

million in 1990 and 10 million in 2000). The figure may be an underestimation if the output price recovers further and an overestimation if the forage availability restricts the growth of livestock population (the model does not yet take this into account). The use of average productivity may not be appropriate since the breed composition has changed considerably and meat-type sheep are currently preferred to wool-type breeds. The model parameters will be updated and replaced, and the model structure will be improved. Range resource availability will be incorporated in the model as well.

During August-September 2001, M. Kobayashi conducted interviews with local scientists and producers to identify the factors potentially responsible for the dynamics of the livestock sector. We collected farm level data in association with the Farm Monitoring Project funded by IFAD/ICARDA. The data will be used to improve the productivity parameters in the mathematical programming model above. Finally, we collected published statistics on livestock production and prices, which are going to be statistically analyzed to test whether the factors identified significantly affect livestock production in Kazakhstan.

Since livestock is a capital asset that provides future production as well as immediate output, it is relevant and important to explore how producers saw the industry's future in order to understand the path the livestock industry has taken. For example, when output price falls, producers will reduce their herd/flock size if they believe that the price will continue to be lower. On the other hand, if they believe that the price decline is only a temporary change, they will maintain their herd/flock size (holding other things constant).

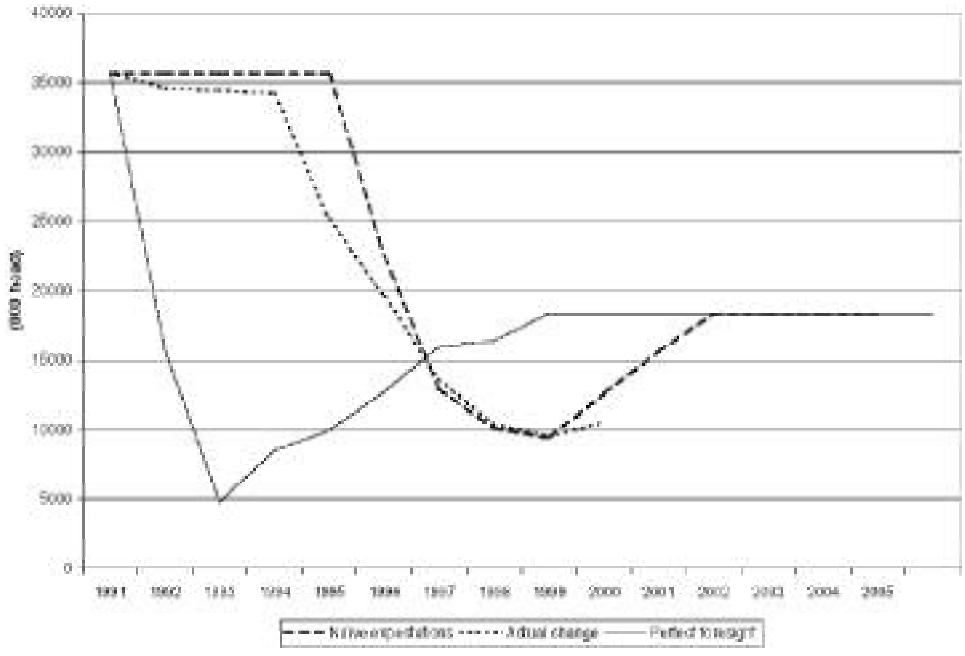
To analyze the importance of price expectations in dynamic problem of livestock production, we constructed a dynamic optimization model for the national sheep flock, and implemented several simulation exercises. Assuming constant meat and wool productivity, birth and mortality rates, and given the levels of current and (expected) future prices, the model calculates the optimal slaughter each year, and hence the time path for the optimal national flock size.

Using the model, we calculated the transition path of sheep population from the 1990 level under two different price expectation formation schemes. Figure 1 shows the following:

- With perfect foresight, the decline in sheep and goat population would have been even larger (because producers would have sold their livestock when the output prices were the highest), but the recovery would have been sooner.
- With naïve price expectations, where forecasts are based only on the current price and the expectation is that the current price will last), the simulated transition path looks close to the actual one.

As seen in Figure 1, the optimal paths differ greatly depending on the producers' view of the future. In the early years of transition, when the economy was extremely uncertain, it is unlikely that the producers had a clear understanding of supply and demand situations of the industry so they could correctly predict the future prices. Indeed, our simulation results show that the optimal path under the assumption of naïve price expectations looks much closer to the actual path than under the assumption of perfect foresight. The results also draw attention to the importance of knowing actual expectations among producers in order to predict where the sector is going. This enables us to form effective policies that will help the sector to achieve a desirable equilibrium. At the same time, the model can be used to analyze the

Figure 1. Simulation of transition path of sheep and goat population under different price expectations formulation schemes.



impacts of having more accurate price forecasts on the welfare of producers and consumers.

Given these results and considerations, our next questions are:

- How did the producers form price expectations?
- What information did they use to predict future prices when the economy was extremely uncertain?
- Did the expectations change during the course of transition?

We will explore these questions by estimating the proportions of producers with different expectation formations and the change in the proportions over time. Once we better understand the expectation formations in Kazakhstan, we will construct a simulation model for range-based livestock producers.

Survey in Uzbekistan

Results of the survey conducted in Uzbekistan in 2000 were analyzed and a MS thesis (J. Seigies) produced based on these results. This study focused on the comparison of forage availability and livestock production practices by smallholders between regions within Uzbekistan and between UZ and KZ. The comparison between countries reflects the interesting fact that although overall country statistics reflect major differences in the evolution of total livestock populations, the trends observed in household production and tenure are similar. Comparisons among regions in Uzbekistan reveal, not unexpectedly, that the more vulnerable regions, such as Karakalpakstan and the semiarid Plains are also the ones that experience the least availability and highest cost

of feed for livestock. The vast majority of household livestock holdings were for the purpose of milk production and as a means of saving. These results are very similar to what was observed in Kazakstan.

Dissemination of results

The PI and other members of the research team visited government and farmers institutions in Kazakhstan and Uzbekistan. Host country scientists were briefed and consulted on the progress and plans of the project. We continued to distribute the Russian version of the GL-CRSP newsletter to villages that were surveyed in 1998, and will include those visited in 2000 in the future.

Several articles were published in Ruminations. Two MS thesis were produced in this reporting period. These publications will be available through regular library services and through the internet.

A major dissemination effort was completed in collaboration with ILRI. Several local scientists wrote technical chapters for a handbook for small producers in Kazakstan. The book was edited by Dr. N. Malmakov and printed in Russian. Several hundred copies of the book were distributed freely to small producers. A Kazak version is under development. The handbook has also been translated to English to facilitate interaction with the English-speaking scientific community.

Gender

Data from this project will provide information that will benefit both the male and female portions of the general population in the region. Results from the project will hopefully encourage women in host countries to become involved in further research that will enhance rangeland primary productivity, develop the livestock sector, and affect regional policies.

This project has continued to support women at all levels: as direct beneficiaries of the research results, as employees to support regional activities (Sidelnikova, Khosmukhamedova, Mamedova, Raushan, Kernshakaya), as collaborating scientists (Karibayeva, Shabanova, Soyunova, Lebed, Gaziantz, Young), as graduate students (Olmstead, Kobayashi, Toderich), and as student assistants (Darmina, Maze).

Policy

Important linkages developed in the past and reported last year continued to operate. This year, we successfully concentrated in furthering our connections with scientists and government institutions in Uzbekistan.

Although Kazakhstan is ahead of the other two countries in terms of reforms, it still does not have well-developed agricultural policies. Local researchers are trying hard to construct such policies. The development of additional objective information at both the aggregate market and also the individual farmer level – and policy analysis that could be based on such information - would be extremely useful for future agricultural policy making. According to a report by the World Bank, the government of Kazakhstan recently initiated a farm restructuring program which seeks, by applying bankruptcy laws to insolvent former collective and state farms, removal of their debt burden and a more efficient management. If the program is successfully implemented, it will promote restructuring of the sector by introducing more competitive forces into the market. By identifying the constraining factors to the restructuring of the livestock sector, our study will complement the government's efforts and possibly augment their effectiveness.

One of the aspects of our research that has attracted the most interest from policy-makers

has been the study of Central Asian rangelands as potential carbon sinks. We envision that the database collected from the CO_2 flux monitoring sites in Central Asia will serve as the foundation for the development of a technological package to identify, evaluate, and monitor "carbon credits". Regional scientists, international collaborators, and policy-makers are just beginning to seriously consider agricultural ecosystems as potential sites for mitigation of climate change. We informed regional scientists and policy-makers about these possibilities, and have obtained significant leveraged funding to create a regional network for carbon flux measurement and modeling. Our continued work in this area will enhance the regional human capacity so that participating countries can rely on their own scientists for the expected future negotiations and measurements that will be necessary in deciding issues related to carbon crediting. One of the main goals of this network is to enhance the regional human capacity so the participating countries can rely on their own scientists for the expected future negotiations and measurements that will be necessary. This aspect of our project received very strong (moral) support from the Central Asia USAID Mission. Outputs from the CO_2 module will help define the role that the expansive rangeland areas of Central Asia play in the global carbon balance; the magnitude of carbon sequestration and, therefore, the potential importance of carbon credits for Central Asian republics; and the best management practices to secure maximum carbon sequestration, support sustainability, and maintain or restore ecosystem integrity.

Besides the scientific relevance of this project, the CO_2 module will result in capacity building that will include explicit training in biophysical interpretations of remotely sensed data. This will involve high-resolution image interpretation and analysis as well as the extraction of changes in temporal responses derived from coarse-resolution AVHRR data. We will provide our in-country colleagues both the data and algorithms concerning the examination of AVHRR-derived vegetation indices and other metrics to track phenological changes and to relate them to biomass production and CO_2 flux magnitude and dynamics. We hope to quantify the spatial extents of these changes and their underlying climatic- and weather-related causes.

In Uzbekistan, the surveys were designed in collaboration with and carried out by personnel from the Uzbek Research Institute of Market Reform, a branch of the Uzbek governmental system charged with investigating and recommending reforms to the current market system. Four of the five members of the livestock division of the Institute directly participated in the surveys. The results of the surveys will ultimately be analyzed in collaboration with the Institute and recommendations will be jointly developed for presentation to policy makers.

OUTREACH

The problem of quantifying the magnitude of CO_2 flux and assessing the carbon sequestration potential in principal rangelands of Central Asia were acknowledged to be of prime importance by administrators at a number of key governmental, research and management institutions in Kazakhstan, Uzbekistan and Turkmenistan, including ministries of the environment/nature conservation, academies of sciences and leading agricultural, land management, and rangeland research institutes. During visits to the region in spring 1997 and 1998, the institutions interested in receiving the data and modeling results from the CO_2 flux subproject included: Kazakhstan (Ministry of Science; Academy of Science; National Academic Center for Agrarian Research;

Ministry of Agriculture), Turkmenistan (Academy of Sciences; Regional Center for Prevention of Desertification; Ministry of Natural Resources and Environmental Protection; Research and Production Center of Ecological Monitoring), and Uzbekistan (Ministry of Agriculture, Institute of Karakul Sheep Breeding). The extension approach adopted in the CO_2 flux module will be based upon: 1) informing the target institutions and individuals about the results of the CO_2 flux evaluations at the three monitoring stations; 2) sharing quantitative models to predict CO_2 flux rates as functions of environmental factors and management decisions; and 3) discussing with the target institutions the resultant maps of CO_2 flux rate and estimated carbon sequestration potentials derived from combining flux models with the GIS of basic ecological resources of the Central Asian states.

A research collaboration between LDRCT and World Bank-Global Environmental Facility (WB-GEF) has been established in a demonstration project to assess and quantify the rates of carbon sequestration in various ecosystems such as good-condition rangelands, degraded rangelands, abandoned croplands, and rehabilitated rangelands. The proposed target site for this demonstration project is the Shetsky Raion in Kazakhstan. Thus, the data collected from the CO_2 module of the LDRCT project will provide key baseline information that will be helpful in establishing the research and rehabilitation activities of the WB-GEF project, which will be implemented in 2002.

Developmental Impact

Quantifying the magnitude and distribution of CO_2 fluxes in the principal rangeland types of Central Asia has direct relevance to understanding the regional status of terrestrial ecosystems. We hypothesize that the capacity of rangelands to sequester carbon could be improved through scientifically based management decisions. For example, the 30-year study of carbon balance of the chernozem soils in northern Kazakhstan conducted at the Barayev Institute of Grain Farming (Shortandy, Kazakhstan) indicated a 25 to 30 percent reduction of humus reserves due to cultivation. Transformation of a portion of these lands, especially in the region of marginal agriculture in northern and central Kazakhstan, into managed pastures will result in an accumulation of a significant reserve of soil carbon. However, in some parts of the region marginal cropping areas, such as desertified steppes and semi-desert rangelands in the foothill zone of Uzbekistan, are being broken out for wheat cultivation.

Determination of the potential effect of these processes on the carbon balance of the soils (where presumably a substantial loss of soil organic matter occurs through accelerated wind and water erosion of light-textured, loess soils) will help in making wise decisions regarding the management of foothill ecosystems. Similarly in Turkmenistan the desert shrub rangelands are being over-exploited by year-round grazing. Data concerning the seasonal dynamics of ecosystem productivity from continuous CO_2 flux measurements will provide important information necessary to make rational decisions in managing these fragile ecosystems.

The CO_2 flux module has maintained close collaboration with the USDA-ARS Rangeland CO_2 Flux Network, including the sharing of data processing algorithms. Results of the research on Central Asian rangelands are being used to compare with flux measurements and inter-validate the flux models derived from the steppe and semi-desert rangelands of the western U.S.A. The CO_2 flux module also cooperated with the International Center for Agricultural Research in Dry Areas (ICARDA), which contributed expertise, equipment, and resources to the

establishment of the CO_2 flux station in Uzbekistan.

Leverage Funds and Linked Projects

Scientists at the USDA-ARS and Utah State University (USU) in Logan, UT (Drs. Douglas Johnson and Nicanor Saliendra) are participating in the LDRCT CO_2 flux module. The USDA and USU salaries and benefits support for Dr. Johnson (10% time) and Dr. Saliendra (50% time) on CRSP-related activities are estimated at $42,000. Additionally, the CO_2 flux module has benefited considerably by significant in-kind support from the USDA-ICARDA project. This includes support to purchase and install two Bowen ratio systems at the Karnap site in Uzbekistan, fencing and security guards to secure the CO_2 monitoring site, a refurbished vehicle for travel to and from the study site, and portable shelter at Karnap for research and security personnel. Support from the USDA-ICARDA project for CRSP-related research in Central Asia is estimated to be about $60,000.

The CO_2 flux module and the GIS module obtained funding from ALO and UC-Davis for the "Enhancement of Human Capacity for a network of CO2 flux studies in Central Asian Rangelands" project. This project resulted in the training of regional scientists and enhancement of the regional human capacity for gaining expertise in the measurement and modeling of carbon fluxes. This grant is completely complementary with LDRCT, and included more than $90,000 in funding and $110,000 of in-kind matching funds from UC-Davis and regional institutions. The first phase of the ALO project was completed in April 2000 when six Central Asian scientists spent about four months of training at Utah State University and UC-Davis. The second phase of this project was completed in March 2001 when a regional meeting was held in Samarkand, Uzbekistan, and a workshop on the CO_2 flux measurements and data processing was conducted through field trips at the Karnap site near Samarkand. Interaction with GIS counterparts in Turkmenistan and Uzbekistan have contributed to the productivity and assured sustainability of the GIS/CO2 activities now being developed in the region.

The CO2 flux module also leveraged significant funds from the Environmental Office at USAID to purchase the two Eddy Covariance Systems and implement the roving CO_2 measurements ($100,000).

Funds were also leveraged with the efforts of the scientists at the EDC to scale-up the CO_2 flux measurements to the landscape or regional levels using AVHRR NDVI data. The USGS at EDC supported the project with $60,000 in-house SIR funds.

Funding from IFAD continued to support the farm monitoring and alternative forage activities of the LDRCT and from ILRI to produce a farm manual and conduct an assessment of rangeland quality in Kazakhstan.

Efforts to leverage funds through a project considered by the International Atomic Energy Agency are under way to complement the Animal production component. Dr Pittroff is advising a proposal by the Republic of Uzbekistan for a large laboratory infrastructure and training program to the International Atomic Energy Agency in Vienna. During the 2001 visit, negotiations to further establish a collaborative structure of Uzbek institutions benefiting from this proposal were conducted. Coordination problems were resolved during a consulting visit of Dr Pittroff in Vienna. A proposal is in progress and will be submitted in December 2001. The proposal is closely coordinated with the technical advisory group of IAEA in Vienna and has excellent chances of success.

Upon invitation by Dr Gustave Gintzburger, CIRAD (formerly ICARDA), Dr. Pittroff visited CIRAD to consult with CIRAD scientists about a possible collaboration between the animal production component and a CIRAD-CSIRO initiative in Central Asia.

TRAINING

Degree Training

Karen Olmstead, MS, 2001, Biology and Agricultural Engineering, A Simple Model of Rangeland Productivity in Southern Idaho Using Landsat Images, University of California, Davis. (50% for 3 months)

Adam Wolf, MS, 2001, International Agricultural Development, Modeling the Farm Landscape in North Kazakhstan; University of California, Davis.

Morgan Doran, MS, 2001, International Agricultural Development, Mulberry Foliage as a Protein Supplement for Ruminant Livestock: Agronomic and Nutritional Properties, University of California, Davis.

Joern Seigies, MS, 2001, International Agricultural Development, Constraints to Smallholder Livestock Development in Uzbekistan, University of California, Davis.

Mimako Kobayashi, PhD, 2003, Agricultural Resource Economics, Livestock Production in a Transition Economy: The Case of Kazakhstan, University of California, Davis.

Short Term Training

Alexander Nikolaenko, from the Institute of Ecology and Sustainable Development, Almaty, Kazakhstan

Three Month Training (March-June 2001) at the EROS Data Center. Mr. Nikolaenko was a quick learner and applied the techniques to process data for the project. He was trained on using classification trees to develop land cover data set. This encompassed selecting training points, building decision trees, and applying them to spatial data. He developed preliminary land cover maps for three ETM+ scenes, one associated with each flux tower location. He was also trained on the use of GPS-laptop real time linkage software (OziExplorer) that allowed real time viewing in the field of digital imagery (ETM+ or land cover). This technique was used by Mr. Nikolaenko to collect more than 150 land cover ground validated points for each of the three scenes. The project covered his travel costs to the three CO_2 flux study sites in Central Asia. His training also included a trip to the Shetsky and Shortandy areas at Kazakhstan on June 20-July 1, 2001 to use the OziExplorer software that linked real-time GPS information with digital images. Mr. Nikolaenko also processed AVHRR NDVI time series data for the project for 1999 and 1998. He processed the spatial daily estimates of precipitation, minimum temperature and maximum temperature into 10 composite periods similar to the NDVI data and the daily net CO_2 flux data. Finally, he provided useful GIS data sets and information including the Kazakhstan Forage Production Map.

The Uzbek collaborator, Dr. Mardonov, spent 6 weeks in the United States between April and June. He was trained in range nutrition methods, use of Captec slow release devices and took part in several intensive sampling periods in ruminant nutrition experiments on the Hopland Field Station of the University of California.

During the 4 week stay of Dr. Pittroff in Uzbekistan, he trained Dr. Mardonov's staff in database management and basic data analysis.

Collaborators from three Central Asian republics participated in a meeting and workshop dealing with CO_2 flux measurements and data processing. For the period of 28 February-14 March 2001, Dr. Saliendra traveled to Uzbekistan and provided on-site training on

the installation and troubleshooting of the CO_2-Bowen ratio instrumentation at the Karnap site near Samarkand. Additionally, processing and quality assurance of the CO_2 flux data were discussed. Participants in the training included Kanat Akshalov (KZ), Muhamet Durikov (TK), Mukhtor Nasyrov (UZ), Bakhtijor Mardonov (UZ), and Tolib Mukimov (UZ).

Workshop:

CO_2 Flux Measurements in Central Asia, 9 March 2001, Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand

A scientific meeting was held following the training to present and discuss the results of the CO2 flux measurements obtained during the last three years, 1998-2000. The CO2 participants also presented the results of their 1998-2000 CO2 flux measurements. The workshop was attended by representatives from the Government of Uzbekistan, ICARDA, and Samarkand State University including:

Mekhlis Suleimenov, Liaison Officer ICARDA, Tashkent, Uzbekistan

D. Khodjaev, Chairman, Dept. of Plant Physiology and Microbiology, Samarkand State University

S. U. Usupov, Director GeneralInstitute of Karakul Sheep Breeding and Desert Ecology

Shrinkulov, Chairman Samarkand Branch of Academy of Science

M. M. Makhmudov, Rangeland Ecologist, Institute of Karakul Sheep Breeding and Desert Ecology

K. N. Toderich, Head of Department, Desert Ecology Research, Samarkand Branch of Academy of Science

A. Abdusattarov, Dept. of Foreign Relations, Uzbekistan Ministry of Agriculture and Water Resources

O. Rakhmatullaev, Professor, Samarkand State University

During his trip to Shortandy, Kazakhstan on May 9-June 22, 2001, Dr. Saliendra trained Adam Wolf and Dr. Kanat Akshalov on the installation, troubleshooting, and data collection and processing using two state-of-the-art eddy covariance (EC) CO_2 flux measurement systems. These two EC systems were moved about every three days to measure CO_2 fluxes for two days at each study site. For the period June 23-October 1, 2001, Mr. Wolf and Dr. Akshalov conducted four cycles of roving EC measurements involving 12 sites (3 ecosystems x 4 replicates) identified near the beginning of the 2001 growing season.

Collaborating Personnel

United States

Laca, Emilio A., Assistant Professor University of California, Davis

Howitt, Richard, Professor, University of California, Davis

Jarvis, Lovell S., Professor, University of California, Davis

Johnson, Douglas A., USDA-ARS, Logan, Utah

Pittroff, Wolfgang, Asst. Professor, University of California, Davis

Plant, Richard, Professor, University of California, Davis

Saliendra, Nicanor Z., Research Associate, Utah State University

Tieszen, Larry, Director International Programs Office, EROS Data Center, South Dakota

Wylie, Bruce, Researcher, EROS Data Center, South Dakota

Reed, Bradley, Researcher, EROS Data Center, South Dakota

Gilmanov, Tagir, Assistant Professor, Biology and Microbiology Dept., South Dakota State University

Sinisa Ivanovic, Graduate Student, Biological and Irrigation Engineering Dept., Utah State University, Logan, UT

Dalsin, Mary, Project Coordinator, University of California, Davis
Grivetti, Louis E., Professor, University of California, Davis
Kobayashi, Mimako, PhD Candidate, University of California, Davis
Young, Julie, SRA IV, University of California, Davis
Olmstead, Karen, Graduate Student, University of California, Davis
Wolf, Adam, Graduate Student, University of California, Davis
Doran, Morgan, Graduate Student, University of California, Davis
Seigies, Joern, Graduate Student, University of California, Davis

Kazakhstan

Akshalov, Kanat, Barayev Institute of Grain Farming
Alimaiev, Iliya, Institute of Forage and Rangelands
Asanov, Kasim A., Professor, Institute of Feed and Pasture
Karibayeva, Institute of Ecology and Sustainable Development
Khosmukhamedova, Zhanna, Project Coordinator Kazakhstan
Malmakov, Nurlan, Institute of Sheep Breeding
Nikolaenko, Alexandr, Institute of Ecology and Sustainable Development
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Increased Lamb Production from Kazakh Finewool Flocks

Narrative Summary

Sheep numbers have decreased markedly in the past 10 years in Kazakhstan and other Central Asian countries. In the past 10 years, privatized farmers have sold sheep for much needed cash, bartered them for food and other supplies, or consumed them for food. The decline in sheep numbers also was accelerated by low world wool prices. Three prolific breeds of sheep (Kazakh Prolific, U.S. Polypay, and U.S. Rambouillet with the FecB gene for high litter size) are being investigated for their ability to improve lamb production from Finewool sheep flocks in Kazakhstan and Kyrgyzstan. Crossbred Prolific Breed x Kazakh Finewool ewes gave birth to .32 to .44 more lambs per ewe lambing than Kazakh Finewool ewes. In addition, the crossbred lambs had growth rates as high or higher than either Kazakh Finewool or Kyrgyz Finewool lambs. It appears that crossing of finewool breeds in Central Asia with certain prolific breeds that should have moderate to good adaptability to the environmental conditions in the area should result in increased levels of lamb production. Improved buffers in diluents for freezing of ram semen appear to increase the survival of ram sperm in frozen-thawed samples. This technology will allow the increased use of frozen semen from superior rams throughout Central Asia through artificial insemination. One example is the use of frozen-thawed semen from prolific breed crossbred rams in Kazakhstan to inseminate ewes in Kyrgyzstan in 2000 and Uzbekistan in 2001.

Research

Problem Statement. Sheep numbers in Kazakhstan and other Central Asian countries have been in a free-fall since they became independent states. In Kazakhstan, sheep numbers have decreased from approximately 30 million head in 1990 prior to independence to 9.8 million head in 2000. Low profitability of the sheep sector has been one reason for the drastic decrease in sheep numbers. After World War II, the local coarse-wooled meat sheep of Kazakhstan were largely replaced with Finewool sheep of Merino-type in order to provide raw wool for the Russian textile industry. The Kazakh Finewool was a new breed developed in the 1950's and 1960's for its wool production. Economic collapse in Russia and a glut of wool on the world market selling at very low prices has left Kazakhstan with few markets and unprofitable prices for its fine wool. Therefore, there has been little economic incentive to maintain sheep numbers.

A second reason for the recent decrease in sheep numbers is due to the privatization of agriculture. When sheep were privatized in the early 1990's, they were the major liquid assets of many farmers and were sold or bartered in order to obtain other agricultural inputs and household necessities. Farm families also consumed many sheep as food. Still today, many of the large cooperative or joint-venture farms pay their members and farm workers with sheep because money is in short supply. The liquidation of the national breeding flock has

resulted in a large supply of sheep meat at reasonable prices available in the market place. However, this cannot continue because the decrease in breeding sheep numbers will eventually result in a shortage of sheep meat in the market place.

Since Finewool sheep have low reproductive rates (approximately 1.25 lambs born per ewe lambing), increases in population numbers are slow. An increase in the number of lambs raised per ewe in Finewool flocks can result in an increase in the number of replacement females produced in order to help rebuild national flock numbers as well as an increase in the amount of lamb meat produced per ewe. With a higher reproductive rate, fewer ewes are required to produce the same amount of lamb meat. This results in less feed required to produce a kg. of lamb meat and less pressure on range lands and other feed resources.

Studies aimed at improving ram semen freezing procedures and artificial insemination techniques have also been conducted with the goal of improved conception rates from artificial insemination with frozen-thawed semen.

Activity One: Improved genetics for lamb production (Medeubekov, Kasymov, Malmakov, Thomas, Gottfredson)

Progress. *Comparison of sheep sired by Polypay, Rambouillet, Kazakh Prolific, and Kazakh Finewool rams for lamb meat production under scientific supervision.*

Materials and Methods. In collaboration with the Center for Sheep Selection and Genetics (CSSG) of the Kazakh Scientific Research Technological Institute of Sheep Breeding (KSRTISB) near Almaty, Kazakhstan, a study was initiated in October 1997 to evaluate the effectiveness of prolific Kazakh and U.S. breeds of sheep to increase lamb production of Kazakh Finewool flocks through an increase in the number of lambs born per ewe. Prolific breeds used in the study were Kazakh Prolific , U.S. Polypay, and U.S. Rambouillet. The Kazakh Prolific was developed by crossing Kazakh Finewool with the prolific breed of Finnish Landrace. The Polypay is a four-breed cross containing equal parts of the breeds of Finnish Landrace, Dorset (a meat breed), Rambouillet (a wool breed), and Targhee (a wool breed). The Rambouillet is the major finewool breed in the U.S., and the particular Rambouillet used in this project are from a flock where the FecB gene for increased ovulation rate is present. All two-way cross ewes resulting from these matings should have a greater prolificacy than the Kazakh Finewool ewes, but the Rambouillet crosses should have comparable fleeces to the Kazakh Finewool whereas the Kazakh Prolific and Polypay crosses should have poorer fleeces.

Semen was collected and frozen from Polypay and Rambouillet rams at the University of Wisconsin-Madison in the autumns of 1997, 1998, and 1999 and shipped to CSSG. Semen was collected from Kazakh Finewool and Kazakh Prolific rams at CSSG during the same years. In the autumns and winters of 1997 and 1998, Kazakh Finewool ewes at the cooperative farm, Aksengerskoe, were inseminated with semen from the four breeds of rams. Semen from Kazakh Prolific rams also was used on Kazakh Prolific ewes to produce purebred lambs. Aksengerskoe is located near KSRTISB and has a long history of involvement with the institute. Prior to privatization of farms in Kazakhstan, the large flocks used in the genetics' program of KSRTISB were located at Aksengerskoe. Many of the breeding flocks of the institute still remain at Aksengerskoe even though the farm is no longer under any government obligation to maintain the flocks. The lambs born in 1998 and 1999 at Aksengerskoe were trekked to the traditional mountain pastures owned by the

cooperative near the border with Kyrgyzstan for summer grazing. The lambs were weaned and weighed on the mountain in August at three to four months of age. Ewes and lambs were trekked back to Aksengerskoe farm in September. Lambs were moved to KSRTISB, fed in pens, and weighed at monthly intervals through approximately one year of age, after which they returned to Aksengerskoe. In the autumn of 1999, semen from the four breeds of rams was used on the cooperative farm Koktalsky (Koktal National Breeding Center) near the city of Taldy-Korgan in Panfilov Region of Almaty Oblast that also has a long history of cooperation with KSRTISB. The lambs born from these matings in 2000 spent the summer on the mountain pastures of the farm near the border with China in southeastern Kazakhstan.

The ewes born in 1998 and 1999 were mated in the autumns and winters of 1999 and 2000, respectively, and lambed for either their first or second time in the springs of 2000 and 2001.

Ewe Reproduction. Experimental ewes were inseminated in November 2000 and lambed in April 2001. The number of lambs born per ewe lambing were: Rambouillet x Kazakh Finewool = 1.61 (n = 12), Polypay x Kazakh Finewool = 1.52 (n = 5), Kazakh Prolific = 1.64 (n = 14), and Kazakh Finewool = 1.20 (n = 14). The small number of ewes with reproductive data indicate that the prolific-breed crossbreds and the Kazakh Prolific are much more prolific than the traditional finewool ewes found in Kazakhstan and give birth to 32 to 44 more lambs per 100 ewes lambing.

Progress. *Evaluation of prolific sheep genotypes in other commercial environments (on-farm trials). (Medeubekov, Kasymov, Malmakov, Thomas, Gottfredson)*

Materials and Methods. Even though the experimental sheep have been raised on two private farms, each farm still has major involvement and oversight of the staff at KSRTISB. In order to evaluate these breeds under more commercial conditions, prolific crossbred rams born in 1998 at Aksengerskoe were mated to ewes on three commercial farms in Almaty Oblast in the autumn of 1999.

Results. On the "Turan" peasant farm in Iliisk Region of Almaty Oblast, which practices year-round pasturing of the Kazakh Meat-Wool (KMW) breed, two crossbred rams (one Rambouillet x KF and one Polypay x KMW) and normal KMW rams were used for breeding in 1999. Performance of the lambs born in 2000 is presented in Table 1. The 1/4 Rambouillet and the 1/4 Polypay lambs had greater birth weights and growth rates than the KMW lambs.

Six of the "better" prolific-cross ram lambs and 36 of the "better' ewe lambs were retained for breeding and evaluated at approximately one year of age for body and fleece weight (Table 2).

Table 1. Birth and weaning weights of lambs born at Turan Farm, Almaty Oblast

Breeding of lamb	Sex	No.	Birth wt, kg	4-mo wt, kg	Daily gain, g
	Ram	15	4.9±0.19	38.4±0.69	279
(Rambouillet x KF) x KMW	Ewe	19	4.7±0.19	35.7±0.73	258
	Ram	26	4.9±0.15	38.9±0.97	283
(Polypay x KMW) x KMW	Ewe	25	4.8±0.17	36.7±0.94	266
	Ram	17	4.4±0.04	34.1±0.94	248
KMW	Ewe	15	4.1±0.04	32.5±0.86	236

Table 2. Yearling body and fleece weights of selected lambs at Turan Farm, Almaty Oblast

Breeding of lamb	Sex	No.	Yearling wt, kg	Fleece wt, kg
	Ram	3	72.3	6.4
(Rambouillet x KF) x KMW	Ewe	12	56.7	4.9
	Ram	3	78.1	6.1
(Polypay x KMW) x KMW	Ewe	14	58.0	5.0
KMW	Ewe	10	57.4	4.8

the retained ewe lambs will be evaluated for reproductive performance in subsequent years.

Progress. *Extension of the Prolific Sheep work beyond Kazakhstan to Kyrgyzstan. (Malmakov, Azhibekov, Abdurasulov)*

Materials and Methods. Frozen semen from Rambouillet x Kazakh Fine-Wooled (KaF), Polypay x KaF, Kazakh Prolific x KaF crossbred rams and Kazakh Prolific rams was frozen at the Kazakh Sheep Breeding Institute and shipped to Kyrgyz Research Institute of Animal Husbandry in October 2000. Semen was frozen in the form of 0.12-0.15 ml pellets using New Zealand Tris-based diluent.

In November-December of 2000, Kyrgyz Finewool (KyF) ewes belonging to "Alamedin" farm, Alamedin Raion, Chu Oblast were artificially inseminated with frozen semen shipped from Kazakhstan.

A control group of ewes was mated with KyF rams. At lambing time in April-May of 2001, all lambs were identified, ear tagged and tattooed.

Records were taken on date of birth, sex, birth weight, litter size and type of birth coat. Lambs will be raised with their dams on natural pastures until 4 to 4.5 months of age when they will be weaned and weighed.

Sheep of KyF breed have a hard constitution, large body size, well-developed skeleton and good conformation. Their wool is dense, and the fleece is well closed. Ewes usually have wool fiber diameter of 60-64 count, whereas rams have fiber diameter of 58-60 count; staple length is of 7 cm and higher. Prolificacy is 1.2 to 1.3 lambs born per lambing. In spring 2001, the KyF ewes used in this study had a mean body weight of 55.8 kg with the range from 40 to 63 kg and a mean fleece weight of 3.7 kg.

Results. Among 112 ewes inseminated with frozen semen from the prolific cross rams from Kazakhstan, 66 (58.9%) lambed to the insemination and delivered 72 lambs (Table 3). Of the 30 ewes inseminated with semen from KyF rams, 20 ewes lambed, and they delivered 23 lambs. A total of 95 lambs were born from 86 ewes (1.10 lamb per ewe lambing).

One-quarter Polypay and 1/4 Rambouillet crossbred lambs were slightly heavier at birth (4.8 and 4.4 kg, respectively) than 1/4 Kazakh Prolific or KyF lambs (4.09 and 4.11, respectively) (Table 4), and the breed groups had similar ranks for one-month weights.

Linear body measurements reflected differences in body weights. Polypay and Rambouillet crosses had slightly greater measurements than Kazakh Prolific crosses and straightbred KyF lambs. (Table 5).

Table 3. Reproductive performance of Kyrgyz Finewool ewes inseminated with frozen semen

Item	n	Breed of sire			
		Polypay x KaF	Ramb x KaF	KaP x KaF & KP	KyF
Number of ewes inseminated (mated) and present at lambing time	142	59	18	35	30
Number of ewes lambed: n%	86	40	10	16	20
Number of lambs born	60.6	67.8	55.6	45.7	66.7
	95	44	10	18	23
Prolificacy	1.10	1.1	1.0	1.13	1.15

Table 4. Live body weight of lambs at birth and at 1 month of age.

Breed	n	Body weight at birth, kg		Body weight at 1 mo of age, kg		Daily gain, g
		Mean	S.E.	Mean	S.E.	
1/4 Polypay	40	4.8	0.19	16.8	0.6	400
1/4 Rambouillet	9	4.43	0.18	16.8	0.4	412
1/4 or 1/2 Kazakh Prolific	16	4.09	0.03	16.2	0.4	404
Kyrgyz Finewool	20	4.11	0.03	16.3	0.4	406

Table 5. Linear body measurements (cm) of the crossbred and control lambs

	1/4 Polypay		1/4 Rambouillet		1/2 or 1/4 Kazakh Prolific		Kyrgyz Finewool	
	at birth	at 1 mo	at birth	at 1 mo	at birth	at 1 mo	at birth	at 1 mo
Height at withers	39.3	53.5	38.3	52.0	37.3	50.0	38.6	51.5
Height at rump	40.0	54.6	39.8	53.8	38.3	51.8	39.9	52.8
Slanting body length	31.9	51.4	31.5	50.4	31.0	48.4	31.6	49.4
Chest depth	17.5	33.5	17.4	32.5	17.3	30.5	17.5	31.8
Chest girth	39.2	64.4	39.0	60.0	38.7	50.3	39.2	59.8
Metacarpus girth	6.1	8.5	6.0	8.0	5.8	6.8	6.0	7.3

Activity Two: Development of Improved Ram Semen Freezing Diluents. (Malmakov, Gottfredson)

Diluents containing tris (hydroxymethyl) amino-methane (Tris) as the main component have been examined for storage of semen from the bull, boar and ram (reviewed by Salamon and Maxell, 1995). However, Tris has poor buffering capacity below pH 7.5 (Good et al., 1966), and more research is required, particularly on those buffers with efficient hydrogen ion buffering capacity in the "sperm tolerant" range of 6.5-7.5 (e.g., N-Tris(hydroxymethyl)-methylaminoethane-sulfonic acid (TES) and N-2-hydroxyethylpiperazine-N'-2-ethanesulfonic acid (HEPES) (Good et al. 1966) and 3-(N-morpholino) propanesulphonic acid (MOPS) (Upreti et al., 1991)).

In 1998-99 we compared a New Zealand Tris-based diluent with a sucrose-EDTA-based diluent developed by Soviet scientists. The laboratory comparison revealed that the New Zealand diluent provided the best cryoprotection for ram semen (Malmakov et al., 1999). A field trial conducted in 1999-2000 in Koktal farm, Almaty Oblast also suggested that semen frozen in the New Zealand diluent had slightly greater fertilizing capacity than semen frozen in the sucrose-based diluent (Table 6).

We studied biological buffers available in the Sigma Chemical Catalogue and found that a buffer with desirable buffering capacity is a Bis-Tris buffer (bis[2-Hydroxyethil]iminotris [hydromethil]methane;2-bis[2-Hydroxyethil]amino-2-[hydromethil]-1,3-propanediol) with a desirable pH range of 5.8 to 7.2. We used this Bis-Tris buffer from Sigma Chemicals Co (B9754) in a preliminary ram semen freezing experiment. The Bis-Tris buffer improved post-thaw motility of ram semen when it was added to the sucrose-EDTA-based diluent (Malmakov et al., 1999).

Because the New Zealand diluent showed the best laboratory and field results, we decided to attempt to further improve the New Zealand diluent and gave up, for the present time, improvement of the sucrose-based diluent. We studied the effect on post-thaw motility of ram semen of substitution of the Bis-Tris buffer for the Tris buffer in the New Zealand diluent. Concentrations of 200, 240, 280 and 320 mM of Bis-Tris also were compared. Semen was collected from two Kazakh fat-rumped rams with the aid of an artificial vagina and evaluated under microscope. Good quality ejaculates were pooled and divided onto five portions and diluted with the respective diluents (Table 7).

The pH of all tested diluents was adjusted to 6.7 by the addition of citric acid. Diluted semen was equilibrated at room temperature for 15 to 20 minutes, placed into 0.25 ml mini-straws; then mini-straws were placed in a small box (like a jacket to prevent cold shock) and chilled in the fridge at 2 to 3°C for 1.5 to 2 hours. Straws with semen were frozen in the liquid

Table 6. Fertility of Kazakh Finewool ewes inseminated with Kargaly semen frozen in sucrose-based and Tris-based (New Zealand) diluents (Koktal farm, Almaty oblast – 1999-2000)

	Diluent	
	Sucrose-based	Tris-based (New Zealand)
Number of ewes inseminated	27	28
Number of ewes lambed	12	15
Fertility %	44.4	53.6
Number of lambs born		
Total	12	17
Males	7	5
Females	6	11

Table 7. Composition of the compared diluents.

Components	Tris-based diluent	Bis-Tris-based diluents – Concentration of Bis-Tris			
	280 mM	200 mM	240 mM	280 mM	320 mM
Tris, g	3.39	-	-	-	-
Bis-Tris, g	-	4.184	5.02	5.86	6.695
Glucose, g	0.467	0.467	0.467	0.467	0.467
Citric Acid, g	1.8	0.682	0.810	0.9	1.08
Sucrose, g	2.15	2.15	2.15	2.15	2.15
Sulfanilamide, g	0.3	0.3	0.3	0.3	0.3
Egg Yolk, ml	14	14	14	14	14
Glycerol, ml	4.3	4.3	4.3	4.3	4.3
Added water up to:	81.7 ml	81.7 ml	81.7 ml	81.7 ml	81.7 ml
pH	6.7	6.7	6.7	6.7	6.7

nitrogen vapor in the MVE 20 LN tank for 3 minutes with an emersion speed of 1 cm/15 sec starting from a height of 7 cm above the liquid nitrogen surface.

Results. Just after thawing, motility of frozen-thawed semen was significantly higher (P=0.032) when concentration of the Bis-Tris buffer was equal to 240 mM (Table 8). After 2 hours of incubation at 37°C, motility was still significantly higher in the semen frozen with the diluent with 240 mM of Bis-Tris (P=0.016).

This experiment showed that replacement of the 280 mM Tris buffer in the New Zealand diluent with 240 mM of Bis-Tris buffer increased significantly (P<0.05) motility of the frozen-thawed ram semen. In our case, post-thaw motility increased by 5% (50.8% vs 45.8%).

Table 8. Motility of thawed and incubated ram semen frozen in Tris-based and Bis-Tris-based diluents (20 observations)

	Tris-based	**Bis-Tris-based diluents, conc. of Bis-Tris:**			
	diluent conc.	**200 mM**	**240 mM**	**280 mM**	**320mM**
Semen motility, %:	**of Tris= 280 mM**				
Just diluted	76.5±1.50	75.8±1.51	75.6±1.59	75.6±1.59	74.5±2.08
Chilled	79.0±.69	78.5±.90	78.5±1.03	79.5±.34	78.8±.71
Frozen-thawed:					
Just after thawing	45.8±1.82 [b]	48.5±1.36 [a,b]	50.8±1.32 [a]	49.3±1.42 [a,b]	48.0±1.33 [a,b]
Incubated for 2 h	44.3±1.75	47.5±1.47	49.8±1.33	47.8±1.38	46.3±1.77
Incubated for 4 h	40.5±1.58	43.5±1.54	44.3±1.86	43.5±1.71	39.8±2.63
Incubated for 6 h	33.3±2.09 [a]	35.0±2.29 [a]	35.6±3.05 [a]	33.0±3.07 [a]	24.9±3.41 [b]
Incubated for 8 h	23.2±3.40	31.3±3.01	33.8±2.74	26.4±3.16	20.9±2.82

[a,b] Means within a row with no superscripts in common are different (***P*** < .05).

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Conf. p. 129. [Abstr.]

Gender

This project does not target or preferentially benefit one gender or age group over another.

Policy

The in-country scientists have communicated the existence and results of this project to government officials in both Kazakhstan and Kyrgyzstan.

Outreach

Results of the project have been presented to the farming population through a field day in both Kazakhstan and Kyrgyzstan. The evaluation of prolific breeds on a peasant farm in Kazakhstan also brings the results of the project directly to the farm population.

Developmental Impact

This project attempts to increase lamb production so Kazakhstan and other Central Asian countries can increase their sheep numbers and increase their lamb meat production at the same time, while improving the efficiency with which range and feed resources are used. Thus the project has a positive effect on economic development at the same time that it has a positive impact on the environment and promotes agricultural sustainability.

Results of this experiment have direct application in the U.S. Much of the sheep industry of the Western and Southwestern U.S. is based on the production of finewool sheep. Due to low world wool prices and loss of a government subsidy on wool in 1995, wool sheep production is unprofitable, and U.S. sheep numbers are falling. U.S. sheep producers in the range states need to switch their emphasis from wool to lamb production, and increased prolificacy of the flocks is one way for them to increase lamb meat production.

Other Contributions

The purpose of this project is to increase lamb production from finewool sheep flocks in Central Asia so that farmers have more efficient and profitable sheep production systems and citizens have more lamb meat available for home consumption of or export.

Leveraged Funds and Linked Projects

This project plus the UC-Davis GL-CRSP project in Central Asia are partners with ICARDA and ILRI in the IFAD project "Integrated Feed and Livestock Production in the Steppes of Central Asia" for a three-year period starting on October 1, 1999. The project is funded for $1.5 million, and the GL-CRSP will receive $250,000. Our project activities are closely coordinated with Luis Iniguez, ICARDA coordinator of the IFAD project.

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COMMUNITY PLANNING FOR SUSTAINABLE LIVESTOCK-BASED FORESTED ECOSYSTEMS IN LATIN AMERICA (PROJECT PLAN—PLANIFICACION LOCAL AGROPECUARIA Y DE LA NATURALEZA)

NARRATIVE SUMMARY

The first goal (Goal A) of our project is to determine how livestock, agriculture, and natural resource uses can be incorporated into the environment in a manner that is ecologically sustainable and that will improve the livelihood of local residents. This goal is to be achieved by working with and empowering local communities. The area focus of our project is the interface between agricultural and forested ecosystems in critical mountainous ecosystems in Latin America. Livestock, especially cattle, dominate these threatened and degraded landscapes, leading to two questions: 1) how can livestock best contribute to the livelihood of the rural montane communities, and 2) how can livestock be integrated into these forest ecosystems in a manner that is ecologically sustainable? Our understanding of these regions and their people has confirmed the necessity of a holistic approach at the level of the community and the watershed. To find viable answers to these questions, one needs to understand the physical, ecological, economic, social, cultural, and political context.

The Problem Model defines a process for describing, studying, planning, implementing, and monitoring the integration of livestock, agriculture, and natural resources uses into natural forest ecosystems to achieve sustainable livelihoods. This process is organized around four steps: 1) Identify the potentials and limitations within the community for sustainable management of natural resources and livestock, and improvement of quality of life. 2) Evaluate current practices of livestock and natural resource management and experiment with alternatives. 3) Generate a participatory process for planning, implementing, and monitoring current and alternative practices. 4) Establish a long-term, on-going, community planning process for natural resource and livestock management.

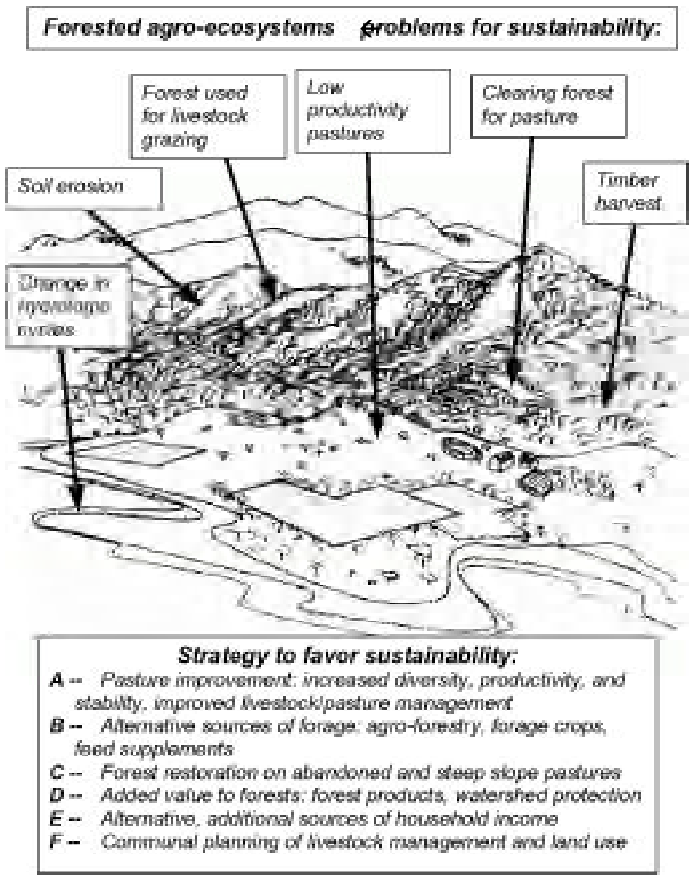
The second goal (Goal B) is to develop general set of processes useful for implementation of community development and natural resource management projects by local people in conjunction with external agents. This goal is aimed at *how* to achieve Goal A through the Problem Model—our a*pproach*. The guiding principals and perspectives, conceptual frameworks and processes, strategies and methods we have adopted, developed, and applied constitute the "tools" of our approach. Based on our comparative experiences in the attempt to implement the same Problem Model and Approach in differing situations in three countries, we continue to work with the elements and methods of our approach with the goal of defining a participatory, process-oriented approach (a "tool box") that can be applied effectively and appropriately to rural communities throughout Latin America. The tool box emphasizes processes of learning and investigation with the following characteristics: process-oriented, holistic, interdisciplinary, participatory, collaborative, bottom-up, facilitative, and flexible. Each links theory to practice.

A third goal, implicit in this type of project, is the strengthening and training of host-country collaborators and institutions and future researchers and practitioners. An important corollary of this goal is the development of new understandings and new ways of seeing for all participants. This project has fostered an open, active exchange of ideas among team members, communities, and local officials. We intended to create a "learning organization," and we have!

ACTIVITIES

Logic and Approach of the Activities. The forested agro-ecosystems that are the target of this project are represented by the image in Figure 1. The two dominant antagonistic systems in this landscape are diversity-rich natural forests and extensive livestock-dominated agriculture. The sustainability of these systems (Question 2 above) is challenged by an array of apparent problems suggested by the figure. While the forests, pastures, and crops (especially maize) are all impacted by the livestock, the pastures symbolically and functionally may serve as the pivot point for change. A strategy to favor sustainability within these systems suggests six activities or tactics that may be employed. The first, A, is to focus directly on the problem—the role of pastures as a source of forage for livestock. Secondly, B, is to consider alternatives for providing other sources for forage. Activity C focuses on the forests and options for restoring their functions. Activity D carries the focus further to the forest to consider other resource and services provided by the forest. A, B, C, and D all deal with the two sides of the pasture-forest dynamic.

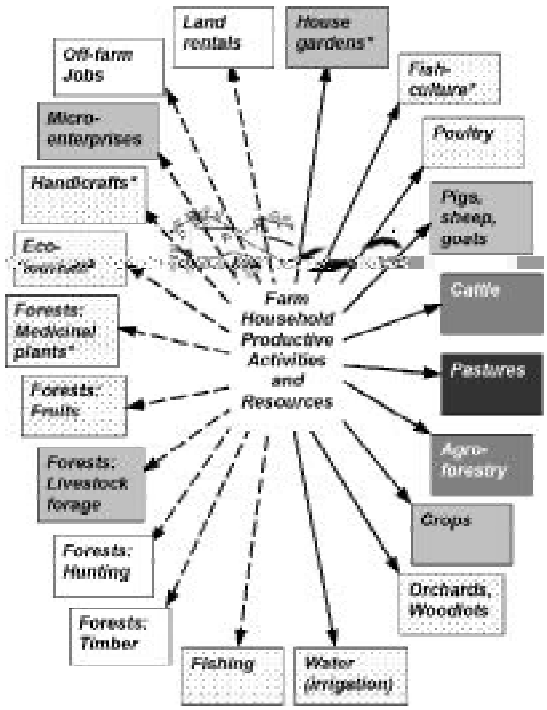
The fifth activity, E, looks beyond this dynamic to consider alternative production systems and sources of income. Farm households in forested agro-ecosystems have potential access to a diverse array of resources and may be involved in a wide variety of productive activities (Figure 2). The relative importance of the contribution of livestock to the livelihoods of the users of these systems (Question 1) needs to be assessed in terms of the full set of productive activities and potential options available. An effective application of a holistic approach seeks an awareness of all the components of the system, but selects components of primary



concern for in-depth study. Thus, although the Project has limited activities with most of the activities and resource uses shown, priorities for study and action are indicated by the intensity of shading with white the lowest priority and black the highest priority → pastures. Livestock, especially cattle, plus their main sources of forage (pastures, crops, agro-forestry, and forest forage) constitute the central set of priority activities.

The other two high priority foci—house gardens and micro-enterprises—have both been identified by the farmers themselves as priorities. House gardens and related small scale horticulture activities have proven to be valuable to contribute to household health and to promote positive interactions within and between households.

Figure 2. Array of farm household productive activities and resources. The right half of the array includes agricultural activities; the left half includes a variety of forest-based resources and a few categories of non-farm-related activities. Priorities of Project PLAN are indicated by shading with priority increasing from white through dotted, light gray, and dark gray, to black.

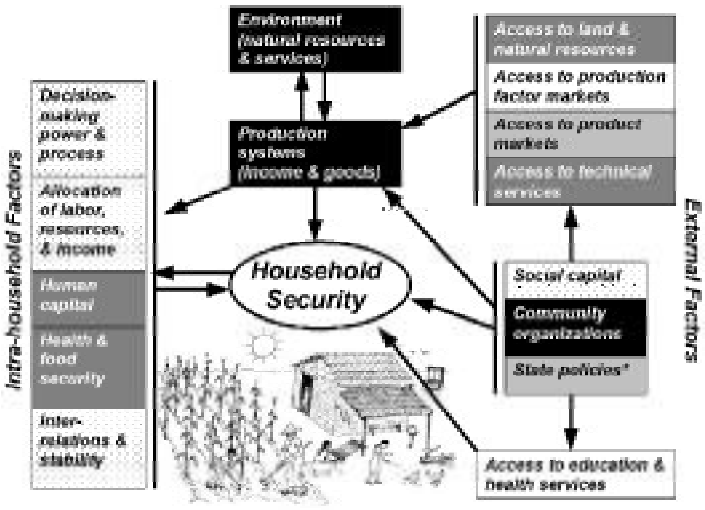


Micro-enterprises as implemented or envisioned by Project PLAN end-users encompass a wide variety of possibilities including products or resources resulting from other activity categories such as those indicated with an asterisk. Certain types of micro-enterprises may serve as effective alternatives for increasing the level and stability of household income, improving equitability of household income/resource distribution, and increasing incentives to conserve the forest. We have observed a strong interest among farm households for alternative, additional sources of income. The exigencies of sustainability demand that we have an understanding of the economic livelihood strategies of households, which led to a study of the situations that favor or disfavor livelihood diversification (see results and discussion under Activity D1.1).

The first five activities of the strategy delineated in Figure 1 can be implemented at the level of individual farms; however, to achieve sustainability of these ecosystems, the application must include the major set of users at the scale of the watershed. This demands large scale planning among the "community" of households using the watershed—activity F. By its very nature, this activity must lead to a greater understanding and consideration of local society, economics, and politics. Cooperation, coordination, and collective action by the "community" of local uses depend on the nature of community interactions and on the existence and effectiveness of local organizations.

Community organization may be perceived as the social "pivot point" of change, serving to connect local households and to empower their dealings with outside forces. Community

Figure 3. Factors influencing household security.



organization is seen as a crucial element favoring social sustainability. Just as understanding the pattern of resource use at the level of the watershed depends on the factors influencing farm households, the dynamics of local social interactions also depends on the factors influencing farm households and their security (Figure 3). This diagram serves to emphasize the four principal targets of the Project: the environment (forests and watershed), local production systems (particularly livestock production), community organization, and household security.

Thus we have developed a strategy to favor local community organization and planning. Priority activities of this strategy are designed to increase household security and empower communities: A) assist in resolution of conflicts over access to land and resources; B) provide technical support to local groups and organizations; C) facilitate linkages among local groups and between local groups and local government, D) provide technical support to improve family food security, and E) provide opportunities targeted for women including encouragement of women's groups and technical support for micro-enterprises and production systems designed for women, and other opportunities for personal development. These activities favor social and political components of sustainabililty and thus provide a necessary complement to those outlined in Figure 1 which are focused on the ecological and economic components.

The specific work "activities" of the project are organized for convenience under a series of general categories—A. Livestock, B. Land Use and Alternative Production, C. Natural Resource Protection, D. Economic Development, E. Social and Community Issues, and F. Food Security. Within each category, activities are designed to contribute to one of three process steps: 1. Problem Definition, 2. Experimentation with Alternatives, and 3. Planning and Implementation. These three steps are intended to define an iterative adaptive planning process. The main activity research lines appear in bold letters and with a letter and number code indicating the sequence of activities for each category/process step. Under the description of each activity, the countries implementing the activity are indicated by capital letters in parentheses (**B** for Bolivia, **E** for Ecuador, **M** for Mexico).

Research Targets of the Activities. Our research targets have been organized by our "Iterative Planning Process" framework which define the process steps noted above. Initial work was more focused on "Problem Identification." Better understanding of the

nature of the problems provides the base for step 2, the search for and selection of possible alternatives for experimentation and evaluation *in situ*. This experimentation with alternatives includes standard experiments with improving pasture forage mixes as well as "experiments" with planning tools for local family organizations. We currently have more "experiments with alternatives" than before; while few activities are dealing with step 3, the implementation and integration of promising alternatives into management plans. Much of our work in step three activities is devising frameworks and information bases for planning and systems for monitoring and evaluation.

Note that the process steps are designed as part of an iterative cycle in which frequent reassessments or more detailed assessments of problems would reoccur (step 1) and "experimenting" with alternatives should be an ongoing part of long-term planning (step 2). The feedback from monitoring and evaluation in step 3 is expected to generate new activities in steps 1 and 2 over time.

We recognize that the categories are of necessity artificial. Clearly, the different perspectives are to be integrated across activities at different process steps and categories. This is most clearly represented under process step 3, which, by its nature must integrate all the categories.

Rationale of research and contribution to sustainability. After each activity, we describe the "Goal" and the rationale for each activity. Our intent here is to show how these diverse activities contribute to the overall goal of sustainability of these livestock-based communities and ecosystems.

Priorities—strategic foci:

The range of activities listed below is intended to provide an awareness and working knowledge of the variety and complexity of issues relevant to the target communities and the bio-physical, socio-economic, and political cultural context in which they exist. However, in-depth, concentrated study and actions will be applied to selected strategic points and issues. Figures 1, 2, and 3 are intended to indicate our relative levels of priority (with darker shadings indicating higher levels of priority) and to illustrate some of the principal connections among our areas of focus.

A: Livestock

A1: Problem Definition. *Goal:* to understand the problems and the factors that influence past and current practices.

A1.1 Livestock production systems: Further assessment of current practices. Farmer criteria for classification and evaluation of livestock and production systems (B). Characterization of livestock production systems and associated risk (B,M). (3 yrs)

Goal: An increased understanding of livestock production as currently practiced including an assessment of impact on the soil and identification of areas for experimentation-investigation in order to develop ideas for improvement.

Rationale: In order to assess sustainable livestock production systems and to introduce or encourage changes that would improve sustainability of these systems, it is necessary to understand how individual farmers in the community and region of study balance their perceived benefits and costs, including risks. This information can then be matched against our own studies and perceptions of the farmers risks and the environmental impacts. As other activities designed to improve sustainability become more refined, our understanding of the farmers' logic behind their decisions will need to become more specific. Since change and

uncertainty with respect to important factors such as the market and the environment are inherent in these systems, observing farmers' responses to change over time is needed to approach a more thorough understanding of the systems. This activity, therefore, must be an ongoing process in which, through time, our understanding of the local situation becomes more and more complete.

Progress.

Cattle space>farm space: Cattle in Bolivia and Mexico go through annual cycles, spending half of the year feeding on crops residues and/ or in pastures and the other half grazing/ browsing in forest. The criollo cattle appear to adapt to this regime shifting form grasses and forbs in pastures to include a wide variety of vines, bushes and trees (the variety of forest species used in Mexico and Bolivia are described under A1.3 below). The Rio La Sal watershed in Bolivia provides a typical local example where the space needed and used by cattle is greater than the average farm size. Farm households are generally situated along the river where the lower slopes and availability of water provides more productive cropland. Poultry and medium-sized livestock (goats, sheep, pigs) are kept on the farm land; however, horses and cattle move over much greater areas, with the cattle feeding extensively in the forest when pasture production is low (see Figure 4). Farm households have neither the land, nor the resources for additional forage or fencing. Cattle move over neighboring farm lands through reciprocal informal collective rights to access (Figure 5). Animals from neighboring farms move together over higher pasture and forest land that in practice is used collectively. This seasonally extensive livestock management system permits resource-poor farmers living within the same area to maintain more animals than would be possible within the limitations of their individual lands. The disadvantages of this system include a) greater risk of disease spread among herds (see A1.4), b) reduced incentives for individual farmers to improve communal pastures, c) fewer management options to protect cattle from danger (see A1.5) or control their feeding patterns, and d) an enhanced level of conflict through frequent incursion of cattle on crops and house gardens.

Options to improve the livestock management system must deal with the social and economic advantages of this system.

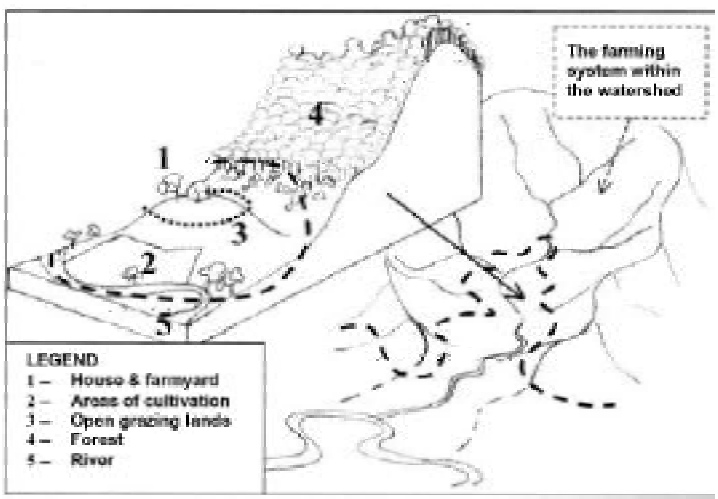


Figure 4. Household livestock productive systems in La Cueva, Bolivia. A typical household utilizes progressively larger areas for raising larger livestock. Cattle are frequently grazed in pastures and nearby forests that extend beyond the lands owned by the household.

Figure 5. Pattern of collective access to individual grazing areas. Numbers indicate individual farm holdings for seven farms. Homesteads for farms 1, 4, and 5 are located within the landscape shown. For farms 1, 4, and 5, dotted lines indicate the limits of their small livestock production areas and dashed lines indicate the limits of their individually owned production areas. The arrow connect grazing areas that are used on the basis of collective access between neighboring farmers.

Intensification of the system will require minimally generation of additional on-farm forage sources and management actions that produce sufficiently large gains to justify the costs of intensive management.

Transhuman systems: An alternative rarely considered, and equally rarely studied, is a more extensive cattle management system termed "transhumance" where families move with their cattle over a large scale, annual cycle. Extensive interviews and direct observation and follows of these cattle-raisers over their traditional sequential use of grazing areas has provided convincing evidence that these same systems have been applied in a sustainable manner over long periods of time. This study, carried out in parallel with PLAN activities supported with outside funds, has enlarged our perspective and understanding of the livestock management systems of these areas: 1) the transhuman system offers an alternative option for sustainability to contrast with the option of intensification; 2) one transhuman system overlaps the Rio La Sal watershed livestock system. Transhuman cattle move seasonally into the "communal pastures" of the upper reaches of the Rio La Sal system where resident households are paid for providing grazing rights for these additional cattle in the system. The juxtaposition of different management systems increases the complexity of planning a management strategy, but, also, provides an excellent opportunity for a comparative study of alternative systems.

A 1.2 Use and management of forage. Evaluation of the production of native forages and identification of topics for farmer/researcher investigation. Local spatial and temporal criteria for forage production. Interaction of native and introduced forage species. **(B,E,M) (3-5 yrs)**

Goal: An improved understanding of the current state of production of native forages including interactions with introduced forages to a mix that improves the forage value (quantity and nutrients) and the soil protection, and increases ecological sustainability.

A1.3 Patterns of animal behavior. Analysis of behavior of different types of livestock (B); cattle foraging and movement patterns (M); and farmer perspectives of the behavior of different types of livestock (B). **(2 yrs)**

Goal: An increased understanding of the behavior of livestock, including cattle foraging and movement behaviors and farmer perspectives of livestock behavior, to inform the development of interventions to improve the

sustainability of livestock use of pastures.

Rationale: Pastures for livestock were already identified as one of the main sources of environmental degradation as well as a problem for effective livestock production. The problem results from the creation of pasture out of forests in riparian zones and on steep slopes coupled with pasture degradation and soil erosion. Therefore, the second level of understanding the nature of this problem is to work with the farmers to identify their perception of sources and use of livestock forage. Although this is a logical subset of Activity A1.1, this focus is emphasized due to its position at the interface between livestock production systems and natural systems. These studies are important to understanding the impact of livestock grazing in forests as well as providing the basis for assessment of the significance of this stage of feeding on their production and health.

Progress.

Cattle foraging behavior in forests. Direct observation of cattle feeding in forests were carried out through day follows of individual animals. A total of 123 species of 39 plant families were eaten; 41% of the species eaten were vines, shrubs, or trees. At each place the followed cow stopped to eat, the surrounding vegetation was sampled to determine relative availability of plants. Of species present within the feeding sphere of the sampled cow, 37-49% of species present were eaten although most at low frequencies relative to availability.

Thirty-two species were preferred (i.e., eaten in greater frequency than availability) making up 11.6% of their diet These preferred species included 10 herbs, 9 trees, 5 bushes, 3 vines, 2 grasses, one grass-like herb, one fern, and one herbaceous epiphyte. The cows showed a slight preference for an additional 29 species constituting 38.3% of their diet.

The cattle followed a regular activity pattern spending 60 to 80% of their time feeding in early morning and late afternoon and spending mid-day resting. While foraging, cattle showed highest preference for slopes between 11-30% with highest preference for slopes between 11-20%. More than 90% of resting periods were spent on slopes less than 20%.

Guarani assessment of livestock forages: The list of livestock forage species generated by the Guarani is more complete than the average farmer due to the Guarani cultural traditions with greater exposure and awareness of nature. They identified 25 species as preferred by cattle, 2 lesser preferred species, and 2 species, eaten but not preferred. They identified 13 species preferred by goats and only 6 species preferred by sheep. Of the 25 species preferred by cattle 10 were grasses, 4 herbs, and 8 trees. In contrast, of 13 species preferred by goats, 0 were grass, 2 were herbs, and 11 trees or bushes. Surprisingly, they recognize only six species preferred by sheep, none of which were trees or bushes.

Experienced Guarani could assess the value of each of nine vegetation types for the grazing/ browsing of cattle, goats, and sheep. Sheep preferred open grassy areas, while goats preferred woods. Cattle adapt well to both situations with preference for up to 25 species in diverse forest. Juan Pablo Esparza's cattle follows from Mexico suggest that the diet of browsing cattle is likely to eat a much broader range of plant species.

Assessment of forage value of native plant species: Assessment and analyses on the importance of native vegetation for sustainable management of the dairy cattle system in Cosanga by S.Molina and F.Calispa, 2001, in collaboration with two other local farmers, Sailor Erazo and Alandi Torres. The establishment of extensive dairy production in this zone has led to extensive clearing of forest to create pastures

planted to productive exotic species. Kikuyo (*Penisetum clandestinum*) now occupies 90% of the pasture area with Pasto Miel (*Setarea* sp.) and Lotus (*Lotus uliginosus*) covering about 10% of the area. Pasture deterioration is an ongoing problem due to problems of trampling in saturated soils associated with high annual rainfall. Deteriorating pastures are invaded by local herbs and grasses, which has been seen as a problem; however, some farmers have noted that cattle avidly eat some of these "weeds." Calispa and key local farmers studied these "invading" weeds to determine their potential value as forage or as threats in the case of those that contain toxins that can harm or kill cattle. They identified 27 local forage species of known local value (Table 1) and obtained nutrient analyses for 12 principal species used by the cattle to evaluate their relative value (Table 2). The three main exotic species were included in the analyses for comparison.

The analyses show that a number of these species, such as Sacha Girasol, Moradilla (*Calandria ciliata*), Suro (bamboo), Fréjol Gualea (*Phaseolus* sp.), and Cola de Conejo (*Panicum poligonatum*) have acceptable levels of nutrients to serve as good forage for cattle. The most promising of these is grass, Cola de Conejo (*Panicum poligonatum*), which not only is a good forage but also very resistant to trampling.

These native species are specifically adapted to a range of micro-habitat sites in the area and, thus offer excellent potential as components of mixed-species associations to improve pasture nutrient quality, productivity, and stability. Similar investigation of forages, already published as part of this Project in Mexico and

Table 1. Herbs and Grasses Eaten by Cattle in Cosanga, Ecuador

Local Sp. Name	Family	Genus and species	% in pastures
Botoncillo	Asteracea	Gallinsoga parviflora C	0.1%
Carrizo	Poacea	Penicetum purpureum Shumick	0.2%
Diente de leÛn	Asteracea	Taraxacum officinalis N	1%
Ajjcillo	Poligonacea	Polujala spp	0.1%
	Rubiacea	Bonemia alleavis (lo) G	0.1%
Totora baja	Cyperacea	Scirpius rigidus	2-3%
Siempre Viva	Balsaminacea	Impatiens balsaminea L	0.5%
Pedorrera	Asteracea	Gallinsoga quadrirachata Ruiz Pov	0.2%
Cordoncillo	Piperacea	Piper eriopodor CDC	0.3%
Calaguala	Polipodiacea	Niphidium albo	0.2%
Verbena	Verbenacea	Verbena litoralis H.B.K.	0.5%
Lengua de Vaca	Poligonacea	Rumex obtusifolius L.	3-5%
Lechuguilla	Asteracea	Graphaluim purpureum L.	0.5%
LlantÈn Macho	Plantaginacea	Plantago australis Lam.	2-3%
Cola de Conejo	Poaceae	Panicum poligonatum	20-30%
Suro	Bambusacea	Chusquea sp.	15%
Sacha Girasol	Asteracea		5%
FrÈjol Gualea	Fabaceae	Phaseolus sp	5%
Moradilla	Portulacacea	Calandrina ciliata (R etP)DC	10%
Totora	Cyperacea	Eleoharis elegans	5%
Pasto Morado	Poacea	Leersia hexandra Scharttz	5%
Lotus (exotic)	Fabacea	Lotus sp	15%
Nudillo	Poacea	Paspalum candidum	5%
Kikuyo (exotic)	Poacea	Penisetum clandestinum	60-80%
Pasto Miel (exotic)	Poacea	Setarea sp	5%
Hierba de FrÌo	Poacea		2%
Gualea	Fabacea	Phaseolus sp	10%

Table 2. Twelve Principal Species of Herbs Eaten by Cattle

Common Name	% Humidity in the Analysis	Proteìn %	Fiber%	Fat%	Ash%	Carbo-hydrates	Energy Total Kcal/Kg	Cal-cium	Phos-phorus
Lotus, Lotus uliginosus	7.4	26.0	15.1	3.9	7.9	54.8	3583	1.15	0.46
Moradilla, Calandrina ciliata	6.0	21.6	17.4	3.5	12.8	56.1	3623	0.30	0.69
Kikuyo,	1.4	19.6	21.7	2.3	8.7	68.0	3711	0.67	0.67
Sacha Girasol	4.1	17.1	14.0	6.5	14.6	61.8	3341	1.5	0.47
Suro (Bamboo), Chusquea sp.	4.02	15.0	26.0	1.5	10.9	68.58	3450	0.50	0.40
Pasto Morado, Leersia hexandra	7.2	14.3	23.8	2.0	15.8	61.5	3212	0.56	1.06
Totora, Eleopharis elegans	4.0	13.5	23.6	1.5	10.5	70.5	3361	0.58	0.66
Nudillo, Paspalum candidum	4.0	13.0	25.0	3.0	13.3	66.7	3458	0.59	0.46
Totora Baja, Scirpius rigidus	5.0	13.0	25.0	1.5	7.7	72.8	3367	0.58	0.40
Pasto Miel, Setarea sp.	6.3	12.9	36.7	2.8	9.5	68.5	3508	0.59	0.54
Cola de Conejo, Panicum poligonatum	3.0	11.0	38.4	2.44	13.2	70.31	3472	0.49	0.40
FrÈjol Gualea, Phaseolus sp.	9.0	10.7	20.7	2.8	9.0	68.5	3420	1.3	0.53
Hierba de FrÌo	7.9	9.0	49.7	1.5	8.12	73.4	3431	0.50	0.41

ongoing in Bolivia, provide part of the information needed to improve pastures in ways which are more ecologically sustainable.

A1.4 Animal health: assessment of local situations and perspectives of the problems including body scoring of cattle, incidence of livestock disease, and local control of endo- and ecto-parasites (B,E)(3 yrs)

Goals: An improved understanding of animal health including knowledge of parasites and evaluation of disease incidence to identify issues of major importance.

Rationale: Although we do not have the resources to rigorously evaluate livestock health, farmer assessments of health, risks, and losses will be very useful to determine the nature of the production problem to be resolved. Body scoring through photos of cattle herds will provide visual individual records of cattle health, a statistical distribution of differences in condition for herds under different management regimes. The body scoring assessment of overall condition may prove very useful in following herds and individual cattle over time allowing tests for correlation with disease, environmental shortages.

Progress: Livestock health problems and extensive grazing: Cattle are the dominant livestock in both the dry Tomatirenda watershed and in the wetter Rio La Sal watershed of Bolivia. A number of families at both sites also raise pigs. Cattle and pigs are important means of savings and income; hence, factors reducing their productivity and survival are causes of concern. The principal source of disease is from parasites, both external and internal. In the Rio La Sal watershed, cattle show a high rate of mortality due to an unidentified disease or parasite manifested by blood in the urine. In the Tomatirenda zone, hog cholera occasionally causes mass death, and cisticercosis is present in the majority of the animals rendering them unmarketable. The list of problems identified below can in large part be attributed to the extensive grazing system, with mingling of herds, poor diet, and little or no management or

control.

- High parasite loads, internal and external
- Uncontrolled epidemics

Livestock problems:

- High rates of inbreeding
- Uncontrolled breeding
- Slow growth and low productivity
- High vulnerability to predators

This situation is exacerbated during the dry season, especially in the Tomatirenda area when scarcity of forage brings some animals, already burdened with high parasite loads, below the minimum (see cows A and B in Figure 7).

The benefits and costs of extensive grazing systems need to be evaluated against short and long term objectives. The collective access management system described under Activity A1.1, while designed to exploit a seasonally marginal system, must also bear the costs of inbreeding and reduced health. Application of a herd monitoring and evaluation system using body scoring could permit a comparative evaluation of extensive and intensive systems under different management regimes.

Cattle body scoring and status: For cattle, body condition scoring is a management tool that helps producers monitor the amount of body reserve their cows carry. Body scoring is a visual subjective measure that permits one to rank relative differences in body fat among cows. Most people can quickly learn to use this tool and, even though people might score cattle differently on the "absolute" scale, nearly all pick out the same relative differences, and hence rank cows consistently. We initiated preliminary trial to monitor cattle using photographs. The wide variation in conformation among herds and between herds presents considerable variation in the relative positions of the hip and pin bones in the hip area, an area where adipose tissue is stored. Side views proved to be most for comparative evaluation. Figure 6 provides a comparison among samples taken from five herds at three sites at the end of the dry season. In the U.S., dairy cattle are scored for body condition on a scale of 1 (emaciated or very thin) to 5 (obese or very fat). Adopting this scale, we scored cows between 0.75 and 3.75. It appears that the relative condition of the cows corresponded well to their scores (Figure 7); thus the cows with a 0.75 score are emaciated and in poor condition. For Wisconsin dairy cows, the ideal body condition score at calving time and at the end of lactation should be about 3.5. Comparing the two Bolivian sites, the two herd samples from Timboy, with its longer dry season and concomitant greater scarcity of forage, show distinctly lower scores with a body score average of 1.65 versus 2.25 for the La Cueva samples. Nearly one fifth of the Timboy cows were scored below one; whereas none of the La Cueva cows observed were in such serious condition. Nevertheless, there is considerable variation

Figure 6. Cattle body scores in Bolivia, samples for 5 herds from 2 sites.

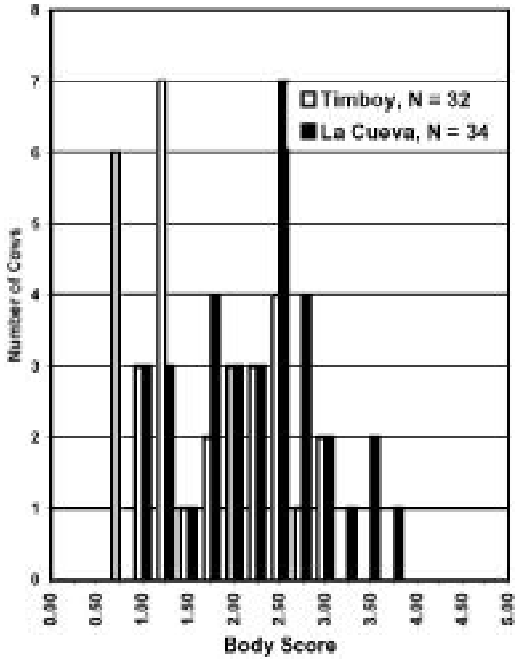
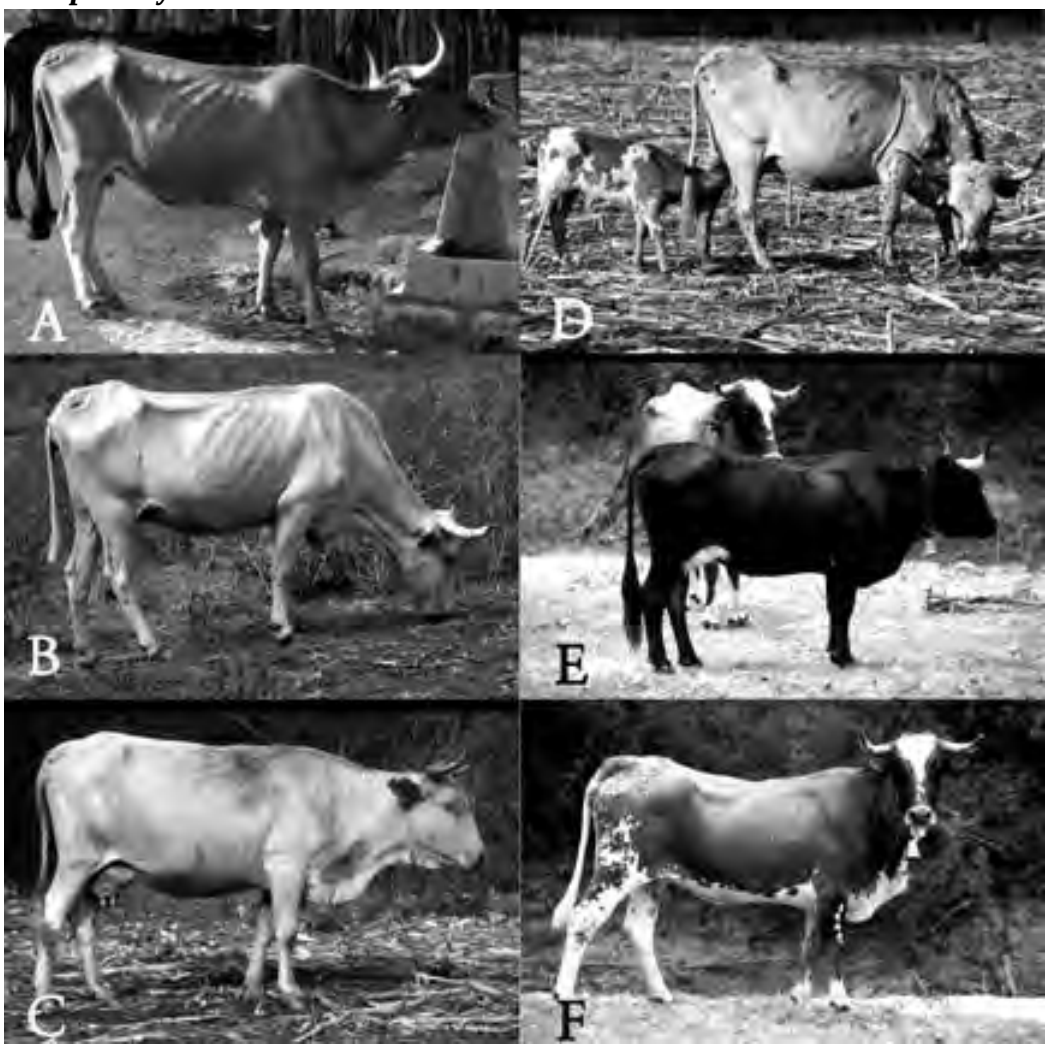


Figure 7. Six examples of cattle from Bolivia. Cows A, B, and C from Timboy were given scores of 0.75, 1.0, and 2.75 respectively. Cows D, E, and F received scores of 1.5, 2.5, and 3.25 respectively.



within herds with many animals below desirable weights.

Given the strong seasonal changes in forage availability and strong differences in management regimes, we intend to expand our application of the body scoring method to allow more detailed statistical comparisons among herds in different seasons and under different management. Using photographs will allow a rapid, reliable and verifiable scoring, which will permit valid comparisons over space and time. Given the great color coat variation of the cattle, the side view photographs will allow us to track individual cattle over time. We plan to use digital cameras at each site to reduce film and processes costs and to facilitate electronic transfers, computer data storage, manipulation, and analysis.

When photographing cattle in the field, we plan to work simultaneously with the farmer, to record the farmer's own assessment and criteria for each cow photographs, so that we may learn the farmer's own methods for evaluating the status of their cows. This work will allow a more meaningful dialogue to understand local rationale for management, and to create opportunities for evaluating alternative management options.

A1.5 Interactions between wildlife and livestock production systems including studies of impact on cattle by vampire bats (M) and Spectacled Bears (E) and impact on crops by rodents (M) and birds (B, E) (2 yrs)

Goal: An increased understanding of the interactions between livestock production systems and various forms of wildlife including birds, vampire bats, rodents, and predators sufficient to inform the design of experiments to resolve problem areas.

Rationale: We have found that attitudes of nature for many farmers are based on negative perceptions of wildlife threats to livestock and crops. Small, focused studies on critical wildlife/ production system interactions are aimed at collecting rigorous scientific data to assess the nature and extent of wildlife depredation. Understanding of these interactions is proving to be even more important than we thought for developing sustainable land use plans. The pilot study of the endangered Spectacled Bear in Ecuador provides a particularly illuminating example. In the past year, Spectacled Bears appear to have been responsible for twenty-eight cattle deaths in the Cosanga watershed. The value of the losses amounting to several thousand dollars is very significant for local farmer/ ranchers who have killed a dozen or more bears within the same period. Our study suggests that deforestation may have reduced natural food sources and may have increased the frequency of incursions of the bears into high-slope forest edge pastures, where the killing of cattle may represent a chance, but serious consequence.

Progress: Ecuador, spectacled bears and cattle: The impact of the endangered spectacled bear on livestock production systems in the Rio Cosanga watershed, Ecuador has been significant in the past year and a half. Our study on livestock depredation, crop raiding, and use of remnant forest fruit trees by the spectacled bear highlights the connection between productive and natural systems. The results underscore the need to change current livestock and land management practices and provide direction for specific management alternatives, benefiting both the farmers and the spectacled bear.

From April 2000 to May 2001, nine farms reported a total of 32 livestock attacks by the spectacled bear, 28 of which were fatal. Farmers were interviewed regarding the attacks and data were collected on farm characteristics such as herd size, farm size, number of hectares in pasture, number of hectares in forest, cow location, and carcass removal practices. The same information was collected from a sample of 9 unaffected farms so we could compare the characteristics of affected farms with unaffected farms. A matched pair analysis revealed a significant difference in carcass removal practices between the affected and unaffected farms (P = 0.03). Spectacled bears typically consume meat as carrion. However, bears may have initially been attracted to cow pastures due to the presence of cow carcasses, and a few may have changed their behavior to active predation.

Farmers have been affected for many more years by the spectacled bear's crop raiding behavior. We monitored the cornfields of 8 farms in two communities to quantify crop damage by the spectacled bear. From February 2001 to the end of April 2001, there were a total

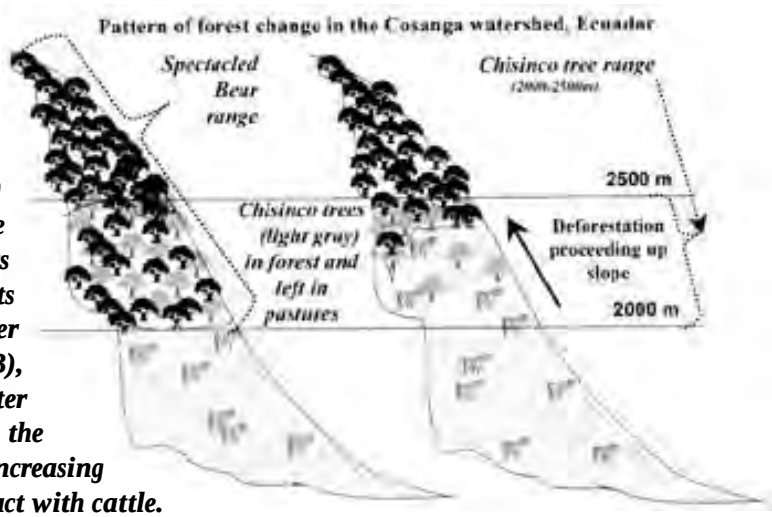


Figure 8. Possible effects of forest clearing practices on altitudinal ranges of Chisinco trees, Spectacled Bears, and cattle as clearing moves above 2000 through the zone of the Chisinco trees. In A, bears feed on Chisinco tree fruits within the forest. After further forest cutting (B), bears may need to enter pastures to feed on the Chisinco fruits, thus increasing potential contact with cattle.

of 8 incursions into 3 cornfields, affecting 136 plants in a total area of 321.69 m^2. We estimated the economic impact of crop raiding, taking opportunity costs into account such as the cost of seed and the labor costs for planting and weeding. The economic impact of crop raiding in this time period was US$4.41. We also quantified the economic impact of livestock depredation by the spectacled bear and gathered data on the replacement cost of the fatally attacked cows. Cows were valued between US$200 and US$400 each, depending on age and quality of the cow. The economic impact of livestock depredation, at US$8,200, was far greater than the economic impact of crop raiding.

As a result, some farmers in the study area have turned toward an indiscriminate hunting of the spectacled bear in an effort to stop the livestock attacks, even though it is illegal, and have even placed poison in corn to kill crop raiding wildlife. Since April 2000, there have been reports of 11 bears killed in the study area, 7 from hunting and 4 poisoned in cornfields. These reports could not be confirmed, but if true, could have very detrimental consequences for this endangered species in the study area.

Our investigation of the spectacled bear's use of remnant forest fruit trees in cornfields and pastures revealed a possible link between livestock management and land use practices and conflicts with the spectacled bear. Experts on the spectacled bear have stated that agricultural activities are replacing some of the best fruit sources for the spectacled bear and that bears increasingly forage in cornfields and in cow pastures where they depredate livestock.

We surveyed 8 farms for the presence of 3 fruit trees that were previously identified as climbed by the bear in cornfields and pastures and identified as constituting part of the diet of the spectacled bear. The three species are: *Nectandra membranacea* (Lauraceae), locally called Chisinco; *Cecropia andina* (Cecropiaceae), locally called Guarumo; and *Hyeronima macrocarpa* (Euphorbiaceae), locally called Motilón. For all trees that were climbed by the spectacled bear, we recorded the species, altitude, diameter at breast height (DBH), tree height, slope, and canopy area. All unclimbed trees of the 3 species were marked and assigned a number. Five unclimbed trees were randomly

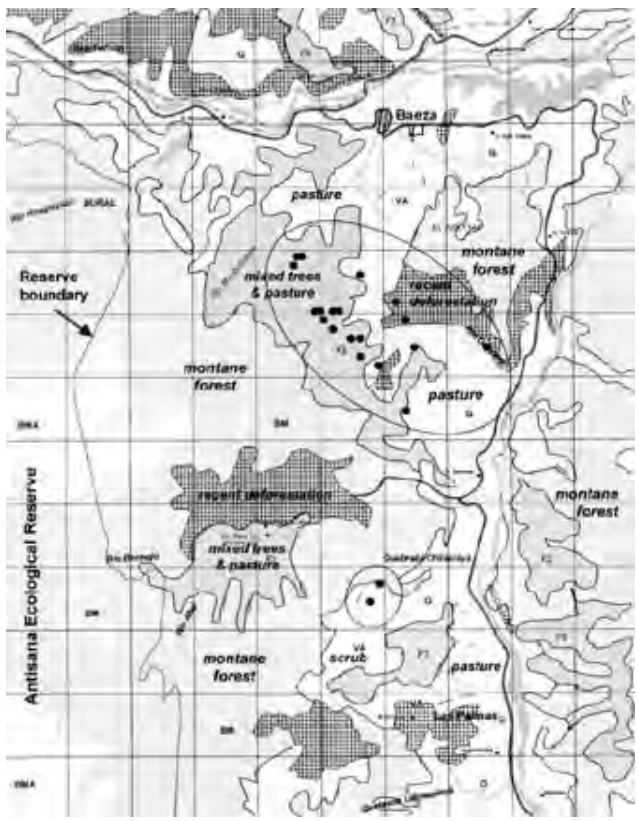
sampled at each farm and the same tree data were recorded as noted above. Logistic regression was used in data analysis to compare the characteristics of climbed and unclimbed trees.

One of the most notable results of this study is that 31 of the 35 climbed trees in fields and pastures were *N. membranacea*. Statistically, the spectacled bear showed a preference for this species (Fisher's Exact Test, $N = 75$, $P = 0.0002$). The fruits in the Lauraceae family, and in the genus *Nectandra* specifically, are known to be lipid-rich, potentially providing greater energy rewards for its consumption. Laurel fruits have been cited as one of the best food sources in other spectacled bear studies. In addition to fruit quality, the distribution of *N. membranacea* in Ecuador may also help to explain the spectacled bear's use of this species in cornfields and pastures (Figure 8). The species has a disjointed elevation distribution in the country; it is found from 0 – 1500 m and from 2000 – ~2500 m altitude. There is much overlap between the limited upper distribution of *N. membranacea* (2000 - ~2500m) and the pockets of high human activity and spectacled bear conflict in the study area (2000 - 2500m). Bears may be attracted to feed outside the boundary of contiguous forest where deforestation, due to agriculture and livestock activities, has reduced the availability of this lipid-rich fruit tree.

These spatial extent of these processes of vegetation change can be seen on the map in Figure 9. The bear attacks on cattle (marked with black dots) occurred in two areas (circled). Forest area cleared recently (between 1997 and 2001) are marked with cross-hatching. Note that the attacks all occurred near forest boundaries (BM) or in the fragmented forest/pasture mosaics (Mixed trees and pasture, F2). Note the marked reduction of the large forest "island" to the right of the main area of bear attacks—one of the remaining blocks of forest with a relatively high density of Chisinco trees.

Mexico, Vampire bats and cattle: An evaluation of the incidence of vampire bat attacks on cattle has been completed. A sample of 72 people were interviewed out of a pool of

Figure 9. Map of land cover showing deforestation that occurred between 1997 and 2001. Sites of cattle killed by spectacled bears are marked with black dots; circles mark the two areas of known attacks. BM & BMA = montane forest; F2 = mixed trees and pasture, including small patches of fragmented forest; VA = scrub vegetation; G = pastures; and cross-hatching shows areas of forest clearing that occurred between 1997 and 2001.



123 cattle owners in 5 communities in the northern part of the Sierra de Manantlán. Eighty-five percent (n=61) of the respondents mentioned that vampire bats have attacked their cattle, while 15% (n=11) stated that their cattle have never been attacked. Of the 85% who responded in the affirmative, 74% (n=45) said that these attacks constitute a problem and 23% said that it was not a problem. One person answered that there was potential for conflict and one person did not respond.

Seventy-four percent (n=53) of the respondents stated that their cattle had been attacked by vampire bats in the past 3 years. Of this 74%, 77% (n=41) responded that it was a problem, 17% said it was not, one person said there was potential for a problem, and two did not answer. The cattle owners' perceptions of the intensity of the problem were hard to ascertain as the question was difficult for the respondents to answer and many gave unclear responses.

In the last 3 years, only 8% (n=6) of the 72 interviewees stated that their cattle sickened as a result of bites by vampire bats with 4% of their cattle reported affected. A total of 20 animals were reported to become sick and 15 died. However, only 3% (n=2) seem to be from reliable sources of "derriengue" (a disease) as these were either confirmed by a veterinarian and/or a description of the symptoms. The other reports are not reliable: one mentioned that a cow bled to death, one mentioned that a cow became sick but did not die, another stated that 3 cows became sick but only 1 died, and one person said that 2 cows died but from an unknown cause. Based on the total number of cattle in the survey population, 0.8% may have died from cattle sickness.

The site or vegetation type most associated with vampire bat attacks, according to the local people, are open areas (36%). Open areas included pasture and a beach next to the river (26%) plus areas next to houses (10%). Sixteen percent stated that there was no difference between sites or vegetation types. 11% mentioned tropical deciduous forest; the same percentage of people stated that places close to caves were more highly associated with vampire bat attacks. The sites of least risk included pine-oak forest (2.5%) and oak forest (3.8%). All respondents mentioned 1 vegetation type, except 7 who mentioned 2 vegetation types or sites and 2 who mentioned 3.

People were also interviewed about their knowledge of bat diets and different types of bats. All respondents (100%, n=72) know that there is a bat that feeds on blood, but only 64% know that there are bats that feed on other items. Some 58% know that bats feed on fruits, 11% know that bats eat insects, 10% know that they feed on flowers, and one person mentioned that there are bats that feed on other items but did not know what.

Of the 46 people (64% of the total) who stated that bats feed on items other than blood, only 39% said that they were different types of bats, 37% said that they were the same type of bat, and 24% said that they didn't know. By grouping those who only know of a type of bat that feeds on blood (n=26, 36% of all interviewed) with those who recognize that bats feed on other items but think that they are the same type of bat, it is revealed that 60% of cattle owners believe that there is only one type of bat and that they attack their cattle. 15% said that they do not know if there is more than one type of but and only 25% of the cattle owners know that there is more than one type of bat.

Bolivia, Bird depredation on crops: Preliminary field assessment of nature and perception of bird crop depredation on maize and citris orchards was conducted. Farmers at both Bolivian sites identified birds, particularly parrots, as critical factors causing serious damage

to maize and other crops. This situation, like that of the bear, poses a serious conflict between conservation and agricultural production. In the case of the maize crops in the Tomatirenda watershed in Bolivia, as many as seven species of parrots, including macaws, may participate in crop depredation. Poisoning or shooting such species important for conservation and for natural forest dynamics would only change the focus of this serious problem. Nevertheless, given marginal nature of these rural communities and their farming systems, this problem needs to be solved. Given the predominance of maize at both sites, a scientific field study to determine the species responsible and the nature and extent of the damage has been designed and will be conducted at both sites in Year 5.

A2. Experimentation with Alternatives

A2.1 Enhancement of farmer ability to improve livestock production systems. Collaboration in farmer experimentation and execution of researcher driven experimentation (B,E,M)

Goal: Increased participation by farmers in on-farm experimentation and an increased capability in adapting the results from such experimentation in order to make farmer involvement a key component of reaching overall project goals.

Rationale: In all three countries, cattle are the dominant livestock, are one of the main direct and indirect causes of forest degradation and cutting, are subject to vagaries in market demand and prices, and appear to rarely be used for family nutrition. Therefore, small scale, more ecological compatible livestock production systems may provide additional sources of income and income, may allow effective use of more environmental niches in the diverse farm landscapes (such as fish ponds), may provide in some cases special resources under control of women and children, and may provide more economic stability through diversification of activities within families and at the scale of a small community. These options may be critical for improving the viability of some farm families and for taking pressure away from deforestation—an expected result that needs to be evaluated.

Progress: Farmer experimentation: Our focus on farmer experimentation is new this year. Experimentation is one of the means by which farmers can respond to change. We might ask what types of experiments do they affect and toward what ends? Considering that rural households generally lack time and resources and are often risk averse, the types of experiments they undertake might offer insight in their view of the world and their visions for the future. Some farmer experiments may well be useful to a wider audience. On-farm experimentation carried out collaboratively between farmers and scientists, focusing the experiments on subjects of genuine interest to the farmer and adding design features and analytical methods that can improve the effectiveness and validity of the experiments.

As researchers investigating rural experimentation, we also have limited time and resources and, therefore, how do we decide which experiments are most likely to yield results that are broadly beneficial? Two different approaches adopted at two of our project sites provide sharply different perspectives and insight. Within the two small communities of the La Cueva site in Bolivia, Jesus Molina. Through a series of talks and interviews, he sought out those who were engaged in on-farm experiments in an attempt to discover the nature and logic of their efforts. The majority of experimenters focused on agricultural subjects. The following six examples are illustrative:

1) Rosa Hoyas experimenting with the

cultivation of soy beans, with four varieties of maize, and with mixed maize and vegetable plantings to provide more effective forage for livestock.

2) Ismael Urzagaste experimenting with breeding local races of maize and with citrus fruit trees.

3) Teodoro Suruguay, landless, experimenting with the cultivation of bananas in La Cueva.

4) Lino Ruiz y Guadalupe Vega experimenting with the cultivation of ornamental flowers.

5) Francisco Ruiz experimenting in land under irrigation with various garden vegetables and improved varieties of citrus fruits. This farmer is also planning to experiment with pasture rotation during the season when cattle cannot find sufficient forage resources in the forests.

All of these experiments will not be studied or replicated with scientific experiments; however, these do serve to demonstrate the variety and nature of the interests of these farming communities. This initial, extensive type of study, provides a useful and necessary vision of the entire situation, which will help to guide the design and application of focused activities and actions. Following the priorities illustrated in Figures 1,2, and 3, we plan to concentrate efforts on pasture improvement experiments as described under Activity A2.2. The interest of some farmers in pasture rotation (#5 above) offers an opportunity to adapt the pasture improvement experiments in Ecuador in collaboration with Bolivian farmers.

A2.2 Improvement of the production and quality of pasture forage through joint experimentation by campesinos and investigators using legume/grass mixes to increase soil fertility; exotic/native forage mixes to increase nutrient content and reduce trampling impact; rotational grazing to improve forage production and reduce trampling impact; and evaluation of alternative legume species (B,E,M) (3-4 yrs)

Goal: An improvement in the quality of feed for livestock (primarily cows) by maize and forage as determined by increased quality and/or quantity of feed and/or by improved livestock health to increase the productivity and sustainability of livestock production.

Rationale: Pasture improvement is one of our strategies to improve livestock production, reduce pasture degradation, and reduce pressure for cutting new forests for new pastures. These studies are being carried out jointly with UW researchers, host-country investigators, and local farmers. In Ecuador, three model farms include several variations on pasture improvement/enrichment as part of following an integrated management plan developed under Project PLAN. Appropriate to the richness of the natural diversity surrounding these pastures in Ecuador, the mixes being tried and the new experiments to be implemented are considerably more diverse than comparable U.S. forage mixes. The complex mixes take advantage of native species planted to enhance nutritive value of the forage and to improve the pasture's resilience to trampling. Informal assessment of a variety of native forb species naturally regenerating in the pastures suggests that most either further enhance the nutritive value of the pasture or are neutral in direct effects. The overall high diversity of grasses and forbs likely reduces the extent of insect damage and contributes to the ecological stability of the system.

Progress: Experiments with mixed-species pastures, Ecuador: We currently have in progress a series on-farm, farmer conducted/researcher assisted experiments on pasture improvement. These are experiments to evaluate key elements

in a rich mix of native species and selected exotic forages including pasture rotation. Two exotics: Kikuyo grass (*Penisetum clandestinum*) and Lotus (*Lotus uliginosus*) form the dominant components; however, these are growing among 15 to 30 species of native forbs and grasses to enhance the nutritional quality of the pasture and increase resistance to trampling (Figure 10). A list of 23 native forages (plus 3 exotic species) and their relative abundances in these pastures (%) a shown in Table 1 under Activity A1.2. During a site visit in July, the pastures were in very good condition, in contrast to neighboring pastures.

Figure 10. Diverse mixed species pasture on farm of Sailor Erazo, Las Palmas, Ecuador, Fabian Calispa of Terranueva (left) and Alandy Torres, participating farmer (right).

Experiments with farmer involvement will be conducted with three different models on these farms. An evaluation of temperate legumes that may be adapted to the region has been planned by farmers, with minor input from UW and local NGO personnel, and will be conducted on three farms. Assistance in developing questions that can be answered and in the design of the field trials was provided by UW scientists and seed will be provided by companies from the USA and New Zealand. The evaluation will take place in existing pastures with no adjustment of normal grazing rotations, so there is no financial risk to the farmers. Visual observations recorded by the farmers and by Project researchers will provide the assessment of success or failure of the legumes.

An experiment to test the impact on milk production by including *Lotus uliginosus* (a legume that has great flooding tolerance and is adapted to the region) in grass pastures was proposed by farmers and local NGOs and designed by UW agronomists, dairy scientists, and statisticians. Suitable pastures exist on two farms to make the comparison between monoculture grass (primarily Kikuyo grass) and grass/Lotus combinations (Figure 10). Farmers will be responsible for recording milk production and rotating livestock through the pastures in an order that will allow statistical analysis of differences in milk production. UW personnel and NGOs will summarize the data that are expected to demonstrate markedly greater livestock performance with addition of this adapted legume to dairy pastures. Ultimately improved productivity of existing pastures should relieve pressure to expand pastures to more sensitive areas of the landscape, and in fact let some erosion prone areas revert back to forest. There is no financial risk to farmers involved in this project and only minimal extra labor will be required.

The feasibility and advantages of corn production in a Lotus living mulch or corn production in bi-culture with perennial beans will be determined in an experiment proposed by UW agronomists and designed with assistance by farmers and local NGOs. A graduate student will conduct this experiment with the assistance of farmers and local NGOs. Labor will be provided by the graduate student, paid local assistants, NGOs, and farmers. Corn grain produced in the experiment will be the farmer's property to partially off-set use of their land. The systems should allow grain, used for livestock and/or human consumption, to be

produced near the home rather than encroaching into forestland (bear and bird habitat) to take advantage of accumulated available soil nitrogen.

One farm wife (and farm owner, Raquel Chuquimarca) extrapolated this idea by inter-cropping peas for house consumption in the Lotus pastures! Other farmers in the community are observing these experiments closely.

A2.3 Reduction of impact of wildlife on livestock and crop production systems: study of livestock management to reduce wildlife contact (bears, E); and evaluation of potential deterrents for bird crop damage (B, E) (3 yrs)

Goal: A reduction of impacts of wildlife (particularly the spectacled bear) on maize in order to minimize farmer losses.

Rationale: Specific research experiments to reduce wildlife damage to livestock and crops are necessary components to promote ecological, economic, and social stability of these agro-ecosystems. The potential advantage of the resources of Project PLAN is to develop solutions that reduce wildlife depredations while simultaneously improving the conservation status of the species responsible. The desirability of finding win-win solutions is particularly important for species like the Spectacled Bear in Ecuador and for the rich assemblage of parrot species that feed on maize and other crops in Bolivia.

Progress: Ecuador, spectacled bears and cattle: This study on an endangered species, the spectacled bear, and its impact on livestock production systems, in particular, has emphasized the connection between the natural and productive systems (see A1.5). Local farmers are greatly affected by the spectacled bear, but the cause may be the extensive land use practices of the farmers as described in Figures 8 and 9. To prevent further conflict, we recommend several alternatives. Since the majority of the bear attacks took place less than 10m from the forest edge, farms that are repeatedly attacked could put up electric fences as barriers. Farmers could cultivate corn in the highest parts of their farms, which could act as a buffer zone between the forest and the cows. Not only could farmers bury cow carcasses to potentially prevent depredation events, but the cessation of the practice of continuous deforestation to create new pastures for cattle could also play a key role. One of our principle recommendations is to implement farm management plans, which provides a link to and emphasizes the importance of other Project PLAN activities. Management plans aimed at improving the quality and availability of forage in pastures so that deforestation does not continue and implementing reforestation projects that will produce food for the bear and also help prevent soil erosion will benefit both the spectacled bear and the local farmers. Please see also Activities A1.5, C1.2, and C2.1 for linkages with the Spectacled bear study.

A3. Planning, Implementation and Monitoring.

A3.1 Evaluation of livestock and forage production systems as part of overall land use management plans (3-4 yrs)

[This activity will be considered as an integral component of activity B3.1 under B. Land Use and Alternative Production Systems]

Rationale: The overall effects of pasture improvement, alternative livestock production systems, and reduction of wildlife depredations need to be evaluated within the broader context of the mix of production systems and management practices within the watershed. This information will be part of overall planning activities being undertaken under step 3 of category B—Land Use and Alternative Production Systems.

B. Land Use and Alternative Production

B1.Problem Definition

B1.1 Planning of land use at different scales: Identification of spatial and temporal characteristics of land use. Analysis of patterns of land use change; local criteria for land use including timber extraction and clearing for pasture. (B,E,M)

Goal: The identification of spatial and temporal patterns of land use including forest reduction to inform project workers about the extent of problems and areas of greatest problems and the change in these over time.

Rationale: We need to determine an accurate map of current land cover and land use and the patterns of change over time. We already have the maps of land cover/use and are now in the process of determining changes in land use over time. We also need to understand how farmers look at the same land and their logic for the changes they make.

Progress: The patterns of land use change coupled with more information about the history have provided an important perspective on the factors that influence land uses and consequently land cover through time. The analyses of the changes in terms of cause and effect are more complicated and form the basis of specific studies in Year 5 in all sites.

Mexico: Descriptive study of land use/land cover change for the Ejido Zenzontla comparing 1971, 1993, & 2000. An example of this study showing patterns of land cover/land use change in Zenzontla between 1971 and 1993 was illustrated in the GL-CRSP Annual Report 2000. This study has now been extended to include changes in 2000. This three part sequence has provided an even stronger basis for evaluating the factors behind these changes at local and large scales (see summary under Activity E3.1). This work is scheduled to be completed as part of the Ph.D. dissertation of Project collaborator Oscar Cardenas.

Ecuador: The Alianza Jatun Sacha/CDC just completed a descriptive study of land use/ land cover change for the Cosanga watershed comparing 1997 & 2000. An inset from their map of recent deforestation provided the basis for the map shown in Figure 9 above. They have coupled the large scale analysis of land use/ land cover change with detailed information of changes on a series of individual farms within the area of the study. This information will provide a valuable basis for understanding the factors causing the land changes and for developing plans and policies for management of land and natural resources in this region by individual farmers, local communities, and the regional government (see Activities B3.1, E2.1, E2.3, and E2.4).

Bolivia: Descriptive study of land use/land cover change for the Tomatirenda and Rio La Sal watersheds comparing 1967 & 1997. Project collaborators in AGROSIG have just completed maps of land use/land cover change for the watersheds of both Project sites in Bolivia: Rio Tomatirenda and Rio La Sal (Figures 11 and 12). The map in Figure 11 shows the pattern of vegetation cover that corresponds very well to soil type and the physiography of the watershed. The maps in Figure 12 show patterns of land use corresponding to 1967 and a different set of land uses distributed much more extensively in the watershed in 1997. Comparisons of distribution of uses in both years correspond to the use of different vegetation zones. The maps illustrate dramatic changes in the relative extent of different land uses. Uses of livestock have increased greatly at the expense of the natural forest types of the watershed.

Figure 11. Vegetation cover of the Rio La Sal watershed, Bolivia

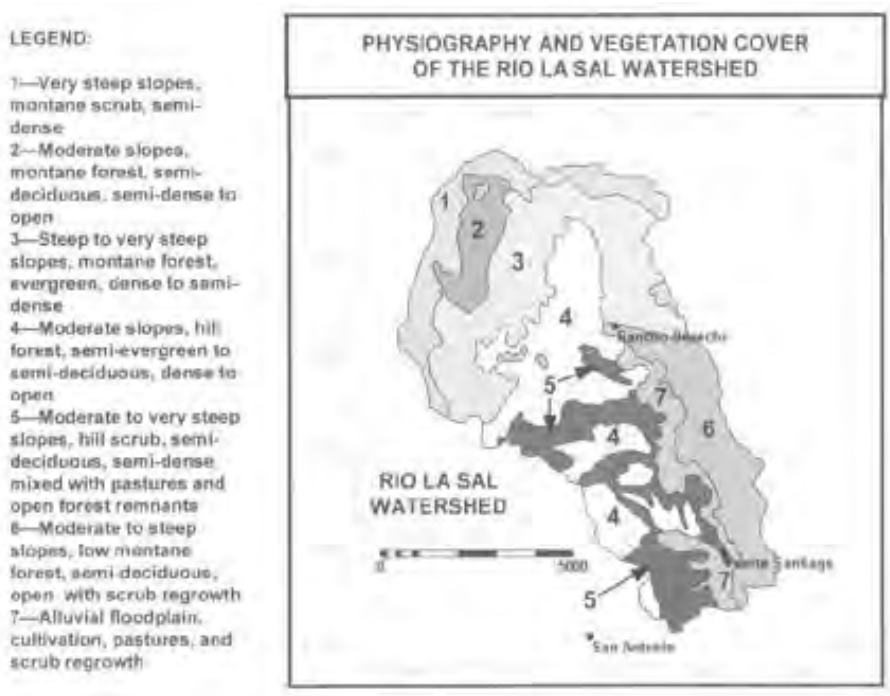
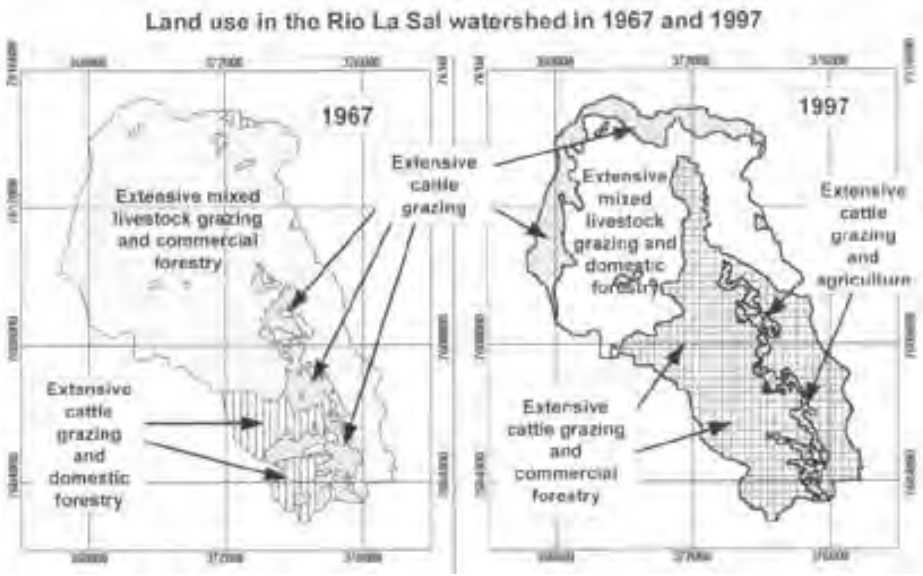


Figure 12 Land use change in the Rio La Sal watershed, Bolivia: types of use in 1967 (A) and in1997 (B).



The changes along with an understanding of the factors influencing them have important implications for sustainable management strategies and for the land use planning and policy in these regions. These sets of maps along with a series of assessments of soils and possible land uses have been developed by AGROSIG to serve as part of the basis for planning for sustainable land use within these watershed. Several researchers on the Bolivian team now have studies in planning and in progress with communities in the region to integrate other components that influence the management of productive systems within these areas. This work will inform our future work as well as local producers and planning entities.

B1.2 Production, use, and management of water. Hydrological characterization of the watershed (B,M); Rehabilitation of the irrigation system (M).

Goal: An improved characterization of water management issues including an understanding of the current hydrological situation in the watersheds and the state of changes in the irrigation systems to identify issues of concern.

Rationale: Availability of water is a regional problem in all three sites. Conservation of the watershed services is thus both a local and regional benefit of high priority. The main use of water in Bolivia and Mexico is for agriculture including irrigation systems. Understanding the use and management of the water is a critical component for sustainability of and within the watershed and will be determined by working closely with farmers and local communities. The studies under this Activity are closely linked with the following (B1.3).

Progress: Models of watersheds a tools for watershed planning:

Three dimensional models of the watershed have proven to be excellent multi-purpose tools to help in education of the nature of the watershed, to use a visioning tool for discussing the location and consequences of watershed problems, and for use in planning sustainable land use. In all three countries, three-dimensional models of the watersheds were either completed or lined up to be finished within the next year. Mexico has a finished model that only lacks a strategic plan for implementation; Ecuador has recently completed participatory education plans for implementation of its management plan, and a model for Rio la Sal in Bolivia is next in line to be built.

Mexico, Rehabilitation of irrigation systems: Status report on the rehabilitation of irrigation systems in Zenzontla completed. As described in early reports, the irrigation areas of Zenzontla along the Ayuquila River were, and could be again, areas of high agriculture production. These irrigation projects are currently in-progress. See also Activity B1.3.

B1.3 Environmental impact study of production activities at the scale of the watershed (landscape and water) Identify degraded areas and factors that promote the loss of productivity and resources; evaluate conditions and causes of degraded pastures (B,E). Impacts of production activities on water quality; use of biological indices (B,M).

Goal: An improved understanding of the impact of production activities (largely but not exclusively livestock) at the scale of the watershed on the environment including water quality and land degradation to identify areas in need of attention.

Rationale: Land use change through deforestation and soil erosion are critical factors leading to the degradation of the watershed with associated consequences for downstream users.

In Ecuador, within the upper watershed of our site, too much water is a problem such that deforestation results in damaging landslides that frequently block access routes out of the region but also, not infrequently, kill people and livestock. Contamination of the water systems due to activities of outside users has occurred and is a threat in all three sites.

Progress: Development of aquatic bio-indicators to assess environmental quality of the Ayuquila River and its watershed:

Mercado-Silva's paper and completed thesis developed a bio-indicator index bases on fish species composition correlated with analyses of a series of biological and social characteristics of the Ayuquila River and West Central Mexico. Assessment of the environmental quality of the Ayuquila River in West Central Mexico, based on a fish-based index of biotic integrity, demonstrated that the environmental quality of the river has improved from previous years when the seasonal impact of organic contaminants from local industry to the river had serious impacts on the biotic community in the river. Impacts from other sources were discussed and recommendations for future management were presented.

Integrated Ayuchila watershed project, Mexico: The PLAN-Mexico team's coordinator, Luis Manuel MartÌnez, is also the leader of a very large project for the improvement of the Ayuquila River watershed, within which the Project sites are located. This large-scale project linked with the University of Guadalajara and the University of Wisconsin and with all the local government municipalities within the watershed includes many components that have and will benefit Zenzontla and the goals of Project PLAN. Potential interaction and collaboration between these two projects are now being considered with the possibility of combining them under the GEF proposal currently in preparation.

B2. Experimentation with Alternatives

B2.1 Systems of agricultural production: potential practices. Evaluation of varieties of maize (B), reduced chemical trials with varieties of maize (M), and use of organic fertilizers (E).

Goal: An increase in knowledge about (non-livestock) agricultural practices including the identification of productive varieties of maize and the evaluation of the effectiveness of alternative fertilizers (organic and/or reduced chemical) to enable development

Rationale: Improved maize production, Mexico and Bolivia: Although our main concern for agricultural improvement is on pasture enrichment and use, maize is a major crop in all three sites and is used heavily both for consumption including marketing of the grain and for livestock forage. Improvements in production, quality, and ecologically sustainability of this crop will have strong effects on the farm community economy and livestock production practices. Heavy reliance on this crop with a low and highly variable margin of profit and with several disadvantages ecologically, however, also reinforces the need to develop alternative production systems, both agricultural and non-agricultural.

Ongoing experiments in Mexico and Bolivia deal with trials with varieties of corn (high yield, high demand varieties versus locally adapted, rain-fed varieties) and with reduce chemical input with advantages both for reducing water contamination as well as for reducing the cost of maize production (chemicals are comparatively very expensive for these farmers).

Mixed cropping in pastures, Ecuador: The success of certain non-invasive exotic legumes such as Lotus offer the possibility of double-cropping maize and/or household vegetables among the Lotus-dominated pastures, thereby accruing several advantages in terms of "free"

nitrogen for the second crop, reduce erosion compared to traditional crop fields, and increase forage production for livestock. These experiments are spin-offs of the pasture enrichment work and will proceed largely through farmer experiments with advice and monitoring by project investigators (see Activity A2.2).

B2.2 Soil and water conservation practices: terracing with stones and trees (M); pasture drainage systems (E); rehabilitation of existing irrigation areas and evaluation of irrigation potential in other areas (M) (3 yrs)

Goal: A better understanding of soil and water conservation practices including rock terracing and use of several drainage systems to provide solutions to conservation problems.

Rationale: These relatively simple conservation methods, each appropriate to local situations, are first steps in reducing erosion and fostering individual and collective action to improve the sustainability of the agricultural lands. These methods offer obvious benefits and open the door to developing more comprehensive farm plans such as those already in place in Ecuador. These practices are carried out primarily by the farmers themselves with advice and monitoring by project investigators.

Progress: Mexico, Stone terracing: The stone terracing in Zenzontla started before Project PLAN as a preliminary measure to reduce soil erosion has been widely adopted and has been supported by Project PLAN as well as the by the government environmental agency (SEMARNAP) that administers the biosphere in which Zenzontla resides. An initial assessment of the stone terraces by a Project specialist in watersheds is in progress. These stone terraces have been established on 56 parcels of cropland; however, preliminary analyses suggests that only ten percent may be functioning satisfactorily due to a variety of potential causes including inadequate placement, poor maintenance, and disturbance by cattle grazing among crop residues. The stone terraces have also been one of the targets for application of agro-forestry which may offer a partial solution to restore the function and improve the stability of these terraces (see B2.4).

Ecuador, Pasture drainage systems: Over the last two years our project partners, working in collaboration with local farmers and their farm management plans, have established experimental drainage systems on 14 ha of pastures. In contrast to the water scarcity problems of Mexico and Bolivia, in Ecuador, saturated soil is a serious agricultural problem. In pastures which have deteriorated and lost cover, cattle have a difficult time moving and lead to further deterioration of the soils as well as incurring health problems from standing in saturated soil for long periods of time. Small drainage ditches coupled with pasture rotation and improved forage mixes (Activity A2.2) have been installed to attempt to alleviate this problem (Figure 13). Initial analysis/farmer perceptions of pasture drainage trials are positive

Figure 13. Drainage canal in mixed species pasture on farm of Sailor Erazo (upper right) (Lower left: Luis Manuel Martínez (Mexico), Nelson Flores (Bolivia), and Ricardo Paita (Bolivia) on site visit.)

as being explained by farmer Sailor Erazo (Figure 13). A more extensive assessment of these drainage trials is expected to be conducted during the coming year.

B2.3 Rehabilitation of degraded areas: Riparian forests (Mojoteras) (M); Reforestation with enrichment on steep slopes (E)

Goal: An improved understanding of methods for rehabilitating degraded areas, primarily riparian forests, to inform large scale rehabilitation efforts.

Rationale: Restoration of forest cover on steep slopes and in riparian stream zones are our highest priorities for the health and improvement of the watershed. With limited resources, we will focus on three opportunities to foster forest restoration on three sites. In Bolivia, we are simply monitoring an interesting of natural forest regeneration on abandoned pastures. The process of formation of natural expanding islands of forest regrowth is a bird-dispersal mediated system that offers possibilities for systematic enhancement to enhance the speed and extent of forest regeneration.

Figure 14. Natural forest regeneration on abandoned pasture enriched with plantings of native timber species, Sailor Erazo farm, Las Palmas, Ecuador

Progress: Enriched forest regeneration from abandoned pastures, Ecuador: Some farmers, as part of their comprehensive farm management plans, are permitting natural forest succession on high slope pastures. In several cases, they are planting seedlings of valuable timber species among the natural regrowth on these "abandoned" pastures to enhance the mix of valuable timber species in the future (Figure 14). The project is working with groups of farmers to provide the seedlings (see Activity B2.4). The farmers will follow through with the management of these regenerating former pastures. This type of forest restoration will not only improve the watershed but will also enhance the future value of that forest for local land owners/users and thus help to ensure long-term protection of these forests. Since the tree planting is done as enrichment of natural regeneration rather than as plantations, there will be reduced risk of pest outbreaks on the trees and direct benefits for conservation of forest biodiversity.

Restoration of riparian forest, Mexico: The tree *Brosimum alicastrum*, called "mojote" locally, is an evergreen dominant in riparian forests which are called "mojoteras." These riparian strip forests are important for watershed protection and appear to be critical habitats for

several endemic birds species. The tree itself produces several useful resources for local people (wood, bark, fruits) as well as providing shade and valuable forage for cattle in dry seasons. The tree appears able to regenerate under moderate grazing pressure; however, when overgrazed, however, no regeneration occurs. These "mojoteras" provide multiple benefits to the full array of users; therefore, they are serving as key foci for conservation plans and for experiments in restoration. These projects are long-term, low demanding activities with a clear contribution to sustainability.

B2.4 Agro-forestry systems: Implementation of living fences for forage, soil improvement, and conservation. Tree nursery and agro-forestry plantations for forage, soil fertility, fruits, and timber. (B,E,M)

Goal: A better understanding of agro-forestry systems including living fences and nursery activities in order to improve conservation and develop alternative income sources like fruits and timber.

Rationale: The advantages of various applications of agro-forestry are obvious and desired by local farmers. A frequent impediment to their application is a source of seedlings. The Project is playing a role to foster collective action through the creation of tree nurseries in all three countries. These nurseries provide relatively rapid and clear benefits to local communities and serve as a model of the advantages of collective action. Activities like this are important elements in an overall strategy to strengthen community organization and capacity for collective action and to attract farmers' interest in overall farm management planning.

Progress: Mexico: The establishment of a tree nursery including several species of native trees has resulted in publication of the new silviculture methods developed for four native forage trees to allow nursery propagation of these species for agro-forestry purposes. A second publication discusses the uses and value of a community tree nursery. Following on this example in Mexico, we have now established tree nurseries at all the other sites with the interest and participation of the local communities. Evaluation of ongoing agro-forestry experiments in Mexico with Leucaena and other tree species is in progress.

Ecuador: A community tree nursery has been establishment through the assistance of the Project and more than 20 ha of on-farm silvopastoral systems have been planted. In addition, trees from the nursery are being used to enrich natural forest regeneration on pastures abandoned with the intention of forest restoration and the creation of future timber products (Figure 14). There is much enthusiasm among participating farmers. Initial experiences have had some successes and some set-backs due to pests and disease problems among new plantings. Nevertheless, the prospects remain positive. We do not doubt the high potential value of agro-forestry to the various productive systems in our target communities; however, experience in attempts to establish tree nurseries in all three countries has provided useful lessons. Despite setbacks, we and groups of local community members remain interested. Experience has already shown us the need and value of promoting communal tree nurseries.

Bolivia: Living fences have been established by community members around the communal cropland plots of two Guarani communities. In the Tomatirenda area, fences are needed around all cultivated field to keep out free-roaming goats, pigs, and cattle. Wire fencing is prohibitively expensive for these marginal communities. Traditional fence are constructed by using tree trunks and heavy limbs to form solid barracades of wood. With increased

densities of people and increase demand on forests for fuelwood, the number of trees needed for fencing results in a significant impact on remaining forests. An experiment was established to make living fences using cuttings from the cactus, Sachrrosa (*Pereskia sacharrosa*). This robust native cactus grows in bush form to about 3.5m. It is common in the area and can be easily grown rapidly from cuttings. In the initial period following planting, new shoots have been attacked by insects resulting in damage to nearly 90% of the new growth. Methods to protect the initial stages of growth are now being considered.

B2.5 Trials with alternative non-traditional products: shade house vegetables (E), medicinal plants (B,M), fruit trees and wild fruits (B,E,M).

Goal: An increase in knowledge about alternative non-traditional products including medicinal plants, shade house vegetables, and fruit trees through experimental trials to identify cost-effective production alternatives for communities and potential for marketing.

Rationale: Dependency on cattle for meat or milk leaves these local farm families with low, variable income, few resources, and uncertainty with respect to nutritional needs of families. Shade houses have already been shown capable of providing a stable, abundant, and diverse supply of quality vegetables and fruits to local families as well as permitting savings of money that would have been used to purchase food.

These shade houses have proven to be key elements of the project in several ways. One, they appear to improve greatly the quality and security of family nutrition (this will be assessed more rigorously through the activities under category F in year 5). Two, the shade houses have served as foci for cooperation and mutual benefit for several families, serving as a positive starting point for fostering the creation of small women's groups and small producer groups. Strengthening the capability of these groups is part of an overall strategy to strengthen community organization and planning (see Activities E1.5 and E2.3).

In all three country sites we have found that local people use a wide variety of non-timber forest products. Women in particular often depend on local plants as the basis for traditional medicines given the high cost of modern medicines. A network of community women's groups has been working with the project to identify and organize local knowledge on the use of local medicinal plants and their proper preparation. As with shade house work, these local groups are serving as nuclei to build communal trust and cooperation within these communities.

Extensions of the shade house strategy include potential local marketing of vegetables, fruits, and medicinal plants. Our partner CER-DET has assisted the preparation and marketing of herbal medicine cures prepared by the Guarani communities in Bolivia through a longer term activity complementary to Project PLAN. In Mexico, the project is assisting a local initiative to grow and market pitaya cactus fruits which have a ready market demand during a time of the year when income from other livestock and agricultural products is very low. These activities can provide small but significant sources of income to women and poor families to increase quality of life (by putting resources under the control of women) and/or to increase the stability/security of family income through the year. Thus, these deceptively small activities can contribute significantly to the economic and social sustainability of these communities.

B3. Planning, Implementation and Monitoring.

B3.1 Development and monitoring of the establishment of management plans: Individual finca management plans (E); community land use/development plan (B,M); watershed management plan (E).

Goal: The development of management plans (and the monitoring of their establishment) for sustainable rural community land-use, watershed, and individual farm development to lead to the implementation of such plans at levels of several different sizes.

Rationale: This activity is ongoing in all three sites. In Ecuador with dispersed communities, we have been successful in fostering individual farm management plans. Three farms are now serving as sites for joint farmer researcher experiments and are also serving as models within the community. Other farmers are now developing management plans for their farms. This year we will continue the slower process of fostering community-wide plans in Mexico and at the La Cueva site in Bolivia and communal land plans with the Guarani in the Tomitarenda watershed in Bolivia.

Progress:

1. Sustainable management farm plans: In Ecuador, three of four initial farms in one community are now in their third year of operation and serving as models; two additional family farm plans are now being implemented; and 7 additional farms from four different communities are now in the process of developing sustainable management plans. A total of 35 farm families from more than six communities are now participating and involved with associated activities of natural resource management and development of alternative productions systems. are participating in the process of developing whole farm management plans.

2. Community management plans: The Guarani communities in Bolivia are currently restructuring their communal plans. CER-DET (the key local partner of Project PLAN among the Guarani) is assisting in the planning applying the focus in process developed by Project PLAN.

3. Promotion and support of regional plans for sustainable development (at the scale of local regional government such as the municipio or canton): In Ecuador, the Municipio of Quijos has recently developed an environmental management plan through participatory citizen workshops. With the support and participation of FUNAN (the key local partner of Project PLAN), the Municipio is currently moving ahead with the development of a development plan within the canton. In Bolivia, AGROSIG developed an integrated series of maps incorporating imporant bio-physical characteristics, land use patterns, and land use potential assessements to serve as a basis for land use planning by communities in the Tomatirenda watershed. A similar set of maps and assessments are nearly completed for the Rio La Sal watershed (see Activity B1.1 and Figures 13 and 14).

4. Fostering government cooperation and collaboration to coordinate environmental and developing planning at the scale of watersheds: The PLAN coordinator of Mexico is now directly involved in a large scale activity fostering collaboration of multiple local regional governments to develop a management plan for the Ayuquila River watershed (the Ayuquila is the main river draining the Sierra de Manantlan Biosphere Reserve and flows through the lower part of the Ejido Zenzontla (the principal study site of PLAN).

B3.2 Development of systems of information: GIS and development of plan for

dissemination of land use information and education/training materials (B,E,M).

Goal: The development of systems information and the dissemination of such information, along with an understanding of their use, to local inhabitants to allow for more informed local involvement in planning activities.

Rationale: One of the challenges of the project is to work with the communities to develop mechanisms for the dissemination and use of background information by the communities as well as a information system for the organization and use of data from monitoring to support adaptive management and an ongoing planning process by the community. This system will also need to incorporate information for planning derived from other categories (e.g, from the livestock, natural resource protection, and economic development categories). The application of this system depends on the progress with small group organizations and community level organization (see under category E).

We have generated a large body of information useful for informing planning activities. Development and implementation of an overall educational strategy has been a goal, but, due to limitations of funds has yet to be finalized and implemented in systematic fashion. This area will need to become more defined soon as the opportunities for its use in developing community groups increases.

C. Natural Resources Protection

C1. Problem Definition

C1.1 Biodiversity: inventory, distribution, and status in the study areas: Floristic inventories(B,M); Vegetation phenological studies(B,E,M); Inventory and distribution of birds by habitat according to status and impact of livestock(B,E,M); GAP analysis and sink/source analysis of endemic and threatened species (M); Study of bird as keystone species (pollination and fruit dispersal)(B,E,M); Inventory of fish species (B,M)

Goal: An improved understanding of biodiversity issues including floristic inventories, inventory and distribution of birds, fish, and various endangered species of plants and animals, particularly as affected by livestock practices, to identify problems of concern.

Rationale: This component is necessary to understand the nature of the animal and plant communities so as to assess the impacts of different land use practices and the possible consequences for land use changes. As inventories become more complete as shown by plotting species area curves, sampling efforts will diminish through time. However, an ongoing, longer term monitoring of selected indicator species will be needed to track any changes and their relation to land use management plans. The biodiversity component is imperative as one of the measures of ecological sustainability.

Progress: Natural forest value—diversity of plant species uses by local people: Botanical/ethnobotanical information continues to build in all three countries. Wild forest plant uses, a critical part of the valuation of the natural forests of the study areas, are now documented in completed manuscripts, books, and systematic databases detailing over 300 plant uses in the Ejido Zenzontla, Mexico, over 100 species with recognized uses in the more recently colonized areas of the Quijos watershed, Ecuador, and 166 medicinal plant species known and used by the Guarani, Bolivia

In Bolivia and Mexico, researchers have compiled recipe books of preparation techniques of medicinal plants to capturing the local, indigenous knowledge a products of long-term cultural experiments. The use and commercialization of these traditional medicines

are dealt with under activities B2.5 and D2.2.This valuation of non-timber forest products changes the balances of some farmer land-use decisions: forest and biodiversity loss for the Guarani translates directly to money/ resources lost.

This year inventories and databases of flora and local use of plant species were updated for all target areas of the three countries.

Endemic fish species inventory and assessment of local fisheries: An update on the composition of the fish community of the Ayuquila River was provided. The 19 species (exotics included) reported for the Ayuquila represent an increase in the number of species known for this river. Four new fish species records were reported for the basin. Different characteristics of the fisheries in the Ayuquila were described. Self-sustenance is the main objective of the fisheries in this river and many impoverished communities depend on its fish for protein intake. Frequency of fishing, catch assessment, gears used, and many other characteristics were presented and analyzed. Additionally, a study of the value of fish species as biological indicators of water quality there (See also Section B1.3). Impacts of land use on these species were also outlined in the study (see Fish Biodiversity and Conservation, under Section 8 of this report.)

Avian biodiversity assessments, Mexico: The project, "Richness and abundance of birds in tropical forests with cattle, in the ejido of Zenzontla", has begun under the direction of Sarahy Contreras. The overall objective of the study is to estimate the richness and abundance of birds in tropical forests in different successional stages. 60% of the objectives have been completed to date. Two months of student training of the songs and observation of birds in the region of Zenzontla were completed. Sampling sites were chosen and a total of 232 parcels in 40 transects, corresponding to different successional stages of tropical deciduous forest, have been sampled.

A list of bird species has been compiled and 171 species are reported. This species richness represents 53% of the species in the Biosphere Reserve and 16% of the species in Mexico. Considering the distribution of species, 65% of the species that are found in the ejido of Zenzontla have a tropical or meso-american distribution, of which 21 species are endemic to Mexico.

Of the total number of bird species, the majority were found in tropical sub-deciduous forest (100), followed by scrub vegetation (96), tropical deciduous forest (95), riparian vegetation (68), pasture (44), cultivated zones (34), and urban zones (19). Of all these species of birds, 19 are included in a conservation category (Norma Oficial Mexicana): 10 are threatened, 5 are under special protection, and 12 are considered rare. The human inhabitants have observed the local migrations of a species that is in danger of extinction, the Green Macaw (*Ara militaris*).

C1.2 Studies of human-environmental interactions: Analysis of vegetation change and study of regeneration dynamics (aspects of impact of cattle under category A. Livestock) (B,E,M); Evaluation of use, status, and vulnerability of catchment forests (B,E,M); Farmer classification of use and management of natural resources(B); Local perceptions on hunting, and livestock/crop damage of Spectacled Bears(E).

Goal: An enhanced understanding of the impacts on the environment of various human productive practices including the effects on vegetation of livestock and the effects on forests of the range of activities as well as local perceptions of these impacts.

Rationale: The aspect of human-wildlife interaction is extremely important for Project

PLAN, since we are focused on working with communities to discover the most healthy, long-term, and optimal quality of life possible. A healthy environment is imperative for this vision, as well as a healthy concept of the impact that humans have on resources. Regeneration plots (paired grazing and grazing exclusion plots) are being used to provide information on impacts of livestock on regeneration of natural vegetation in Mexico and Bolivia, where the use of the forest is a significant part of the annual grazing/ foraging strategy for cattle and other livestock.

Progress: Spectacled bear, Ecuador: In Ecuador, the human-environment relationship has focused on the Spectacled bear, an endangered species indigenous to the project area. Louise Galasso, a Master's student from UW-Madison, has been studying this relationship over the past year, and conducted interviews with local people as part of her research.

Seventeen individuals with farms in five small communities in the Ecuador study area were surveyed regarding their attitudes towards wildlife in their fields. An excerpt of the results follows:

- 68% of respondents stated that wild animals damaging crops is the biggest problem they encounter in their cultivated fields.
- When asked which animals visit their fields, 88% said the oropendula (large species of bird), 76% said the squirrel, 71% said rats, and 71% said the spectacled bear.
- 47% of the respondents stated that the oropendula causes the most crop damage, followed by the squirrel and spectacled bear each at 29%. 12% stated that rats cause the most damage and only 1 person (6%) attributed the most damage to insect larvae.
- 58% of respondents stated that crop damage by wildlife is worse today than it was five years ago. 33% stated that it has not changed.

Local environmental knowledge and awareness, Bolivia: Magaly Flores completed a study on the "Identification and analysis of local criteria for the classification and evaluation of natural resources." In the past, local knowledge was not valued and subsequently was not incorporated into management of local natural resources. Recently there has been a renewed interest in local knowledge combined with an understanding that this knowledge is imperative for ecosystem management. The report found that the local inhabitants posses a deep knowledge of their watershed, not only on the macro level such as the regeneration of forests, but also on a smaller scale such as intimate knowledge of cultivated fields.

Also indicated by the results was the fact that local people value the assemblage of local flora and fauna based on the knowledge that it supports their families' livelihood and health. Local actors use their knowledge of the watershed resources not only to care for their crops but also to gather such resources as wild fruits and leaves that are used for medicinal purposes. Their knowledge is also used for hunting and fishing, both of which help to sustain the family. Given the profound knowledge and general use of their environment, the ultimate goal of this study is to work with the local people on developing sustainable ways to manage their resource base.

Vegetation regeneration plots (exclusions),Bolivia, Mexico and Ecuador: In Bolivia they have now established 20 paired regeneration/grazing plots in five different vegetation types at two different sites (10 each site) and initial vegetation sampling of plots in

database and summarized. Vegetation species composition of regeneration plots at both sites in Bolivia shows them to be ecologically diverse and comparable in plant species diversity to each other and to the Mexican sites (Tomatirenda: 421spp/ha; 74 tree spp/ha; Rio La Sal: 400 spp/ha; 62 tree spp/ha) (Mexican botanical inventory of a larger area in Zenzontla has registered 438 spp including 86 spp of trees).

The Mexican sites now have data for five years of monitoring. An initial assessment of the vegetation is completed and one publication in press on the impact of extensive catttle management on the structure of dry tropical deciduous forest , "Estructura arbórea del bosque tropical caducifolio usado para la ganaderÌa extensiva en el norte de la Sierra de Manantlán, MÈxico: Antagonismo de usos." (citation under Publications, below).

In Ecuador, the use of regeneration plots (exclusions) was terminated; Grazing/browsing by cattle in forest is not an integral element of the cattle production system in Ecuador. Cattle graze in pastures and may browse forest edges. The use of the forest for cattle production is to clear forest to make more pastures (discussed above). Forest regeneration in abandoned pastures will be studied using other techniques more appropriate to sampling and following specific fields.

C2. Experimentation with Alternatives

C2.1 Environmental education to improve human-environment interaction: Diffusion of environmental education through education material and workshops; Involvement of community in biodiversity and conservation assessments. (B,E,M)

Goal: An enhanced community awareness of problems of human-environment interaction and increased community involvement in their assessment in order to enable community participation in resolving human-environmental conflicts.

Rationale: In Ecuador, there has already been considerable effort at environmental education with school groups and citizen groups at various levels as well as direct collaboration with a local regional agriculture/forestry school to add appropriate environmental and sustainable development material into the curriculum. All three countries have considered developing a number of different venues for environmental education to reach more sectors of the communities over the past year.

Progress: Environmental education with birds, Mexico: As a complement to the ecological research activities carried out in the ejido Zenzontla, a series of environmental education activities addressed to children in elementary and junior high schools were conducted during the "Week of the Birds", November 2001.

The activities consisted of a speech and slide show about birds, in which general information about birds was given, such as: different kinds of birds, shape and function of body parts, types of bird habitat, types of food, bird migration, threats to birds and examples of the birds of tropical forests.

After the slide show, a puzzle game was conducted for the elementary school children, in which rubber-made bird bodies were given to the children along with several kinds of food, bills and legs for them to use to complete the birds, according to every bird's diet and habits.

In junior high schools a different activity was conducted. The kids were shown the different techniques used in ecological research of birds. A mist net was set and the kids were shown how it works. The kids then went on a short bird-watching trip for which they were given binoculars and field guides.

At the end, every child was given a brochure containing general information about birds (basically, an abstract of the speech) and 10 plates, each containing black and white drawings of birds to be colored, the birds' common and scientific names, and information about habitat type, food, season in which the bird can be found, relative size, and distribution.

The speech was given to a total of 222 children in 4 rural communities (Zenzontla, El CamichÌn, Ventanas and La Canita), 5 in kindergarten, 151 in elementary schools and 66 in junior high schools. In addition, another version of the speech was given to 15 people attending an adult education program in Zenzontla.

Environmental and sustainable development education, Ecuador: A workshop with presentations of the results of research that had been conducted in the study area was given during June 2001 with the participation of local inhabitants from the communities of Baeza, Las Palmas, Bermejo, Cosanga, El Dorado, and Las Caucheras. Local authorities from the Municipality, Agroforestry High School, ESPEA University participated as well as representatives from the Ministry of Agriculture, the team of park guards, and local organizations. Among the themes discussed were the creation and objectives of the Antisana Ecological Reserve, highlighting the need for sustainable development in the zone that encompasses consideration of the environment and social-cultural, economic and political aspects.

The preliminary findings of the spectacled bear study were also shared with the participants along with a video on the spectacled bear. Not only were the findings, methodology, and importance of local participation in the study highlighted, but the participants were able to learn more about the spectacled bear (its behavior, habits, habitat and food requirements) and discuss actions to protect the species.

C2.2 Development of community family-based ecotourism: Participatory evaluation of potential for ecotourism (B,E,M); Trials with small group visits with local families and farmer lagoon reserve (B).

Goal: An understanding of the potential for ecotourism to develop economic incentives for environmental protection.

Rationale: Ecotourism, if properly developed, can serve as an additional alternative source of income for local communities as well as adding value for the conservation of key local natural sites as resources. The sites in Ecuador have a great potential for ecotourism. The sites in Bolivia currently have a much more limited, local potential; however, the few experimental small group visits at the La Cueva site have been promising. Even small-scale local ecotourism based in the local community could generate enough income to more than offset the local cost and effort needed to protect local habitats for biodiversity.

Progress: In Ecuador, community members have been selected and recruited for ecotourism training activities, such as site visitations. Also, funds have been allocated for future tourism development. Both the community members and the partner NGO's feel like there is plenty of potential, with PLAN's assistance, for generation of sustainable revenues through ecotourism.

C3. Planning and Monitoring

C3.1 Conservation of ecosystem services, natural forests and biodiversity. Incorporation of forest and watershed conservation in management plans (individual and collective) [see Development and monitoring of management plans under category B] (B,E,M)

Goal: The incorporation of conservation objectives in broader land use management plans under Activites B3.1 and B3.2.

Rationale: This is one activity where conservation biologists and GIS specialists have worked together to assist in the identification and spatial visualization of conservation priorities and the appropriate incorporation of conservation objectives into overall land use/ management plans.

Progress: Several examples serve to illustrate the value of integrating conservation information and perspectives with perspectives of resource users to develop scenarios to inform planning acitivities.

Example 1: the possible causal effects of deforestation on endangeredment of the Spectacled Bear and its recent depredation on cattle are described under Activity A1.5.

Example 2: the use of fish as bio-indicators of the health of the Ayuquila River in Mexico (Activity B1.2 and C1.1) provide a compelling picture of the natural and productive value of maintaining the natural fishery of this river. All the data collected have the potential to be used in the overall management of the Ayuquila watershed. In addition, these data help emphasize the importance of these fisheries to local communities.

Empowerment of impoverished fishermen along the river is critical to the effective management of the Ayuquila and its resources. Their opinions on environmental issues related to the Ayuquila and their recommendations for river management were presented and analyzed. Overall, fishermen considered fish and environmental quality as good and that it has improved when compared to recent years. The involvement of the most direct users of the river in the decision making process for the management of the whole watershed is urgently needed, when considering that these stakeholders will be the most impacted by any actions taken.

D. Economic Development

D1. Problem Definition

D1.1 Analyze external impacts on community economic flows: Create a quantifiable model of economic flows within a given time frame and examine external impacts such as livestock price fluctuation, livestock product import policies, and other economic and political reforms (B,M) (2-3 yrs)

Goal: An understanding of the impacts on the local economy of external shocks, such as livestock price fluctuation and broad economic and political actions, through the development of a model of economic flows into and out of the community.

Rationale: This activity involves the construction of a model designed to foster understanding of the influence of external market forces and policies on economic flows within the community and between the community and external agents. An important new focus for the economic aspect of the project is this study of livelihood diversification by Alexis Eakright.

Progress: Livelihood diversification is the active social process by which rural families construct a diverse portfolio of activities and social support capabilities over time in order to survive and/or to improve their standards of living. Diversification of livelihoods has been the focus of many development projects, even though it is seen in contradictory ways in economic literature. It has been characterized as both a deliberate household strategy for accumulation of wealth and an involuntary response to crisis or survival strategy. Livelihood diversification can also have differential implications for rural inequality, rural agriculture, productivity and investment, and environmental degradation. These contradictions make it imperative to examine

livelihood diversification within a specific context, and to distinguish between categories of households when studying its determinants, effects, and appropriateness as a development goal.

Livelihood Diversification: Household-level Analysis and Asset Categories:

Several authors have categorized households by their asset holdings in order to examine: labor allocation and income sources in Mexican ejidos, environmental impact, and income diversification. This study employs a household survey conducted in 2000 to examine livelihood diversification in 43 households (64%) of the Zenzontla Ejido, Mexico. Households are differentiated by their holdings of the following assets: labor, education, low quality land and high quality land.

The following are the four categories of households determined through analysis of households assets:

I Less educated, Landless – 15 households
II Educated, Landless – 7 households
III Landholders of Low-quality Land – 8 households
IV Landholders of High-quality Land – 11 households
(two households are outliers – hold both high and low quality land)

Human Assets: Adult members of households in group II have an average of 6.7 years of education, while adults in households of groups I, III, and IV have averages of 4.1, 4.2, and 4.0 years of education, respectively. While the landless households of groups I and II have dependency ratios above 100 (121 and 110 respectively), land owner groups III and IV have dependency ratios in the 50's (59 and 52 respectively). (See Table 3 below.)

Land Assets and Use: Landholders with low-quality land (III) own larger areas than those with high quality land (IV), averages of 47.1 ha versus 11.0 ha respectively. While households of group III cultivate more land than those of group IV (7.1 ha versus 5.9 ha), those with high quality land cultivate a much larger percentage of the land they control, 68%, compared to the

Table 3: Asset Holdings According to Household Category

Household Category	I. Uneducated, Landless Households	II. Educated, Landless Households	III. Owners of Low-quality land	IV. Owners of High-quality Land
Number of Households	15	7	8	11
Land Ownership and Use				
Land Owned (ha)	0.000 [0.000]	0.000 [0.000]	47.125 [41.361]	10.977 [5.577]
Land Used (ha)	11.321 [25.717] (n=14)	3.857 [6.663]	47.313 [41.777]	8.750 [3.743]
Land Cultivated (ha)	2.067 [1.972]	2.714 [3.806]	7.064 [5.559]	5.909 [4.123]
Human Capital				
Average Education within Household (years)	4.082 [1.160]	6.689 [1.270]	4.210 [0.914]	4.027 [1.259]
Labor				
Number of Adults in Household	3.200 [1.971]	3.857 [1.676]	4.750 [2.659]	3.545 [1.508]
Dependency Ratio (# children/# adults x 100)	121.111 [94.169]	109.524 [84.221]	58.542 [48.448]	51.515 [73.717]

Table 4: Cattle Holdings by Household Asset Category

Household Category	I. Uneducated, Landless Households	II. Educated, Landless Households	III. Owners of Low-quality land	IV. Owners of High-quality Land
Number of Households	15	7	8	11
Cattle				
Percentage of households that own more than five adult individuals	0	28.571	37.5	63.636
Percentage of households that "share" or manage more than five adult individuals	13.333	14.286	12.5	18.182

low-quality landowners (III) who cultivate 15% of the land they control. While categories I and II do not own land, they can sharecrop or rent in land. On average, households in groups I and II cultivate 2.1 and 2.7 hectares respectively. (see Table 3)

Difference in Activity Choice among Asset Groups*: *Livestock

Households with different asset holdings will presumably diversify their livelihoods in distinct ways, carrying out different productive activities to differing degrees. For example, approximately 64% (7 of 11) of households with high-quality land holdings (group IV) own and care for a cattle herd larger than 5 adult individuals. In contrast, only 37.5% (3 of 8) of households with low-quality land holdings own and care for herds larger than five. Surprisingly, 28.6% (2 of 7) of group II households, the educated landless, own and care for a herd larger than 5 adult individuals, while none of the uneducated landless households of group I own more than 5 head of cattle. However, 13.3% of group I households "share" or care for herds larger than five. Households that "share" herds of cattle are responsible for their care and receive an agreed upon proportion of the herd's offspring from the owner. Households in groups II, III, and IV may also "share" herds: only one household in each of groups II and III share a larger herd, while two households (18.2%) in group IV share a herd larger than five adult individuals. (see Table 4 .)

Livelihood Diversification: Gender Analysis and Time Use

Livelihood diversification can also manifest itself differently within the household according to gender. Men and women have differential access to the household's productive assets. They also have different household production responsibilities, different labor market opportunities, and may have different exposure to both environmental and economic risk. Women of the household are often closer to their subsistence minimum. The proximity to subsistence minimum of both men and women is reflected by their relative "threat points", as described in the conjugal contract household model. The "threat point" is the socio-economic level at which each person would live if the conjugal union were uncooperative or broken.

Different levels of livelihood diversification are reflected in men and women's time use. Recall interviews covering a twenty hour time period were used to collect time use data in a study conducted in 1999 in the Zenzontla Ejido,

Mexico. The ten households participating in the recall portion of the study had a total of 20 women and 27 men. **Even though adult men outnumber adult women in the study, women still carried out a more diversified portfolio of activities.**

Activities relating to agriculture and livestock make up the bulk of **men's time use** (60% of working and leisure time). Additionally, 10% of their time was used in wage labor, and 4% in extractive activities, such as firewood collection or fishing.

Meanwhile, **women** spend 53% of their waking hours in household work, including cooking, cleaning, laundry, childcare and other household production. However, they also participate in agricultural and livestock activities, spending a combined 14% of their working and leisure time on these tasks. Additionally, 6% of their time was spent in wage labor, 1.5% in extractive activities, 1% running small businesses, and 0.5% in community service.

D1.2 Characterize rural livestock marketing: identify agents, channels, and institutions that participate in marketing of meat, milk, cheese and other livestock products from watershed management systems. Estimate the value added by each agent (B,E,M) (2 yrs)

Goal: A characterization of rural livestock marketing at the watershed level, focusing on the effect of various agents and intermediaries upon the profitability of livestock activity for local producers, and in turn upon their production strategies. Isolation of the marginal impacts of various factors will assist in the development of strategies to improve marketing and profitability of livestock and livestock products at a community level.

Rationale: This activity will involve working with local farmers as well as marketing agents and institutions to characterize the local marketing system for rural livestock. This is an ongoing activity whose intent is to determine problems, limitations, and opportunities for local farmers, and is on-going. See Activity D1.1.

Progress: Monica Martinez Nolivos was contracted to conduct a feasibility study of the processing and commercialization of milk and its derivatives in Cosanga. Cheese was the principal end product under consideration in the study. Specifically, the possibility of constructing a small cheese-making facility in Cosanga was examined. The city of Quito, only 2 hours away, is a huge potential market for the eventual production of cheese in Cosanga, especially fresh cheese.

The study identified strengths, opportunities, weaknesses, threats, and recommendations facing possible cheese-making micro-enterprises. An interested local organization already established in the community can assume the responsibility of cheese production. The cost of production is quite low, and the production of fresh cheese does not require highly specialized conditions. Challenges to cheese production include lack of former experience in cheese-making, as well as problems in sanitation, especially mastitis, which is a disease that can adversely affect the quality of milk. The study pointed out that some farmers might be adverse to improving the sanitary conditions that would make cheese production possible. Another threat to the production of cheese is the possibility that Nestle, the major buyer of crude milk in the area, might retaliate against the producers and suspend any assistance that might have been given in the past.

Recommendations of the study included the improvement of livestock management so that mastitis can be avoided and development of skills necessary for the management of micro-enterprises such as administration, accounting, and marketing.

D1.3 Identify potential non-traditional agricultural, livestock, and natural resource products: shade house vegetables (E,M); fruit trees and wild fruits (B,E,M); and medicinal plants(B,M).

Goal: Increase awareness within project of the range of potentially sustainable productive activities as opportunities for alternative sources of resources and income to farm families.

Rationale: Ecological diversity and diversification of agricultural production are widely recognized as appropriate development and conservation goals. Following the structure of the survey instrument, database, and analytical methodology devised for the Mexico study, we can readily apply a similar study with households in the Bolivian communities. Since patterns of livelihood diversification are specific to household asset holdings, as well as the economic and environmental context in which a households and communities are embedded, comparing the two studies will lend insight into the utility of income or livelihood diversification as a development goal. (See Activity D1.1.)

Progress: Currently, a list of potential non-traditional alternatives has been generated, along with preliminary plans for investigation methodology in determining social, productive, and economic feasibility of each alternative.

Mexico, Assessment of household economic strategies: Arturo Moreno and his students have an extensive household economic survey in progress to explore the options for improvement of local infrastructure. Arturo Moreno of the Mexico team has been working with women of the Zenzontla area to discover means by which to increase the opportunities available to the women, as well as to maximize the benefits if the activities in which they already engage. One of Arturo's specialties is the nature of economic flow patterns within a community, and how these patterns affect the local people. Because of his knowledge and expertise and the participatory nature of the research, household access to productive activities has increased in this region.

Mexico, Medicinal plants: Using local interest by women in medicinal plants and traditional medicines, Arturo Moreno has organized a series of workshops with women of Zenzontla. A recent workshop explored the use of herbal ointments to soothe the skin and ease the symptoms of cold and fever. Two women and one man facilitated the workshop in the community of Ventanas.

Apart from the valuable information exchange that occurred between the facilitators and the participants about medicinal plants, the facilitators gained other important insights about local knowledge in general. For example, the participants agreed that the age of a woman has no real influence on her knowledge base of the use of medicinal plants. There was no clear distinction between the knowledge of younger women and that of the older generation. Furthermore, the women reported the use of over 100 medicinal plants in the areas surrounding Zenzontla and Ventanas. Twenty-nine women were present in the workshop, all of whom gained new knowledge about the use and value of ointments generated from specific species of local plants. The women's groups formed to work with medicinal plants will serve as a source to generate experiments with production of traditional herbal medicines (Activity D2.1) and are serving as a source of collective cooperation and action for the women involved. The activities of small interest or producers groups like these offer further opportunities developing human and social capital and for increased empowerment of women within the communities (Activity E2.3).

D2. Experimentation with Alternatives

D2.1 Experiment with and evaluate activities to improve household access to income generating and other productive activities, and improve community economic flows (E, B).

Goal: To develop potentially sustainable alternative production systems to improve community economic flows. To facilitate the improvement of community infrastructure and organization so that households can maximize returns to their income generating activities and improve access to market, thereby improving the flow of goods out of community and income and goods into the community. To improve access to some income-generating activities for households of limited resources by addressing information problems and credit market imperfections.

Rationale: This activity deals with a variety of small-scale, household-level experiments as part of alternative or additions to traditional production systems. Although we have noted the potential value of these small-scale production activities to local families and as vehicles for fostering community cooperation, this activity will *evaluate* the economic viability and sustainability of these small individual or household enterprises. We must emphasize that these small enterprises appear to be highly desired by the families of livestock producers. Our study of economic diversification suggests that it is the poorer families who are most in need of the benefits of these activities, and, yet, who are most limited in their ability to incorporate them into the household strategy due to lack of resources such as land, labor, skills, or capital. Therefore, it is the technical support, and in some case material support, provided by the project to promote these enterprises that makes it possible for households of limited resources to enter into one of these small enterprises. Lack of technical information, lack of market information, lack of credit, and lack of business experience are limitations which the project can work with the community to overcome.

Progress: Alternative productions established, Ecuador: Experiments with alternative production systems (micro-enterprises) ahs been most advanced in Ecuador where 7 families from the Rio Cosanga communities have established alternative production activities with assistance through the Project including small scale intensive production of trout, chickens, and pigs. These have been so successful that one of the local producer groups supported by the Project, APROPAL, has begun to manage their own funds to support the establishment of community production systems.

Alternative production trials, Bolivia: Several experiments with alternative production systems are in progress in Bolivia including 1) marketing of traditional herb medicines, 2) family-based eco-cultural tourism, 3) production of local fruit-based wine, 4) handicrafts, and 5) basketry. Others based on production of micro-livestock and fish culture are being investigated.

D2.2 Market analysis for non-traditional agricultural, livestock, and natural resource products: facilitate and generate market studies for non-traditional items produced by the community, such as small animals, agro-forestry, pisciculture, birds, apiculture, lombriculture, greenhouse vegetables, ecotourism handicrafts, cheese, native fruits, and medicinal plants (B,E,M).

Goal: A solid understanding, through a market study, of the specific potential for non-traditional production including various medicinal plants, shade house vegetables, and milk derivatives to inform communities whether

or not to proceed with implementation.

Rationale: This activity is focused on evaluation of potential for additional and/or non-traditional types of micro-enterprises. It is important to evaluate the feasibility of such alternatives, since the resources of the project can open doors to a wider range of alternative productive activities that might not have otherwise been available to households. Including new activities in household economic portfolios may improve household well being while buffering environmental stress caused by strict dependence upon traditional productive systems.

Progress: Assessment of local production conditions and accessibility to markets, La Cueva Bolivia: Ricardo del Carpio began a preliminary assessment of marketing potential in the communities of Fuerte Santiago and Rio la Sal. Specific goals of the study were to analyze the affect of global neo-liberal policies on community members, and on the natural resource base including marketing of livestock and various forest products. Problems that often surface in terms of local marketing of agricultural products, reactions of the local people to these problems, and solutions that are utilized in the communities were analyzed. The researchers discovered a significant capacity for self-management of market strategies, but outlined several factors including positive and negative incentives affecting marketing of natural resources.

Market study for commercialization of maize, Guarani communities, Bolivia: Carlos Corillo of CER-DET has designed and initiated a study of local commercialization of maize in the Guarani Region of Itika Guasu, Bolivia. The study will analyze the costs of production of corn in the area, as well as the forms of marketing that already occur and the most influential aspects of this commercialization. Community structure and organization will be analyzed, in terms of capacity for marketing. The intent of the study is to define feasible strategies to improve the marketing of maize, which would lead to increased income of the local producers.

D3. Planning and Monitoring

D3.1 Implementation of a system for economic planning [incorporate this aspect of planning into the overall land-use planning at farm, community, and watershed levels—see B3.1] (M)

Goal: The successful implementation of community programs for non-traditional production, if these have been shown to be economically feasible, to provide additional sources of income.

Rationale: As with other planning steps, this activity will deal with how to incorporate economic considerations appropriately into overall land use/management plans for farmers and communities. This activity is on-going.

Progress: Many steps have been taken toward reaching this goal in conjunction with other activities. The study on Livelihood Diversification (see Activity D1.1) has shed light on the need for more economic analysis at the household level. This level of concentration is new for Project PLAN, and should fit nicely into the larger-scale goal of incorporating economic alternatives into comprehensive management plans.

E. Social and Community Issues and Policies

E.1 Problem Definition

E1.1 Analysis of community organizations & actors: Analysis of community & actors and the decision-making process (B,E).

E1.2 Identify successes and failures in natural resource management due to

organizational and institutional deficiencies: Identification & characterization of different actors and their involvement in management of natural resources (B,E)

Goal: An enhanced understanding of community organizations and actors including the decision-making process and a diagnosis of strengths and weaknesses of organizational management to inform efforts to improve community organization.

Rationale: This activity is focused on understanding the current community and small group organizations and how they are linked with other actors and institutions in the region. These local organizations may serve as potential means to motivate collective efforts to promote rural development and conservation of natural resources. Understanding their interests and capacities will help determine the type of support the project can provide to strengthen the organization and capabilities of small groups within these rural communities (see Activities E2.3 and E2.4).

Progress: Survey and characterization of local organizations, Ecuador: The importance of organized communities or groups has already been emphasized. Previous study has already identified a number of factors that discourage the development of social capital and community organization in the zone. Experience has shown that it is more effective to work with the local organizations that exist where possible rather than try to create new ones. A study of those few organizations that do exist will be very useful to understand how and why they work.

Katty Hernandez has implemented a study 1) to determine what local organizations exist in are area around Baeza in the Canton Quijos, and 2) to select five sample organizations for more detailed study.

Twenty-seven registered organizations were identified and grouped here according to interest:

- Cooperativa agricola—Agricultural cooperative (1)
- Centro agricola—Agriculture center (1)
- Comuna—Agricultural commune (1)
- Agroartesanal piscicola—Fish (trout) culture producers (7) *
- Agroartesanal avicola—Poultry producers (2)
- Artesanal agropecuaria—Livestock/ agriculture producers (5) *
- Agricola ganadera/pecuaria—Cattle or Small livestock producers (3) *
- De productos lacteos—Dairy products producers (2)
- Agropecuaria, turistica, y artesanal—Livestock/agriculture, handicrafts, tourism (1) *
- Horticolas, fruitcolas y floricola—Vegetable, fruit, and flower producers (1)
- Asociaciones o Grupos de Damas—Women's groups (3) *

Five groups were selected for further study (see * above) based on the following criteria:

1) they represent different types of interests (see the types marked with * above), 2 they are located in the Rio Cosanga watershed but represent different sectors or parishes, 3) they are currently functioning and have existed two or more years, 4) they are represented by small and medium land owners, and 5) they include groups with different gender makeup (men only, women only, and mixed).

Two of the groups selected, AGROPAL (the Association of Producers of Las Palmas) and La Asociación de Damas Primero de Noviembre de Cosanga (a women's group of Cosanga), have been working closely with Project PLAN. AGROPAL includes the principal farmer families who have implemented sustainable management plans (see Activity B3.1), who have

established vegetable shade houses (Activity B2.5) and who are participating in the mixed-species pasture improvement experimentation (Activity A2.2). Members of both these organizations participated in the Project PLAN annual conference and workshop held in Quito and Baeza in July, 2001.

This work has been carried out in consultation with the councilor of the Municipio of Baeza and expect to involve the active participation of the councilor in this study as a "collaborative member" of the research team. It is hoped that this collaboration with the Municipio will lead to local government commitment and institutional support for efforts aimed at strengthening local organizations in the zone (Activities E2.3 and E2.4).

E1.3 Examine the effects of public policy on the use and management of natural resources: Describe the social, economic, and political processes, (local, regional and global in scope), related to land use changes. Identify ecological changes caused by land use changes. Study of effects of public policy on patterns of land use (M)

Goal: An enhanced understanding of the effects of public policy on the patterns of land use to inform efforts for educating and working with the community for improved land use.

Progress: Government policies and land use change in Mexico: Oscar Cardenas in a study of land cover/land use change from 1971 to 2000 in the Ejido Zenzontla has been examining the broader influence of government policies on land use change. One of the dominant patterns of land change in Mexico (and in all areas of the Project) has been clearing of forest for agriculture and extensive livestock production. The following excerpts from Oscar's dissertation study provide a summary of policies and their probable influence that need to be considered in the formulation of strategies to favor sustainable land use in the Project's target communities.

Deforestation is the process of permanent loss of forested areas to other land uses such as agriculture, cattle grazing, development of infrastructure and urban areas, among others. It involves the interaction of many forces in any particular area, including social, economic, political and environmental forces with the consequent social and environmental effects: Competition and inequality among different land users for resources distribution and environmental degradation motivated by the changes in land-cover and land-use. In developing countries, although several factor are associated with deforestation, most of them are related to the development of agricultural practices and livestock grazing. The expansion of livestock production and therefore the increasing demand in pastureland, along with the increase of rain-fed agricultural production, the increase of areas affected by forest fires and poorly managed timber extraction in most of the forested areas of the country, have certainly motivated more forest conversion in Mexico than other economic activities. Over the last 40 years, forested areas have decreased in Mexico while the area dedicated to agriculture and cattle ranching has increased over time. At the end of the nineties, Mexico was considered as the 5th "Top Ten" deforesting countries in terms of total forest loss.

Under the National Development Plan 1989-1994 (*Plan Nacional de Desarrollo, PND*), the government of Mexico initiated the modification of the land tenure in Mexico and opened the road to future international investors, acts expected since Mexico's opening to the world market. However, these initiatives have originated a destabilization of the traditional systems of production and the displacement of

rural communities due to the expansion of commercial agriculture.

A significant element of these reforms included that altered the collective status of Mexican ejidos. In late 1991, amendments to the constitution of Mexico gave the collective right of ejidatarios to dissolve the ejido and distribute the property among members thus granting to ejidatarios of the rights to sell, rent, sharecrop, or mortgage their individual parcels and to enter into joint ventures and contracts with private (including foreign) investors and stockholding companies. Since these reforms were applied to Mexico's rural areas, ejido and community lands have been subject to commerce and rent, changing the traditional use of land.

These reforms along with other policies favoring Mexico's livestock and agricultural sectors affected deforestation by influencing the incentives to convert forest land for these economic activities, rather than maintain the forest for timber production, harvesting of non-timber products, tourism, watershed protection and other uses. Thus, the comparative returns gained from converting forests to agricultural and livestock production are a major factor determining deforestation. This is especially true in the case of livestock production, a highly land-extensive process in Mexico's rural areas.

The establishment of pasturelands for cattle grazing also increases the probabilities for forest fires incidence. These areas are generally located adjacent to mountains and forested areas, which increases the risks of forest fires when peasants clear their lands. Both slash and burn agriculture and pasturelands establishment are more often associated to deforestation and thus land-cover and land-use change.

Fire is one of the most important factors behind forest modification and/or conversion in Mexico. As a tool in agriculture, fire has been utilized since pre-Hispanic times in the country. Fire is widely utilized by farmers in Mexico's rural areas because reduces personal effort and demands little or no capital and technology. Fire is applied during land clearing for crops (especially for maize cultivation) and pasturelands, which also incorporates nutriments to the soil, although, fire is also used as a means for solving conflicts in land tenure and/or property rights.

Important steps to counter the degradation of forested areas and favor conservation were undertaken by the government of Mexico in the mid '90s. This included the creation of the National Institute of Ecology (*Instituto Nacional de EcologÌa, INE*) in 1992 and the Secretary of the Environment, Natural Resources and Fisheries (*SecretarÌa del Medio Ambiente, Recursos Naturales y Pesca, SEMARNAP*) in 1994. INE was incorporated to SEMARNAP in 1994, which oriented the policies of natural resources conservation toward an increase on land under protection and the incorporation of local actors in the process (communities and the governments of the states and municipalities of the regions where the protected areas were established).

An important assumption with these policy changes is that participation of local actors in the planning, management and conservation of natural resources will, in time, reduce environmental effects such as deforestation and changes in land-cover and land-use. Project PLAN is working with communities whose economies are mostly livestock-based. Some of these communities, like those of the Ejido Zenzontla, are directly affected by the reforms and are vulnerable to considerable changes in land ownership and use. These same communities fall in part under the environmental restrictions imposed by the the Sierra de Manantlan Biosphere Reserve established in 1987. Thus, these communities will provide an interesting opportunity to

determine how the relative influences of market, agricultural policies, and the regulations of the reserve will influence their patterns of change in land-cover and land use in the country.

Factors influencing changing land use in rural communities in a biosphere reserve, Mexico: Michelle Young, a student at UC Davis, is currently working on a study entitled "Changing land uses in the context of a Livestock Revolution, transnational migration and a Biosphere Reserve." This study situated in the Sierra de Manantlan Biosphere Reserves is a direct complement and approach to the questions raised by Cardenas' study summarized above. Young's study attempts to analyze whether reserve restrictions affect decision-making patterns of local people who live and work in and around the reserve. Immediate modification of the methodology became necessary when many respondents to survey questions did not know the boundaries of the reserve. Respondents instead were asked about all of the restrictions on their land. Although it may not be possible to correlate specific land-use decisions with the effects of the reserve, it will at least be possible to determine the relationship between perceived restrictions on land use and household decision about land use. The study already points out the need for increase outreach to community members about the Reserve.

Preliminary data analysis reveals the following characteristics:

- 55% of sample households are landless and have no cattle
- 19% own land but no cattle
- 24% own land as well as cattle
- 2% own 1-2 head of cattle but are landless

According to a respondent, renting pasture is the single most important income-generating activity in the area. This has important implications for land use patterns. More data will be generated from this study, including ways in which the Reserve, through government land grants to the ejido, has affected household land-use decisions.

E1.4 Identification and analysis of differences between legal and common law standards regarding land access, ownership, and tenancy in the watersheds: Identification of conflicts these differences may create. Typology of land conflicts in the Rio La Sal watershed (B.)

Goal: An enhanced understanding of issues relating to land conflicts, including legal as well as common law matters, to inform efforts for resolving such conflicts.

Rationale: One of the prime prerequisites promoting sustainable land use is secure land tenure and secure resource use rights. In our target communities, there are residents with secure title, others with customary titles without legal papers, squatters with or without rights, residents with conflicting titles, absentee landlords, and others without access to land. Social sustainability is not feasible without some regularization of this these situations. This activity is designed to clarify the legal and common law context within which these communities fall. The results of this activity will inform Activity 2.2 below.

A second approach under this activity is to investigate the types and causes of conflict within these rural communities Understanding the basis for conflicts among local stakeholders, and of the structures in place to resolve conflict between them will be very useful to guide the formation of effective "experiments" to favor cooperation and to strengthen local organizations and their capacities for effective collective action.

Progress: Tenure: Land tenure insecurity was early recognized as a source of serious

conflict and as a disincentive for on-farm investment and sustainable management. This is a serious political issue that is difficult to address; however, it has become clearer that its influence on community livelihood and sustainable management could not be ignored. This year, Susana Lastarria formed a working group within the project to begin a systematic study of the land tenure issue. The first stage is to characterize the legal legislation and the customary norms that determine access to and ownership of land within the communities of the Project in each of the countries. The following summarizes aspects of the tenure systems and situations affecting our project communities in Bolivia and Mexico.

Land tenure situation, Bolivia: In 1993 and 1995, legislation that devolves decision-making and development planning to the local level was passed. Also in 1995, a new land law was enacted that promotes the titling and registration of land (whether as communal property or private property). This legislation has encouraged communities to regularize the titling and registration status of land (this has implications for their relationship to large landholders who have traditionally held local control) and to organize themselves to develop and solicit funding for community programs.

The two communities in Tarija province have very different legal and customary land tenure systems. One is based on private ownership and the other on community ownership. Timboy is a Guarani community which has a customary tenure regime. The Guarani communities in the Chaco region have long fought to obtain legal recognition of their customary or territorial tenure rights. Tapiete, another Guarani community, received legal title to its territory (24,000 hectares) on 7 April 2001, after a long struggle with central and local government. Tapiete is the first indigenous territory to receive legal title in the Tarija Chaco region. Other indigenous communities/ territories that are in the process of legalizing their customary tenure situation are Weehenayek, Yacuiba, and Itika Guasu.

Rio La Sal is a community of peasant farmers with medium and small-sized holdings. These holdings are held in private ownership although it is not clear how many families have legal title to their land. Some of the families are renting land from landowners who are either still living in the community or have moved out of the area. A titling program promoted by central government may spark conflict between these families because some long-term tenants may feel they have ownership rights to the land they have been occupying.

Both communities include large private landholdings as part of the landscape—what is not clear is the legal standing of these owners of large landholdings. In the Timboy area, although the land has always belonged to indigenous communities, land claims by large landowners has meant that these estates graze their livestock on community land. There are also land claims by other non-community persons (*terceros*) who have occupied land in the Timboy area. In Rio La Sal, control of some of the best land (bottom valley land) is in the hands of large cattle ranchers.

Land tenure situation, Mexico: Three general types of land tenure exist in Mexico which are directly tied to existing property regimens: private, social, and public. Private tenure refers to private property and has its origin in the 16th century with the establishment of haciendas and ranches. The term "social tenure" has its origin in prehispanic times in the case of numerous indigenous communities while ejidos emerged as one the results of the Mexican Revolution (1911-1917). In both cases, the campesino communities manage their territory

in a communal manner with respect to water and forests, while each member has his/her designated land parcels to work. The indigenous communities differ from the ejidos in the sense that the manner with which their internal organizations relate to land and natural resources depends on the customs and traditions of each of the indigenous peoples. Social tenure disappeared de jure with the reform of Article 27 of the 1992 Mexican Constitution which described the right and obligations relating to the land. Finally, public tenure refers to the lands and natural resources that are directly under the mandate of the State.

The rural zones, such as the Manantlan region of western Mexico, can be considered as an "arena", where we encounter social actors with different interests who have been involved in negotiations over the access, use and management of natural resources. As a result of these negotiations, social rules have been defined that determine the manner of use and mangement of natural resources in the mountainous regions of the Sierra de Manantlan. These social rules which refer to the term "tenure" can be formal in character (in accordance with the laws of the State), or informal (in accordance with social agreements and customs of these agrarian communities).

Generally it is the government agencies that formulate formal rules dealing with the manner of normalizing agrarian practices with the goal of achieving sustainable development and conservation of biodiversity. Despite this intention, government policies often have unintended consequences that work against sustainability and conservation. Nevertheless, there exist a multitude of informal rules in agrarian communities that control the social life of their inhabitants and which may interact in a competitive manner with formal rules. As a consequence of different rules and norms, conflicts arise over access, use, and management of natural resources.

The studies in progress will focus first on the impact of formal and informal tenure rules on campesino strategies for the use and management of natural resources—the different ways in which households mobilize production factors (capital, labor, and land) for livestock, agricultural, and forestry productive systems. A greater understanding of the dynamics of tenure rights in these communities will inform the design of interventions to favor sustainable management and conservation. A second focus is an analysis of government programs and policies that influence the daily life of these communities and the conflicts that arise from the interactions of formal and informal tenure rules. This aspect begs for assistance in reinforcing and, where appropriate, introducing means for the resolution of conflicts. A final focus of these studies will be an analysis of the different institutions involved and possibilities to improve inter-institutional coordination. The results of these studies will provide the basis for interventions (Activity E2.2).

Conflicts: their sources and resolution, Bolivia: Study of conflicts allowed a direct focus on patterns of livestock management in which spatial and temporal variation of forage coupled with land limitations results in local farmers using communal pasture land and forests to pasture large livestock (cattle and horses) (see Figure 5 above). Carlos Vacaflores and Rhinda Calla completed a study entitled "The Efficiency of Institutional Regulations in Local Management of Natural Resources" be translated and prepared for publication this coming year. This study showed how spatial foraging necessities of livestock lead to particular patterns of conflict, as well as the limitations and opportunities of local societal institutions to resolve conflicts. This study was instrumental in showing how the interaction of bio-physical

and social factors shapes local livestock management patterns as well as providing insight in how the project might promote improved community cooperation through existing mechanisms.

The long-term study explores the manner in which the exigencies of different production systems interact within a community that includes livestock producers, farmers without large livestock, and landless residents. Conflicts arise over the difficulties of farmers to gain access to resources (especially pasture and forest areas), damage to crops caused by free-roaming livestock (a consequence of the extensive systems of livestock management), and damage to crops caused by wildlife species. The paper explores how the distribution of resources within the watershed (see Figures 13 and 14) and the nature of productive systems influences patterns of land use and decision-making.

The authors develop a typology of conflicts that can be used to provide a framework to guide studies of conflicts within the other project communities. This study documents customary mechanisms and patterns of conflict resolution within the community. The patterns of land use not only provoke certain types of conflicts but also creates a level of interdependency that could serve as the basis for cooperative management as a viable option for these local communities.

This document will be extremely useful for the continued development of a large-scale management plan for the area. Information such as this that sheds light on the dynamics of the community and the relationships that weave it together are imperative for the enhancement of the community-oriented nature of our project, and in turn for the long-term benefit of the people.

E1.5 Gender analysis of agriculture, livestock, and natural resource use: Generate information regarding agricultural, livestock, & natural resource activities in which women participate (M). Identify opportunities for development & proposal of alternatives (B).

Goal: An increased understanding of issues relating to gender differences in agricultural, livestock, and natural resources activities and also of the current educational processes with watersheds to inform plans for providing more opportunities for women.

Rationale: Women rarely have much access to resources or much power in decision-making in rural communities. Women are typically overworked with many demands on their time and very long working days with few opportunities for them or their children. If we are to improve the livelihoods of these rural families, we need to thoroughly understand the needs, limitations, problems, desires, and potential for women and families. We have been sensitive to this issue since the beginning of this project, we are now working with local women's groups in each of the countries, and we will continue to develop this aspect of the project. Not only is social sustainability not possible without appropriate incorporation of women's needs and development; we believe that by providing greater access to resources and supporting an increase in decision-making by women, we can improve the quality of lives of these rural families.

Progress: Gender study of time use allocation and livelihood diversification, Mexico (see associated discussion under D1.1).

Perspectives of a women's group, La Cueva, Bolivia: Interviews with the women In the communities of Fuerte Santiago and Rio la Sal, conducted by April Sansom high-lighted the perception that the roles of women are centered on behind-the-scenes, less conspicuous decision-making processes. "The women, however, perceive themselves as having control over

decisions that affect their families' every day activities and attitudes. These decisions are seen to be less obvious in terms of large-scale land use or community planning, but are understood to be extremely important in the daily welfare of family members." Men and women both understand that decision-making processes in which women are the principal figures provide the fabric for daily activities of the community. Furthermore, it is apparently understood by most that "the decisions for which men have the primary responsibility are the ones that involve activities less directly tied to daily household survival. Because of this, women are perceived as making less weighted decisions, even though these decisions are based on immediate needs."

For example, within family groups in the communities, men are considered the managers of the larger livestock, including cattle. Grazing pastures, corrals, and slaughter of individual cows are all areas in which men have the primary jurisdiction. Women, in turn, generally maintain responsibility over yard livestock, such as pigs, chickens, and ducks. Women also have relative decision-making power over household gardens and the collection of water and firewood from nearby streams and woods. Moreover women carry distinct responsibility for orange and grapefruit orchards near the home.

"Neither men nor women view themselves in particular as natural resource managers. Instead, the concentration is based on supporting families with the land available, and making decisions accordingly. By nature of their livelihood, the people attempt to make sound decisions, but do not see themselves as having the luxury or the emphasis for making decisions based on criteria other than need or necessity."

E2. Experimentation with Alternatives

E2.1 Examine impacts of public policy changes on natural resource management and thus land use: conduct pilot study examining how different models of land use management are effected by public policies with the intent to use these models and findings to inform community leaders and local officials of the potential consequences, positive or negative, of public policies; with the aim of raising awareness these influences and raising opportunities for improvements (B).

Goal: A more detailed understanding of the impacts of public policy changes on natural resource management and land use through comparative case studies and database establishment to inform community reactions to such change and/or propose change useful to the community.

Rationale: This is a new activity that will attempt to identify changes in local policies that will favor sustainable land use and associated practices within the region of our target communities. The subsequent steps will depend on the progress and results from this coming year.

Progress: In Ecuador, the team members of Project PLAN have initiated a series of meeting with local government institutions, principally the municipal government of Baeza. These meetings have the purpose of disseminating information about the activities of the project to local government officials. From this series has arisen discussions about possible strategies for action in the watershed area, and a general focus of officials to a more thoughtful approach in terms of natural resource management policy. Additionally, members of the municipal government were heavily involved in the fourth annual Conference of PLAN in Quito this past summer (see Policy section 6).

E2.2 Educate local people about general legal aspects of land access, ownership, and tenancy, as well as on other laws affecting their use of natural resources: Facilitate information on legal land rights in La Cueva watershed (B). Experiment with interventions and design a community plan to secure land access and rights for watershed residents, if feasible (B,M)

Goal: Improved public understanding of issues relating to land tenancy including use of natural resources through education and development of trial plans to enhance the capability of inhabitants to resolve conflicts and make better use of the resources.

Rationale: With regard to land and other natural resources, tenure systems vary across the three Project PLAN countries, with different property systems and different specific property rights. In addition, households in the communities do not have equitable distribution of these resources. Although the communities are comprised mostly of smallholder families, some families do not have sufficient land to support themselves, and other families have been able to accumulate large extensions of land (see descriptions of tenure situations under Activity E1.4 above).

While we do not have the legal mandate, expertise, or resources to intervene in the solution of the complex land tenure problems and conflicts within the area of our study, we can and shall provide accurate information and technical support for community actions to improve the land tenure situation. Our Bolivian partner, CER-DET is already involved in providing technical support for land reform to assist the efforts of the Pueblo Guarani to secure their traditional rights to their lands. Our NGO partners can play an appropriate role as intermediaries to encourage the improvement of the land tenure and land access situations in our target communities.

Progress: We are currently building up detailed background information under Activity E1.4. This information will then be made available to local communities. The nature of the interactions in each country will dictate different strategies for Project PLAN to follow. Serving as a source of accurate information and acting as a facilitator and working collaboratively with local governments, we are convinced that the project can assist in the improvement of the land tenure situation within the target communities.

E2.3 Strengthen and empower social actors and organizations for community development and natural resource management: Support existing organizations and facilitate emergence of new organizations if necessary (B,E); Exchange of farmers from different communities (M).

Goal: A strengthening and empowerment of individuals and organizations in communities through the development of community strategies and exchange of information among communities to provide the community with enhanced capability to affect decisions to improve natural resource management.

Rationale: This activity is aimed at increasing the capacity of local groups/ organizations to be able to build trust and cooperation, plan communal projects, generate effective collective action, and negotiate effectively with outside actors and institutions. One of our goals is to foster a "learning process" within these groups.

Progress: We have continued active operation of producers' groups and women's groups in the "communities" of the Project areas (B,E,M): Active women's groups organized around the use of medicinal plants in Mexico, 6 active women's groups and producers' groups in Ecuador, 3 active community groups (one

women's group) in the Rio La Sal area (B), and multiple active women's and community groups in the Guarani communities (B).

The integration of women and other traditionally marginalized groups has been proven to strengthen the fabric of communities in many projects, and is so far a very positive outcome of our work with all the communities in all sites. We are encouraged by the response of both women and men to the emphasis on women's groups in the communities, as well as the excitement of women about strengthening their organizational capacity and structure. This is one route through which we can facilitate the improvement of the quality of life in these rural farm "communities."

For example, the Centro de Madres in Fuerte Santiago continues to explore avenues for increasing earning power and involvement in the Rio La Sal area. These women are excited about exchanging ideas with other women's production groups throughout Bolivia, in order to widen and develop skills for producing salable items. The Fuerte Santiago group has officially requested assistance from JAINA in acquiring skills and knowledge for further capability-building in terms of group organization and production skills.

In the past, the Centro de Madres of Fuerte Santiago and Rio la Sal have been affiliated as one organization. However, the distance between the two communities and the difficulties in communication have proved to be significant challenges in the past, and the women of Rio la Sal have expressed their interest in organizing their own group, independent of Fuerte Santiago women. The women of Rio la Sal believe that the inception of a separate organization will allow them to develop creative, meaningful, and collective programs for their community.

E2.4 Design a plan to strengthen local natural resource management capacity: establish coordination mechanisms among natural resource management organization and institutions, both internal and external to the community, in order to identify community sustainable management policies for the watershed (B,E,M) (3-4 yrs)

Goal: A strengthening of natural resource management capacity on the part of the community including a linkage of communities and institutions to allow communities greater control of the resources.

Rationale: This activity aims to extend the support of local community groups and organizations by fostering linkages between these groups and other actors and institutions including local government. The Ecuador-team has provided a compelling example of the potential value and power of these vertical linkages in the case of their linkages of community groups with officials of the regional Municipio (see section E2.3 above.) The double work of enhancing the organizational and negotiating abilities of small community groups and facilitating and strengthening their links with local government and other regional institutions is a key element in fostering social sustainability of these communities.

Progress: In Ecuador, the Project has developed strong links with government officials at the Municipio level—a "county" level regional government that is very important for local policy, support of local community initiatives and for coordination of activities in the region. This linkage has been very positive with improved interchanges between community leaders and the Municipio. Two government officials, Hugo Jati and Jaime Rodriguez, participated actively in the Project PLAN annual meeting in Quito. Agreements between the Municipio of Baeza and the members of Project PLAN have sparked coordinated action in the

themes of productive aspects of community activity, as well as strengthening of local actors and their voices in the management process. This link has encouraged and initiated further collaboration between internal and external actors, and generated enthusiasm for furthering linkages in the area. Many of these collaborations have resulted in the desire on the part of local people in the Rio Cosanga watershed to focus on participating in organizations that foster capacity-building and community strengthening activities. This local desire is extremely exciting because it exemplifies the fact that the community has been creating its own initiatives.

In Mexico, the large project for the improvement of the Rio Ayuquila watershed that includes important collaborators also in Project PLAN (see B1.2) has opened important levels of dialogue between local regional governments and local residents about mutual interests in sustainable development of natural resources and watershed protection. This has opened the opportunity for more dialogue between Zenzontla communities and their Municipio.

Additional collaboration with Municipio officials of Entre Rios has also been initiated in Bolivia as part of a newly developing plan to bring the Project to a higher level of visibility where it can serve as a support and source of ideas and training for local government officials and where it can serve as a more effective facilitator for improve communication and support between local government and these communities.

E3. Planning, Implementation and Monitoring

E3.1 Social and cultural evaluation of prevailing practices and selected alternatives: determine the potential impacts of practices under consideration by Project PLAN on families and communities. Examples of alternatives include agro-forestry plantations, nursery, soil conservation practices, women's productive activities, etc. (B,E,M) (4-5 yrs)

Goal: A clear understanding of social and cultural aspects of prevalent and alternative practices so as to be able to determine the potential impact of alternative practices related to natural resource management, land use, land tenure and other areas in common

Rationale: This activity is focused on the systematic evaluation of project activities. Our greater involvement of local farmers and community representatives in our work and planning is creating a situation conducive to eliciting constructive feedback and evaluation directly from the intended beneficiaries of our work.

Progress: April Sanson has begun to interview local women in La Cueva, Bolivia. Many of these women are involved in an organized group, the Centro de Madres. The women of Fuerte Santiago have undertaken a variety of pursuits in the past, including various forms of embroidery and small-scale food sales. At one time they shared three sewing machines among them, but the ownership of these machines has been contested and caused a rift within the group.

The principal interests of the Centro de Madres in Fuerte Santiago are obtaining funds to promote the activities of the group, the participation of more community women in activities, and the exploration of ways in which the group can promote community health.

In Rio la Sal, the women in the past have made miniature dolls and various forms of woven products as well as food items. These women have identified personality conflicts and differences of opinion as issues that have hindered the progress of the group in the past. They believe that workshops or training sessions

in capacity-building and cooperation will help them to succeed in their efforts to reorganize.

F. Food Security

F1. Problem Definition

F1.1 Identify systems of food production and acquisition: Determine types of production, purchasing, collection and food assistance (B,E,M) (1-2 yrs)

Goal: The identification of systems of food production and acquisition, focusing on the integration of components to inform efforts to improve the system as a whole.

F1.2 Identify patterns of food utilization: Preparation practices (B,E,M) (1-2 yrs)

Goal: The identification of patterns of food utilization, including post-harvest and preparation practices, to inform efforts to improve the pattern.

F1.3 Evaluate food security status at household level, including dietary intake, sources of micro-nutrient-rich foods; consumption patterns and intra-household distribution (B,E,M) (1-2 yrs)

Goal: The evaluation of food security status at the household level including dietary and nutrient intake as well as intra-household distribution issues to promote activities to improve food security status.

F1.4 Infant feeding practices; Breastfeeding and weaning foods (B,E.M) (1-2 yrs)

Goal: The assessment of infant feeding practices including lactation practices to develop strategies to better inform parents about improved infant nutrition.

Rationale: This category, dealing with nutritional status and food security, contributes a new focus to the project which started less than a year ago. This set of diagnostic activities (F1.1—1.4) were designed to provide a fairly complete picture of the availability and quality of foods and the nutritional status of families and communities in the target areas. The team members leading these activities have been working closely with the three host-country teams. It has become very clear through this first year that food security is perceived in the target communities as an ever present need. Community members responded very positively to this activity, expressing great interest in options to improve food security within the entire family.

Food security must be seen as a fundamental requirement for a sustainable livelihood and, therefore, a critical component of "social sustainability." During year 5, other activities will be linked with this one, such that the approach of the project to families will be more integrated, involving sources of assistance and opportunities for self-development. Here the project priorities for food security, human development, household security, alternative production systems, particularly for women, and community organization converge.

Progress: This was the first year on the Project for this set of activities. Instuments were developed for the initial assessments of food security to be carried out in two to three communities at each site: Mokomokal, Saladito, Fuerte Santiago, and Rio La Sal in Bolivia; Las Palmas and Cosanga in Ecuador; and Ventanas (in the Zenzontla Ejido), San Miguel Ayotitlán, and La Ventana in Mexico. Following activities were conducted during the trips: 1) Meetings and workshops with local PLAN-teams and other national and international organizations and institutions working on food security and nutrition; 2) Field trips to communities located in the work area of PLAN; and 3) Preliminary assessment in food security and nutrition using qualitative methods (transect walks, focus groups, interviews, daily dietary intake reports).

Poor nutrition in these populations often starts in utero and extends, particularly for girls and women, well into adolescent and adult life. It also extends through generations. Malnutrition that occurs during childhood, adolescent, and pregnancy has an additive negative effect on birth weight of infants. These infants with low-birth weight who have suffer intrauterine growth retardation are born undernourished and are at higher risk of dying in the neonatal period or later in infancy. If they survive, they are more likely to experience a variety of developmental deficits. Therefore, in these focus groups we tried to determine the general nutrition status by gathering information on dietary patterns and the existence of aid programs in the area in women of reproductive age and their infants and preschoolers.

Food insecurity was associated with many psychological manifestations such as sadness and desperation, and also to a permanent desire to eat. Food insecurity meant family conflicts between parents and a constant crying of the children when they are hungry. Participants related the concept of food insecurity also to the lack of food (low availability), but also to not having enough money to buy food (low accessibility). Food insecurity consequences by the children were malnutrition and under weight, reduced school performance, and increased incidence of illnesses (diarrhea and upper respiratory infections). By adults food insecurity was associated with lack of motivation and energy to work and illness. An attitude persists among the communities as if nutrition issues are responsibility mainly of the women.

Men associated food insecurity with poverty, difficulties for the production of foods, such as lack of supplies, low soil quality, and not having enough land to grow staples. They feel bad for not been able for supply their families with enough food and for needing to migrate to other regions to find a job. There is a feeling of having to ”bear the situation” as it is.

In the three countries, some of the families in the participating communities own cows and ox. These animals are used mainly as a “savings account” and are never used for family consumption. In Rio La Sal and Fuerte Santiago people have had their cattle in the forest because of the lack of food in their own land. In Ecuador, cows are raised for dairy production; the milk is sold to the nearby Nestle factory. Only one or two families of the ones interviewed save some milk for their own consumption. The amount of milk produced by the cattle in Ecuador is very little, but for many families is the main source of cash. In Mexico, although some cows were dying because of the drought, the families never kill them to utilize their meat. They keep the cows alive as long as possible. In the three countries cows and ox are sold in case of family emergencies or to cover costs.

The most difficult periods regarding food security are different by country. In addition, while in Mexico and Bolivia during the dry season people confront a reduction of their food supplies, in Ecuador the rainy season is the worst period because of the huge amount of rain, which causes flood and lost of crops. Malnutrition and hunger were associated with a number of causal factors such as not eating enough food as well as a variety of foods, not eating “good” or the “right” foods, lack of resources, and parasites.

In a few cases, malnutrition of children was related to parasites and bad water quality. Water is a big problem not only for irrigation. Families consume in most of the case water that is been carried from nearby rivers or creeks. Chlorination or boiling water for human consumption is a very unusual practice. The prevalence of parasites is very high, which affects seriously the health and nutritional status of individuals (infection, bleeding, reduced bioavailability of nutrients).

For women, the main causal factor mentioned was lack of money to buy enough food. The context of food insecurity was described as plagued by unemployment, very little local opportunities to work, lack of equipment and training in agriculture, reduction or lack of food aid programs and reduced local availability of food. Food insecurity was also associated with low quality of available food items, meaning low nutritional content or not fresh foods. The lack of knowledge in nutrition and the lack of training in how to develop gardens or to breed small animals was one of the main causes linked to food insecurity.

For men, Unemployment and lack of support from the government are seen as the most important causes of food insecurity. In many cases, but mainly in Mexico, the men think that they don't have the resources to improve their capacity of producing food. The lack of technical knowledge is also seen as a cause of not having enough food. As a consequence of food insecurity men identified lethargy (not having the needed energy to work) and sickness.

As one of their coping strategies, women would eat at last and less than other family members. In contrast to the women, men affirmed that in their families everyone eats at the same time. If there is not enough food their family would eat first.

Alternative Interventions Identified by Women's and Men's focal groups: Women identified different possible interventions that would help them to deal with food insecurity and to reduce its consequences:

1) Development of a project to provide water for irrigation;

2) Development of family and school gardens and small green houses (Ecuador);

3) Small animals projects (chicken, rabbits, guinea pigs, trout);

4) Access to drinkable water;

5) Development of job opportunities for men and women locally;

6) Food production projects for own consumption and for the market;

7) Education and training in nutrition, gardening, small animal production, food storage and utilization; and

8) Information about how to improve existing family gardens and provision of seeds, tools and fertilizers.

Men identified the following interventions as the best solutions to deal with food insecurity:

1) Development of family and school gardens,

2) Production of small animals,

3) To have access to drinkable water,

4) To develop projects to have enough irrigation water for their crops,

5) Production of seeds,

6) Enhance the production of cash crops,

7) To receive training in agricultural techniques,

8) Food production projects (vegetables and small animals) should provide food and cash, and

9) Corn mill.

Strategies to increase food security include options that can be incorporated effectively into ongoing activities of Project PLAN such as the following.

Home and community gardens can be improved with the introduction and experimentation with selected varieties of fruits that are good sources of vitamins and micronutrient rich vegetables such as green leafs, spinach, types of cabbage other than the white sort, and yams. In Ecuador gardening has been combined with composting and humus worm breeding projects. The compost is also enriched with chicken manure. Unfortunately, the use of chicken manure is limited to small amounts that

are collected in hen houses.

Most of the families have small animals, mainly chicken, but also ducks and turkeys. In general, chickens represent the most available source of animal protein (meat and eggs). Both products are also an important source of cash and the wealthiest families within the communities raise a good number of chickens for the local market. There were complaints of high losses are due to predators and to lack of technical assistance in chicken breeding and care. Other options for raising small animals such as rabbits, guinea pigs, have been tried by a few families; however, technical assistance is required to improve their success.

Fishing is a common practice in the communities (Fuerte Santiago, Ventanas, Las Palmas and Cosanga); however, pollution of the rivers has caused very critical problems in the quality of the fish available (small size, contaminated meat) and diminishing of some species. In Ecuador there is very high interest in developing projects to produce different types of fish. In Cosanga, Ecuador some families are producing trout for commercial purposes and for own consumption with very good results. Development and conservation of ponds, as well as fishing projects in the rivers, show a huge potential to increase the availability and consumption of animal products.

The family gardens and small animal projects are mainly run by the women, who also have sometimes their own organizations, such as the Asociación de Damas de Cosanga or the Handicrafts Cooperative in the GuaranÌ communities in Bolivia. The small family enterprises taught the families many lessons about small animal care and management. This type of projects has a very good potential in providing the communities with very much needed animal products. There are many challenges though, which need technical assistance for their solution. Providing of protection against predators is one of the most prevalent needs.

In the three countries the consumption of animal products (small and large livestock) is limited. This is accentuated in the poorest families of the region for whom more than a month can go by before they eat an animal product food. The impact of this in the nutritional status of these populations is of great concern to us, especially for infants, children, women of reproductive age and the elderly. The implementation of small animal projects that are easy to take care and that reproduce rapidly is a possible idea to alleviate this difficulty.

GENDER

Women as project participants: One of the principal overarching goals of Project PLAN since its inception has been searching for equitable methods of including men and women of all ages in the activities, benefits, and visions of the project. We have tried to include both women and men in investigative activities and as research informants throughout our work. More studies concentrating on women have begun within the scope of the project, and we look forward to incorporating the results of these studies into our future planning and strategy (see Activity E 1.5.) In order to acquire a clear understanding of historical impacts of land use, patterns of land use change have been a focus of several of our project components. Critical to the full comprehension of these land use change patterns is the understanding of the role of women in the process. We hope to continue fostering the learning process in terms of gender and land use.

Our studies have shed light on such imperative aspects of gender analysis such as level of organization present, variations on production strategies, and motivational factors for decision-making. This year, one student has begun the

process of working specifically with women's groups in Bolivia on decision-making in terms of natural resources and long-term planning for resource management based on prioritization of concerns. Because the important roles of women are often overlooked in the agricultural and natural resource management spheres, we feel like the inclusion of their perceptions and input in our project is a particularly important aspect of our contribution to the great scope of natural resource management planning endeavors.

Bolivia: Women of the communities in La Cueva, Bolivia, have over the past years held influential positions in the local branches of community government. Project PLAN and our partner NGO's have supported this involvement through our activities and planning with the local people. This year, one of our Master's students began her applied research project, focussing on perceptions of roles of women and men. She is working specifically with an organized women's group in Fuerte Santiago that currently involves itself in productive and collective activities. The group has expressed interest in developing strategies for women to actively participate in proactive activities for improvement of opportunities for women. Natural resource management issues have surfaced as one of the areas in which this will be possible. (See Activities E 1.5, E 2.3, and E 3.1.) The groundwork for this applied research was set out this summer, and next spring she will return to Bolivia to continue working with the women's group for empowerment and more responsibility in decision-making.

The President of the Organization Territorial be Base, the government-organized community group in charge of planning, mapping, and officiating territoriality and land conflict in the La Sal River watershed, is a woman also closely involved with project collaborators and project activities. Two of the six members of this group are women. This group has a strong voice in the management and decision-making of the area, and the project continues to foster our relationship with the group in order to continue focusing on community concerns.

Ecuador: Several of the activities that we have undertaken in Ecuador have the distinct goal of assisting women and their families. Local communities have expressed interest in experimentation with house garden production of fruits and vegetables in Cosanga, in order to provide the better nutrition for family members, as well as an alternate means for women to generate their own income. These activities have only just begun but are promising for the future of the project (see Activity B 2.5.)

Mexico: Mexican team members have been working closely with community members of Zenzontla to identify and inventory medical plants utilized by families for various types of remedies. One team researcher also works closely with community women to evaluate economic conditions that affect women in the area, and ways to diversify gained income. Income diversification and exploration of alternative revenues have been important underlying factors in the motivation of the project.

Additionally, an interesting new vantage point for Project PLAN in terms of economic focus is the study of livelihood diversification, especially among women. The Master's thesis study soon to be completed by UW student Alexis Eakright explores livelihood diversification and how it affect local women of Zenzontla (see Activity D.1 under Economic Development.)

Women as project collaborators: 26 of 84 active members of PLAN are women. We have continually encouraged women to further their involvement in the project's goals and visions.

Trainees: Twelve of the 26 members of the project who were working on various degrees this year were women. **Bolivia:** Six members of the 25-member Bolivian team are women. **Ecuador:** Four members of the 15- member team are women. **Mexico:** Four members of the 20-member team are women.

In the United States, seven of the eight students directly involved with PLAN over the last year were women. Additionally, the Project Assistants of Project PLAN have always been women. Four of the faculty researchers on the United States team are also women. Several of the key players of our counterparts in Bolivia and Ecuador are women who have contributed greatly to the design and success of their country's role in the project as well as the overall function. Kattia Hernandez of Ecuador and Pilar Lizarraga of Bolivia in particular have led the way in shaping the important and active roles of women in our project. The presence of key women on the project has definitely influenced project activities and has created a favorable environment for even more women to join the project.

POLICY

Our project fosters strong working relationships with outstanding partner NGO's in each of the three host countries. Many of these NGO's work daily with local governments or institutions, and maintain close ties with them. Through this network, a vast amount of valuable information is exchanged and passed on to government officials. Working agreements between our partner NGO's and local government agencies have been an insightful complement throughout the span of our project.

Bolivia: Our partner NGO's in Bolivia have developed strong ties to the local government structures there, many of which have grown out of useful collaborations. In particular, AGROSIG, one of our Bolivian partners, was conceived from a government program, funded through international sources, whose grant was soon to expire. Our Bolivian partners took the initiative to spearhead a non-governmental agency focussed on collecting important biophysical data and collaborating with local people in experimentation and exploration of alternatives for livestock management. This unique situation has proven to be extremely helpful to the goals of the project and will continue to generate important data and collaborative efforts.

Ecuador: This year has seen some extremely exciting developments in the relationship between the local government of the Municipality of Baeza and Project PLAN. Representatives of the municipality attended the workshop in Quito, in order to continue the on-going exchange of ideas and information that has allowed the increased involvement of the government in project activities.

Directly related to the farmer experimentation that our project has developed and about which we continue to generate ideas, the Municipality of Baeza has set up demonstration plots in the community so that farmers can see for themselves how experimentation works, and what the results of different activities are. Many farmers have taken advantage of the opportunity to learn more about possible outcomes of experiments, and the project has been extremely successful. Municipal workers are constantly in contact with NGO partners in Baeza and Quito in order to maximize the effectiveness and potential for learning of the experimentation plots.

Mexico: The relationship between the Universidad de Guadalajara and SEMARNAP, the Mexican government agency slated with the responsibility for administration of the Sierra de Manantlán Biosphere Reserve, continues. Because of the collaborative working agreement

between these entities, our project has a wider range of influence, with both parties benefiting from the exchange.

Outreach

An overarching goal of Project PLAN is to foment the outreach and educational activities that necessarily go hand in hand with participatory conservation and development work. It is our firm belief in sustainability through education and progress through information exchange that makes the outreach portions of our project so imperative. The community-oriented nature of our project allows to engage in constant outreach activities with local people through community organizing efforts by partner NGO's.

Educational Activities: In Bolivia, educational activities continue to remain strong. This past summer a workshop for children was conducted by JAINA personnel along with UW students. The children, aged 7 to 13, were asked to draw and identify various species of birds common to their area. These children were then asked to describe the birds, and elaborate which ones caused damage to the crops of the village. In this way, the researchers were able to gain more insight into which birds were perceived to cause the most problems for the community, and the children could exercise their knowledge of local species and learn a little about the natural history of each one. Additional workshops are planned for the coming field season.

Outreach from the farming communities: One very exciting aspect of our Annual Workshops that began last year and continued on into this year at the Workshop in Ecuador is the participation of community members involved with project activities in their villages. This year the participants were Tony Hoyos of Fuerte Santiago, Bolivia, Andres Segundo of Timboy, Bolivia; and Alandi Torres and Stalin Molina of Las Palmas, Ecuador. Their participation and presentation to fellow farmers was extremely valuable in the on-going efforts for furthered community understanding, exchange, and outreach. We hope to continue this pattern of farmer participation in future workshops.

Outreach from farmer planning groups in the U.S.: This year, as part of our special Conceptual and Methodological Workshop in Madison, (see section 11 of this report), we made a field visit to a local Wisconsin farm, where the farmers are utilizing Scottish Highland cattle in their efforts to restore their land to its native oak savanna conditions. These cattle have the capability to forage on invasive species of trees, whose seedlings are tough and unpalatable to domestic species if cattle. The Wisconsin farmers, along with UW researchers involved with Project PLAN, have delineated a system of parcels in order to measure and monitor the efficacy of the cattle in the restoration plan. Our Latin American counterparts were able to visit with these folks for an entire afternoon, and much valuable information was gained by all. Since local people along with students in several of the sites in three countries have been using parcels as a means of monitoring effect of livestock on species diversity, the farm visit was an avenue by which to broaden the foundation of ideas for farmer experimentation, learning, and outreach.

Developmental Impact

Environmental Impact and Relevance. a) Biodiversity. Each of the three sites in which project PLAN is active borders a biological reserve, where local people live and work within the context of threatened or unique biological resources. We have placed priority on the protection and conservation of these rare and internationally significant types of resources, and

feel that lessons learned and models produced from our work will ultimately be useful in conservation efforts throughout the region. The strategies for conservation of biodiversity within the project have provided a connective fabric among all three project sites.

1) Fish Biodiversity and Conservation—Mexico. This year, a master's student has completed a thesis containing a comprehensive fish species inventory for the Ayuquila River in the *ejido* of Zenzontla. Furthermore, the study outlined the value of these fish species as indicators of river water quality. This study shed light on the fact that fish populations exhibit strong negative effects in areas where the river transects agricultural or grazing lands and no riparian buffer zone exists. The data collected in the study was used to develop specific guidelines for conservation in the Ayuquila river system. The information gathered will be extremely useful in the continued management of the riparian area for the process of on-going collaboration with the local people in terms of ensuring the long-term health of the river system (see Activities C 1.1 and C 3.1.)

2) Spectacled Bear Study—Ecuador. Data collected by a Master's student focusing on human-wildlife conflict, specifically depredation by endangered Spectacled bears of Ecuador, have identified specific fruits of different tree species most often used by the bears as forage or cover. Also, the investigation concluded that most bear attacks on cattle occurred at the forest edge. This insight has led to the generation of recommendations for the community for the removal of cattle from pastures in close proximity to forest patches. This information and the data collected on crop-raiding occurrence have enabled partner NGO's and local people in the Rio Cosanga watershed to begin the implementation of measures specifically designed to protect the threatened Spectacled bear (see Activities A 1.5, C 1.2 and C 2.1.)

3) Bird Conservation and Inventories—Bolivia. This year, as part of the continuing effort for conservation of avian biodiversity in southeastern Bolivia, students and NGO partners have begun to develop inventories and information on crop depredation by various bird species. This is an on-going process, and the Master's theses that result from these activities will contribute to the efforts to work with local people on ways to minimize wildlife damage to crops while maximizing potential for protection of birds. Specific attention, through interviews and workshops with community members, has been paid to local knowledge of ecosystem processes and indigenous species (see Activity A 1.5)

Agricultural Sustainability.

1) Descriptive studies of land use change—Mexico, Bolivia, and Ecuador. Detailed, comprehensive studies of land use change have been extremely important in the overall goal of facilitating the understanding of the impacts farmers have on land cover over time. Although follow-up studies are needed and in progress in order to fully understand the implications of cover change in terms of cause and effect relationships, the studies have provided valuable insight into land use. Furthermore, they have shed light on the cycle of land use as related to socioeconomic factors affecting decision-making among farmers. This multi-dimensional aspect of focusing on land use change, we believe, is vital to working together with members of our partner communities on sustainable management of resources in the future (see Activity B 1.1.)

2) Transhumancia Study—Bolivia. In the spirit of broadening our knowledge base about

the relationships between sustainable livestock production and management decisions made by communities, members of our Bolivian team have completed a study on traditional regional cattle migration patterns and cycles. These cycles generally occur with seasonal variation in conditions. Traditionally, some cattle herds have been allowed to travel and migrate over great distances, while others have been kept closer to the home front. The study pinpointed the overlap of different types of herds as providing an interface where genetic material and disease are exchanged, as well as a kind of forum for the fostering of agreements between groups of ranchers or on the institutional level. Conclusions include the idea that many farmers are provided with an economic opportunity that counteracts the disadvantage of not having access to any kind of road. This study has spearheaded the use of a new device for understanding long-term effects of livestock management decisions on large-scale areas, and illuminates the integral relationship between community decision patterns and the efficient and sustainable use of resources.

Contributions to U.S. Agriculture. Because of the inter-disciplinary, integrated nature of our project, we believe that lessons learned throughout the process can be useful to agricultural systems throughout areas in which there are forests and livestock. In places where farmers are desirous of implementing a more integrated approach to managing natural systems within a framework of livestock production, our process-oriented approach could be adapted to specific situations and regions. Over the last year, we have facilitated exchange between farmers and NGO workers of our Latin American teams and their counterparts in Wisconsin. A very exciting example of this was the visitation of Latin American colleagues to a farm in central Wisconsin that uses Scottish Highland cattle as the primary tool for native ecosystem restoration of the landscape (see workshop section in this report.)

Contributions to Host Countries.

1) Sustainable Development and Environment. Project PLAN continues to orient its activities to the long-term well-being of the communities we work with and the land on which they depend. Analysis of this well-being occurs through the conservation of unique ecosystems and biodiversity, reduction in the degradation of remaining resources, and the enhancement of the quality of life of those involved.

The project has and will continue to increase the capacity of local institutions and researchers to evaluate approaches to integrated interdisciplinary problem-solving, drawing from a wide variety of methods and perspectives. This problem-solving capacity is the most important long-term aspect of a community-level approach to conservation and development, and is what will allow communities to continue their progress towards effective long-term management of resources on their own. Project PLAN specifically focuses on enhancing this capacity, and the host countries will benefit in many ways from this startegy.

2) Education. The tremendous number of host country students that are involved with Project PLAN through an adjunct thesis project or study has greatly increased. These students are contributing important information and experience to the project and the institutions involved. Most of these students are men and women who wish to continue working in the conservation and sustainable development field. These students will be the leaders of this type of action in their respective regions in the future. We believe that good natural resource management decisions are based in good science,

and the students involved with Project PLAN assist constantly in fomenting this connection.

3) Capacity-building. Our commitment to strong effective communication among organizations and partners involved with our project has enabled free exchange of information. This in turn has allowed the strengthening of capacity of all colleagues and community members in the loop. Exchange of ideas and experiences has proven to be extremely valuable in the on-going nature of the project. Host countries and domestic team partners alike have expressed the sentiment that the movement of information among groups has been one of the highlights of involvement in the project.

Linkages and Networking. Project PLAN is constantly increasing its number of contacts and ties to people and organizations within the member countries as well as internationally.

a) Within target countries. The process of fostering valuable working relationships among organizations in Bolivia and Ecuador is on-going. Positive results are evidenced by stronger ties and increased collaboration among host country partners. Partner NGO's have strengthened their ties to the people's organization of the Guarani in Bolivia, and continue to explore ways to work with this organization for the good of all. The Pueblo Guarani has enlisted our partner NGO's in Bolivia to assist with such projects as production of fabrics and other handi-crafts by local women. The relationship between the NGO's in each of the countries is constantly getting stronger as projects and ideas develop.

b) International Linkages. Project PLAN has generated a tremendous amount of valuable information and opportunity for exchange among the three countries as well as other outside institutions. In order to make this experience accessible to large number of people, we have established a website that outlines PLAN milestones and contains information about the range of activities that we have undertaken. This resource, along with our continued constant email exchange of information allows all parties involved to remain within the communication loop that makes our project so strong. We are proud to maintain open lines of communication and exchange of ideas that foster an environment of trust, collaboration, and mutual respect that gives everyone involved a sense of community within the project itself. Continuing plans for PLAN workshops and meetings also foment an environment conducive to a shared partnership and vision.

Collaboration with international research centers. The majority of our collaboration efforts have been focussed on organizations within the countries with which we work directly. We hope that, as our project continues to grow and focus on more specific issues, we can extend our network base to other organizations involved in similar important work throughout the world.

Other Contributions

Contributions of Project PLAN are many and varied, and are particularly centered around shared information with university personnel, NGO contacts throughout the US and Latin America, and the continued opportunity for students to participate in an applied, meaningful learning experience as a major component of their graduate study. Furthermore, our project has the distinct aim of promoting critical thinking and proactive decision-making among community members. This aspect of our project affects the improvement in quality of life for individuals and communities. Contemporary community development literature outlines the fact that good community structure and

function involves a purposeful concentration on democratic processes, including collective decision-making. These are exactly the types of interrelations that our project promotes.

Leveraged Funds and Linked Projects

UW-Madison based grants:

NAVE Summer Research Grants from the Latin American, Caribbean, and Iberian Studies Program, J.J. Davis Fund, Department of Zoology; "Crop damage in corn and citrus caused by Bolivian birds." (Additional funds for undergraduate research assistant.) Summer 2001. Young, A. $2,500

Entemann Prize, Department of Zoology, "Women's groups and natural resource management decision-making in Bolivia." Summer 2001. Sansom. $2,000

Environmental Studies International Research Fund: "Characterization of participants and non-participants in Project PLAN in the Ejido of Zenzontla, Jalisco, Mexico." $2,000

UW Graduate School: "The relationship of time allocation and economic diversification to household well-being and sustainability in an ecological buffer zone." Zepeda. (Note: this grant is reflected as 11mos of the 18 mos of Graduate student RA matching support for Project PLAN from the UW Graduate School + $2500 for travel and supplies) $18,930

Host-Country based grants

Bolivia

FIA, "Fortalecimiento del Proceso de Autogestión del Itika Guasu," Community Diagnostics, CER-DET. $1,000

AECI-INTERMON, "Desarrollo Multisectorial con Población Guarani en la Región del Itika Guasu, Tarija 2ʃ Fase." CER-DET. $3,375

FIA, "Fortalecimiento del Proceso de Autogestión del Itika Guasu." CER-DET. $1,300

AECI-INTERMON, "Desarrollo Multisectorial con Población Guarani en la Región del Itika Guasu, Tarija 2ʃ Fase." CER-DET. $400

AECI- INTERMON, " Desarrollo Multisectorial con Población Guarani en la Región del Itika Guasu, Tarija 2ʃ Fase." CER-DET. $2,500

Universidad de Juan Misael Saracho with ZONISIG, "Evaluación de calidad de agua de Rio Salado." $1500

Ecuador

Proyecto de Parques en Peligro, USAID-The Nature Conservancy. FUNAN. (Five year grant.) $20,000

PROBONA: "Proyecto Cosanga" FUNAN (Fundacion Antisana) $16,000

Convenio FUNAN-OIKOS: "Educacion ambiental en Cosanga" $4,000

Mexico

ACUDE Investigative Program, Univeristy of Guadalajara $1,500

Universidad de Guadalajara, "Análisis de la economìa rural de zonas marginadas: estudios de caso en la Sierra de Manantlán." $17,000

PACMYC (Programa de apoyo a las culturas municipales y comunitarias,) "Rescate de la Herbolaria y medicina tradicional en el ejido Zenzontla." $30,000

Apotaciones Complementarias $15,000

USMEXUS—Universidad de California-Davis. Nutrition study. $1,500

TOTAL LEVERAGED FUNDS: $140,505

TRAINING

In progress

Adautt, Samuel, B.S. May 2001, Climate and Botany: Evaluation of pasture productivity and impacts on natural vegetation, Tomatirenda watershed, Bolivia. Universidad Autonoma Juan Misael Saracho, Bolivia

Alejos de la Fuente, Isidro, Mexico. M.S. 2003, Agronomy: Experimentation with sheep fed with corn stalks treated with urea and an energy and protein supplement. Colegio de Postgraduados, Texcoco, Mexico

Cardenas-Hernandez, Oscar, Mexico. Ph.D. July 2001, Land Resources: Land cover/ use changes in Mexico with respect to government policies and market forces: case study of land cover/use changes and ecological consequences in Zenzontla, Mexico, Institute for Environmental Studies, University of Wisconsin-Madison. Exchange with University of Guadalajara, CUCSUR, USA/Mexico

Castellanos, Carla-Blanca, Mexico. B.S. Aug. 2002, Ecology: Study of bird distribution and reproduction in forests affected by cattle (Zenzontla), CUCBA, University of Guadalajara, Mexico

Corso, Orlando, Bolivia. B.S. 2002, Animal Science: Incidence of Cisticersosis in Swine in the Tomatirenda watershed (Bolivia), Universidad Tecnica del Beni, Bolivia

Eakright, Alexis, USA. M.S. (Double) Aug. 2001, Conservation Biology and Sustainable Development; Agricultural and Applied Economics: Evaluation of family strategies in terms of labor distribution, economic diversification, technology adoption and participation (Zenzontla, Mexico), Institute for Environmental Studies and Dept. of Agricultural and Applied Economics, University of Wisconsin-Madison, USA

Erdman, Joshua, Ph.D. June 2003, Zoology: Ecological interactions of keystone fruit-eating bird species and fruiting plants, Cosanga, Ecuador, Dept. of Zoology, University of Wisconsin-Madison, USA

Esparza, Juan Pablo, Student, Mexico. B.S. 2002, Zoology: Habitat use and forage selection by cattle in forests of the Ejido Zenzontla (M), IMECBIO, CUCSUR, University of Guadalajara-Autlan, Mexico

Espinoza, Linder, Bolivia. Ph.D. 2005, Study of the causes and consequences of land use/land cover change in west central Tarija, Bolivia, Universidad de Sevilla, Bolivia

Flores, Marbella, Mexico. M.S. 2002, Change in soil/land use (Mexico), IMECBIO, CUCSUR, University of Guadalajara-Autlan, Mexico

Galasso, Louise, USA. M.S. Dec 2001, Conservation Biology and Sustainable Development: Ecological and economic analysis of crop and cattle raiding by Spectacled Bear (Ecuador), Institute for Environmental Studies, University of Wisconsin – Madison, USA

Gonzales, Jorge, Bolivia. B.S. 2002, Law: Natural resources tenure rights in the Rio La Sal watershed (Bolivia), Universidad Autonoma Juan Misael Saracho, Bolivia

Hernanez, Yoyi, USA. M.S. May 2002, Structure and diversity of bird communities in relation to fragmented habitats among the agro-ecosystems of Zenzontla (Mexico), Institute for Environmental Studies, University of Wisconsin, USA

Jurado Nery, Monica Rosario, Bolivia. M.S. August 2002, Agronomy: Evaluation of damage by birds on maize in Entre Rios region (Bolivia, Universidad Autonoma Juan Misael Saracho, Bolivia

Mercado-Silva, Norman, Mexico. M.S. August 2001. Zoology: Fish communities, fisheries and public perception of the Ayuquila River in West Central Mexico, Dept. of Zoology, University of Wisconsin-Madison, USA

Mercado-Silva, Norman, Mexico. Ph.D. 2004, Zoology: Fish communities, fisheries and public perception of the Ayuquila River in West Central Mexico, Dept. of Zoology, University of Wisconsin-Madison, USA

Montaño, Maria, Spain. M.S. 2002, Small-holder perception of ecological degradation in Mexico, Universidad Autonoma de Barcelona, Spain

Morales, Veronica, Mexico. M.S. 2002, Rural economy analysis (Mexico), Universidad de Chapingo, Mexico

PerÈz, Rafael, Mexico. B.S. August 2002, Ecology and natural resources: Rehabilitation of irrigation system of the Ayuquila River in Zenzontla, IMECBIO, CUCSUR, University of Guadalajara, Mexico

Reyes, Evelia, Mexico. M.S. 2002, Rural economy analysis (Mexico), University of Chapingo, Mexico

Sansom, April, USA. M.S. June 2003, Conservation Biology and Sustainable Development: Participatory research on women's groups and decision-making for natural resources (Bolivia), Institute for Environmental Studies, University of Wisconsin-Madison, USA

Tapia, Carlos, Bolivia. B.S. 2002, Business: Market for community production (Bolivia), Universidad Autonoma Juan Misael Saracho, Bolivia

Villena, Aldo, Bolivia. B.S. 2002, Forestry: Community forest management (Bolivia), Universidad Autonoma Juan Misael Saracho, Bolivia

Young, Andrea, USA. M.S. June 2003, Zoology: Study of crop depredation by parrots and other birds and animals (in Bolivia), Dept. of Zoology, University of Wisconsin-Madison, USA

Young, Michelle, USA. M.S. 2002, Food production and biodiversity conservation: dual constraints in the context of the livestock revolution (Mexico), University of California, Davis, USA

Zamora, Julian, Mexico. M.S. 2002, Changes in land/soil use (Mexico), IMECBIO, CUCSUR, University of Guadalajara, Mexico

Zavalza, Felix, Mexico. B.S. August 2002, Impact of livestock on the productivity of natural vegetation (Mexico), IMECBIO, CUCSUR, University of Guadalajara, Mexico

Workshops

Conference/Workshop, Ecuador:
Fourth Annual PLAN Workshop

Location: Quito and Cosanga Region, Ecuador.

Dates: 12–19 July, 2001

Participants: 27 of the project participants. Team participation: Bolivia—5, Mexico—7, Ecuador—10, University of Wisconsin—5.

Institutions: The University of Wisconsin and each of the partner NGO's from Bolivia, Ecuador, and Mexico were involved in the workshop.

Purpose: The purpose of the workshop was to exchange ideas and progress of each group involved, and to present results of studies and activities. Also, we aimed to further develop plans for monitoring of our activities, and to coordinate the experimentation that will be carried out by local farmers. A visit to the field reinforced the successful exchange and constant flow of information among the project participants. Other key aspects of our activities in this workshop were the development of a strategy for Year 5 and planning for Year 5 for the entire project as well as in country groups.

Many new ideas were generated, concerning further collaborative activities between country teams and strategies for the advancement of our team priorities. One of the most exciting aspects of this workshop was the attendance of community members from La Cueva and Timboy (Bolivia) and Las Palmas

(Ecuador.) The active participation of these 4 farmers with the other PLAN attendees in such a workshop demonstrates the continuing philosophy of Project PLAN as an inclusive grass-roots endeavor.

Workshop, USA: "Conceptual and Methodological Workshop."

Location: Madison, Wisconsin

Dates: February 20-25, 2001

Participants: 25 members of the PLAN Team, including the nutrition team from UC Davis.

Institutions: All of the partner NGO's from the host countries had participating delegates.

Purpose: Key themes of this workshop included further developing a monitoring plan for our project, fostering the participation of community members in project activities, farmer experimentation design and application, and strategies to foment cooperation among groups and partner organizations. This workshop was extremely beneficial to the project, as it specifically addressed overarching goals of each of the three teams' long-term visions.

For the monitoring aspect of the project, the key advancements during this workshop were discussing and forming ideas about how to integrate particpation and monitoring, and how to identify the exact type of information we need to insure the success of the monitoring program. Also discussed was the question of how to facilitate monitoring and evaluation in the communities, so that the local people themselves are carrying out meaningful monitoring activities in their own communities.

The other principal theme of this workshop was the aspect of increasing the level and concentration on participation across the activities of PLAN. Topics included ways in which to work with the diversity of actors involved in the various communities, the facilitation of communication between external agents and community members and organizations, and how to foster empowerment of local actors and stakeholders in relation to other external actors.

Equally important for the participants of the workshop was the introduction to Hugo and Ana, who are spearheading the nutrition and food security aspects of the project. These researchers were able to present their strategy and plans to the group so that they could be incorporated into the larger vision of the project. This first integration was extremely successful and the nutrition aspect of the project has moved forward progressively (see Activity Section F.)

Collaborating Personnel

Bolivia

Adautt, Samuel, Natural resource management, soils and botany, AGROSIG, Evaluation of pasture productivity and impacts on natural vegetation

Baldivieso, Erlan, GIS expert, AGROSIG, GIS, mapping support

Beltran, Rafael, Computer expert, AGROSIG, GIS, mapping and computer support

Calla, Rhinda, Sociology, JAINA, Sociological studies; community development

Carranza, Freddy, Agronomy, JAINA, Agronomy; community development

Castro, Miguel, Director, Lawyer, CERDET, Institutional support in application of development projects

Cuba, Ruben, Agronomy, Botany, CERDET, Use and commercialization of medicinal plants, community organization

Del Carpio, Ricardo, Agronomist, business, JAINA, Agronomy, community development

Espinoza, Linder, Director, Researcher, Forestry, Natural resource management, GIS

Specialist, AGROSIG, Evaluation of natural resources

Flores, Magaly, Agronomy, Forestry, JAINA, Bolivian, Community development; forestry and biodiversity studies

Flores, Nelson, Resource management, soils and botany, AGROSIG, Evaluation of pasture productivity and impacts on natural vegetation

Gallarda, Norberto, Lawyer, CER-DET, Land Tenure

Gonzales, Jorge, Student, Law, JAINA, Legal analysis on resource access & community development

Jurado, Monica, Student, Agronomy, Biology, AGROSIG, Relation avifauna & agriculture

Lizárraga, Pilar, Researcher, Sociology, JAINA, Socioeconomic analyses and methodological support; autodiagnostics, perspectives studies, and participatory work and community organization

Lozano, Angelo, Agronomist, CER-DET, Natural resource management, livestock projects

Mealla, Grover, Agronomist, CER-DET, Planning and coordination, community organization & commercialization

Molina, Jesus, Agronomist, JAINA, Agronomy, community development

Montaño, Blanca, Sociology, CER-DET, Organization of community groups and women's artisanal groups, coordination of family food security activities

Mujica, Roberto, Agronomy, ecology, AGROSIG, Quality evaluation of water resources

Paita, Ricardo, Agronomy, Ecologist, CER-DET, Agro-ecology, agronomy, livestock projects

Roth, Erick, Director, Psychology, Environmental Education, CIEC, Advice on environmental and community education—application and strategies

Ruíz, Jorge, GIS and Agronomy, AGROSIG, Evaluation of natural resources

Vacaflores, Carlos Director, Researcher, Agronomy, JAINA, Coordination of project; socioeconomic analyses; autodiagnostics, perspectives studies, and participatory work and community organization

Villena, Aldo, Student, Forestry, JAINA, Community forest management

Ecuador

Calispa, Fabian, Researcher, Agronomy, Terranueva, Evaluation of livestock production, pastures, and agroecology

Castellanos, Armando, Ecologist, Jatun Sacha/CDC, Biodiversity

Cisneros, Jaqueline, Researcher, GIS, CDC, Mapping and GIS support; biodiversity inventory support

Hernández, Kattya, Researcher, Anthropology, Fundación Heifer, Local actors study, participatory work & community organization; coordination of project activities

Larrea, Fernando, Director, Anthropology, Fundacion Heifer, Coordination of project and advice on integrated community development approaches

Molina, Stalin, Extensionist (Representative, Community of Las Palmas), FUNAN, Support in impact of natural resource use on vegetation; community development

Mosquera, Gustavo, Researcher, Biology, FUNAN, Biodiversity studies and environmental education

Muñoz, Juan Pablo, Anthropologist, Terranueva, Anthropological studies

Murillo, Isabel, Researcher, Sociology, FUNAN, Community studies

Peñafiel, Marcia, GIS Engineer, Jatun Sacha/CDC, Coordination of biodiveristy & GIS

Pinos, Gonzalo, Researcher, GIS, mapping, CDC, Support in application of mapping and GIS

Ronquillo, Juan Carlos, Ecologist, Jatun Sacha/CDC, Biodiversity

Ruiz, Armando, Ecologist, FUNAN, Support in animal biodiversity studies

Serrano, Manuel, Researcher, Forestry, FUNAN, Support in impact of natural resource use on vegetation; community development

Utreras, Victor, Researcher, Biology, FUNAN, Support in animal biodiversity studies

Mexico

Aguirre, Angel, Ecologist, IMECBIO, Water quality

Alejos de la Fuente, Isidro, Student, Agronomy, Colegio de Post-graduados, Experimentation with sheep feed

Cárdenas, Oscar, Professor, Natural Resource Management, (UW-Student, Land Resources), IMECBIO/UW-Madison, Analysis of land use and land change due to government policies

Carranza, Arturo, Researcher, Soils, IMECBIO, Soils evaluation

Castellanos, Carla-Blanca, Student, Zoology, IMECBIO, Avian biodiversity study

Contreras, Sarahy, Researcher, Zoology, IMECBIO, Avian biodiversity study

Cuevas, Ramon, Professor, Botany, IMECBIO, Botanical and ethno-botanical studies

Esparza, Juan Pablo, Student, Zoology, IMECBIO, Cattle habitat and forage selection study

Gerritson, Peter, Professor, Sociology, IMECBIO, Socioeconomic evaluation; participatory work

Guevara, Ruben Dario, Research, Soils, IMECBIO, Soils evaluation

Guzman, German, Botanist, IMECBIO, Botany-flora

Hernández, Guadalupe, Research, Agronomy, IMECBIO, Agronomy, agro-forestry experimentation

Iñiguez, Luis Ignacio, Professor, Zoology, IMECBIO, Support for animal biodiversity studies and wildlife/agriculture interaction studies (rodents and vampire bats)

Martínez, Luis Manuel, Professor, Limnology and Watersheds, IMECBIO, Coordination of project; soil and watershed evaluation and mapping; hydrology and water quality studies

Moreno, Arturo, Professor, Economics, IMECBIO, Economic studies; participatory work including medicinal plants project with women's groups

Pineda, Maria del Rosario, Professor, Botany and Ecology, IMECBIO, Botanical studies of vegetation change

Ramírez, Manuel, GIS Engineer, IMECBIO, GIS

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GLOSSARY

A-AARNET	ASARECA Animal Agriculture Research Network
AAU	Addis Ababa University
ABS	American Breeders Society
ACIAR	Australian Centre for International Agricultural Research
ACT	Almanac Characterization Tool
ADG	Average daily gain
AFPC	Agricultural and Food Policy Center
AFRNET	African Feed Resources Network
AGRIS	International Information System for the Agricultural Sciences and Technology, FAO
AGROSIG	Servicios Agro-Informaticos de Apolyo a la Planificacion para el Uso y Manejo de los Recursos Naturales
AID	Agency for International Development, Washington D.C., USA
AIGACAA	Asociacion Integral de Ganadevos en Camelidos de los Andes Altos
ALRMP	Arid Lands Resource Management Project
AMREF	African Medical Research Education Foundation
ANP	Applied Nutrition Program
ANPP	Annual Net Primary Productivity
AP	Animal Production
APEX	Multi-crop simulation model
APROPAL	Association of Producers of Las Palmas
ARC	Agriculture Research Council
ARD	Association for Rural Development
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa

ASF	Animal Source Foods
ASP	Agrosilvopastoral
ASPADERUC	Asociacion para el Dasarolla Rural de Cajamarca
AT	Assessment Team
ATI	Appropriate Technology International
ATW	Assessment Team Workshop
AVHRR	Advanced Very High Resolution Radiometer
AWF	American Wildlife Federation
B	Barbados Blackbelly Sheep
BASIS CRSP	Broadening Access and Strengthening Market Input Systems Collaborative Research Support Program
BC	Barbados x Sumatra Sheep
BIFAD	Board for International Food and Agriculture Development
BLUE	Best Linear Unbiased Estimator
BPP	National Rubber Research Institute, Indonesia
BPT	Balai Penelitian Ternak, Bogor, Indonesia (Animal Husbandry Research Institute)
BR	Bowen Ratio
BW	Body weight
CAP	Common Agricultural Policy
CAR	Central Asian Republics
CARDI	Caribbean Agricultural Research and Development Institute
CARE	Cooperative for American Remittance to Europe, Inc.
CATIE	Centro Agronomico Tropical de Investigacion y Ensenaza
CBE	Commercial Bank of Ethiopia
CBPP	Contagious Bovine Pleuropneumonia
CCD	Convention to Combat Desertification (United Nations)

CCPP	Contagious Caprine Pleuropneumonia
CDC	Centro de Datos para la Conservacion
CEDEP	Centro de Estudios para d'Oesarrollo y la Participacion
CER-DET	Centro de Estudios Regionales para el Desarrollo de Tarija
CGIAR	Consultative Group on International Agricultural Research
CHDC	Child Health and Development Center
CIAT	Centro Internacional de Agricultura Tropical
CIDICCO	Centro Internacional de Informacion Sobre Cultivos de Cobertura
CIEC	Centro Interdisciplinario de Estudios Comunitarios (Interdisciplinary Center for Community Studies)
CIESTAAM	Center for Economic, Social, and Technology Research on World Agriculture and Agribusiness
CIP	Centro Internacional de la Papa - International Potato Center
C/LAA	Caribbean/Latin American Action
CLAS-UMSS	Centro de Levantamientos Aerospaciales y Aplicaciones de SIG
CMO	Crisis Mitigation Office
CNA	Confederacion Nacional Agropecuario
CNCPS	Cornell Net Carbohydrate and Protein System
CNG	Confederacion Nacional Ganadera
CNL	Crocker Nuclear Laboratory
CONDESAN	Consorcio para el Desarrollo Sostenible de la Ecoregion Andina
CORAF	Conference de la Recherche Agronomique des Responsable Africains et Francais
CP	Crude protein
CPV	Capripox virus
CRES	Center for Resource and Environmental Studies
CRIAS	Coordinating Research Institute for Animal Science, Indonesia

CRSP	Collaborative Research Support Program
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSSG	Center for Sheep Selection and Genetics
CSU	Colorado State University
CT	condensed tannins
CUCSUR	Centro Universitario de la Costa Sur, Universidad de Guadalajara
CURLA	Centro Universitario Regional del Litoral Atlantico
d	day
DANIDA	Danish International Development Agency
DEM	Digital Evaluation Model
DOM	Digestible Organic Matter
DM	Dry Matter
DPG	Dual Purpose Goat
DPIRP	Drought Preparedness Intervention and Recovery Program
DSS	Decision Support System
ECF	East Coast Fever
EE	Effective Environment
EEC	European Economic Community
EEP	External Evaluation Panel
EHNRI	Ethiopian Health and Nutrition Research Institute
ELISA	Enzyme linked immunosorbent assays
EMBRAPA	Brazilian National Agency for Agricultural Research
ENNIV	Peruvian Living Standards and Measurement Survey
ENSO	El Nino and Southern Oscillation
EPG	Eggs per Gram
EPIC	Erosion Productivity Import Calculator
EU	Edgerton University

EW	Extension Worker
EWS	Early Warning System
FA	FARM Africa
FAO	Food and Agriculture Organization, United Nations
FCC	Fertility Capability Classification System
FD	Full-day
FDC-PROSAT	Fondo de Desarrollo Campesino -- Programa del Servicio y Assistencia Tecnica
FEWS	Famine Early Warning System
FIA	Fundacion Interamericana
FIRA	Fideicomisos Instituidos en Relacion con la Agricultura
FISO	Food Information System Unit
FLACSO	Facultad Latinoamericana de Ciencias Sociales
FMD	Foot and Mouth Disease
FOSS	First in Food Analysis
FUNAN	Fundacion Antisana
GAN Lab	Grazingland Animal Nutrition Laboratory
GEF	Global Environmental Facility (World Bank)
GIEWS	Global Information and Early Warning System (FAO)
GIS	Geographic Information System
GLCI	Grazing Lands Conservation Initiative
GO	Government Organization
GPS	Global Positioning Systems
GSE	Greater Serengeti Ecosystem
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
h	hour

H	St. Croix Sheep
ha	Hectare
HC	St. Croix x Sumatra Sheep
HEM	Hemicellulose
HH	Household
HPI	Heifer Project International
HSPC	Human Subject Protection Committee
HW	Health Worker
IADB	Inter-American Development Bank
IAE	International Agricultural Economics
IAP-MU	International Agriculture Programs - Missouri University
IAR	Institute for Agricultral Research
IARC	International Agricultural Research Center
IBTA	Instituto Boliviano de Technologia Agropecuaria
ICA	Instituto Colombiano Agropecuaria, Colombia
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICIPE	International Centre of Insect Physiology and Ecology
ICRAF	International Centre for Research on Agroforestry
ICRISAT	International Crops Research Institute for the Semiarid Tropics
ICRW	International Center for Research on Women
IDIAP	Agricultural Research Institute of Panama
IDRC	International Development Research Centre (Canada)
IEMUT	French Tropical Veterinary Institute
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGADD	International Governmental Authority on Drought and Development
IICA	Interamerican Institute for Cooperation in Agriculture

IIML	Integrated Information Management Laboratory
IIN	Instituto Investigacion Nutricional
ILRAD	International Laboratory for Research on Animal Diseases
ILRI	International Livestock Research Institute
IMAS	Integrated Modeling and Assessment System
IMECBIO	Instituto Manantlan de Ecologia y Conservation de la Biodeversidad
INCALAC	Industria Cajamarquina de Lacteos
INCAP	Instituto de Nutricion para Centro America y Panama
INEGI	Instituto de Estadistica, Geografia e Informatica
INIA	Instituto Nacional de Investigacion Agrarias
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarios
IP2TP	Installation for Research and Assessment of Agricultural Technology
IPB	Bogor Agricultural University
ISLP	Integrated Small Livestock Project
ISNAR	International Service for National Agricultural Research
JAINA	Comunidad de Estudios
JDA	Joint Development Associates
JESS	Jubba Environmental and Socioeconomic Studies
KARI	Kenya Agricultural Research Institute
KCB	Kenya Commercial Bank
KDPG	Kenya Dual Purpose Goat
KDRSRS	Kenya Department of Resource Surveys and Remote Sensing
KEVEVAPI	Kenya Veterinarian Vaccine Production Institute
kg	kilogram
KLDP	Kenya Livestock Development Program
KNP	Katavi National Park
KRTISB	Kazakh Research and Technological Institute of Sheep Breeding

Ksh	Kenya Shilling
KUSCCO	Kenya Union of Savings and Credit Cooperatives
KWS	Kenya Wildlife Service
KWVA	Kenya Women's Veterinary Association
KZ	Kazakstan
LAC	Latin American Countries
LAI	Leaf Area Index
LDC	Lesser Developed Country
LDRCT	Livestock Development and Rangeland Conservation Tools (GL-CRSP Project)
LEWS	Livestock Early Warning System
LGCA	Loliondo Game Area
LINDA	Livestock Information Network Development for the Americas
LPRI	Livestock Production Research Institute
LS	Livestock
LU	Livestock Units
M	Composite Population Sheep: 25% St. Croix, 25% Barbados Blackbelly, 50% Sumatran Sheep
MALDM	Ministry of Agriculture, Livestock Development and Marketing
MCF	Malignant Catarrhal Fever
MDP	Marsabit Development Project (GTZ)
ME	Management Entity
MIAC	MidAmerica International Agricultural Consortium
MOA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
MOH	Ministry of Health
MOU	Memorandum of Understanding

MRC	Mpala Research Center
MUCIA	Midwest Universities Consortium for International Agriculture
NAARI	Namulaonge Agricultural and Animal Production Research Institute
NAFTA	North American Free Trade Agreement
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NCA	Ngorongoro Conservation Area
NCRSP	Nutrition Collaborative Research Support Program
NCSU	North Carolina State University
NDF	Neutral detergent fiber
NDVI	Normalized Difference Vegetation Indices
NES	Nucleus Estate Smallholder
NFTA	Nitrogen Fixing Tree Association
NGO	Non-Governmental Organization
NIH	National Institute for Health
NIRS	Near Infrared Reflectance Spectroscopy
NIS	Newly Independent States
NOAA	National Oceanographic and Atmospheric Administration
NOVIB	Counterpart International (Uzbek NGO)
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NREL	Natural Resource Ecology Laboratory
NRN	Natural Resources Network
NSDV	Nairobi Sheep Disease Virus
NSF	National Science Foundation
NUTBAL	Nutritional Balance Analyzer
OADB	Oromia Agricultural Development Bureau

OAU	Organization of African Unity
OCPB	Oromia Cooperative Promotion Bureau
ODA	Overseas Development Administration
ODI	Overseas Development Institute
OFDA	Office of Foreign Disaster Assistance
OMD	Organic Matter Digestibility
OMI	Organic Matter Intake
OPC	Ovine pulmonary carcinoma
OPMM	Outreach Research Project at Membang Muda
OPP	Outreach Pilot Project
OPS	Outreach Project for the Sosa
ORP	Outreach Research Project
OvLV	Ovine lentivirus
PA	Participatory Appraisal
PAC	Program Advisory Committee
PAR	Photosynthetic Active Radiation
PARIMA	Pastoral Risk Management Project (GL-CRSP)
PCV	Packed Cell Volume
PEM	Protein-Energy Malnutrition
PENHA	Pastoral and Environmental Network in the Horn of Africa
PHYGROW	Plant Growth/Hydrology/Yield Simulation Models
PI	Principal Investigator
PL480	Public Law No. 480
PLAN	Planificacion Local Agropecuaria y de la Naturaleza (Spanish title for GL-CRSP project: Livestock-Natural Resource Interface Project)
PM	Problem Model
PRA	Participatory Rural Appraisals

PROMETA	Proteccion del Medio Ambiente Tarija
PRR	Proyecto de Reconstrucion Rural
PSICA	Information System and Agricultural Census Project
PVO	Public Volunteer Organization
RAINAT	Research and Assessment Installation for Agricultural Technology
REDSO	East African Region USAID
RERUMEN	Latin American Network of the Small Ruminant CRSP
RF	Range Forage
RFA	Request for Assistance
RFP	Request for Proposals
RGR	Rukwa Game Reserve
RH	Relative Air Humidity
RIAP	Research Institute for Animal Production, Bogor, Indonesia
RISPAL	Latin American Network for Animal Production Systems Research, IDRC
RMSC	Root Mean Square Corrected
RS	Remote Sensing Technologies
RS	Resident Scientist
RSG	Ranching Systems Group
RVFV	Rift Valley Fever Virus
S	Sumatra Sheep
SA	Small Animals
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SAGAR	Secretaria de Agricultural, Ganaderia y Desarrollo Rural
SALTLICK	Semi-Arid Lands Training and Livestock Improvement Centres of Kenya
SANREM	Sustainable Agriculture and Natural Research Management CRSP
SARI	Selian Agricultural Research Institute
SBPT	Balai Penelitian Ternak, Sei Putih, Indonesia (Animal Husbandry Research Institute)

SCT	Spatial Characterization Tool
SE	Socio-Economic
SEAD	Servicios de Apoyo al Desarrollo
SECOFI	Secreatria de Comercio
SEIR	Susceptible, Exposed, Infected, and Removed
SEMARNAP	Servicio Nacional del Medio Ambiente, Recursos Naturales y Pesca
SES	Socio-economic Status
SICA	Proyecto Censo Agropecuario y Sistema de Informacion
SNIM	Servicio Nacional de Informacion de Mercados
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SON	Soil Organic Nitrogen
SORDU	Southern Rangeland Development Unit
SPAN	Strengthening Partnerships with National Agricultural Systems
SR-CRSP	Small Ruminant Collaborative Research Support Program
SRNET	Pan-African Small Ruminant Research Network
SRUPNA	Small Ruminant Production Systems Network for Asia
T	Temperature
TA	Technological Alternatives
TACIS	Technical Assistance to the Commonwealth of Independent States
Tair	Air Temperature
TANAPA	Tanzania National Parks
TAMU	Texas A&M University
TCP	Technical Cooperative Program (FAO's assistance Program)
TDN	Total digestible nutrients
TE	Terraneuva
Techpac	Technology Package

TK	Turkmenistan
TNC	The Nature Conservatory
Tsoil	Soil Temperature
TT	Technology Transfer
UACh	Autonomous University of Chapingo
UCD	University of California, Davis
UCR	University of Costa Rica
UCV	Universidad Central de Venezuela, Maracay
UMC	University of Missouri-Columbia
UN	University of Nairobi
UNALM	Universidad Nacional Agraria La Molina
UNAM	Universidad Nacional Autonoma de Mexico
UNDOS	United Nations Development Office for Somalia
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNMSM	Universidad Nacional Mayor de San Marcos
URIMR	Uzbek Research Institute of Market Reform
USAID	United States Agency for International Development
USAMRID	United States Army Medical Research Inst. of Infectious Disease
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USU	Utah State University
UT	Utah
UW	University of Wisconsin
UWI	University of West Indies
VOCA	Volunteers in Overseas Cooperative Assistance
WAICENT	World Agricultural Information Center

WAN	Wide Area Network
WB	World Bank
WHO	World Health Organization
WKO	West Kazakhstan Oblast
WMO	World Meterological Organization
WSU	Washington State University
WI	Winrock International Institute for Agricultural Development
WILD	Women in Livestock Development
WINS	Women Infant Nutrition Support
Wsoil	Soil Moisture
WTO	World Trade Organization
WWF	World Wildlife Fund
ZONISIG	Proyecto Zonification Agro-ecologica y Establecimients de una Base de Datos y Red de Sistema de Informacion

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